Design Document

Team: MOBI Silver Team

Project: Beep baseball

Date: July 24th, 2019

1 Table of Contents

1 2

2 2

3 4

4 5

4.1 6
4.2 6
4.3 6
4.4 7
4.5 8

5 11

5.1 11
5.2 11
5.3 12
5.4 13
5.5 16
5.6 16
5.6.1 16
5.6.2 17

6. Current Design **7**

Appendix A: Past Semester Archive **8**

A.1 25
A.1.1 Past Team Members 8
A.1.2 Past Timeline 8

Appendix B: 25

B.1 26
B.2 27
B.3 **Conceptual Design** **11**
B.4 28
B.5 30
B.6 31

2 Revision History

Date	Author	Revisions Made
July 24th, 2019	Jack Anderson	~~Section 4.3 - Design Lead~~ ~~Section 5.2 - Design Lead, electrical subteam~~ Appendix B Section B.3 - w/ Hari fill out table + summarize electrics subteam stuff Appendix B Section B.4 - w/ Mifta fill out table + summarize electrics
July 23rd, 2019	Hannah Burnau	~~Section 3: Design Status~~ ~~Section 4.4 - Project Manager~~ ~~Section 5.3 - Project Manager~~ ~~Appendix B Section B.6~~ ~~Appendix B Section B.4 - w/ Janna summarize materials~~
	Mifta Darge	Section 6 - electrical subteam Appendix B Section B.1 (update paragraph below table) Appendix B Section B.4 - w/ Jack fill out table + summarize electrics
	Janna Jackson	Section 5.2 - materials subteam DONE Section 6 - w/ Evan for materials subteam DONE Appendix B section B.3 - summary for materials below table DONE Appendix B Section B.4 - w/ Hannah summarize materials
	Sammie Ng	Section 4.5 (make a table/chart, can be based on the one shared in the Google Drive folder) - Project Archivist Section 5.4 - Project Archivist (needs updated) Section 5.6.1 and 5.6.2 - Project Archivist
	Evan Pearson	Section 4.1 - Project Partner Liaison Section 4.2 - Project Partner Liaison

		Section 6 - w/ Janna for materials subteam Appendix B section B.5 - fill out table and summarize (questions we'll ask, how it'll help future teams, etc.)
	Harivansh Vaid	Section 5.5 - Financial Officer Appendix B section B.2 (paragraph summary, updates, tolerances, etc.) Appendix B Section B.3 - w/ Jack fill out table + summarize electrics subteam stuff

3 Design Status

Phase 6: Service / Maintenance	**Status:** *To be done Fall 2019 for high fidelity prototype* *Continuation in Fall 2019 from Summer 2019 end of semester prototype delivery with personalized delivery checklist and questionnaire to community partner* **Semester:** *name in which it was completed*

Phase 5: Delivery	**Status:** *Iteration 1 and 2 in process, low-fidelity materials prototype at minimum sent to team via mail along with questionnaire* **Semester:** *TBD, partial Summer 2019*

Phase 4: Detailed Design	**Status:** *In Process Summer 2019 / To be done Fall 2019* **Semester:** *name in which it was completed*

Phase 3: Conceptual Design	**Status:** *Completed* **Semester:** *Summer 2019*

Phase 2: Specification Development	**Status:** *In Process Summer 2019 - continue in Fall 2019 from questionnaire feedback* **Semester:** *Summer 2019*

Phase 1: Project Identification	**Status:** *In detailed process Summer 2019 - continue in Fall 2019 from questionnaire feedback* **Semester:** *Summer 2019*

***Note** : Identify which of the three (Completed/ In Process/ To be done) your project is in.

4 Project Charter

4.1 Description of the Community Partner

This section should address such questions as:

- Who is the project partner for this project?
  - The project partner is the Indy Edge beep baseball team.
- What is the overall mission of the project partner?
  - Currently the project partner is running out of beeping baseballs for their sight-impaired players as a result of breaking internal components. The overall mission is to not only improve upon the existing beeping baseballs, but to provide the team with working balls for practice.
- Who will benefit from the project?
  - The Indy Edge beep baseball team, as well as hopefully other beep baseball teams will benefit from a newly designed ball. The Indy Edge team will be the recipients of these balls once they are complete.
- Who will receive the project outcomes/deliverables?
  - The Indy Edge as well as the other baseball teams. If the product is also officially approved, then it might even be received by the Beep Baseball Association.

4.2 Stakeholders

This section should address such questions as:

- Who will be affected by your project other than your customer?
  - Our main stakeholders include:
    - Indy Edge
    - Indy Thunder
    - Other beep baseball teams
    - Friends and family of those who play on a beep baseball team
    - People with visual impairments who could become a part of the manufacturing process
    - Bosma Enterprises
- Who has a vital interest in the project's success?
  - The Indy Edge team has the most vital interest, but it also extends out to the other beep baseball teams and the association

4.3 Project Objectives

This section should address such questions as:

- Why are you doing the project (i.e. what is the motivation or need for the project?)
  - The Indy Edge beep baseball team has been running out of beeping baseballs with which they can play. While they had ordered some earlier this year, the shipment was lost. The only company that produces the beep balls is severely behind on orders for teams all over

the United States. The Silver Team is looking for a way to not only fix the balls they currently have that have stopped working, but also to improve upon the current design for the future.

