Design Document Fall

Team: Lakota

Project: Greenhouse/Learning Center

Date: 12/7/18

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2 Revision History

Date	Author	Revisions Made
9/30/18	Greenhouse/Learning Center Teams	Created the design document
12/3/18	GH/LC Teams	Initial document update for Final Design review

3 Design Status

Phase 6: Service / Maintenance	**Status:** ***To be done*** **Semester:** ***To be done***
Phase 5: Delivery	**Status:** ***To be done*** **Semester:** ***To be done***
Phase 4: Detailed Design	**Learning Center Status:** ***In Progress*** **Semester:** ***Fall 2018*** **Greenhouse Status:** ***In Progress*** **Semester:** ***Fall 2018***
Phase 3: Conceptual Design	**Learning Center Status:** ***Completed*** **Semester:** *Fall 2018* **Greenhouse Status:** ***Completed*** **Semester:** *Fall 2018*
Phase 2: Specification Development	**Status:** ***Completed*** **Semester:** *Spring 2018*
Phase 1: Project Identification	**Status:** ***Completed*** **Semester:** *Fall 2017*

4 Semester Documentation (Fall 2018)

4.1 Team Members

Team Member	Year	Major	Role
Aimee Atakere	Sophomore	Chemical Engineering	Team Member
Marshall Beard	Freshman	FYE – First Year Engineering	Team Member
Sami Bijonowski	Junior	Civil Engineering	Team Member
Peter Chung	Freshman	FYE – First Year Engineering	Team Member
Jonathan Damon	Sophomore	Civil Engineering	Project Manager
Bridget Fitzgerald	Freshman	FYE – First Year Engineering	Team Member
Bryce Hines	Freshman	FYE – First Year Engineering	Team Member
Katie Johnson	Sophomore	FYE – First Year Engineering	Team Member
Kirit Khanna	Junior	Computer Engineering	Design Lead
Russell Kim	Freshman	FYE – First Year Engineering	Financial Officer
Jacob Lundgren	Sophomore	Civil Engineering	Design Lead
Thao Nguyen	Junior	Chemical Engineering	Project Partner Liaison
Alyssa Tamvakis	Sophomore	Mechanical Engineering	Team Member
Abigail Thompson	Freshman	FYE – First Year Engineering	Team Member

4.2 Current Status and Location on Overall Project Timeline

There are currently two different projects in this subdivision of the LAKOTA team: a learning center located on the Oglala Lakota College (OLC) Rapid City Campus near Pine Ridge Reservation, and two greenhouses; one on the same campus which is an ordered kit, as well as one in the city of Kyle in South Dakota. Oglala Lakota College received a grant for $40,000 from AIHEC to construct a pre-built greenhouse on their Rapid City Campus and the Greenhouse team is working with them on the interior design. The Purdue EPICS Learning Center team is working with the CEM (Construction Engineering Management) Senior Design Team. The CEM team is handling the design of the exterior and some of interior of the building while the Purdue EPICS team is focusing on the permanent seating and heating structure for the interior of the building, labeled the Rocket Mass Heater.

The Learning Center team is currently in the detailed design phase, they have prepared a final design for the Rocket Mass heater and now need to get the design approved by professionals before it can be built in the structure.

The Greenhouse team is currently finalizing the designs and sketches that will be used when implementing the physical greenhouse model. In addition, work is being done to calculate the operating costs of the greenhouse on daily and annual scales. Finally, the specific plant and herb layout needs to be confirmed and built into the greenhouse beds.

5 Project Plan

5.1 Team Goals

The overarching goal for this project is to create a learning center and a greenhouse that helps the elder generation of the Lakota Tribe share their farming culture with the younger generation. While the project aims to physically develop two building structures, there exists also the metaphysical aim of creating opportunities for community members to be educated and educate themselves. The greenhouse in specific will focus on small, focused growth that will give people experience to a wide variety of plants and how they can be grown. With this knowledge being shared across the community, it will lead to the further development of agricultural knowledge in the area and lay the beginnings to combat the food sovereignty problem on the reservation.

