



Design Document

Team: CR

Project: AR Sandbox

Date: 08/03/2018

Article I. TABLE OF CONTENTS

ARTICLE I.	TABLE OF CONTENTS	2
ARTICLE II.	REVISION HISTORY	4
ARTICLE III.	DESIGN STATUS	6
ARTICLE IV.	PROJECT CHARTER	7
<i>Section IV.1</i>	<i>Description of the Community Partner</i>	7
<i>Section IV.2</i>	<i>Stakeholders</i>	7
<i>Section IV.3</i>	<i>Project Objectives</i>	7
<i>Section IV.4</i>	<i>Outcomes/Deliverables</i>	7
<i>Section IV.5</i>	<i>Expected Semester Timeline</i>	8
	SEMESTER DOCUMENTATION	9
<i>Section V.1</i>	<i>Team Members</i>	9
<i>Section V.2</i>	<i>Current Status and Location</i>	10
<i>Section V.3</i>	<i>Goals for the Semester</i>	12
<i>Section V.4</i>	<i>Semester Timeline</i>	12
Subsection V.4.01	Spring 2018	12
Review (January) - done		12
<i>Section V.5</i>	<i>Semester Budget</i>	16
<i>Section V.6</i>	<i>Transition Report</i>	19
Subsection V.6.01	Proposed Delivery Timeline	19
Subsection V.6.02	Draft Timeline for (next semester) and Relationship to Overall Project Timeline	19
<i>Section V.7</i>	<i>Current Design</i>	20
APPENDIX A:	PAST SEMESTER ARCHIVE	26
<i>Section A.1</i>	<i>Fall 2017</i>	26
Subsection A.1.1	Past Team Members	26
Subsection A.1.2	Past Timeline	26
<i>Section A.2</i>	<i>Spring 2018</i>	26
Subsection A.2.1	Past Team Member	26
Subsection A.2.2	Past Timeline	27
APPENDIX B:	OVERALL PROJECT DESIGN	28
<i>Section B.1</i>	<i>Project Identification</i>	28

<i>Section B.2</i>	<i>Specification Development</i>	28
<i>Section B.4</i>	<i>Detailed design</i>	32
<i>Section B.6</i>	<i>Service / Maintenance</i>	34
APPENDIX C	SOFTWARE DOCUMENTATION	35
<i>Section C.1</i>	<i>Linux Installation</i>	35
<i>Section C.2</i>	<i>Downloading and installing the software</i>	36
<i>Section C.3</i>	<i>Calibrating the Kinect</i>	37
<i>Section C.4</i>	<i>Calibrating the projector</i>	38
<i>Section C.5</i>	<i>Launch the AR Sandbox</i>	39

Article II. REVISION HISTORY

Date	Author	Revisions Made
2/10/2018	Baker Noonan	Sections 1 through 6
2/10/2018	Luciano Handel	Sections 1 through 6
2/10/2018	Hannah Flynn	Sections 1 through 6
2/10/2018	Cole Stecyk	Appendix
2/14/2018	Cole Stecyk	Status and Location on Overall Project Timeline, Appendix B
2/14/2018	Baker Noonan	Appendix A & B
4/11/2018	Cole Stecyk	Design Status, 5.2, 5.3, 5.4, 5.6, 6
4/11/2018	Baker Noonan	6
4/15/2018	Cole Stecyk	All
4/15/2018	Yash Malhotra	Section 5.1, 5.2, 5.3
4/25/2018	Baker Noonan	All
4/25/2018	Cole Stecyk	Transition Doc 5.6
4/25/2018	Harsh Patel	5.5
4/25/2018	Yash Malhotra	Appendix C, C.1, C.2, C.3, C.4
7/07/2018	Koryn Jozwiakowski	Design Status, 4.5, 5.3, 5.4, 5.5, 6
7/07/2018	Xi Chen	Expected semester timeline, Team members, current status and goal. General format
7/07/2018	Wenyu Jing	Section 4.5, 5.4, B.2
7/07/2018	Francis Sarkodie	Appendix C
8/03/2018	Xi Chen	Appendix C.5, How to Launch the software, Proofread, Section V5(Budget form), Section V2 (Current Status)

08/05/2018	Wenyu Jing	Section 4.5, 5.4, B.2.1, C.4, V.7.02
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Article III. DESIGN STATUS

Phase 6: Service / Maintenance	Status: <i>To be done</i> Semester: <i>name in which it was completed</i>
Phase 5: Delivery	Status: <i>In Process</i> Semester: <i>Summer 2018</i>
Phase 4: Detailed Design	Status: <i>Completed</i> Semester: <i>Summer 2018</i>
Phase 3: Conceptual Design	Status: <i>Completed</i> Semester: <i>Spring 2018</i>
Phase 2: Specification Development	Status: <i>Completed</i> Semester: <i>Spring 2018</i>
Phase 1: Project Identification	Status: <i>Completed</i> Semester: <i>Fall 2017</i>

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

Article IV. PROJECT CHARTER

Section IV.1 Description of the Community Partner

We have several project partners here at Camp Riley. We are working with Bradford woods, the owner of the land that Camp Riley is situated on, as well as Champ Camp and AGAPE. Tim Street is the main point of contact for our team, and we have been in contact a few times regarding our project. We will be sure to keep Tim and his team updated with our progress and any questions we may have during our project.

Section IV.2 Stakeholders

Stakeholders for this project include the children attending Camp Riley and the staff working there. We want to make this project accessible to everyone who is using it. We do not want this project to be a competition for the children using it, but rather a place where they can be a kid and not have to ask for help while using our project. The staff needs to be able to deal with the sand and everything that we have that comes with the project. We must make it easy to use for them as well in case it needs to be moved, cleaned, etc.

Section IV.3 Project Objectives

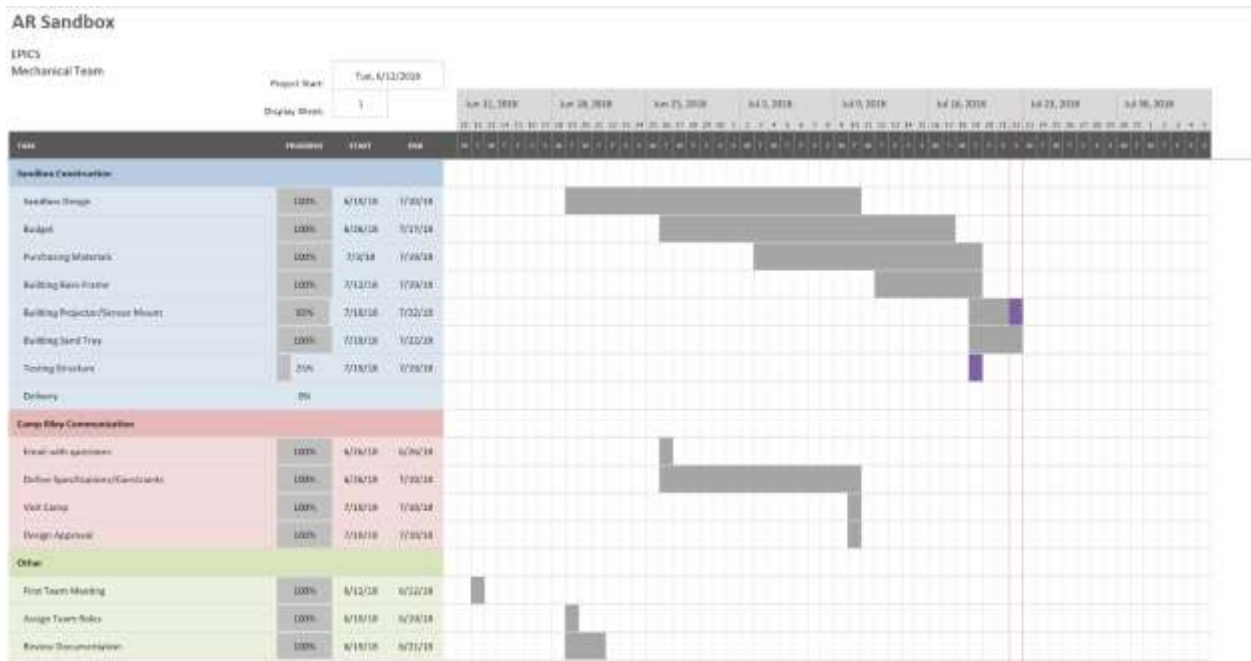
Our objectives for our project can be found later in this design document. In summary, our objectives are to obtain and work on the computer, install the software, calibrate the sensor and projector, build the sandbox and make a lesson plan.