- How does your project fit within the mission of the project partner and your team?
    - The mission is to provide the team(s) with durable and reliable balls to practice and play with as they currently use broken balls. The project that we are working on is to replace the parts that are easily breaking inside the ball with more durable parts. We also plan to make the ball more comfortable for the players to handle in terms of pitch and loudness so that the older players can also hear the ball clearly.

4.4 Outcomes/Deliverables

This section should address such questions as:

- What are going to be the project results?
    - A high fidelity prototype that can be used for practices at least
        - will have complete mock materials
        - materials testing was done on adhesive reinforcements
        - stitching was carefully studied and redone once the ball was opened
        - there are 2 options for the electronics - a silicon, PVC, or metal tube OR a silicone or caulking filling around the electronics (depending on finish electronics size/shape)
        - a boring method was developed for placing a tube in order to avoid stitching as an alternative option, as well
    - A goal/objective for the future team to accomplish
        - Get answers to the questionnaire we develop upon sending prototype (low-fidelity) to community partners
        - find points of failure
        - review methods for specifications, design considerations, and manufacturing plans and adapt iteration 2 from user feedback
- When the project is finished, what will be left behind by your team?
    - ~~Iteration 1: Fixing up beep baseballs that have already been used by teams, are broken/only used for practice, and returning a product to them that is usable for games~~
        - did not work

- Iteration 2: Creating a new design, because of outdated parts from the old telephone company, with a new speaker, new materials, new placement for interior components, new recharging system, etc.
    - low-fidelity to be complete by design review/mock review
- Iteration 3: Something that can last an entire season, if iteration 2 cannot. Something that is waterproof, low pitch, and more easily manufacturable
    - Fall 2019
- Documentation: Problem Identification, Specifications, Preliminary Failure Analysis + scale, Manufacturing instructions, Testing instructions, Conceptual Design, Budget, Design Documents, Transition Documents, Semester Timeline + future work, Ordering materials information, Testing materials/equipment resources
    - Summer 2019 - start on all documents, see SharePoint
    - testing is our own made up tests for stretching/drop testing the adhesives to reseal the leather from boring out holes
    - manufacturing with Bosma - considering blind/visually impaired people, availability of parts to avoid current problem with beeper ball, etc.
- Testing/manufacturing: Completion of some testing (likely with team), completion of some materials analysis such as force testing, preliminary FEA testing, and early suggestions for Bosma Enterprises
    - FEA testing in simulation with 3d modeled capsule as potential possibility
    - Is it hitable? How do we measure that? Are the adhesives strong? How do we measure that?
- Future work: Iteration 3, future suggestions for the Fall 2019 team

4.5 Expected Semester Timeline

Week	Day	Tasks/Goals
1	1	Selecting a project Learning the EPICS process Learning the design process Meeting new team Teaming activity Assigning team roles Research problems that current design has

	2	Preparing PIGs for the team - individual and whole team Initial teaming Establishing team meeting times outside of labs Beginning ideation Discussion of team roles Reviewing regulations of the game of beep baseball Reviewing past team documentation and design ideas Problem Identification Brainstorm possible solutions
2	1	Establishing subteams - materials and electrical Team Code of Conduct Documenting brainstorming, individual accomplishments, reflections Beginning new budget Starting to order materials Selecting a type of speaker for new design Developing criterion for materials selection Identifying possible points of failure in softballs Contacting community partners - phone call Figuring out how restitch a softball and what materials to order for that Learning how to establish SMART goals
	2	Finish ordering materials Assigning individual things to research for next meeting Early breadboard prototyping Kapok vs foam analysis Manipulating silicone tubing - cutting materials Removing kapok from cotton string layer, measuring materials, attempting to assemble materials Rough prototype of initial design Capsule housing for the electrical components
3	1	Combining speakers and breadboard Voltage calculation Waveform generators for decibel analysis Developing battery specifications Decisions about parameters of beeping - frequency, pitch, etc. Drafting a low-fidelity capsule/tubing “alien” prototype Start of CAD model for screw cap battery capsule Needed new sewing needles Tried using curved sewing needle - made progress on learning to sew Beginning to organize design review materials Thorough explanation of dFMEA analysis using example
	2	Figuring out a time for mock review Setting up new visit with community partners Awareness of mid semester expectations and assignments

		Getting someone certified on driving a Purdue van Renting a Purdue van Driving to Indy and back Meeting Steve and team and hearing feedback on prototype Putting together a full low-fidelity prototype Sewing up the softball Drilling holes into the softball Making a new foam “bread bowl” protective layer instead of plastic capsules Determination of ease of new conceptual design vs old and selection of new Large vs small speaker analysis Full conceptual design Coin cell batteries instead of 9V Design Review structure and organizational pattern (design process)
4	1	Mock review session for Design Review Presentation of Design Review Feedback discussion New SMART goals for semester Re-evaluation of semester timeline Careful consideration of new specifications Starting new iteration by manipulation of old practice softballs acquired from team on visit that past weekend
	2	N/A Discussion via text of assignments due at mid semester Completion of Design Document as team
5		Further discussion of Design Review feedback New PIGs based on new SMART goals based on feedback from review as well as community partner visit Iteration 1 and trying out old softball parts with new speakers PCB modeling Waterproofing - coating/spray and research Light vs heavy ball and distance covered - physics How to keep kapok away from electronics Using foam or kapok to absorb shock from hitting Figure out battery housing COMPLETION of iteration 1
6	1	Working more on iteration 2 Low-fidelity prototype of battery components Figure out reinforcement of leather layer to kapok layer Determination of FEA testing Move toward Detailed Design Phase
	2	Figure out voltage to produce correct frequency Determine components used to prevent overheating