6 Project Identification

6.1 Description of the Community Partner

Our community partners are Oglala Lakota College and the residents of the Pine Ridge Native American Reservation. This reservation is home to about 3,500 people facing a poverty rate of 47.4%. Despite this, the Lakota tribe has been able to sustain a very rich and vibrant culture, especially in agriculture. The Lakota people have a variety of prayers for growing, nurturing and harvesting plants. They also have special techniques for farming that have been passed down through generations. By having these strong traditions, the Lakota people have been able to stay connected with their ancestors and their history.

6.2 Stakeholders

Our stakeholders include the Oglala Lakota College (OLC) and the residents of the Pine Ridge Reservation. The Greenhouse/Learning Center team at Purdue are creating a design that will serve to benefit mostly the residents of the reservation by designing a facility and learning environment to use for a cultural and educational benefit. Since the learning center will be located on the Oglala Lakota College Campus they are a vital stakeholder, but since the project's goal is to impact the community, the voices of the residents and elders are just as important. We have several student and faculty contacts at OLC and SDSMT that we work side by side with to help us contact the stakeholders and gather information.

Project: Greenhouse/Learning Center	
Number	*Stakeholder*
1	Residents of the Pine Ridge Reservation
2	Students at OLC
3	Members of the Lakota Nation located in Rapid City and Kyle, South Dakota.

6.3 Social Context

The greenhouse and learning center will function to create a hands-on learning environment where the Lakota culture can be preserved and taught to the younger generations by the elders of the tribe. The Lakota culture is significant factor throughout the entire design processes. For example, one of the requirements for the greenhouse is an east facing door that signifies the directions connection to the rising sun and the beginning of a new day . Another example is that the learning center will be seven sided to represent the 7 rites of the Lakota people. These requirements along with others listed below allows us to create a project that will "connect the Lakota back to the land."

6.4 User Needs

Project	**Greenhouse/Learning Center**	
Number	*User need*	*Stakeholder*
1	Learning center 7 sided	The tribes that make up OLC.
2	Door facing east	The tribes that make up OLC.
3	Cultural plants (will be picked by them)	The tribes that make up OLC.
4	Seperate room for mushrooms	The tribes that make up OLC.

5	No cement floor	The tribes that make up OLC.
6	Try to make as energy efficient as possible	The tribes that make up OLC.
7	Try to involve the community as much as possible	The tribes that make up OLC.

6.5 Project Objectives

We are working with SDSMT and OLC to create a greenhouse and cultural center where the residents of Pine Ridge and OLC students can share their cultural identity through community gatherings and other events. The structures will be built based on cultural specifications. This will facilitate the Lakota Nation's goal of educating the youths about their traditions and culture as well as address the food sovereignty issue on the reservation. The greenhouse will also be able to grow culturally relevant plants and provide a space for people from all over the community to learn and teach others about their culture and history.

6.6 Outcomes/Deliverables

By the end of this project the deliverables will be a cultural center and an educational greenhouse at OLC's campus in Rapid City. The project partners have expressed urgency to complete the greenhouse facility due to the grant's deadline. Therefore, we have focused on the greenhouse of the project and are looking to deliver a design to be constructed starting in Spring break 2019. Simultaneously, the other team are working on the learning center and will deliver a design for that as well.

7 Specification Development

7.1 Learning Center Benchmarking/IP

Cultural centers can be seen around the world in almost any place. The purpose of this cultural center is to create an environment to learn about the specific culture that interacting with its people. The 4 Directions Cultural Healing Lodge will be particularly important because it will be a place where tribal leaders can interact with the younger members of the tribe and community to prevent any part of their culture from being lost or forgotten. Our role in this project is to ensure that the design of this cultural center can best help them achieve that. Our solution is to design a building structure that fulfills their present and future needs, an area for the tribe elders to communicate with the community, also meetings offices/classrooms.

An example of a cultural center is the Dwyer Cultural Center in Harlem, NY. The focus of this building/organization is to celebrate Harlem culture. It is accomplished through all events such as jazz nights, local art exhibits, and discussions held at the center. Some of these discussions involve community leaders as guest speakers, others are more open-ended, while many are a combination of the two. By simply teaching people about Harlem culture, they are increasingly aware of the significant impact that Harlemites have had on the melting pot that is America today.

