Design Document

Team: GLASS

Project: RHIW

Date: July 31st, 2019

1 Table of Contents

1 Table of Contents 2
2 Revision History 3
3 Design Status 4
4 Project Charter 5
4.1 Description of the Community Partner 5
4.2 Stakeholders 5
4.3 Project Objectives 6
4.4 Outcomes/Deliverables 6
4.5 Expected Semester Timeline 7
5 Semester Documentation (current semester) 8
5.1 Team Members 8
5.2 Current Status and Location on Overall Project Timeline 8
5.3 Goals for the Semester 9
5.4 Semester Timeline 10
5.5 Semester Budget 11
5.6 Transition Report 13
5.6.1 Summary of Semester Progress / Comparison of Actual Semester Timeline to Proposed Semester Timeline 13
5.6.2 Draft Timeline for (next semester) and Relationship to Overall Project Timeline 14
6. Current Design 15
Appendix A: Past Semester Archive 26
A.1 Summer 2019 26
A.1.1 Past Team Members 26
A.1.2 Past Timeline 26
Appendix B: Overall Project Design 28
B.1 Project Identification 28
B.2 29
Summary of Specification Development Phase ..... Error! Bookmark not defined.
B.3 Conceptual Design 30
B.4 Detailed design 31
B.5 Delivery 32
B.6 Service / Maintenance 33

2 Revision History

Date	Author	Revisions Made
7/24/19	Ali Alkahtani	Updated Section 6
7/24/19	Cameron Keiper	Completed work for draft, in-depth editing, completion of Section 6 and Appendices
7/24/19	Elise Tessero	Updated Sections 4.4, 5.6, 6. Updated 5.5 formatting.
7/23/19	Elizabeth Manes	Updated Section 6 and added to the Appendices
7/21/19	Maggie Pogue	Updates to section 5.5 and 6
7/6/19	Cameron Keiper	Made edits for clarity, added links, and finished Appendices
7/5/19	Talah Tayeb	Updated section 6 and section 5.2
7/5/19	Ali Alkahtani	Initial document completion
7/4/19	Cameron Keiper	Initial document completion
7/4/19	Maggie Pogue	Initial completion of Sections 5.4 to 5.6 and Appendix A.1.2.
7/3/19	Elise Tessero	Initial completion of Sections 4.1 to 4.4.
7/3/19	Elizabeth Manes	Initial document completion

3 Design Status

Phase 6: Service / Maintenance	**Status:** *To be done* **Semester:** *N/A*
Phase 5: Delivery	**Status:** *To be done* **Semester:** *N/A*
Phase 4: Detailed Design	**Status:** *To be done* **Semester:** *N/A*
Phase 3: Conceptual Design	**Status:** *In Progress* **Semester:** *Summer 2019*
Phase 2: Specification Development	**Status:** *Completed* **Semester:** *Summer 2019*
Phase 1: Project Identification	**Status:** *Completed* **Semester:** *Summer 2019*

4 Project Charter

4.1 Description of the Community Partner

Our Community Partner is the Riley Children's Hospital in Indianapolis, Indiana. The hospital is among the top children's hospitals in the country with 9 individually ranked pediatric specialties. Riley Hospital for Children remains the only nationally ranked children's hospital in Indiana. Our specific partner within the hospital is the Division of Pediatric Physical Medicine and Rehabilitation. This specific division's mission is to maximize the health, physical function, and mental well-being of its patients. This project will benefit patients by creating a uniquely interactive experience focused around enjoyment and motivation throughout the therapy process. It will also benefit the floor physicians and medical team providing for these children. It offers a new pathway to excite the children and bring joy during therapy.

Our administrative contact for the hospital is Taylor Cole. She is the administrative assistant in the Division of Pediatric Physical Medicine and Rehabilitation. Communication is through both phone and email. She is our contact for the project.

4.2 Stakeholders

This project has multiple stakeholders, both within the hospital and the community. The hospital will benefit by having an additional resource to provide care for patients. The patients, their families, and the community, all benefit by being the recipients, either directly or indirectly, of that increased care. The physicians and medical staff all have a vital stake in the project's success. Each have provided input, communicated through Taylor, for their wishes concerning the design of this project. Upon completion of this project, we will be providing a multisensory experience for children of ranging abilities, including the deaf and blind.

The patients will also benefit from this project. The goal of the unit is also to provide medical treatment and therapy to children while not severely impacting the patient's development and experience. Children learn through sensory input such as touch, sight, taste, sound, etc. The goal of this project is to provide that vitally important experience of exploration and discovery to recovering patients in an environment that otherwise lacks those opportunities. Stemming from that, the parents are also stakeholders in their child's happiness and health, one of which can be improved by the completion of this project.

The last stakeholder for this project is the community. As improvements are made to the Pediatric Physical Medicine and Rehabilitation Division, more patients will travel further to receive this high-quality care. This benefits local hotels, restaurants, and businesses in general by increasing revenue opportunities. The businesses surrounding the hospital have vital interest in the hospitals success as this is a large market in which they receive their customers.