Section IV.4 Outcomes/Deliverables

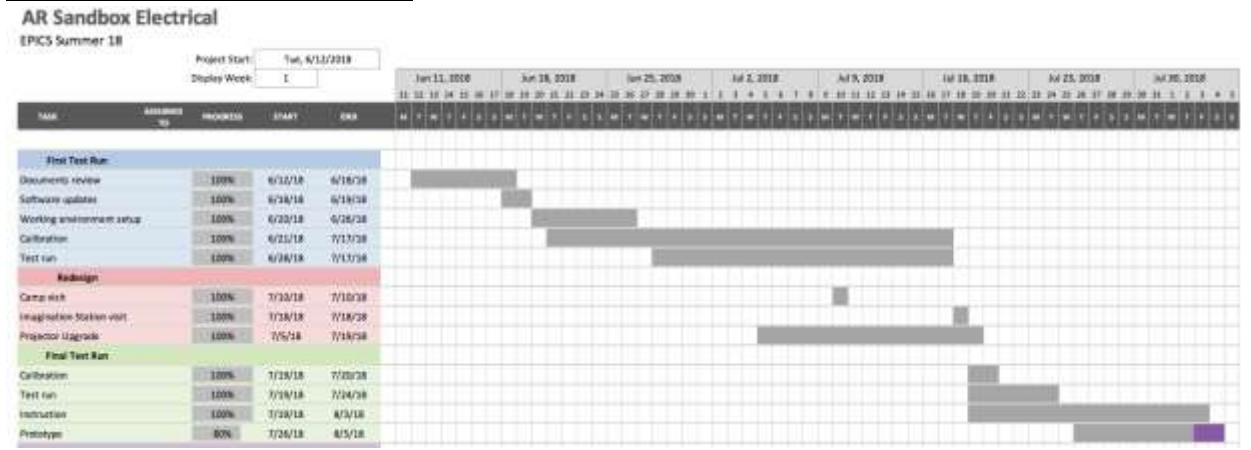
Our deliverables for this project are a fully functional, modular sandbox, a computer with needed hardware to run the software and a lesson plan to back up our project.

Section IV.5 Expected Semester Timeline

Mechanical Team Gantt Chart:



Electrical Team Gantt Chart:



SEMESTER DOCUMENTATION

Section V.1 Team Members

Xi Chen - Project Manager, Electrical Team member

Koryn Jozwiakowski - Mechanical Team Design Lead

Nicholas Formica - Mechanical Team member, Project Partner Liaison

Kimberly MacKay - Mechanical Team member

Mohammed Bo Khamseen - Mechanical Team member, Financial Officer

Wenyu Jing - Electrical Team Design Lead

Lingess Rajoo - Electrical Team Member

Francis Tengey - Electrical Team Member, Project Archivist

The role of the Design Lead is to be keep the team on track. The Design Lead must make sure everything will be delivered on time. The responsibilities of this role also include making sure everybody knows what they are supposed to be doing, so there is no confusion. It is also important for the Design Lead to lessen the workload of the other team members by helping them whenever possible.

The Project Partner Liaison oversees the contact between the project partner and the team. The Liaison is expected to be the only line of contact between the two parties, so that there is no confusion for the project partner. The Liaison's main duties are to e-mail the project partner as well as any other individuals or companies the team may need to contact.

The Project Archivist has probably the most work to do on the team. The Archivist's job is to keep meeting notes, upload those notes to OneNote, upload team progress to the Semester Template on OneNote, and to manage/complete the design document.

The Financial Officer oversees the finances for the entire ISD team. If money is needed to fund part of any of the projects, the Financial Officer is the person they go to. It is their responsibility to get the purchase approved and then to keep track of the money the team has left.

The rest of the team members do not have specific roles. Their role is to do the required research for the project and to help everybody else. The roles of a team member may vary week to week.

Section V.2 Current Status and Location

Subsection V.2.01 Spring 2018:

The team is working hard to complete and sandbox construction and Xbox Kinect/ 3D camera calibration. In the beginning of the semester, everything was going as planned according to our GANTT chart, however we experienced major delays in March. March was the month that was supposed to be focused on the sandbox construction. By the end of March, the plan was to have the sandbox completed and to start working on the user's manual and Kinect calibration. The delays we experienced were do due our ability to obtain our materials. Several weeks were wasted due to improper communication and confusion between the team and the EPICS department. We were under the impression that the items would be shipped to us or picked up and brought to the EPICS lab. Adding to the delay was the process of reserving an EPICS van and finding a time to drive and pick up the materials, for only registered EPICS drives could drive EPICS vehicles. We also suffered from lack of staffing in the EPICS build lab, preventing us from using the power cutting equipment outside of class time. The revised GANTT chart reflects these setbacks.

The team has put in long weekends to catch up on the missed time. Currently the upper and lower "tables" of our sandbox design are built. We have also attached the wheels on the bottom posts of the sandbox table. The remaining steps for sandbox construction include installing foam guards around the edges for increased safety. When the sandbox is complete the remaining tasks are those that were originally planned for April. These include the Kinect calibration, user's manual, and delivery checklist. The final activity required to deliver is failure testing which is still to be done.

Unfortunately, now that we have the wheels on the sandbox we are discovering problems not known previously that make it unlikely that the AR sandbox will be delivered this semester. The major problem is that the warped wood table legs caused the joints between the table surface and the legs to not be perfectly square. We did not think that this would be a major issue, however after stacking the two tables on top of each other we discovered that the wooden legs on the top and bottom table did not line up well, making it impossible to properly fasten the latches to the legs. In addition, the top table that holds the projector and Kinect is not as stable as it needs to be. We thought that woods glue would help fix this issue, but the legs still wobble. For some reason, even if we tighten the bolts holding the legs to the table top, the bolts will sink into the soft wood of the legs before they close the gap between the legs and the table top. We have tried adding a washer, but with no success. We cannot deliver a sandbox that does not look professional and is slightly unstable. It would reflect poorly on our team and it could be considered unsafe around the kids. The team who continues this project next semester will have time to fix these mistakes and deliver this project.

Subsection V.2.02**Summer 2018:**

This summer we have total 8 member in AR Sandbox, as a result, we separate the members in half, one part for mechanical design & build, which focus on build the stand and design the overall structure of AR Sandbox, etc. The other part for electrical design & test, which focus on install the software, perform corresponding calibration process, and manage the electrical system of the AR sandbox. As a result, the AR Sandbox transformed from team into a project consist with two different teams.