The Black Cultural Center (BCC) at Purdue was used as another resource to help us understand what a learning center is and how they help the community. The Learning Center team was lead through a tour of the BCC and was taught every piece of the building was designed to represent African Americans. One of the first examples was BCC's front desk which was specifically designed to look like a boat that was used to carry slaves over from West Africa. Another example is the entrance of the BCC which is in the shape of a keyhole which were located at the entrances of African tribes in Africa. The BCC also contained lots rooms used for study, meetings, practices by all the organizations and members a part of the BCC.

The Native American Educational and Cultural Center at Purdue is a great benchmark for the Learning Center. This facility (at Purdue) represents all tribes represented by students at Purdue. A few takeaways on the function of the building was a meeting space, studying space, and a general place for Native American students to hang out and destress. For instance, the director described to us a situation where a Native American student was very stressed around finals time and came to the center for help. There, she was able to smoke tobacco in a room at the center. The center creates a community/safe space at the school. Related to building design, the director expressed that she wishes that she had a working fireplace, more space for outside events, space for a garden, and more flexibility of the center.

7.2 Greenhouse Benchmarking/IP

Plans/designs for greenhouse can be purchased commercially. However, we have not found a design that fits the needs and requirements of our project partner and is able to resist the rigors of the South Dakota weather. There would not be issues/barriers from intellectual property as we do not use existing blueprints but create our own design, which focuses on this particular situation. The proposed solution may or may not be potentially patentable based on a wide variety of factors. Besides, we do not know the exact nature of what we are building it is difficult to determine if it is patentable.

The greenhouses at the Purdue Horticulture Facility were also utilized to get a better understanding about what a professional greenhouse is made out of and what it takes to build one. We were able to meet with the facility's manager several times to discuss the different aspects of the greenhouse including what material they used for the exterior (polycarbonate/glass) and how much that type of facility would cost (300 per square foot, if on the cheap side). We also talked extensively with him about irrigation systems, and the pros and cons of different set ups. With these pieces of information we were able to get a better understanding of how to go about designing and making decisions for our greenhouse.

The Thunder Valley greenhouse also supplied valuable ideas. it uses geothermal technology and fans as a means of temperature control. 8 pipes snake 16 feet deep into the ground to transfer latent heat from the ground to the greenhouse and vice versa, thus keeping the greenhouse warm in winter and preventing it from overheating in the summer. The top is made of polycarbonate sheeting. The greenhouse survived winter and the interior was noticeably warmer than the exterior upon inspection.

7.3 Specifications

Project	**Greenhouse and Learning Center**

Number	*User need*	*Specification number*	*Specification*
1	Fit the cultural wants (Learning Center)		
		1.1 1.2 1.3 1.4 1.5	7 sided learning center Door facing east Cultural plants (picked out by the Lakota people) Seperate room for mushrooms No cement floor
2	Greenhouse specifications		
		2.1 2.2 2.3 2.4 2.5 2.6	20 by 48 ft As energy efficient as possible Use solar panels Do not use electricity for primary source of heating Have an irrigation system that conserves water Window roof
3	Learning Center Specifications		

		3.1 3.2 3.3 3.4	Must be 7 sided Must have enough space for a classroom of people Door must be facing east Related to food sovereignty
4	Both structures must withstand the weather		
		4.1	Large hail (“baseball”) 70 mph winds 100+ f degree weather <0 f degree weather snow pile up