4.3 Project Objectives

The main objective for this project is to provide an interactive, accessible, multi-sensory environment with the express purpose of interactivity in the physical therapy process. The hospital contains multiple walls which are decorated in a manner akin to an external environment. These walls are already decorated, but lack the interactivity desired by the staff. The goal of this project is to meet the needs, desires, and wishes of the staff in order to provide the best possible experience for these children on their road to recovery.

4.4 Outcomes/Deliverables

There are two main deliverables:

1. An Interactive Butterfly Stand:
    a. This will be installed next to the butterfly wall. The stand will support jars with fake butterflies in them. When a child taps the top of the jar, the butterfly inside moves through the exaction of a DC motor. The intensity of the butterfly movement depends on the frequency and force applied by the user to the jar lid.
2. Interactive 100ft Therapy Course:
    a. This will consist of creating a vinyl start line, reminiscent of the Indy 500's start line. There will be both tactile, auditory, and visual feedback for the children undergoing therapy throughout the course. Sensors attached to speakers will be positioned throughout the hallway in order to provide encouragement to the children as well as other continuously cycling lights. The goal is to make the course emulate the Indy 500 and therefore be more involved for the children.

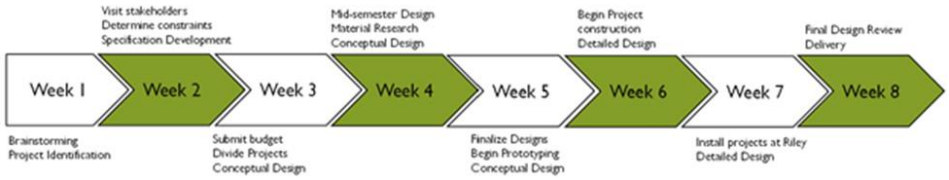
After speaking with the project partner, there are two continuing deliverables for ongoing teams.

1. The Interactive Finish Line:
    a. Due to construction at the end of the hallway, we are unable to get the go ahead to finish our interactive course at the finish line. Once construction is completed or closer to completion, the floor will know more about the intentions of that portion of the hall. With that, another team will be able to finish that fabrication and installation.
2. LED Lap/Name Display:
    a. The project partner has also iterated on multiple occasions that they would like an LED lap wall in which children's furthest "lap" (distance) can be recorded. That way they can see their name and how their fellow friends/patients are doing on the floor. That way they can interact and motivate each other.

4.5 Expected Semester Timeline

What is the timeline for completion of the project?

- Week 1: Brainstorm ideas and prepare questions to ask during the project partner visit.
- Week 2: Visit project partner in Riley Children's Hospital in Indianapolis to ask our prepared questions, determine our constraints, and get feedback on our initial ideas.
- Week 3: Decide what projects to work on, divide team into sub-teams to complete projects, decide and submit projects budget.
- Week 4: Material research in order to finalize conceptual design, contact project partner for approval of material, and Mid-Semester Design Review.
- Week 5: Finalize design based on project partner approval, order missing materials, and begin creating prototypes.
- Week 6: Begin project construction and test them.
- Week 7: Complete project construction, complete blueprint for following team including ideas that we are unable to deliver due to construction occurring in the Riley Children's Hospital.
- Week 8: Deliver and install projects in Riley Children's Hospital, and Final Design Review.



What are the major milestones?

- Meeting project partner and determining project constraints.
- Determining projects that will be implemented and dividing them between sub-teams.
- Finalizing design for projects.
- Completing project construction.
- Delivering project to Riley Children's Hospital.

When is the project intended to be completed?

07/30/19

5 Semester Documentation (current semester)

5.1 Team Members

- Talah Tayeb, Geology and Geophysics, Project Manager.
- Cameron Keiper, Electrical Engineering, Design Lead.
- Elise Tessero, Environmental and Ecological Engineering, Project Partner Liaison.
- Margaret Pogue, Electrical Engineering, Financial Officer.
- Ali Alkahtani, Mechanical Engineering, Team Member.
- Elizabeth Manes, Biomedical Engineering, Project Archivist.

5.2 Current Status and Location on Overall Project Timeline

Butterfly Stand Status:

Currently, we have built three Butterfly Stand prototypes, and changed the jars containing the butterflies from glass to plastic. The prototypes were built with the materials available in the EPICS design lab, as the project partner has not responded on our inquiry regarding the approval of materials based on the fire rating of the hospital. We have contacted the project partner to arrange the delivery of one prototype to receive user input on the different heights and are waiting for a response. The timeline will need to be changed due to the unresponsiveness of the project partner, as no project is scheduled to be delivered to them by week 8, as is stated in the current timeline.