		Possible manufacturing of more than one prototype Move toward Deliverable Phase
7	1	Determining possible issue for electrical component overheating in PVC pipe and kapok Testing of reinforcement for leather and kapok layer PCB assembling Determine battery choice for the circuit
	2	Preparing for final Design Review Community partner visit/possible delivery
8	1	Mock Design Review Presenting Final Design Review Reviewing feedback and discussion
	2	N/A because after July 31st Transition Document completion Interpretation of Design Reviewer feedback Suggestions for future team Final IER, Peer Evaluation, Design Doc, uploading to SharePoint, etc. Final Reflections

5 Semester Documentation (current semester)

5.1 Team Member

Jack Anderson - *Design Lead,* electrical subteam

Hannah Burnau - *Project Manager*, materials subteam

Mifta Darge - *Webmaster*, electrical subteam

Janna Jackson - *Team member*, materials subteam

Sammie Ng - *Project Archivist*, materials subteam

Evan Pearson - *Project Partner Liaison*, materials subteam

Hari Vaid - *Financial Officer*, electrical subteam

5.2 Current Status and Location on Overall Project Timeline

The current prototype has two 555 timer circuits that produce a tone at approximately 1350 Hz at a rate of 4 Hz. There are plans to make a custom printed circuit board for the circuit, but it currently exists on both a protoboard and a pre-fabricated 555 timer circuit board we purchased.

There are currently multiple working prototypes for how to encase the electrics inside of the ball. One option is a hole underneath the leather casing. The electric components would then be covered in a silicon

gel to make them waterproof, placed inside of the ball, and the ball would be resewn. The second working prototype is a tube that runs through the center of the ball. The electric components would be encased at the very center of the tube, allowing sound to radiate to either end of the ball. One end of this tube would be accessible from the outside of the ball, creating a way for the user to remove the entire tube and change the batteries if needed. Further testing will need to be done to decide which prototype provides better protection for the internal components.

5.3 Goals for the Semester

GOALS OF INDY EDGE

Most Important

- durability
    - making sure we have an interior capsule that can take more of the force without breaking
    - making sure we can distribute the force of a hit evenly no matter where the hit occurs on the surface of the ball
    - any way in which we put the electronic interior components into the ball must be resealable AND must maintain the original tension of the kapok so as not to change the softness of the exterior or interior at a certain point along the circumference of the ball
    - the stitching, if we take apart seams, must be restitched and tied off in such a way that it does not then fall apart
    - the electronics cannot catch fire with kapok, should try to be waterproof with whatever coating we put, and should not break upon hits
- availability
    - trying to source parts responsibility such that Bosma would also be able to get them for years to come
    - trying to get cheap parts that are still durable, but are not going to exceed the previous price of $30, although we could increase the price if the beep softballs last longer
    - making sure that it is easily reproducibility in a short amount of time

Other Wishes

- lower pitch ball - working on tolerance for that value
- louder sound - through materials, which could not be tested because of limitations in electrics being incomplete
- waterproof - some type of coating/spray
- endeavor with Bosma and potential employment

GOALS OF ADVISING TEAM

Most Important

- materials testing - trying new caps, trying new adhesive reinforcements for the leather
- force analysis - free body diagram type of analysis
- high-fidelity prototype - Fall 2019
- clear direction for future team - questionnaire + sending low-fidelity prototype
- something valuable for community partner - durable thing to practice

Other Wishes

- failure analysis with scales, completely done
- FEA testing
- product for iteration 1
- product for iteration 2
- clear ideation on iteration 3
- Bosma Enterprises connection

5.4 Semester Timeline

Week	Day	Tasks/Goals
1	1	Selecting a project Learning the EPICS process Learning the design process Meeting new team Teaming activity Assigning team roles Beginning ideation and prioritizing of tasks
	2	Preparing PIGs for the team - individual and whole team Initial teaming Establishing team meeting times outside of labs Beginning ideation Discussion of what to do this Summer Reviewing regulations of the game of beep baseball Reviewing past team documentation and design ideas Pinpointing concerns with previous designs Problem Identification
2	1	Establishing subteams - materials and electrical Finding new subteam meeting times Team Code of Conduct Documenting brainstorming, individual accomplishments, reflections Beginning new budget Starting to order materials Selecting a type of speaker for new design Developing criterion for materials selection Identifying points of failure in softballs Contacting community partners - phone call/video chat