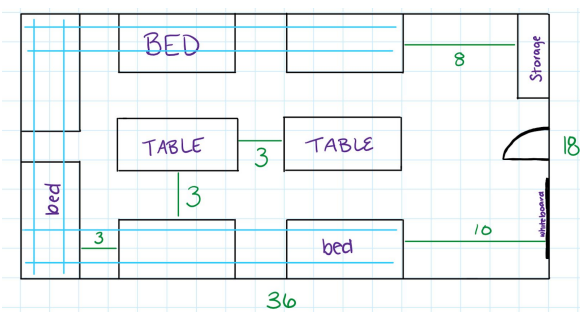
8 Conceptual Design

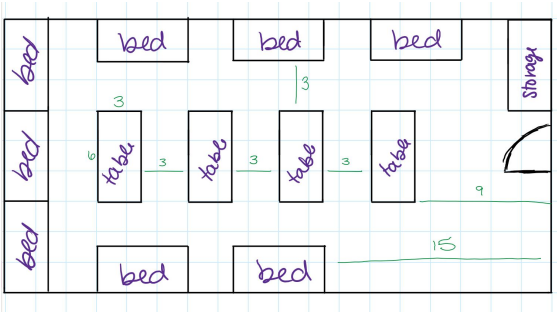
8.1 Brainstorm

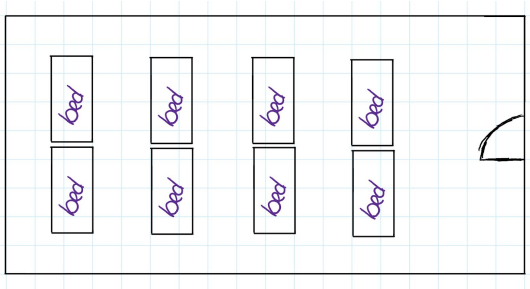
Greenhouse irrigation

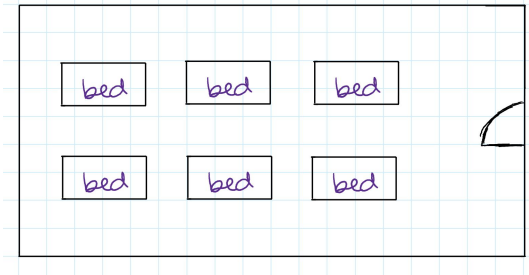
Based on our research, we’ve concluded that a drip irrigation system will best fit the user needs for the greenhouse. We do not have a final layout for the beds/pots in the greenhouse yet, so we’ve drafted and updated layouts based on other learning greenhouses and input from our project partners. With tables in the middle, we’ve discussed using water globes to supply water to potted plants.