Interactive Cheer System Status:

The Interactive Cheer System is currently still in the conceptual design phase. Prototyping is undergoing. The individual systems such as the traffic light and the sensor-audio system have all been completed. There is still some trouble getting the PIR sensor to work with the NPN transistor to output a digital low. The stoplight is fully functional and ready to be integrated. The next steps are for these two systems to be put together and fully integrated as one system. Thankfully, the audio system can run independently of the Arduino that controls the light due to the board that is being used. Once the full systems are integrated, a more detailed design can be constructed and then refined.

5.3 Goals for the Semester

The goals for the RHIW team during the Summer 2019 semester were agreed upon by the team, our project partner, and our EPICS educational staff. These goals are measurable and quantifiable either through direct observation, analysis, or reflection. The goals are presented in the format of a list below this line of text.

Team Goals

- Deliver some form of product/solution by the end of the Summer 2019 Semester.
- Make sure the project partner has a positive experience working with our team.
- Ensure an easy transition for continuing teams including brainstorms, design constraints, etc.
- Gain experience working in a multi-disciplinary, multi-cultural team.
- Learn something new.

Project Partner Goals

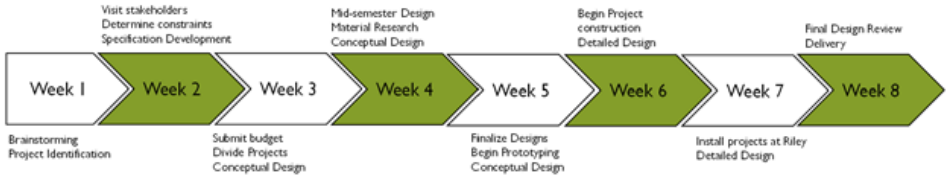
- Deliver some form of product/solution by the end of the Summer 2019 Semester.
- Prioritize the children's safety and enjoyment in all aspects of the design.

EPICS Staff Goals

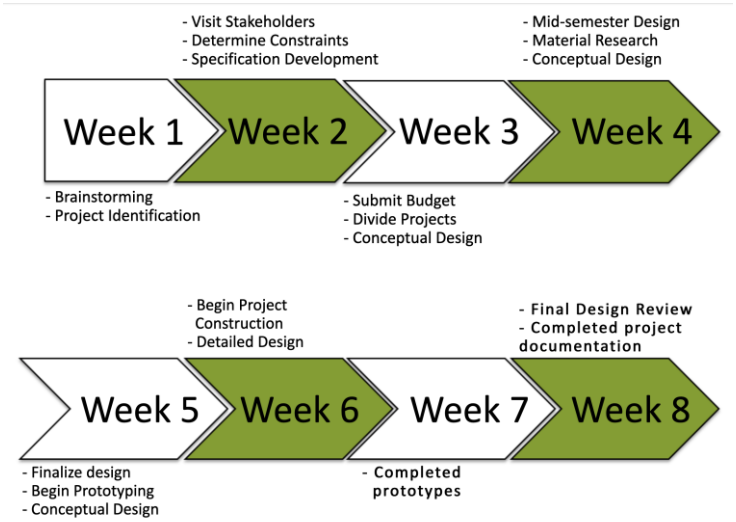
- Deliver some form of product/solution by the end of the Summer 2019 Semester.
- Make sure that the projects were sufficiently complicated (at the discretion of the EPICS Staff per a conversation), particularly in an Electrical Engineering sense.

5.4 Semester Timeline

Projected Semester Timeline:



Actual Semester Timeline:



5.5 Semester Budget

Project 1: Butterfly Stand		
Items required for project		**Estimated cost**
1.1	Structural Materials	200
	TOTAL	**$200.00**
Project 2: The Start Finish Interactive Cheer System		
Items required for project		**Estimated cost**
2.1	Vinyl floor stickers with install	700
2.2	Arduino/sensors/electrical components	200
2.3	Decorative Materials	100
	TOTAL	**$1000.00**

Included are the items we have already purchased:

- Interactive Cheer System Materials:

1.

ITEM DESCRIPTION (Including how pricing was obtained)	QUAN	UNIT COST	TOTAL COST
ELEGOO MEGA 2560 R3 Board ATmega2560 ATMEGA16U2 + USB Cable for Arduino Projects	2	$ 14.99	$ 29.98
SainSmart 16-Channel Relay Module	2	$ 14.99	$ 29.98
12V 5A Power Adapter AC 100-220V to DC 60W Power Supply US Plug Switching PC Power	1	$ 10.99	$ 10.99
DIYmall 5 Pack HC-SR501 Pir Motion IR Sensor Body Module Infrared for Arduino	1	$ 9.49	$ 9.49
		$ -	$ 0.00
		$ -	$ 0.00
Shipping		$ -	$ 0.00
			$ 80.44

2.

