



Design Document

Team: Lakota

Project: Greenhouse

Date: 11/30/17

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2 Revision History

Date	Author	Revisions Made
09/29/17		Revision 1 Initial creation for mid-semester review
11/27/17		Revision 2 Adjustments for final review
12/6/17		Revision 3 Added transition document aspects and modified document aspects with new information

3 Design Status

Phase 6: Service / Maintenance	Status: <i>To be done</i> Semester: <i>To be done</i>
Phase 5: Delivery	Status: <i>To be done</i> Semester: <i>To be done</i>
Phase 4: Detailed Design	Status: <i>To be done</i> Semester: <i>To be done</i>
Phase 3: Conceptual Design	Status: <i>In Progress</i> Semester: <i>Fall 2017</i>
Phase 2: Specification Development	Status: <i>In Progress</i> Semester: <i>Fall 2017</i>
Phase 1: Project Identification	Status: <i>Completed</i> Semester: <i>Fall 2017</i>

4 Semester Documentation (Fall 2017 Mid-semester)

4.1 Team Members

Team Member	Year	Major	Role
Pheobe Appel	Sophomore	CHE – Chemical Engineering	Webmaster
Aimee Atakere	Freshman	FYE – First Year Engineering	Financial Officer
Jonathan Damon	Freshman	FYE – First Year Engineering	Team Member
Shamya Dey	Freshman	FYE – First Year Engineering	Project Archivist
Taihai He	Junior	CMPE – Computer Engineering	Team Member
Kendall Kyle	Junior	CIVL – Civil Engineering	Project Manager
Jacob Lundgren	Freshman	FYE – First Year Engineering	Design Lead
Brendan Proudfoot	Freshman	FYE – First Year Engineering	Team Member

4.2 Current Status and Location on Overall Project Timeline

Our team is in the process of developing rough design sketches and concepts to pitch to our partners. We hope these early designs will help get more specifications and details about the project. We have each drawn out personal designs keeping in mind the other specifications that we already have and will converge these ideas together to make more completed looking designs to show our partners. Also involved in our designs is the research that we have conducted all throughout the semester, even with the project direction shifts, most of the research is still helpful in design ing the rough details of a greenhouse. Once we have presented these ideas and gotten feedback for them, we can narrow down are specifications and do more tailored work.

4.3 Goals for the Semester

By the end of the semester we hope to have our rough designs completed and shared amongst all the members of all the teams for analysis. this way next semester’s people can look them over and analyze them to potentially help in their final design as well. Also we plan on providing a detailed transition document to help next semester’s Purdue team get started as quickly as possible and pick up where we left off.

5 Project Plan

5.1 Gantt Chart

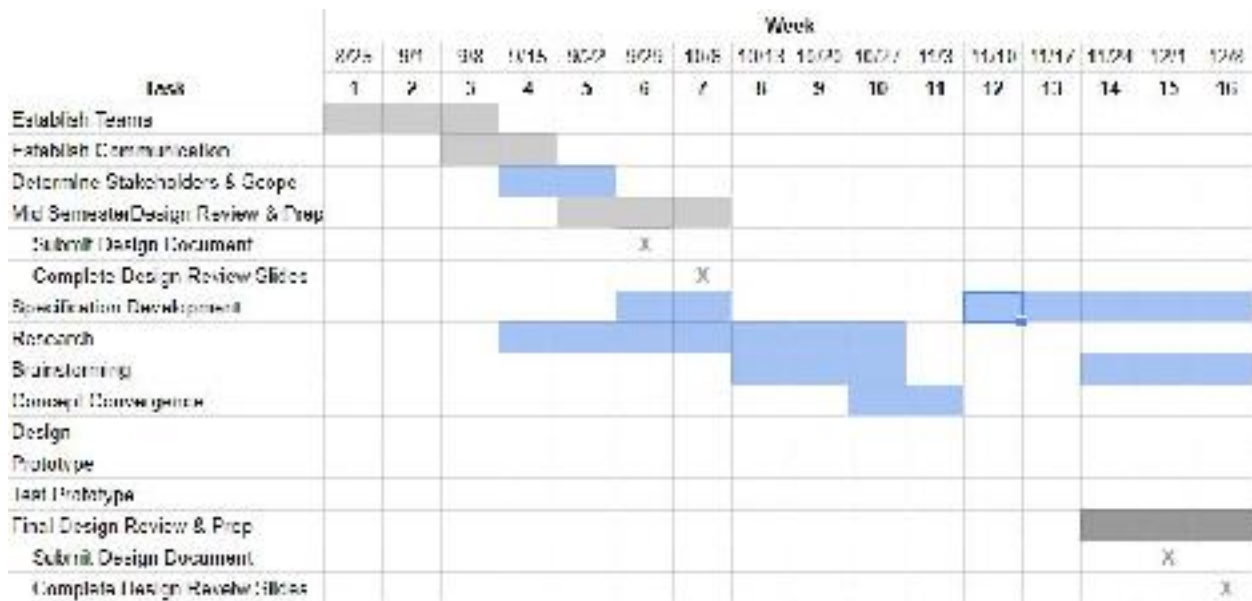


Figure 1. Fall 2017 Gantt Chart for the Greenhouse sub-team of the Lakota EPICS team.