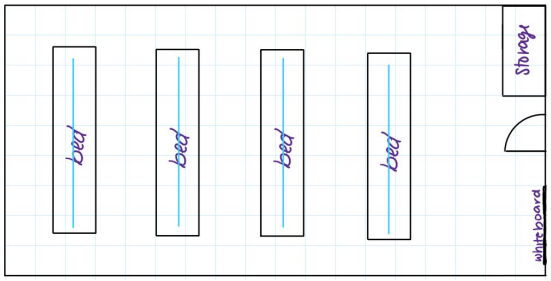
8.2 Low-Resolution Prototyping



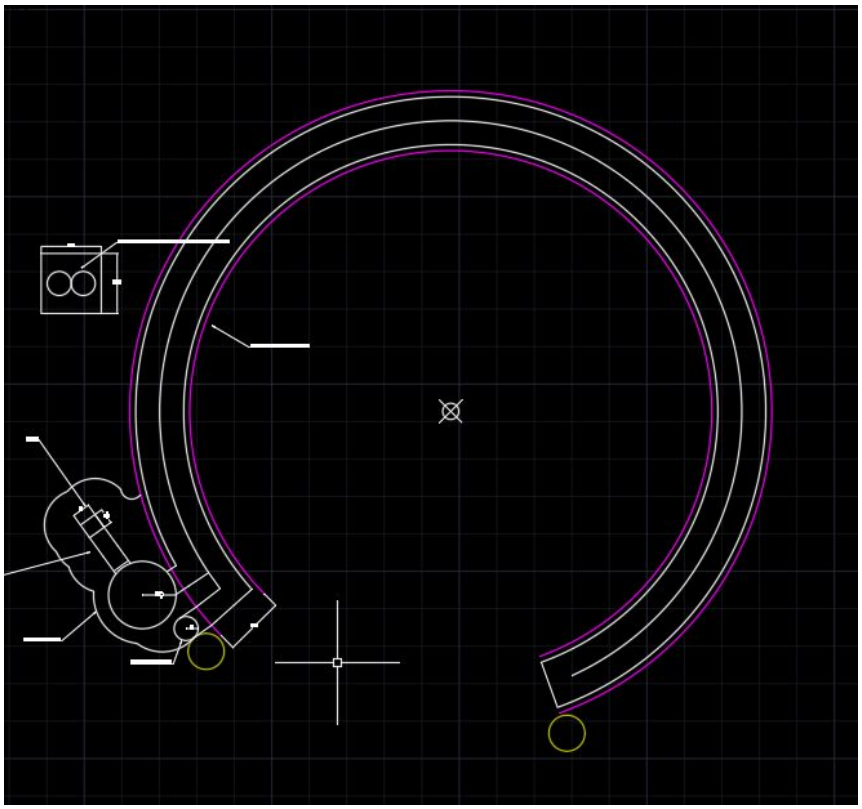


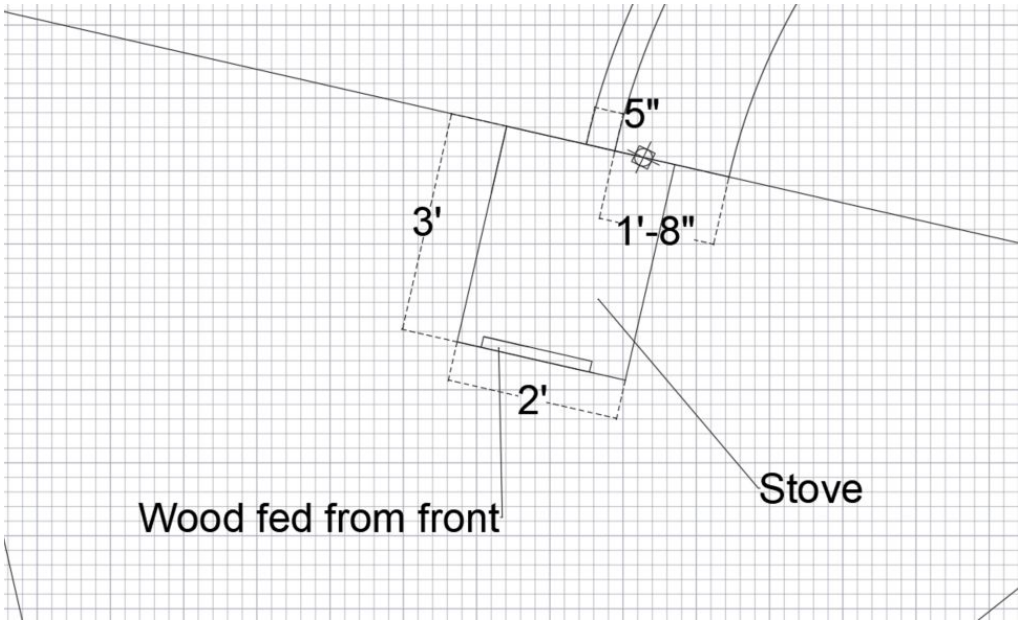


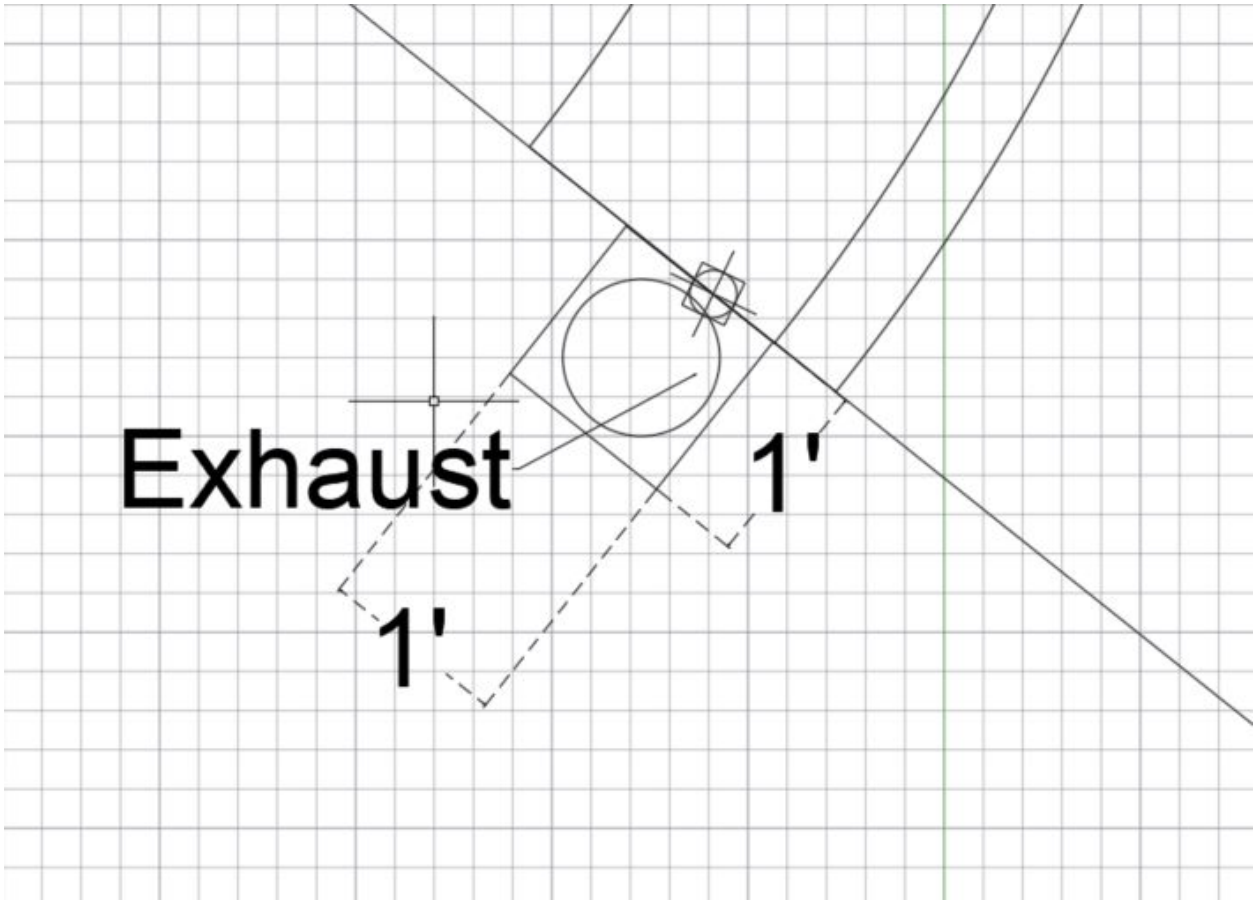




Learning Center




5"
3'
1'-8"
2'
Stove
Wood fed from front



9. Current Design Summary

9.1 Project Identification

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

Summary of Project Identification phase of design….

After working on the project throughout last year we were able to identify the specific needs of our partners with regards to what the structures needed to include (learning center and greenhouse). We were able to ask questions from our partners all last semester and get feedback from them. Our weekly calls and communication helped us gain the information we needed over time.

9.2 Specification Development

Phase 2: Specification Development	**Status:**
● Understand and describe context (current situation and environment)	Completed
● Create stakeholder profiles	Completed
● Create mock-ups and simple prototypes: quick, low-cost, multiple cycles incorporating feedback	Completed
● Develop a task analysis and define how users will interact with project (user scenarios)	Completed
● Identify other solutions to similar needs and identify benchmark products (prior art)	Completed
● Define customer requirements in more detail; get project partner approval	Completed
● Develop specifications document	To Be Done
● Establish evaluation criteria	Completed

Summary of Specification Development phase of design….

The size of the greenhouse will be 18x36x10.5 feet, and the size of the cultural center is still being debated and worked out. The primary focus of the structure during the design should be to provide a quality learning center that feels connected to nature that could also substitute as a cultural center for the people.