ITEM DESCRIPTION (Including how pricing was obtained)	QUAN	UNIT COST	TOTAL COST
Tower Light - Red Yellow Green Alert Light with Buzzer - 12VDC	1	$ 27.50	$ 27.50
Adafruit "Music Maker" MP3 Shield for Arduino w/3W Stereo Amp - v1.0	1	$ 34.95	$ 34.95
Adafruit Audio FX Sound Board + 2x2W Amp - WAV/OGG Trigger -16MB	1	$ 29.95	$ 29.95
Speaker - 3" Diameter - 4 Ohm 3 Watt	2	$ 1.95	$ 3.90
	2	$ -	$ 0.00
		$ -	$ 0.00
Shipping		$ -	$ 10.17
			$ 106.47

3.

ITEM DESCRIPTION (Including how pricing was obtained)		QUAN	UNIT COST	TOTAL COST
5A power adapter		1	$ 10.99	$ 10.99
breadboard jumper wires		1	$ 6.49	$ 6.49
			$ -	$ 0.00
			$ -	$ 0.00
			$ -	$ 0.00
			$ -	$ 0.00
Shipping			$ -	$ 0.00 -
				$ 17.48

- Butterfly Stand Materials:
  1.

ITEM DESCRIPTION (Including how pricing was obtained)		QUAN	UNIT COST	TOTAL COST
Anicle Romantic Glass LED Lamp Butterfly Jar Bottle Valentine Children Gift Home..		3	$ 9.99	$ 29.97
			$ -	$ 0.00
			$ -	$ 0.00
			$ -	$ 0.00
			$ -	$ 0.00
			$ -	$ 0.00
Shipping			$ -	$ 29.97 -
				$ 59.94 -

  2.

ITEM DESCRIPTION (Including how pricing was obtained)		QUAN	UNIT COST	TOTAL COST
Butterfly jar		2	$ 19.50	$ 39.00
			$ -	$ 0.00
			$ -	$ 0.00
			$ -	$ 0.00
			$ -	$ 0.00
			$ -	$ 0.00
Shipping			$ -	$ 0.00 -
				$ 39.00

  3.

ITEM DESCRIPTION (Including how pricing was obtained)		QUAN	UNIT COST	TOTAL COST
Anicle Romantic Glass LED Lamp Butterfly Jar Bottle Valentine Children Gift Home..		3	$ 9.99	$ 29.97
			$ -	$ 0.00
			$ -	$ 0.00
			$ -	$ 0.00
			$ -	$ 0.00
			$ -	$ 0.00
Shipping			$ -	$ 29.97 -
				$ 59.94 -

  4. Jar Prototype Materials:
     - 3 various cylindrical plastic jars at Walmart: $12

5.6 Transition Report

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

The current project for RHIW was started this semester (summer 2019). The team visited the stakeholders at Riley Hospital on June 18 and began brainstorming project ideas. In the first two weeks the team moved from project identification to specification development. In week three, the teams divided the work amongst two projects and worked on the budget for each. July 2nd, we had mid-semester review and that week the team also ordered materials for the electrical components of the Indy 500 wall project.

The team has stayed on track with the timeline for the most part and are ahead of schedule with the butterfly project as that group is ready to begin construction of the final project. The largest setbacks have been from working with hospital parameters. All materials must be approved my building maintenance and communication has been slow because all emails follow a chain of command that makes responses slow to come by. The most efficient response to this issue for our team was to organize all questions we had into a numbered list so they could respond with answers to each question as they heard from building managers.

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

Project naming for proposed future semester timeline:

- Butterfly Stand & Interactive Mechanisms: BSIM
- Interactive Cheer System: ICS

Week 1	•Get familiar with overall project details to include both subprojects.
Week 2	•Visit stakeholder
Week 3	•Become familiar with prototypes and completed conceptual design for both subprojects •Begin project updates
Week 4	•BSIM: Recieve feedback from project partner on which prototype design chosen to deliver to hospital for testing •ICS: Begin conceptual design for adding speakers to hallway
Week 5	•BSIM: Complete prototype and deliver for testing •ICS: Complete conceptual design for adding speakers to hallway
Week 6	•BSIM: Take collected data, plan detailed design, and order final design materials •ICS: Create prototypes
Week 7	•BSIM: Complete detailed design and prepare product for delivery •ICS: Move into detailed design
Week 8	•Mid-semester design review •BSIM: Deliver final product
Week 9	•BSIM: Complete - move team to ICS team for decorative material design (ICSDM). Design floor decals and flag materials •ICS: Detailed design for adding speakers to current system
Week 10	•ICSDM: Order, test, and integrate decorative material into full ICS system. •ICS: Install new speakers and test sensors.
Week 11	•Delivery of full ICS system
Week 12	•Project identification for LED wall project
Week 13	•Project identification for LED wall project
Week 14	•Specification Development for LED wall
Week 15	•Specification Development for LED wall
Week 16	•Final design review •Update Design Document

6. Current Design

The physical therapy unit of Riley Children's Hospital is currently in need of a small interactive display for their Butterfly Mural Wall and an extended interactive system for their physical therapy Indy 500 hallway. After meeting with our project partner, Taylor Cole, and completing the specification development phase of the design process we began brainstorming ideas. After brainstorming ideas, we selected two major projects which best fit our project specifications. The decision was made using the weighted decision matrix shown below.