		Figuring out how restitch a softball and what materials to order for that Learning how to establish SMART goals
	2	Finish ordering materials Assigning individual things to research for next meeting Beginning to establish a gantt chart Early breadboard prototyping Kapok vs foam analysis Manipulating silicone tubing - cutting materials Removing kapok from cotton string layer, measuring materials, attempting to assemble materials Ideation on recharging system - batteries idea Placement of batteries, capsule, tubing, etc ideation Initial conceptual design Screw cap idea and ideation on execution
3	1	Combining speakers and breadboard Voltage calculation Waveform generators for decibel analysis Developing battery specifications Decisions about parameters of beeping - frequency, pitch, etc. Start of failure analysis Drafting a low-fidelity capsule/tubing “alien” prototype Start of CAD model for screw cap battery capsule Needed new sewing needles Tried using curved sewing needle - made progress on learning to sew Beginning to organize design review materials Thorough explanation of dFMEA analysis using example
	2	Figuring out a time for mock review Setting up new visit with community partners Awareness of mid semester expectations and assignments Getting someone certified on driving a Purdue van Renting a Purdue van Driving to Indy and back Meeting Steve and team and hearing feedback on prototype Putting together a full low-fidelity prototype Sewing up the softball Drilling holes into the softball Making a new foam “bread bowl” protective layer instead of plastic capsules Determination of ease of new conceptual design vs old and selection of new Large vs small speaker analysis Full conceptual design Coin cell batteries instead of 9V Design Review structure and organizational pattern (design process)

4	1	Mock review session for Design Review Presentation of Design Review Feedback discussion New SMART goals for semester Re-evaluation of semester timeline Careful consideration of new specifications Starting new iteration by manipulation of old practice softballs acquired from team on visit that past weekend
	2	N/A Discussion via text of assignments due at mid semester Completion of Design Document as team
5		Further discussion of Design Review feedback New PIGs based on new SMART goals based on feedback from review as well as community partner visit Iteration 1 and trying out old softball parts with new speakers PCB modeling Waterproofing - coating/spray and research Light vs heavy ball and distance covered - physics How to keep kapok away from electronics Using foam or kapok to absorb shock from hitting Figure out battery housing COMPLETION of iteration 1
6	1	Working more on iteration 2 Low-fidelity prototype of battery components Figure out reinforcement of leather layer to kapok layer Determination of FEA testing Move toward Detailed Design Phase
	2	Visiting community partner for feedback on rough prototype Make modifications based on feedback received Move toward Deliverable Phase
7	1	Finalizing prototype Delivery and manufacture instructions
	2	Preparing for final Design Review Community partner visit/possible delivery
8	1	Mock Design Review Presenting Final Design Review Reviewing feedback and discussion
	2	N/A because after July 31st Transition Document completion Interpretation of Design Reviewer feedback Suggestions for future team Final IER, Peer Evaluation, Design Doc, uploading to SharePoint, etc.

		Final Reflections

5.5 Semester Budget

TEAM BUDGET FORM

Team Name: Silver Team (MOBI Summer 2019)

Did you apply for a grant? (Circle)	Yes	No
Select if this form is being filed for the academic year or the semester. (Circle)	2019	Summer

Project 1: Beeper Ball

	Items required for project	Estimated Cost
1.1	Softballs	80
1.2	Yarn and needles	10
1.3	Speakers	30
1.4	Capsules	10
1.5	Electronic Components	40
1.6	Batteries	20
1.7	Tubes	10
1.8	Miscellaneous	100
1.9		
1.10		
	TOTAL	$300.00

5.6 Transition Report

5.6.1 Summary of Semester Progress / Comparison of Actual Semester Timeline to Proposed Semester Timeline

The team had a great timeline and idea of approaching at the very beginning. While everyone did research and contributed some ideas to tackle the materials and electrical component issues, the team was not able to decide on a feasible, manufacturable beeping ball. Electrical sub-team had issue with the circuit and was not able to figure out and the materials sub-team was not able to have a set approach due to the battery housing issue. Fortunately, towards the end of the semester, both teams were able to overcome the issues faced and able to make a rough prototype. Documentations on obstacles and possible solutions were made for future teams to work on based on it.

Comparing our actual semester timeline to the proposed timeline, I would say our team did a pretty good job. Despite having trouble to deliver a working prototype, we were able to identify the problem and thought of possible solutions which would be able to solve the problem the old ball has. Unfortunately, trying to improve the electric circuit within such a short period with only few people with experience was hard. Though based on our progress, we made a significant improvement from the old ball. Unforeseen circumstances hindered our progress and we tried our best to solve them within the short period of time.

5.6.2 Draft Timeline for (next semester) and Relationship to Overall Project Timeline

For next semester group that would work on this project, the group's notebook has documented what we have achieved and what should be improved on our continued to work on to have a working prototype. A draft timeline for next semester team would be somewhat similar to an example below:

Week	Tasks/ Goals
1	- Continue to find solutions for circuit overheating - Improving the circuit making it more efficient
2	- Decide on battery used and rechargeability - Figure out proper battery housing and placement - Possibly insulating the electrical components with some sort of insulator to prevent overheating issue
3	- Start prototyping
4	- Community partner visit and feedback
5	- Feedback review and possible modifications
6	- Brainstorm possible issue might face when played (weather, impact absorbtion etc)
7	- Prototype based on feedback and community partner visit
8	- Review from professionals
9	- Manufacturing and delivery instructions to Bosma Industries
10	- Completion of prototype for design review
11	- Done!