This graph has changed over the course of the semester, in accordance to the project direction at that time

6 Project Identification

6.1 Description of the Community Partner

Our community partner are the residents of the Pine Ridge Native American Reservation, and we have paired with them to design a useable greenhouse-like facility. We will be working with the South Dakota School of Mines and Technology (SDSMT) and the Oglala Lakota College (OLC) on the multiple designs for the different stakeholders involved and the different design specifications that

these different stakeholders require. This project will directly benefit the community by providing them with an educational facility that will also cultivate plants pertinent to the culture and history of the area.

6.2 Stakeholders

Our stakeholders include the Oglala Lakota College (OLC) and the residents of the Pine Ridge Reservation. The Greenhouse team at Purdue's design will serve to benefit mostly the residents of the reservation by giving them a facility and learning environment to use for a cultural and educational benefit. While many of the potential uses for the facility are still not completely confirmed it is important to the stakeholders to have a learning environment inside of the facility. We do not have direct contact with the stakeholders themselves, but our partners at OLC do and have been helping guide the project through the providing specifications from the stakeholders.

Project: Greenhouse	
<i>Number</i>	<i>Stakeholder</i>
1	Residents of the Pine Ridge Reservation
2	Students at OLC
3	Members of the Lakota Nation located in Rapid City, South Dakota.

6.3 Social Context

The Lakota Native Americans are located on the Pine Ridge Reservation South Dakota and this reservation has been placed on untillable land. Because they cannot farm for themselves they are unable to feed themselves with food that comes from the reservation and the only place they can purchase food is a convenience store. Building a community center where OLC can teach their community members about this issue and about the traditional farming of their ancestors will help fix this issue. Through education of the community more awareness regarding this issue will be brought up.

6.4 User Needs

Project	Greenhouse	
<i>Number</i>	<i>User need</i>	<i>Stakeholder</i>

1	A center that will help the Lakota people preserve their history and culture	The tribes that make up OLC.
2	Durable enough to withstand the weather in South Dakota	The tribes that make up OLC.

6.5 Project Objectives

We are working with SDSMT and OLC to create greenhouses in which the residents of Pine Ridge and the Students at OLC will be able to learn about their culture and hold community gatherings. This will facilitate the Lakota Nation’s goal of educating their youth about their traditions and culture. The greenhouse will also be able to grow culturally relevant plants and provide a space for people from all over the community to come and learn and teach others about their culture and history.

6.6 Outcomes/Deliverables

By the end of this project the deliverables will include, one completed large greenhouse/cultural center, with a heavy focus on the cultural aspect, at OLC’s He Sapa campus in Rapid city. Additionally, a user manual detailing the design, construction, and required materials for the final structure. The purpose of this project is to give them a guide so they can build these greenhouses themselves rather than have a team of EPICS students producing a large number of greenhouses. Our community partner would like to be able to build the greenhouses themselves. Once the project is complete we hope that the individuals of Pine Ridge will have the knowledge needed to begin growing food for themselves and their family.

7 Specification Development

7.1 Benchmarking/IP

Large greenhouses are not a new idea, and plans for them 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 Dakotan weather. There wouldn’t be issues or barriers from intellectual property as we are not using any existing blueprints, instead designing a brand new design, which is focused on this particular situation. The proposed solution may or may not be potentially patentable based on a wide variety of factors and as we do not know the exact nature of what we are building it is difficult to determine if it is patentable.

7.2 Specifications

Project	Greenhouse		
<i>Number</i>	<i>User need</i>	<i>Specification number</i>	<i>Specification</i>
1	Be educational and able to help students to gain knowledge		
		1.1	Fits about a class worth of people in a space designated for learning
		1.2	Provide an area for elders to speak
2	Inside a size constraint.		
		2.1	40 ft * 40 ft
3	Cost-effective		
		3.1	Rough estimate 25,000
4	Durable enough to withstand the weather in South Dakota		
		4.1	Large hail ("baseball") 70 mph winds 100+ f degree weather snow pile up

8 Conceptual Design

Based on the fact that the specifications had been shifted after mid-term review, new brainstorming sessions were needed to meet new requirements for the greenhouse. After the trip to North Dakota, the requirements of our partner have been updated to date, while the specifications are still waiting to be concluded and confirmed. By meeting outside of the lab, the greenhouse team was able to come up with an updated timeline and a schedule about what can be done by the end of this semester.