All project members are working consistently on the AR sandbox. Since the entire summer semester only have 8 weeks, the time is quite compact for us. First week, all the member of this project went through the design document from last semester, which gives us information we have so we can have a general idea about the progress of previous semester. From week 2 - week 4, which is the current week (4th week), we tested the specification provided in previous document. But unfortunately, some details provided in the previous semester are off a lot. Both Electrical Team and Mechanical Team quickly response to this issue and brainstormed some alternative way, but it is still under testing. If everything goes well, both team will finish their design and testing from week 5 to week 7. At week 8, if possible, we will assemble the mechanical part and electrical part of the AR sandbox together, test and deliver it.

Right now everything went well and works perfectly. By switching to the new projector and re-install the entire system, everything runs fluently without any lagging, the calibration process was success, too. we get a quite precise image and response effect in a short time. At the end of semester, the only issue so far is the alignment. This can be done within week. after everything is done, we are able to deliver it.

Section V.3

Goals for the Semester

Subsection V.3.01

Spring 2018:

Our goal for this semester is to deliver our fully functional and operating project to Tim Street and the children attending Camp Riley this summer of 2018. We believe that we have planned for a successful semester and hope to adhere to our timeline as close as possible.

Subsection V.3.02

Summer 2018:

Our goal this semester is to deliver our project to Tim Street and the children attending Camp Riley at the end of the summer semester 2018. We are progressing quickly to this goal, and as long as we stay on track we should achieve this goal.

Section V.4

Semester Timeline

Subsection V.4.01

Spring 2018

Review (January) - done

- Last semester documentation
- Semester plan & goals

Planning (February) - done

- Budget
- Purchase orders
- Sandbox design

Building (March) - done

- Computer setup
- Building the box

Building and Documentation (April) – in process

- Manual for user
- Possible upgrades
- Building manual
- Calibration documentation
- Calibration
- Failure testing

[Gantt Chart](#)

Subsection V.4.02

Summer 2018

Review (Week 1) - done

- Last semester documentation

- Semester plan and goals

Verifying and Improving (Week 2-4) - in progress

- Test last semester's specs
- Possible improvements

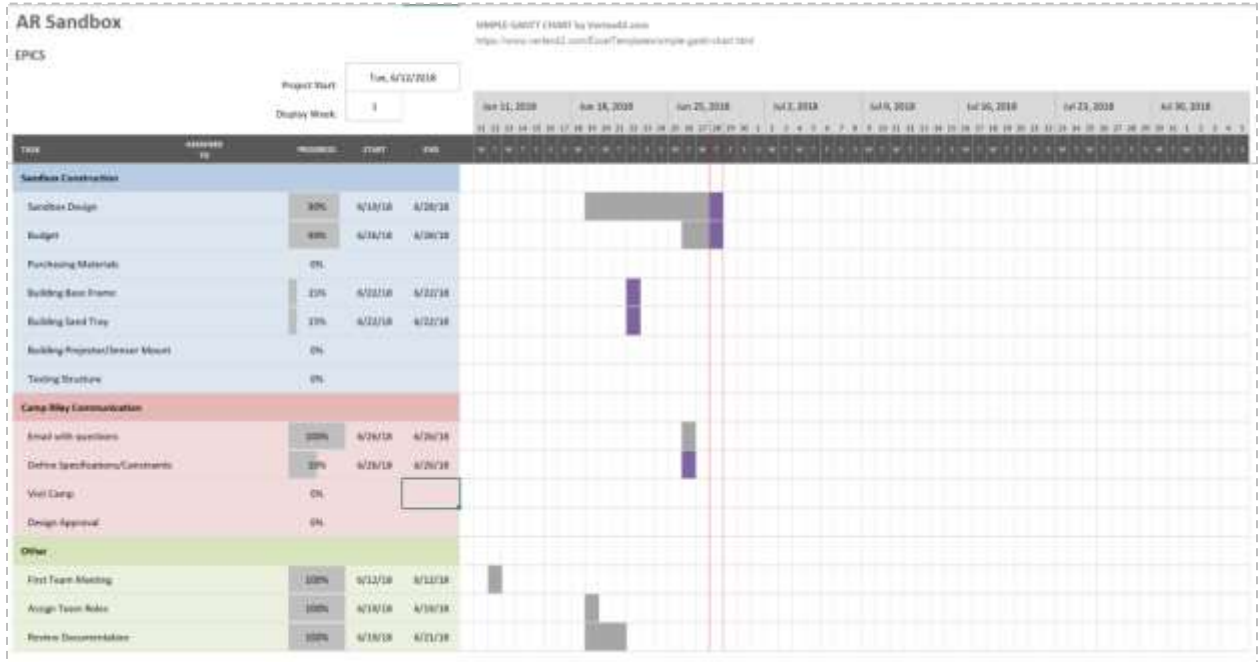
Building and Testing (Week 5-7) - in progress

- Implement improvement
- Construct major part and test it

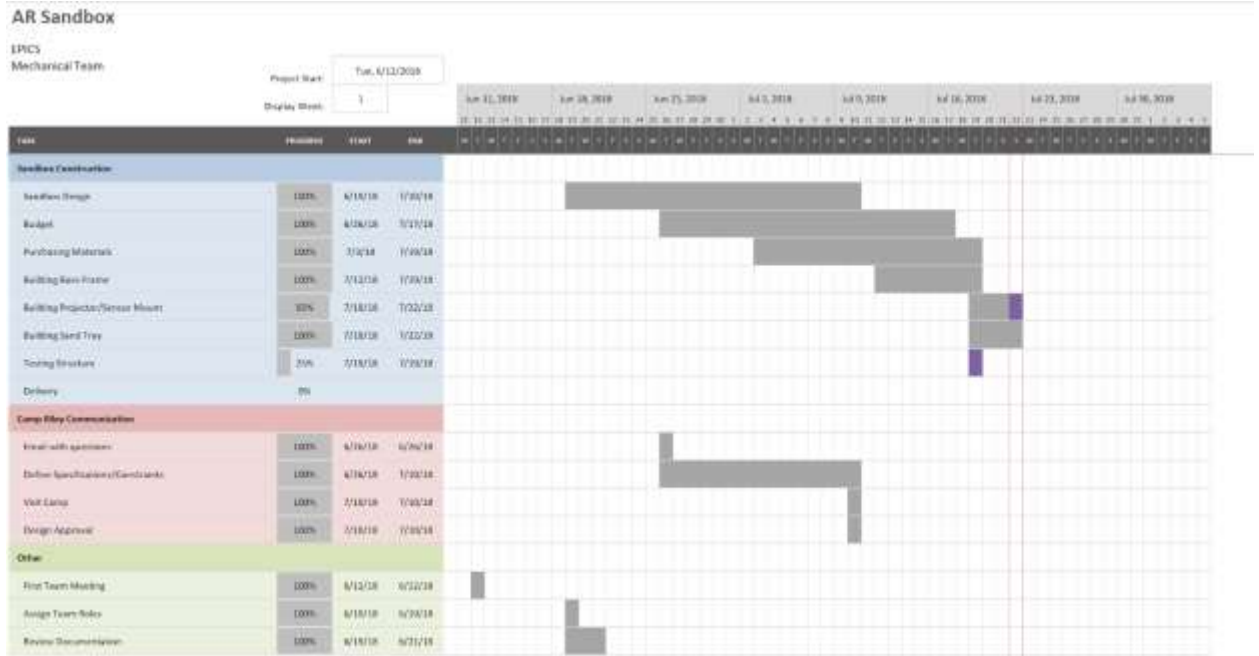
Final Testing (Week 8) - in progress

- Assemble the sandbox prototype
- test prototype
- deliver it

Gantt Chart for Mechanical Team:



At the end of semester:



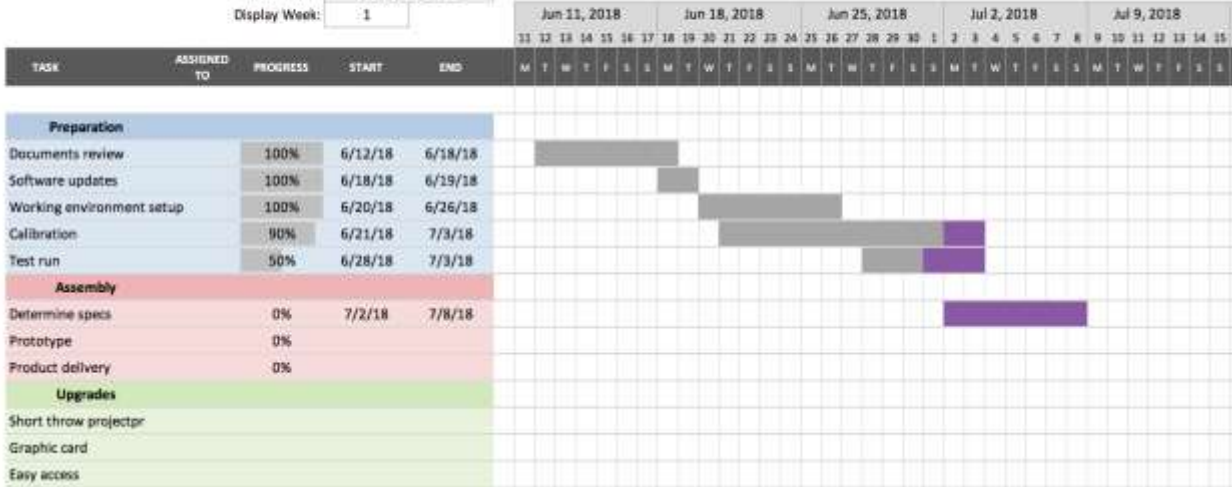
Gantt Chart for Electrical Team:

AR Sandbox Electrical

EPICS Summer 18

Project Start: Tue, 6/12/2018

Display Week: 1



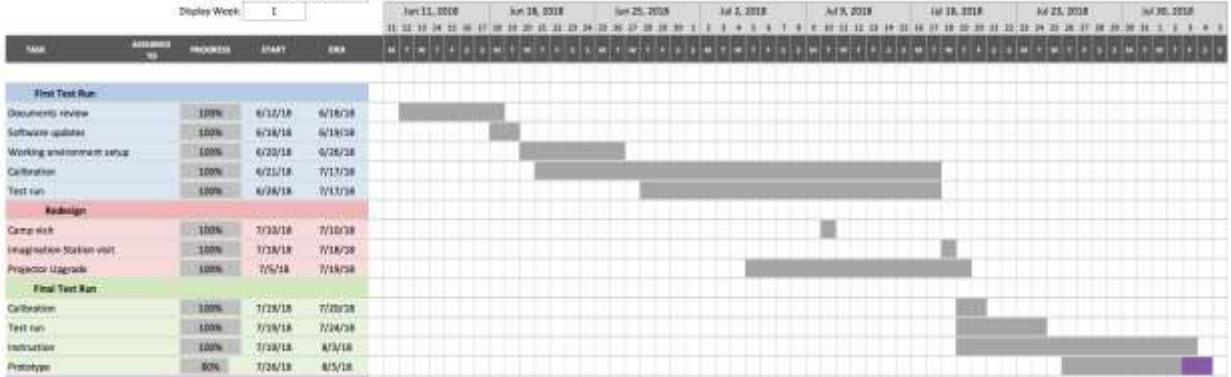
At the end of semester

AR Sandbox Electrical

EPICS Summer 18

Project Start: Tue, 6/12/2018

Display Week: 1



*Section V.5**Semester Budget***Subsection V.5.01****Spring 2018:**

This project would require a budget of \$total + tax to be completed. We need a high-end computer, a short-range projector, a 3D Camera and constructions materials for the mount and the sand box. The budget will be used to buy the following:

Computer	Quantity	Price per unit (\$)	Total price (\$)	
HP Pavilion Premium Gaming Desktop	1	\$660.00	\$ 660.00	+ tax
Projector				
InFocus Corporation IN114v XGA	1	\$329.5	\$ 329.5	+ tax
Other items we need				
19" Dell 1905FP DVI/VGA LCD Monitor	1	\$44.95	\$ 44.95	+ tax
Amazon Basics Keyboard and 3-Button USB Mouse	1	\$19.99	\$19.99	+ tax
Building materials				
Gorilla glue	1	\$5.84	\$5.84	+ tax
AMENVTOOL Frame Woodworking Band Clamp Strap Ratcheting Miter Mitre Vise Picture Make DIY	1	\$14.55	\$14.55	+ tax
frame wood working band clamp	1	\$13.98	\$13.98	+ tax
edge table protectors	1	\$9.99	\$9.99	+ tax
natural sand	3	\$2.80	\$8.40	+ tax
2x4 8ft long	6	\$3.18	\$9.54	+ tax
1/4 in Plywood (4ftx4ft) for Canopy	1	\$10.48	\$10.48	+ tax
4x4 Beams	4	\$8.98	\$35.92	+ tax

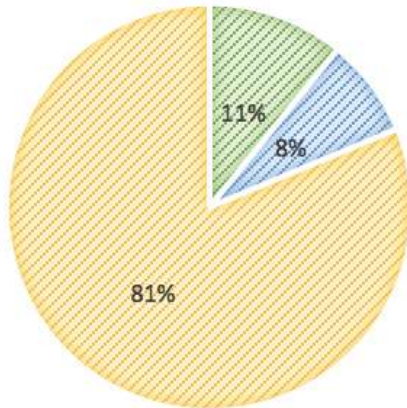
1/4 in Cedar Plywood (4ftx4ft) for Sandbox Base	1	\$40.10	\$40.10	+ tax
2x8 6 ft lumber plank	4	\$6.58	\$13.16	+ tax
Clear coat finish	1	\$36.97	\$36.97	+ tax
Chest Latches	8	\$2.98	\$23.84	+ tax
Paint Brush	3	\$1.40	\$4.20	+ tax
Total pre-built computer			\$1107.73	+ tax