6. Current Design

What our team has been done:

- Read previous documentation (Spring 2019 & Summer 2019)
- Research to know more what is the present status of beep baseball, and its electrical & mechanical components
- Visited the actual site of beep baseball (9/29/19)
- Finished setting up the overall goal for the beep baseball design process
- Finished finalizing the budget

What our team is currently working on:

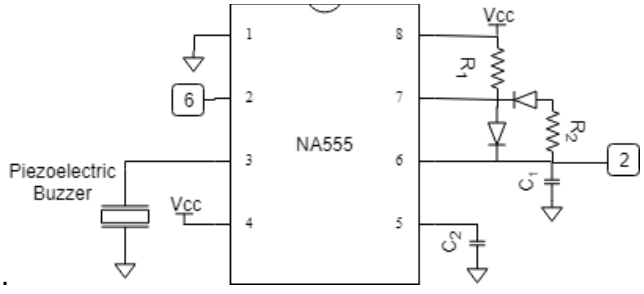
- The development of idea for how de-gutting process will work for beep baseball
- The development of idea for how electrical and sound system will work for beep baseball

What our team hopes to achieve by the end of fall of 2019 semester

- We are hoping to create a prototype of de-gutting version of beep baseball as well as the ball with electrical and sound system.
- We are hoping to, then, make a decision for creating final design of beep baseball with updated electrical system, updated sound system, and de-gutting components.

The Beeper Ball currently has a soldered proto-board circuit inside of it. The first NA555 Timer in the circuit below creates a 4Hz 70% duty cycle square wave. This signal determines how often the ball will beep, and is sent to the reset pin of the second 555 timer. This timer creates a 1350Hz signal at the interval dictated by the first timer.

Earlier Prototype without second timer:



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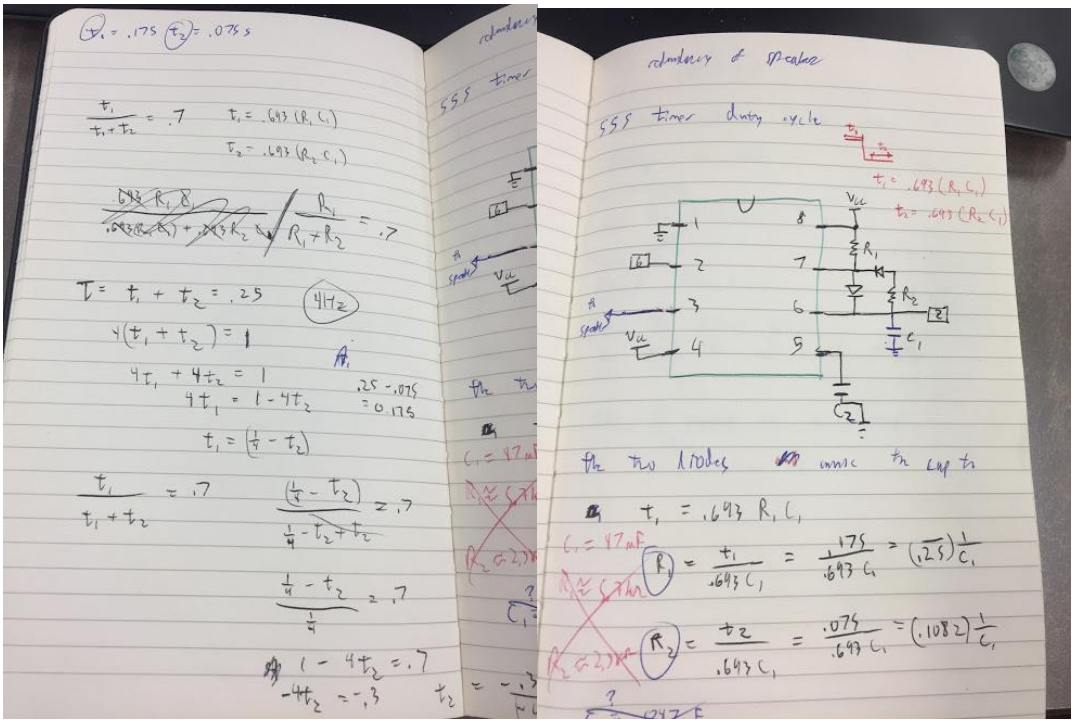
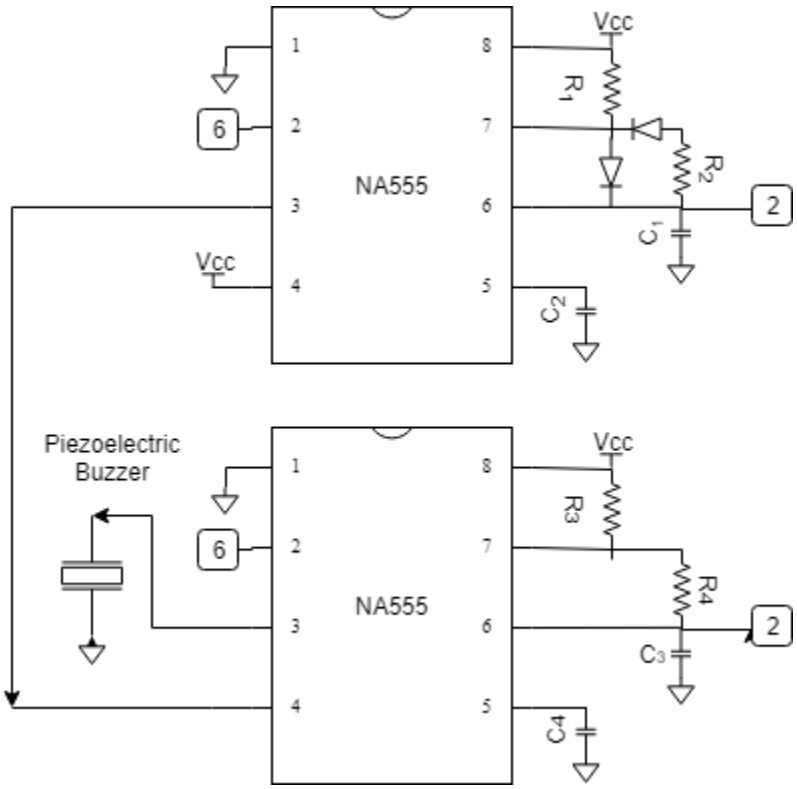