Weighted Decision Matrix							
	Cost	Ease of Installation	Materials	Complexity	Importance to Partner	Building Code Adherence	Total:
Painting Ceiling Tiles	3	1	2	2	3	1	12
LED Display	1	2	2	2	3	2	12
Racecar on Track	4	2	4	2	2	3	17
Vinyl Stickers	1	5	3	5	4	4	22
Flashing Lights in Audience	3	3	3	2	3	2	16
Butterfly Jars	4	4	4	3	4	5	24
Stop Light	4	4	2	3	2	3	18
Removable Name Tags	3	3	4	3	4	2	19
Flapping Butterfly Wings	2	3	3	2	3	3	16
Interactive Cheer System	2	3	3	4	5	4	21

Table 1. The values for each design specification are assigned on a scale of 1 to 5 where the larger values indicate a better match.

After forming the weighted decision matrix, we separated the Riley Hospital Interactive Team into two sub-teams in order to focus on the two different designs. The current designs for both the Butterfly Wall and Indy 500 DreamWorks Wall projects are outlined below.

Butterfly Stand:

The design for the Butterfly Stand was chosen after discussing with the project partner's needs. The stand will serve as further motivation and celebration for patients who have completed their treatment and are graduating, as well as attract the attention of visiting and new patients to the graduation wall.

The location of the Butterfly Stand is next to a Butterfly Graduation Wall. The wall is decorated with the names of the children - on butterfly stickers - who have completed their treatment and are "graduating" from the physical therapy floor. The wall is 19ft x 8ft with a colorful drawing covering the whole wall. Our idea must add some interesting/interactive element to the wall, and it must not cover the wall.

Butterfly stand project specifications:

1. Create a butterfly project in all patients could interact with
2. Chosen butterfly mechanism requires the capacity hold 3 interactive butterfly mechanisms in jars.
3. Chosen jars must be made of non-breakable material.
4. Height of butterfly mechanisms must accommodate to all possible ability levels and ages of hospital patients.
    a. Information found:
        i. Typical children's wheelchair height: 8" to 20"
        ii. Average height of standing child from 2 to 18 years of age: 33.7" to 69.2"
    b. Wide range of possible heights led to assumptions of following heights for prototype testing and height feedback:
        i. Heights:
            1. 17 inches
            2. 26 inches
            3. 36 inches
5. Design must disguise different height levels to prevent patient discouragement of in reaching highest mechanism.
6. Stand material must meet Riley Children's Hospital fire rating requirements.

Computer model of the 3 main prototypes:

Names from left to right: Tree with Shelves, Pillar Tree, Pillar Whimsical.

Commented [AA1]: Shouldn't it be, ",and Pillar Whi.."

Commented [CK2R1]: Nah its not a sentence, just a list of info

Commented [CK3R1]:

Detailed Information of Each Prototype:

1. Tree with Shelves:

Idea behind the Tree with Shelves design of this stand is to resemble a tree with each shelf being a tree branch. Further decoration will be added through paint and decorative foliage.

Unpainted computer-based model:	***Unpainted built prototype:***
	 *Shelf heights from bottom to top:* 1. 17 inches 2. 25.5 inches 3. 37 inches
Painted built prototype:	***Painted built prototype with butterfly jars:***

Tree with Shelved prototype demonstration video can be found in Documents > Project Documentation > RHIW > Summer 2019 > 6-Project Files > 1-Buttrfly Stand

2. Pillar Tree:

Pillar Tree is the second idea that went into prototype phase and was based on the idea of having the shelves separate to give more space of artistic attributes. It also gives the project partner the freedom to arrange the pillars as they wish.

Unpainted computer-based model:	*Unpainted built prototype:*

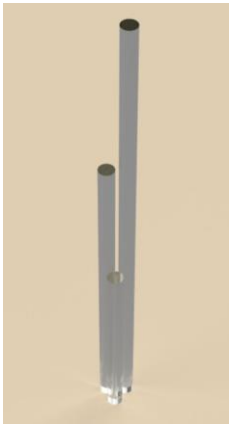
	 *Shelf heights from bottom to top:* 1. 17 inches 2. 26 inches 3. 36 inches
Painted built prototype:	***Painted built prototype with butterfly jars:***

3. Pillar Whimsical:

Similar in design to the Pillar Tree, the Pillar Whimsical is a three-level stand that allow the butterfly jars to be placed upon. The key differences are the material of the stand and the design. Firstly, it would be made from clear PVD instead of wood. This choice was made when the project partner conveyed a concern for the fire rating of the stand without clarifying what fire rating meant. So, we went ahead and made an alternative to our original idea of using wood and recreated the Pillar Tree design. Secondly, even though the PVC will take the same form of the Pillar Tree, it will not resemble a tree and instead would have a stylish filling design that is yet to be explored by the next team. Currently, we created the prototype with dirt inside of the PVC to show how the filling will act as weight to stabilize the stand and where the design of the pillar is.