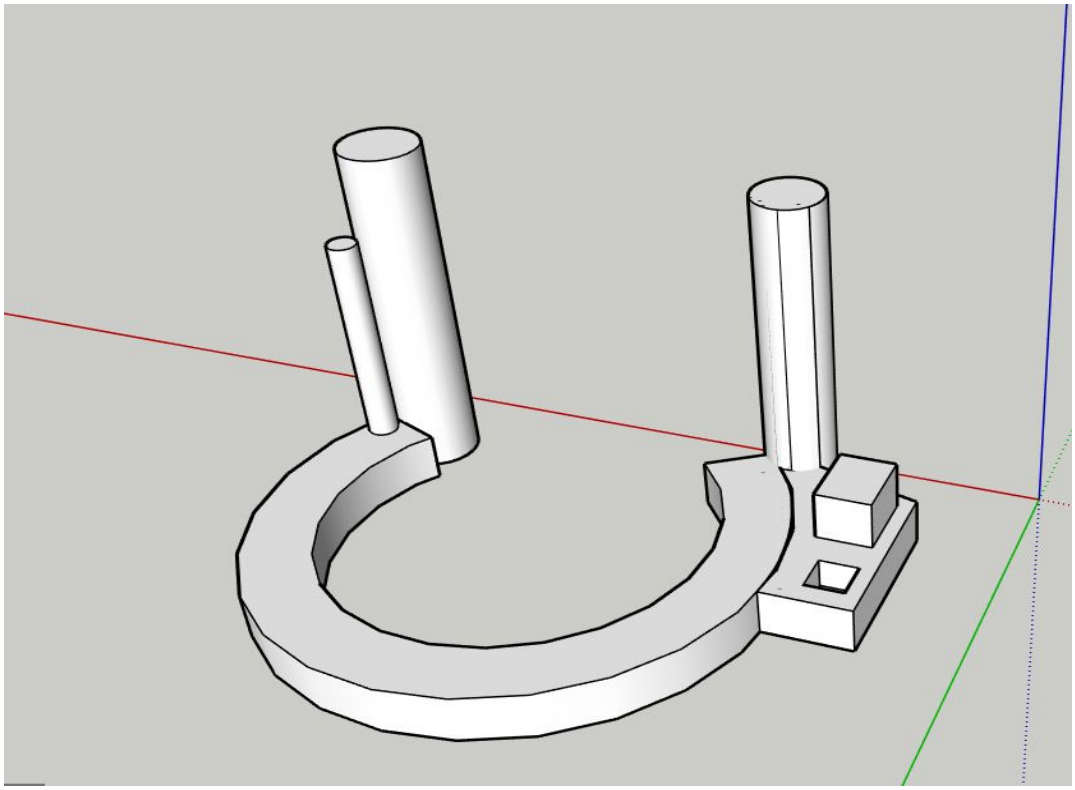
9.3 Conceptual Design

Phase 3: Conceptual Design	**Status:**
• Complete functional decomposition	To Be Done
• Brainstorm several possible solutions	Completed
• Prior Artifacts Research	Completed
• Create prototypes of multiple concepts, get feedback from users, refine specifications	Completed
• Evaluate feasibility of potential solutions (proof-of-concept prototypes)	Completed
• Choose "best" solution	To Be Done

Summary of Conceptual Design phase of design….

We have looked at pictures of other learning greenhouses, taking note of the layout of the plant beds, and we've started some rough designs for irrigation placement based off of those layouts and some ideas from our project partners.

The CEM design team is working on the design of the building while the Learning Center team has created a rough design for the rocket mass heater. CAD images of the seating and heater has been included above.



9.4 Detailed Design

Phase 4: Detailed Design	**Status:**
• Bottom-Up Development of component designs	To Be Done
• Develop Design Specification for components	To Be Done
• Design/analysis/evaluation of project, sub-modules and/or components (freeze interfaces)	To Be Done
• Design for Failure Mode Analysis (DFMA)	To Be Done
• Prototyping of project, sub-modules and/or components	To Be Done
• Field test prototype/usability testing	To Be Done

Greenhouse

The greenhouse team created an excel document to break down the pricing for each of the box layout designs chosen by our project partners. It analyzes the space available for planting vs how much each box would cost to build or buy for 3 different designs. The wood that will be used to build the boxes will be pine.

The team did some irrigation designs, including consultations from experts/greenhouse managers in the surrounding areas. We have pricing for different components of the system from several different suppliers.

Learning Center

The team has specified a few dimensions for the rocket mass heater so far. This is not a complete detailed design. The bench will be 20’’x20’’ in height and width, the outer arc length will be 45’10⅝’’. From inside to outside the seating will consist of a clay flue, a layer of cardboard on the sides and the top, ceramic fiber for the next 4 ft, a layer of bricks on the sides and the bottom, a layer of concrete rebar, a thin layer of clay, and a thin glaze on the outside. These design decisions have to be approved by a professional before moving on.

9.5 Delivery

Phase 5: Delivery	**Status:**
• Complete deliverable version of project including Bill of Materials	To Be Done

• Complete usability and reliability testing	To Be Done
• Complete user manuals/training material	To Be Done
• Complete delivery review	To Be Done
• Project Partner, Advisor, and EPICS Admin Approval	To Be Done

9.6 Service/Maintenance

Phase 6: Service / Maintenance	**Status:**
• Evaluate performance of fielded project	To Be Done
• Determine what resources are necessary to support and maintain the project	To Be Done