555 timer duty cycle
$t_1 = .693(R_1 C_1)$
$t_2 = .693(R_2 C_1)$
$T = t_1 + t_2 = .25$
4Hz
$t_1 = .693 R_1 C_1$
$C_1 = 47\mu F$
$R_1 = \frac{t_1}{.693 C_1} = \frac{.175}{.693 C_1} = (.25)\frac{1}{C_1}$
$R_2 = \frac{t_2}{.693 C_1} = \frac{.075}{.693 C_1} = (.1082)\frac{1}{C_1}$

Current Design:



R1 = 5300 Ohms, R2 = 2300 Ohms, R3 = 160 Ohms, R4 = 34 Ohms

C1 = C2 = 47uF, C3 = C4 = 4.7uF

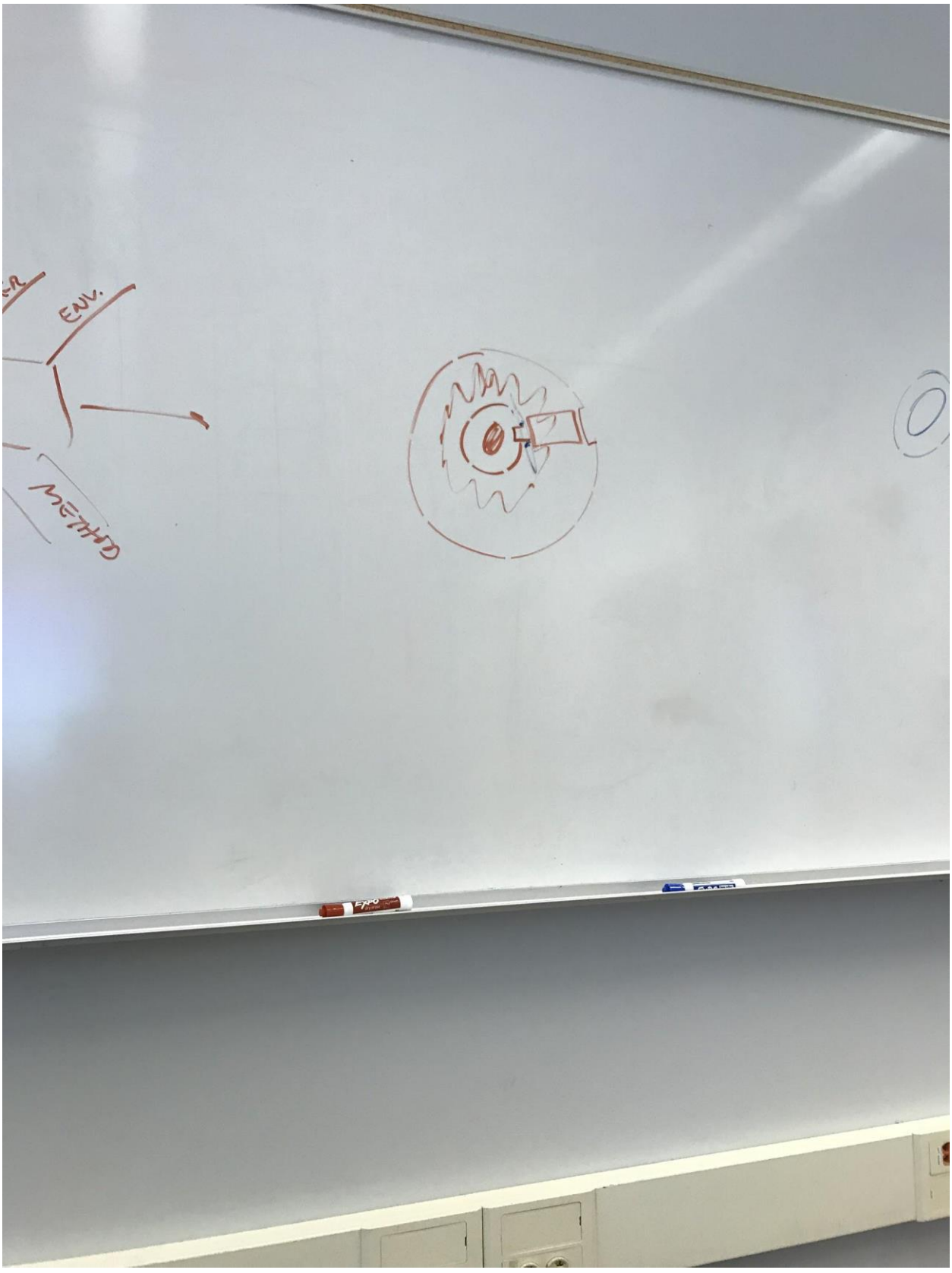
There are currently two prototypes for how to encase the electrics inside of the ball. One current prototype consists of a hole underneath the leather casing. The electric components would then be covered in a silicon gel to make them waterproof, placed inside of the ball, and the ball would be resewn. This prototype is yet to be finished. The design for this prototype was made to account for a larger protoboard and speaker inside of the ball. The piping used for the following prototype would, in theory, not be large enough to contain the components needed, and therefore was a solution if larger electric components were needed to create the sound needed.