Subsection V.5.02

Summer 2018

Items bought for project	Cost	Category
1/4" x 3" Zinc Power Lag (43 pcs)	14.62	Fasteners
8" Lag screws (4pcs)	3.8	
6" Lag screws (6pcs)	12.32	
Corner Braces 6.25 X 1.5 X 1 (6 pcs)	38.94	
Kinect Mount	16.12	
4 Pack Caster Wheels Swivel Plate Stem Brake Casters	28.99	
ALEX PLUS® Acrylic Latex Caulk Plus Silicone - 10.1 oz	1.96	
2 x 8 x 8' Cedar Lumber (2pcs)	59.98	Wood
4 x 4 x 8' Cedar lumbr (2pcs)	52.54	
1 x 12 x 10' Cedar Board	48.69	
Microsoft XBOX 360 Kinect Sensor(Certified Refurbished)	34.99	Electronic Equipments
BenQ WXGA DLP Short Throw Projector (MW632ST)	609.89	
Dell Optiplex 980 Desktop Computer (refurbished)	168.29	
Used Nvidia GeForce GTX 970	321.7	
19" Dell 1905FP DVI/VGA LCD Monitor	44.99	
AmazonBasics Keyboard and 3-Button USB Mouse Combo	20.98	
StarTech.com 6 ft Powe Extension Cord	5.99	
TOTAL		\$1,484.79

■ Wood ■ Fasteners ■ Electrical Equipment



EPICS AR Sandbox	\$1,484.79
Cheapest Commercial Alternative	\$6,661.99

The yellow portion is the cost for Electrical Team, the other part is the cost for Mechanical Team

Section V.6 Transition Report

Subsection V.6.01 Proposed Delivery Timeline

The sandbox will be delivered by the end of the Summer 2018 semester.



- Screw on latches
- Put on pool noodles
- Mount projector and Kinect with the computer

Subsection V.6.02 Draft Timeline for (next semester) and Relationship to Overall Project Timeline

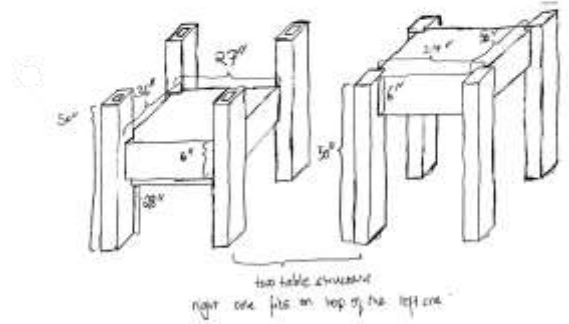
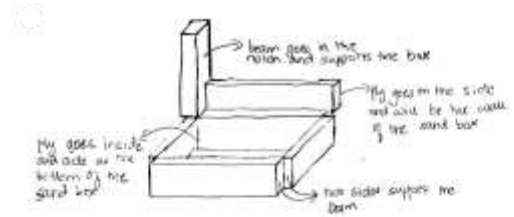
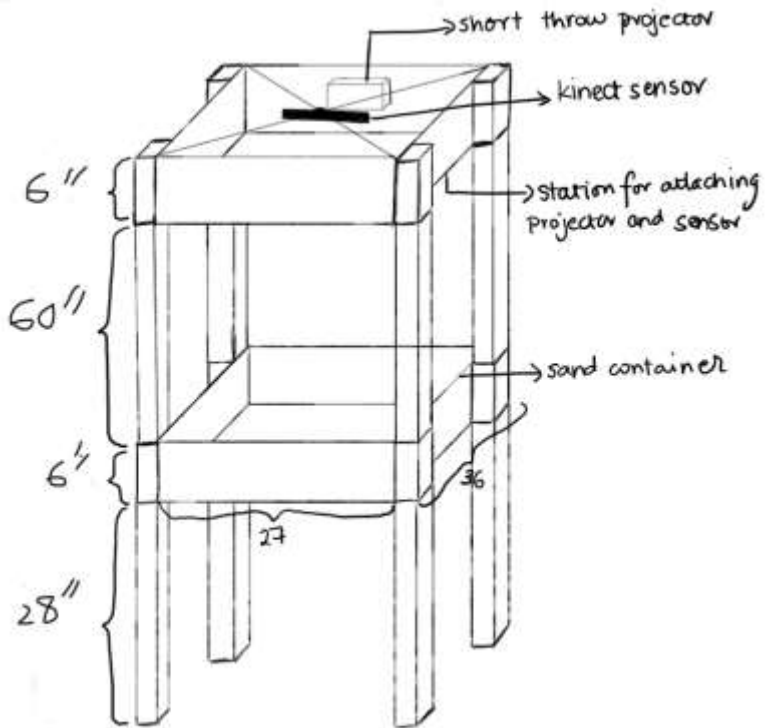
The sandbox will be delivered by the end of the Summer 2018 semester. Group during later semesters should focus on attaching the electronics to the, now, stable mount. The Kinect sensor should be attached in the middle of the top “table” (we have already cut a whole for that. The projector, should be placed at the border (also with a whole cut for that).

Some of the final touches the team should consider are the following: Pool noodles on sharp edges, paint and coating and fix all the wires still. Some possible upgrades are a motorized, adjustable base and moon sand. At the moment we have applied a coating of sealant to the wood surface.

Regarding the code, everything is working perfectly besides the automatic start. We could not figure out a way to make the software run just by turning the PC on. The next team should either make that or attach a display, a mouse and a keyboard.

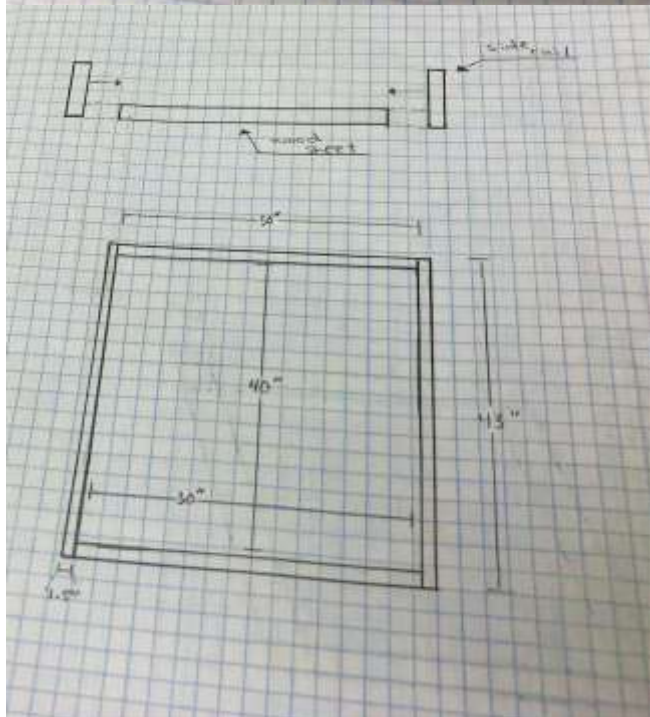
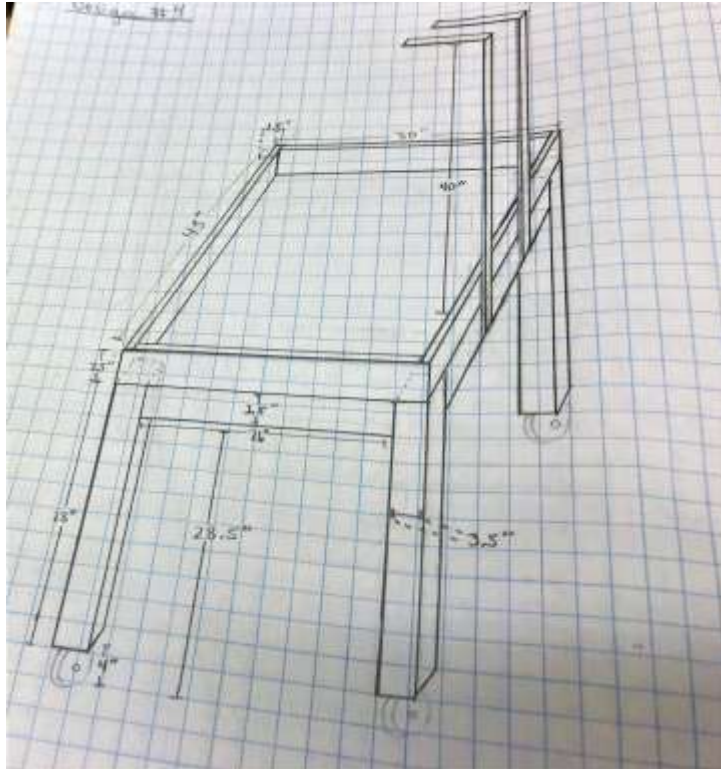
Section V.7 Current Design