Computer-based model:	***Built Prototype***	***Built Prototype with Butterfly Jars:***



Shelf height from bottom to top:

1. 16 inches
2. 24 inches
3. 34 inches

Our first idea was a stand with two butterfly jars on the top shelf made from wood. A video example of the butterfly jars can be found here. The stand would be 1.5 feet in height taking up a 2ftx2ft floor space. While the first iteration did add some interactive element to the wall, it didn't account for the different ages of children doing their therapy. So, we came up with second idea with three butterfly jars and a different stand design. The stand would consist of the middle pillar at height of 3 feet with two shelves connected at appropriate heights to accommodate everyone. Then, a third design was suggested where instead of having a main pillar with shelves, it would be three pillars at the appropriate heights. While the different designs for the Butterfly Stand have been explored, we ran into an issue with the material used for the stand. We were notified that the stand should comply with the hospital's fire rating and are waiting for the project partner to respond with clarifications. The end of the semester has come, and we didn't receive anything from the project partner about the fire rating. So, we went ahead and came up with the idea of replicating the wooden pillars and make them out of clear PVC.

Interactive Cheer System:

The design specifications identified for the Interactive Cheer System were determined to better clarify the needs of the project partner. The interactive system should be something that can be heard, seen, and touched so that to accommodate the various abilities of as many patients as possible. With these constraints we decided the interactive cheer system will include two microcontrollers which will drive four speakers and one stop light.

The hallway mural was donated by DreamWorks and has its own set of constraints which must be preserved. The hallway is a total of 100 feet long and the goal of the children is to walk down the hallway as far as they possibly can.

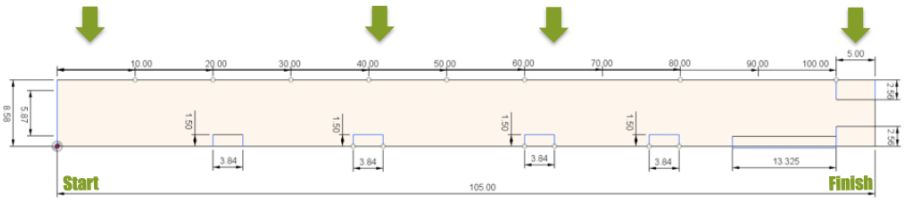


Figure 2. The above image was created to show the distribution of the cheer system elements.

One microcontroller will be positioned at the first arrow which will be responsible for driving the flags at the beginning of the race, initiating the first speaker count down, and the tower stoplight. The two speakers positioned at the second and third arrows will be connected to the sound board and a PIR sensor which is intended to function as a switch. The last microcontroller will be positioned at the final green arrow and will control the finale speaker. A flow chart was made to better explain the process described above.

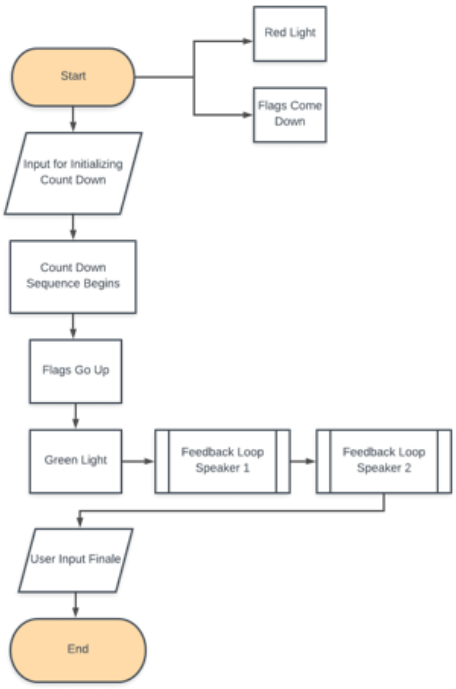


Figure 3. Flowchart for the interactive cheer system design.

The microcontroller we will be using is the Arduino Mega and we will need Adafruit audio shields in order to transfer an audio file and drive each of the speakers. We will be using a button for user input at the beginning to start the sequence and two sensors in order to trigger the speakers in the center. The light we will be using is a stoplight tower also created by Adafruit.

Another flowchart was created as a second iteration of the starting sequence to further explain the use of the first microcontroller. Each individual element was given a pin number which correlates with specific pins on the Arduino.