The second working prototype is a tube that runs through the center of the ball. The electric components would be placed at the center of the tube, allowing sound to radiate to either end of the ball. One end of this tube would be accessible from the outside of the ball, creating a way for the user to remove the entire tube and replace if needed.

Tube for the electrics

Electrics tube inside of the ball- the pipe is now cut flush with a screw cap on the end.

Further testing is needed to determine which of these prototypes is the recommendation for the final design.


ENV.
METHOD

Rough prototype of battery/electronic housing inside ball.

Appendix A: Past Semester Archive

A.1 Past Semester Spring 2019

The previous design involved a hard ABS plastic shell - possibly for waterproofing and durability. The problem is that impact due to hitting a ball with a bat will crack/crush the ABS plastic. That is where the team needs to conduct a force analysis this semester and figure out what solutions are really best. Of course, implementing complex solutions like that aren't feasible for Bosma. It's also too expensive for teams. Unless, of course the cost/benefit can be determined. Such as, teams buy a really expensive ball that lasts a lot longer. We want to give them something that lasts a long time and is really cheap. The team also never ever implemented a low pitch solution, which was expressed by the community partner. The team used an expensive, complex, and large microcontroller instead of a PCB with 555 timers.

A.1.1 Past Team Members

Refer to Spring 2019 Design Document. Every member is new.

A.1.2 Past Timeline

Refer to Spring 2019 Design Document. Every member is new.

***Note:** Keep adding the information after every semester.

Appendix B: Overall Project Design

B.1 Project Identification

Phase 1: Project Identification	Status:	Evidence can be found:
Goal is to identify a specific, compelling need to be addressed		
● Conduct needs assessment (if need not already defined)	Accomplished	Notebook Week 2
● Identify stakeholders (customer, users, person maintaining project, etc.)	Accomplished	Notebook Week 2
● Understand the Social Context	Accomplished	Notebook Week 2
● Define basic stakeholder requirements (objectives or goals of projects and constraints)	Accomplished	Notebook Week 2
● Determine time constraints of the project	Neutral	Notebook Week 4

Summary of Project Identification phase of design

Our project identification phase was accelerated due to this being a summer session. The first two weeks was getting informed with our project partner Indy Edge and what beeping baseball was about. We scheduled a phone call and our initial idea was to move forward with any prototype ideas we could come up with, given the perimeters they defined. The biggest issue was with the electrical components inside the ball. It costs around $35 a ball and breaks within 2 innings of a 6 inning game. We plan on creating a version 1.0 before the end of the semester. This project can be more defined and hopefully will continue on until Indy Edge has a finished project.

B.2 Specification Development

Phase 2: Specification Development	Status:	Evidence can be found:
Goal is to understand "what" is needed by understanding the context, stakeholders, requirements of the project, and why current solutions don't meet need, and to develop measurable criteria in which design concepts can be evaluated.		
● Understand and describe context (current situation and environment)	Accomplished	Prototype improved the electrical component.
● Create stakeholder profiles	Accomplished	In semester documentation.
● Create mock-ups and simple prototypes: quick, low-cost, multiple cycles incorporating feedback	Accomplished	Rough prototype made.
● Develop a task analysis and define how users will interact with project (user scenarios)	Neutral	Developed a FMEA
● Identify other solutions to similar needs and identify benchmark products (prior art)	Accomplished	Referred to previous project from other colleges.
● Define customer requirements in more detail; get project partner approval	Neutral	
● Develop specifications document	Accomplished	In semester documentation.
● Establish evaluation criteria	Accomplished	

Summary of Specification Development phase of design….

Specification development was an expedited process as there was a lack of time due to this being a summer session. We divided the specifications into a couple of parts: Absolutely required for the ball [Beep, Size, Frequency, etc.], done in the previous version but can be changed [Charging, Duration, Cost, etc.], and preferred by the team [Pitch, Loudness, etc.]. The specifications were developed with the official rules of Beep Baseball Association along with the feedback acquired from the Indy Edge Team [previous semester documentation was also taken into account while specification were developed]. The list of specification prepared were followed when brainstorming and creating prototypes.

B.3 Conceptual Design

Phase 3: Conceptual Design	Status:	Evidence can be found:
Goal is to expand the design space to include as many solutions as possible. Evaluate different approaches and selecting "best" one to move forward. Exploring "how".		
● Complete functional decomposition	Complete	In semester documentation
● Brainstorm several possible solutions	In progress	Notebook Summer - Week 4-6
● Prior Artifacts Research	Complete	Notebook Summer - Week 2-5
● Create prototypes of multiple concepts, get feedback from users, refine specifications	In Progress	Notebook - Week 6
● Evaluate feasibility of potential solutions (proof-of-concept prototypes)	In Progress	
● Choose "best" solution	In Progress	

Summary of Conceptual Design phase of design….