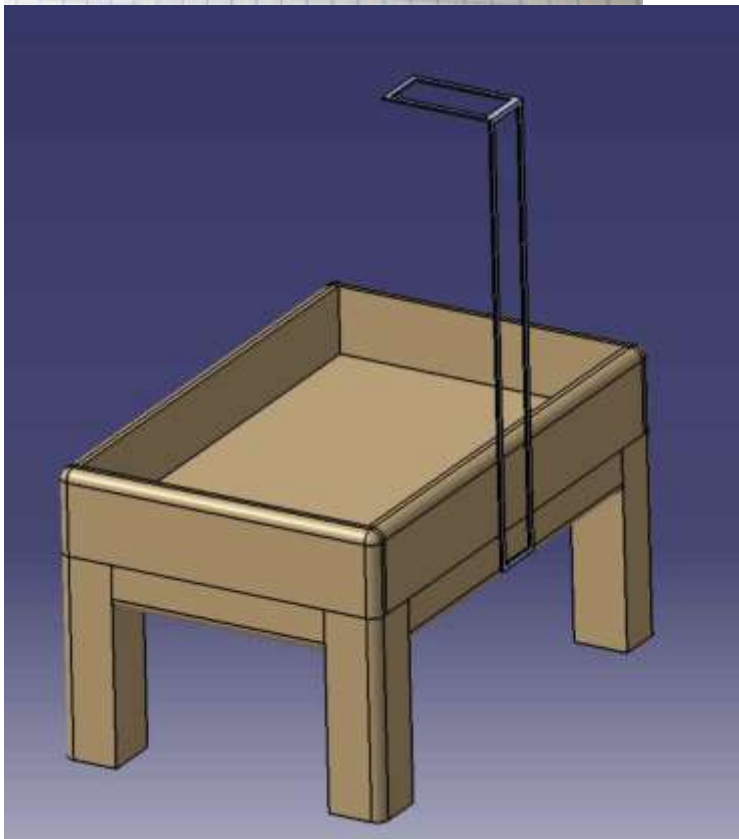
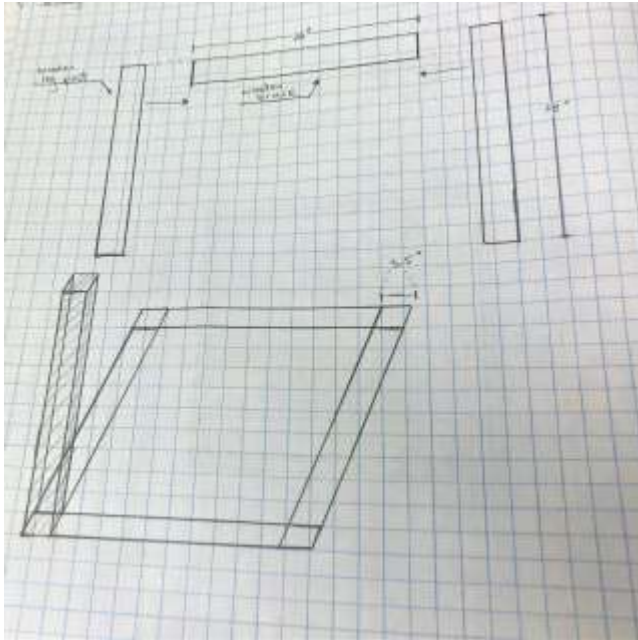
Subsection V.7.01 Spring 2018





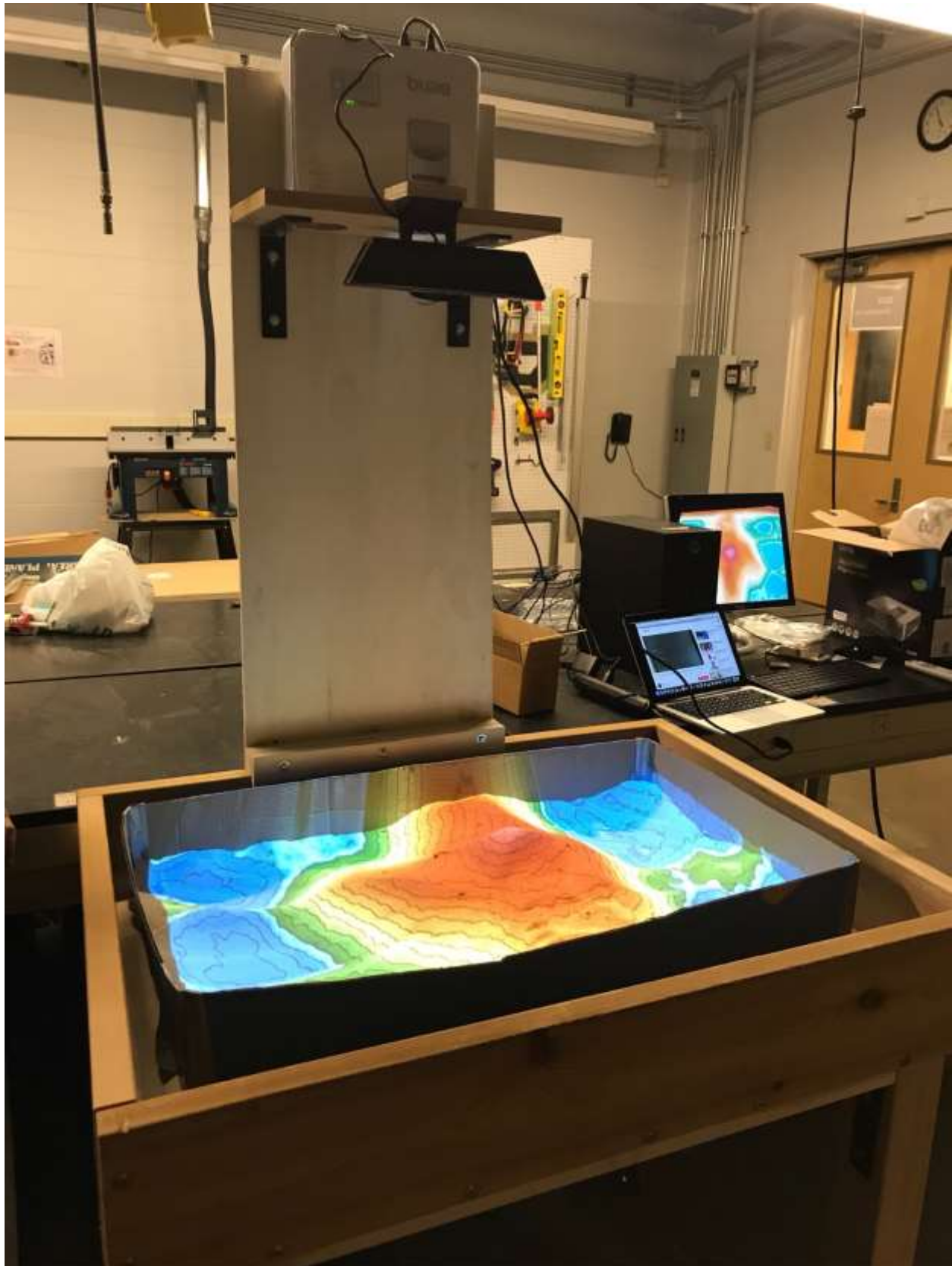
Subsection V.7.02 Summer 2018:





Final prototype:





APPENDIX A: PAST SEMESTER ARCHIVE

Section A.1 Fall 2017

Subsection A.1.1 Past Team Members

- Reshav - Design Lead
- Luciano - Team Member
- Addie - Team Member
- Mike - Team Member
- Ryan - Team Member
- Bryan - Team Member

Subsection A.1.2 Past Timeline



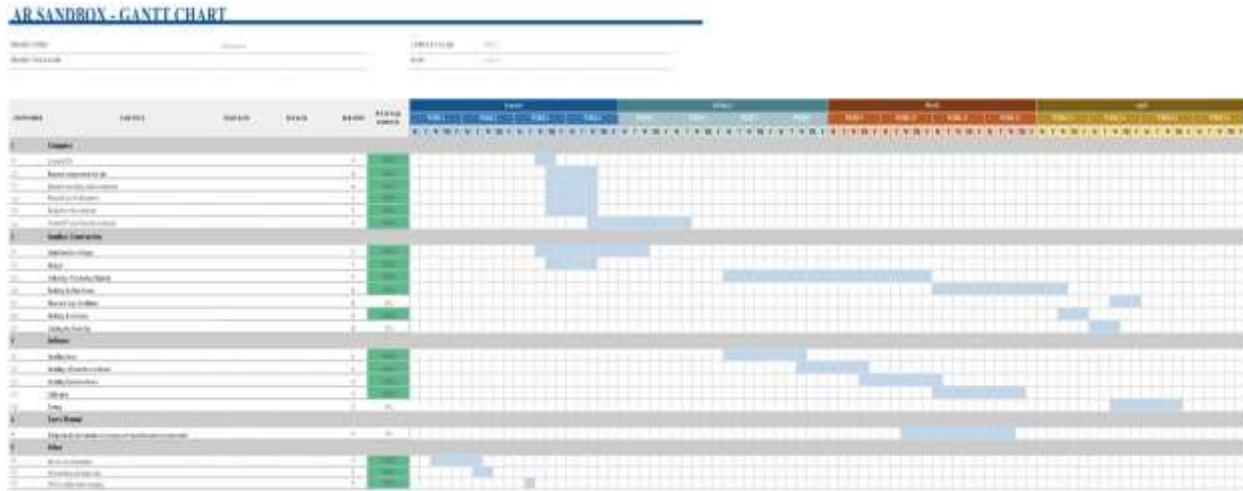
Section A.2 Spring 2018

Subsection A.2.1 Past Team Member

- Luciano Handal- Design Lead
- Yash Malhotra- Design Lead
- Baker Noonan- Project Partner Liaison
- Hannah Flynn- Financial Officer
- Cole Stecyk- Project Archivist

Harsh Patel- Financial Officer (Camp Riley team)

Subsection A.2.2 Past Timeline



Paste in previous semester timelines to indicate what was accomplished during this semester.

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

APPENDIX B: OVERALL PROJECT DESIGN

Section 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)	Completed	See “Sailboat” documentation
● Identify stakeholders (customer, users, person maintaining project, etc.)	Completed	See “Sailboat” documentation
● Understand the Social Context	Completed	See “Sailboat” documentation
● Define basic stakeholder requirements (objectives or goals of projects and constraints)	Completed	See “Sailboat” documentation
● Determine time constraints of the project	Completed	See “Sailboat” documentation

This project is to design an augmented reality sandbox. The key stakeholders are Camp Riley and Bradford Woods. The basic stakeholder requirements are for the box to be 3 by 2.25 feet and for the sandbox to be compact. The target deadline for this project is to have it complete by the end of the spring 2018 semester. The reason for this is to have it available to the children for summer camps.

Section 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)	Completed	See “Sailboat” documentation
● Create stakeholder profiles	Completed	See “Sailboat” documentation
● Create mock-ups and simple prototypes: quick, low-cost, multiple cycles incorporating feedback	Completed	See “Sailboat” documentation

<ul style="list-style-type: none"> Develop a task analysis and define how users will interact with project (user scenarios) 	Completed	See "Sailboat" documentation
<ul style="list-style-type: none"> Identify other solutions to similar needs and identify benchmark products (prior art) 	Completed	See "Sailboat" documentation
<ul style="list-style-type: none"> Define customer requirements in more detail; get project partner approval 	Completed	See "Sailboat" documentation
<ul style="list-style-type: none"> Develop specifications document 	Completed	See "Sailboat" documentation
<ul style="list-style-type: none"> Establish evaluation criteria 	Completed	See "Sailboat" documentation

We were supplied with requirements for the project. The computer needs to have at a minimum a NVIDIA GeForce GTX 970, an Intel Core i5 CPU running Linux mint (3 ghz min). The gap between the floor and the bottom of the sandbox must be between 28 inches and 34 inches to accommodate a wheel chair. Additionally, the sandbox frame must be a 4:3 ratio to effectively utilize a short-throw projector which project an image natively at 4:3.

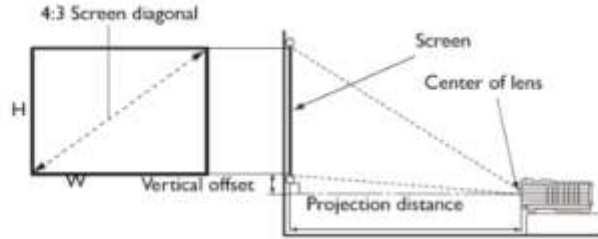
Subsection B.2.1 Summer 2018

After the assembly the sample set up and the first test run, we discovered that the performance achieved by the current software is not ideal. There is several seconds lag till the projector reflects the change in the shape of the sand. We discovered that this is mainly due to that our current graphic card is not enough for such work load. Upgrade to GTX1070 or above is recommended. Moreover, the image size of the projector is too small for current design, due to not enough focus length. A short-throw projector is needed to achieve required image.

Research on the projector:

The available image size is determined by focus length (the throw ratio), the lower and more adjustable the better. [https://en.wikipedia.org/wiki/Throw_\(projector\)](https://en.wikipedia.org/wiki/Throw_(projector))

In order to meet our requirement (40*30 when 40 inches away), a particular model (BENQ MW632ST) was selected. (the image size sheet shown below, it can produce a 50*32 in image when 40.5 in away, the image will match the 40*30 requirement after changing the aspect ratio)



Screen Size				Distance from screen (inch)			Vertical offset (inch)
Diagonal		W (inch)	H (inch)	Min length	Average	Max length	
Inch	mm			Max zoom		Min zoom	
40	1016	34	21	24.6	27.1	29.5	0.51
60	1524	50	32	36.9	40.5	44.2	.78
80	2032	68	42	49.2	54.1	59.1	1.06
100	2540	85	53	61.5	67.6	73.8	1.33
120	3048	101	64	73.8	81.2	88.5	1.57
140	3556	118	74	86.1	94.7	103.3	1.85
160	4064	136	85	98.4	108.2	118.1	2.12
180	4572	153	95	110.7	121.8	132.8	2.4
200	5080	169	106	123.0	135.3	147.6	2.6
250	6350	212	132	153.7	169.1	184.5	3.3
300	7620	254	159	182.5	202.9	221.4	3.9

End of semester update: after reinstalling the OS and software and changing to a short-throw project (BENQ MW632ST), optimal performance is achieved. Video footages can be found in the SharePoint folder: Sandbox/Testing and Calibrations.