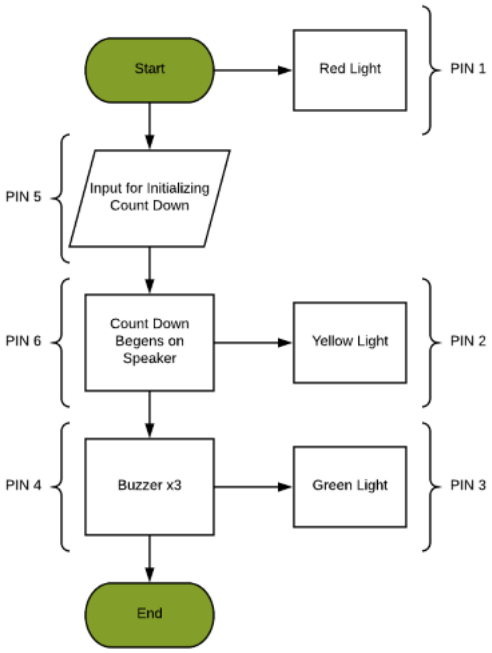
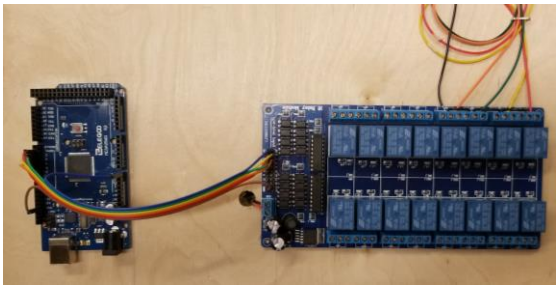
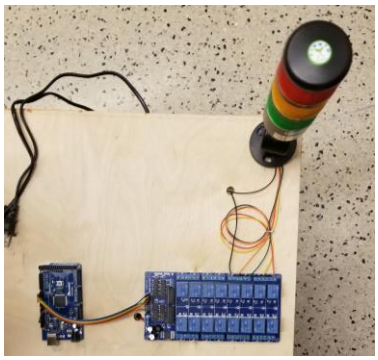


Figure 4. Flowchart for the starting sequence of the interactive cheer system design.

Stoplight:

The stoplight purchased was also produced by Adafruit and is driven by the first Arduino Mega. The Arduino contains code which drives the stoplight. The stoplight has a separate wire labeled for each pin on the Arduino for the green light, yellow light, red light, and the buzzer. The relay is controlled by the Arduino which supplies a 5V output to each of the pins when the Arduino code calls for the output. The Arduino can only output 5V so a relay system must be utilized to power the stoplight which requires 12V. For the lights and the buzzer to work they must be supplied with a binary 0 or a LOW (0V). This is supplied by the relay which acts as a switch to provide the necessary signal.





Speakers:

The speakers are controlled by the sound board fx, and the PIR sensors. The speakers are attached to the end of the sound board which is must be powered by a 5V input. (The 5V input can be supplied by a wall black and a normal MicroUSB power cord.) For the sound board to send out a signal to the speakers the sound board must be supplied a LOW to the pin which holds the .WAV sound file. (The pin should be connected to ground or supplied 0V.) The sound board contains an amplifier which amplifies the signal to send to the speakers.

PIR Sensors:

The code for testing the PIR sensors with a LED light attached to pin 13 on an Arduino has been provided in the Appendix. The PIR sensor requires a 5V input and a connection to ground. The output of the sensor is attached to pin 2 providing a 5V input to the Arduino. The Arduino accepts the input and when triggered supplies a 5V output to the LED.

The PIR sensors will work instead of the Arduino to control the soundboard like a switch. When the PIR sensor is triggered by motion it sends a 5V output, however the speakers need a LOW instead of a HIGH. A transistor has been attached (PN222) to act as an inverter which now provides the required 0V output to the sound board. When the sensor is triggered by motion the speakers will play the .WAV file on the attached pin.

Appendix A: Past Semester Archive

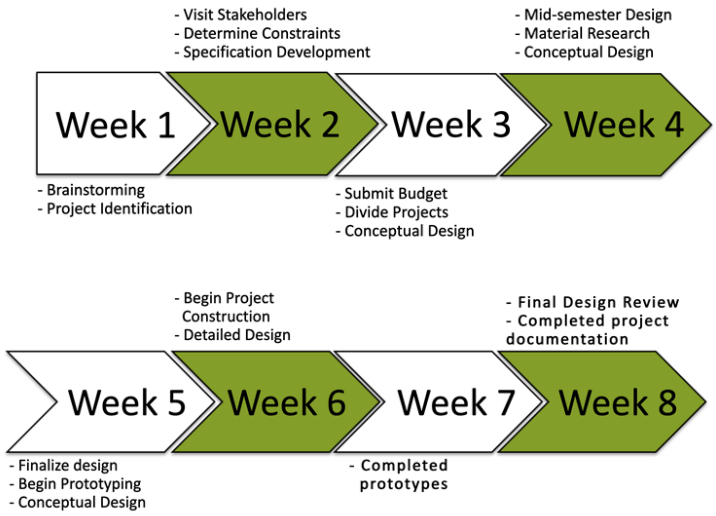
A.1 Summer 2019

A.1.1 Past Team Members

Summer 2019:

1. Talah Tayeb, Project Manager, ttayeb@purdue.edu
2. Cameron Keiper, Design Lead, ckeiper@purdue.edu
3. Elise Tessero, Project Partner Liaison, etessero@purdue.edu
4. Margaret Pogue, Financial Officer, poguem@purdue.edu
5. Ali Alkahtani, Team Member and Design Tester, aalkaht@purdue.edu
6. Elizabeth Manes, Project Archivist, emanes@purdue.edu

A.1.2 Past Timeline



A.1.3 Code for Testing the PIR Sensor

```
int led = 13;            // the pin that the LED is atteched to
int sensor = 2;          // the pin that the sensor is atteched to
int state = LOW;         // by default, no motion detected
int val = 0;             // variable to store the sensor status (value)

void setup() {
```

```
 pinMode(led, OUTPUT);     // initalize LED as an output
 pinMode(sensor, INPUT);   // initialize sensor as an input
 Serial.begin(9600);       // initialize serial
}
void loop(){
 val = digitalRead(sensor);  // read sensor value
 if (val == HIGH) {          // check if the sensor is HIGH
  digitalWrite(led, HIGH);   // turn LED ON
  delay(100);                // delay 100 milliseconds

  if (state == LOW) {
   Serial.println("Motion detected!");
   state = HIGH;      // update variable state to HIGH
  }
 }
 else {
   digitalWrite(led, LOW); // turn LED OFF
   delay(200);           // delay 200 milliseconds

   if (state == HIGH){
    Serial.println("Motion stopped!");
    state = LOW;      // update variable state to LOW
  }
 }
}
```

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)	Complete	Project Partner Visit (Web view)
• Identify stakeholders (customer, users, person maintaining project, etc.)	Complete	Section 4.2
• Understand the Social Context	Complete	Section 4.1
• Define basic stakeholder requirements (objectives or goals of projects and constraints)	Complete	Section 4.3, Section 4.4, Section 5.3
• Determine time constraints of the project	Complete	Section 4.5, Section 5.4

This phase was completed mostly within week 1 and week 2 of the project. All information and its location about the project identification phase can be found in the table above.

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)	Complete	Section 4.1
• Create stakeholder profiles	Complete	Section 4.2
• Create mock-ups and simple prototypes: quick, low-cost, multiple cycles incorporating feedback	Complete	Section 6
• Develop a task analysis and define how users will interact with project (user scenarios)	Complete	Start and Finish Line (Web view) (See flowchart)
• Identify other solutions to similar needs and identify benchmark products (prior art)	N/A	Unique solution
• Define customer requirements in more detail; get project partner approval	Complete	Section 4
• Develop specifications document	Complete	Section 6
• Establish evaluation criteria	Complete	Constraint Emails (Web view)

This phase is complete. It is ever evolving though. Specifications will continue to change due to the nature of the relationship with the project partner.

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	To be done	N/A
• Brainstorm several possible solutions	Complete	Brainstorming (Web view)
• Prior Artifacts Research	N/A	Unique solution
• Create prototypes of multiple concepts, get feedback from users, refine specifications	In progress	Start and Finish Line (Web view) (Under Arduino Materials, waiting for shipment to get in)
• Evaluate feasibility of potential solutions (proof-of-concept prototypes)	In progress	Section 6
• Choose "best" solution	In progress	Design Spec. and Weighted Dec. (Web view)

This phase is still undergoing. Waiting on approval from project partner to move ahead with it.

B.4 Detailed design

Phase 4: Detailed Design	**Status:**	**Evidence can be found:**
Goal is to design working prototype which meets functional specifications.		
• Bottom-Up Development of component designs	To be done	N/A
• Develop Design Specification for components	To be done	N/A
• Design/analysis/evaluation of project, sub-modules and/or components (freeze interfaces)	To be done	N/A
• Design for Failure Mode Analysis (DFMEA)	To be done	N/A
• Prototyping of project, sub-modules and/or components	To be done	N/A
• Field test prototype/usability testing	To be done	N/A

Summary of Detailed Design phase of design….

To be done

B.5 Delivery

Phase 5: Delivery	Status:	Evidence can be found:
Goal is to refine detailed design 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	To be done	N/A
• Complete usability and reliability testing	To be done	N/A
• Complete user manuals/training material	To be done	N/A
• Complete delivery review	To be done	N/A
• Project Partner, Advisor, and EPICS Admin Approval	To be done	N/A

Summary of Delivery phase of design….

To be done

B.6 Service / Maintenance

Phase 6: Service / Maintenance	Status:	Evidence can be found:
• Evaluate performance of fielded project	To be done	N/A
• Determine what resources are necessary to support and maintain the project	To be done	N/A

Summary of Service/Maintenance phase of design….

To be done