The conceptual design for the electrical subteam consists of 2, 555 timers connected in such a way that one produces the frequency of the beep at 4Hz and the other produces the pitch of the beep at 1350Hz. This circuit is then connected connected up to multiple piezo-electric buzzers which would produce the required beeping sound at the volume of 90db at 10 cm. The circuit and the buzzers were intended to be powered by at 15V charged drawn from 5 3V coin cells pieced together. The 555 timer set to a frequency of 1350Hz worked at the default 50% duty cycle whereas the one set to a frequency of 4Hz worked at a 70% duty cycle manual setup using comparable diodes and resistors as it was perceived to increase the volume of the beep made.

The overall conceptual design for the materials subteam is some form of a core in which the electrics will be housed. One of these options is a removable piece of pipe containing the electric components which runs through the diameter of the ball. The other is a core containing the electric components which is then covered in silicon, placed under the leather casing of the ball, and the ball is resewn.. In either case, the sound will radiate through the ball so it may be heard regardless of the orientation of the ball on the ground while in play.

B.4 Detailed design

Phase 4: Detailed Design	**Status:**	**Evidence can be found:**
Goal is to design a working prototype which meets functional specifications.		
● Bottom-Up Development of component designs	*In progress Summer 2019* - materials subteam *In progress Summer 2019* - electrics subteam	**Final Design Review Presentation,** prototypes in the locker, OneNote notebooks, Design Doc, Transition Doc
● Develop Design Specification for components	*In progress Summer 2019* - materials subteam, *To be complete Fall 2019* *In progress Summer 2019* - electrics subteam	**Specifications** document in **SharePoint** Individual OneNote notebooks Regulations of game
● Design/analysis/evaluation of project, sub-modules and/or components (freeze interfaces)	*In progress Summer 2019* - materials subteam, *To be complete Fall 2019* *In progress Summer 2019* - electrics subteam	**Prototypes** in lab as well as information in **Transition Document** for how to approach problems or what considerations were used by Summer 2019 team
● Design for Failure Mode Analysis (DFMEA)	*In progress Summer 2019* - materials subteam, *To be complete Fall 2019* *Fall 2019* - electrics subteam	**Failure Analysis** in **SharePoint** for materials subteam from Summer 2019
● Prototyping of project, sub-modules and/or components	*In progress Summer 2019* - materials subteam,	**See locker**

	To be complete Fall 2019 *In progress, mostly complete Summer 2019* - electrics subteam	
● Field test prototype/usability testing	*To be complete Fall 2019* - materials subteam ?? - electrics subteam	Initial drop testing/specifications/stretch testing by materials subteam Summer 2019, evidence in OneNote under "lab days" ?

Summary of Detailed Design phase of design….

The detailed design phase for the materials subteam involved reinforcements of the leather with holes bored for the speakers, with an alternative solution of silicon gel filling if not. The holes for the speaker were planned to be cut with metal straws; an adaptation of the way the hole for the pipe was created with a sharpened pipe. This design included consideration of minor details like flammability of kapok, or waterproof coating spray ideas (OneNote - Hannah). There was plenty of documentation and specifications were updated along with careful note of which adhesives were attempted - Sammie. The team also had to figure out manufacturing of the boring and the stitching of the seams - Evan. Even after the team examined the broken balls, it was difficult to determine what the actual point of failure was. The materials subteam decided that any way in which we could attempt to ensure that the internal components did not break or stop working was essential for the detailed design.

On the electrical side of things we approached the detailed design phase by adding a second 555 timer to change the tone of the beep. We decided the diodes used to adjust the duty cycle of the signal were only necessary on the 4hz timer. The second timer adjusted the frequency of the tone to 1350hz. We investigated using a 9v battery instead of the current 5 coin cell batteries powering the prototype.

B.5 Delivery

Phase 5: Delivery	**Status:**	**Evidence can be found:**
Goal is to refine detailed design so as to produce a product that is ready to be delivered! In addition, the goal is to develop user manuals and training materials.		
● Complete deliverable version of project including Bill of Materials	*In progress*	

	Fall 19' eta	
● Complete usability and reliability testing	Fall 19'	
● Complete user manuals/training material	Fall 19'-Spring 20'	
● Complete delivery review	Spring 20'	
● Project Partner, Advisor, and EPICS Admin Approval	Spring 20'	

Summary of Delivery phase of design….

B.6 Service / Maintenance

Phase 6: Service / Maintenance	Status:	Evidence can be found:
● Evaluate performance of fielded project	*Incomplete, but In Progress*	**SharePoint** under what will be "Questionnaire for Community Partner following Summer 2019" or something to that effect
● Determine what resources are necessary to support and maintain the project	*Questionnaire, low-fidelity prototype, community partner feedback, analysis of durability, fitting of electronics, audibility of electronics through materials*	Evidence in Design Document, Transition Document, individual subteam accomplishments in the notebook, and to be determined by Fall 2019 team

Summary of Service/Maintenance phase of design….

Service/maintenance will be most effective if our low-fidelity prototype can in fact be complete by Design Review. If the materials are all durable and do not fall apart or fail. If all the new adjustments we make are going to be approved by the regulations committees at a national level. If the electronics can be heard, at a lower pitch/frequency, by the team. If they can not only field the ball but also hit the ball. If none of these necessities can be fulfilled by the low-fidelity prototype, or simply not all of them, then it will be up to the Fall 2019 team to look at those questions posed to the community partner, our design suggestions and ideation, and make determinations about how to make a higher fidelity prototype that will meet all the requirements.