Section 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	Completed	See “Sailboat” documentation
● Brainstorm several possible solutions	Completed	See “Sailboat” documentation
● Prior Artifacts Research	Completed	See “Sailboat” documentation
● Create prototypes of multiple concepts, get feedback from users, refine specifications	Completed	See “Sailboat” documentation
● Evaluate feasibility of potential solutions (proof-of-concept prototypes)	Completed	See “Sailboat” documentation
● Choose "best" solution	Completed	See “Sailboat” documentation

Last semester, the Sailboat team completed the conceptual design phase for this project. They came up with a list of possible designs to try and adapt the sandbox to be as functional as possible. They got feedback from the final design reviewers about heights and dimensions that we could build the box around. The best solution that we eventually came up with this semester was the dual box design, that doesn’t restrict a side of the box.

Section 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	Completed	See our design above
● Develop Design Specification for components	Completed	See our design above
● Design/analysis/evaluation of project, sub-modules and/or components (freeze interfaces)	Completed	See our design above
● Design for Failure Mode Analysis (DFMEA)	To be Completed	
● Prototyping of project, sub-modules and/or components	Completed	See our design above
● Field test prototype/usability testing	To be Completed	

Summary of Detailed Design phase of design....

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 Completed	
● Complete usability and reliability testing	To be Completed	
● Complete user manuals/training material	To be Completed	
● Complete delivery review	To be Completed	
● Project Partner, Advisor, and EPICS Admin Approval	To be Completed	

Summary of Delivery phase of design....

Section B.6 Service / Maintenance

Phase 6: Service / Maintenance	Status:	Evidence can be found:
<ul style="list-style-type: none">• Evaluate performance of fielded project	To be Completed	
<ul style="list-style-type: none">• Determine what resources are necessary to support and maintain the project	To be Completed	

Summary of Service/Maintenance phase of design....

APPENDIX C SOFTWARE DOCUMENTATION

Section C.1 Linux Installation

1. The system we went with is the current version of the LINUX MINT 64-BIT MATE desktop.
2. Get a PC or any system that has at least an NVIDIA GeForce GTX 970 and an Intel core i5 or i7 processor that clocks in at 3GHz(minimum).
3. To install Linux
 - a. Download the software from the Linux website (<https://linuxmint.com/download.php>).
 - b. Create a bootable drive. You can do this using a ISO image burner. The one we used is the startup disk maker.
 - c. After creating the bootable drive you can go into the BIOS of the system. This can be done by using different key combinations for different systems. After you are in the bios change the order of booting and make the USB boot option the priority boot option.
 - d. Once this is done, turn on the computer while the USB drive is inserted and the LINUX MINT system that you installed into the USB is the one that is going to be opened.
 - e. After this by going through the user manual available in the desktop for LINUX MINT, you can follow the instructions for removing windows from the desktop and making LINUX the primary software on the computer.
 - f. Once this is done your desktop is ready. While the most recent download of LINUX MINT should have all the required drivers, if there are any that are required you can download them from any open source website.

Section C.2 *Downloading and installing the software*

1. Open the terminal window which can be opened from the easy access menu.
2. To install the Libraries from UC Davis and build the Vrui VR kit run the following lines of code in the terminal window:

```
cd ~  
wget http://idav.ucdavis.edu/~okreylos/ResDev/Vrui/Build-Ubuntu.sh  
bash Build-Ubuntu.sh
```
3. The step above might ask for the username and password of the admin for installation.
4. Once this is done, to install the Kinect 3D video package run the following code in the terminal window:

```
cd ~/src  
wget http://idav.ucdavis.edu/~okreylos/ResDev/Kinect/Kinect-3.4.tar.gz  
tar xfz Kinect-3.4.tar.gz  
cd Kinect-3.4
```
5. Once this is done you can check by using the following:

```
Make  
sudo make install  
sudo make installudevrules  
ls /usr/local/bin
```
6. Once this is done to see if it worked properly you need to see if the list shown contain the entries RawKinectViewer and KinectUtil. If it does the installation is successful.
7. To install the AR sandbox files run the following commands in the terminal window:

```
cd ~/src  
wget http://idav.ucdavis.edu/~okreylos/ResDev/SARndbox/SARndbox-2.4.tar.gz  
tar xfz SARndbox-2.4.tar.gz  
cd SARndbox-2.4
```
8. Run make to make sure the installation is successful.
9. After the last step all the libraries are set up and the software is in the system.

Section C.3 *Calibrating the Kinect*

1. Plug the first generation Kinect sensor into the computer. To do this you might require an adapter depending on the computer you have.
2. After the Kinect is plugged into the computer and the power supply for calibration run the following code in the terminal window.

```
sudo /usr/local/bin/KinectUtil getCalib 0  
cd ~/src/SARndbox-2.4  
RawKinectViewer -compress 0  
// while doing this make sure to point the Kinect sensor to a field of view that has  
many depth variations.
```
3. Once this is done the Kinect calibration is complete. The height calibration for the Kinect can be done using instructions available on the Microsoft website.

Section C.4 Calibrating the projector

Subsection C.4.1 Spring 2018

For projector calibration instructions go to the following website and follow the instructions step by step:

[AR Sandbox Calibration \(up to date\)](#)

Subsection C.4.2 Summer 2018

We followed the instructions for calibrating the projector left by the previous team and we did hit some issues during the process of calibrating. First of all, when calibrating the projector, we had to make sure that the distance between the camera and the lowest point of the sand is good enough for the 3D camera to get a signature feedback. We found that a distance of about 90 centimeters was ideal for our test run setup. Next, make sure that you have installed the ARSandbox software correctly and have setup the Calibrate Projector executable in order to be able to calibrate the projector. We have already set this all up but if for any reason the software gets deleted or overwritten those steps will need to be completed in order to be able to successfully calibrate the projector. One of the main issues we met when trying to calibrate the projector was trying to create a focus point for the 3D positional crosshair. What we did was attach a cd disk to a long thin stick and then we drew crosshairs on it in order to be able to capture the tie points. The tie points are the three-dimensional positions that the 3D camera needs to be able to calibrate the projector. The second issue we are hitting at the moment is to actually get all the tie points in order to calibrate the projector. If any of the tie points are too far off the crosshair it corrupts the whole calibration process. An advice I will leave and also something that we intend to probably use in the future is to make sure that the hand holding the focus point is steady and tries to keep and very uniform height throughout the calibration process.



Section C.5 Launch the AR Sandbox

1. Launch the Computer
2. Login the account with password “arsandbox”
3. A icon with name “AR Sandbox” is on the desktop
 - This is a shortcut we created for easier access
4. Double click it
5. Select pop up window
6. Press “F11” to enter full screen mode.
7. The software is running
8. If want to quit the software, press “F11” again,
9. Then click the “x” on the top left corner of the window.