8.1 Brainstorm

The greenhouse team has made some rough designs for the greenhouse according to the latest requirements. Some of the designs are based on the greenhouse examples that the team members have seen both at Purdue University and in North Dakota, and some are the ideas provided by our partners. Also, the researches we have done at the beginning of the semester were considered to specify the details of the designs. The designs are shown below and they are still waiting for the reviews & comments by our partners to help specify the details of the specifications and the requirements.

8.2 Low-Resolution Prototyping

(descriptions below)

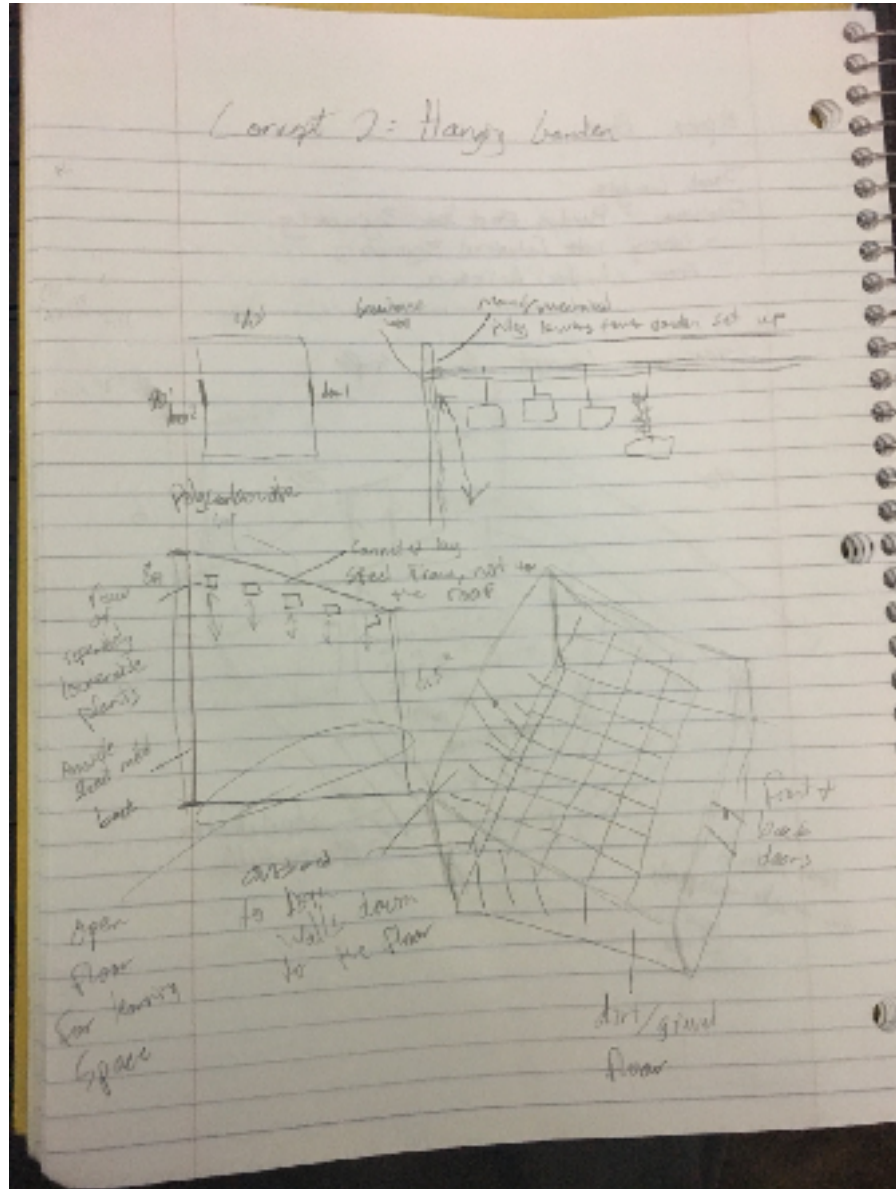


Figure 1 (above)

In this prototype, the greenhouse roof is slanted to the side to face the sun and provide an equal amount of sunlight to each of the suspended rows of plants at the ceiling of the facility. The goal of this design was to provide the entire floorspace of the facility to be open for the learning aspect of the specifications and have the plants connected to a pulley system from the ceiling. Each row is able to be lowered on its own, all the way down to ground level, so the plants can be taken care of and displayed at different times, whenever the user wanted to. They are hung up to the ceiling to receive the sunlight needed to grow, clear the floor-space for other activities, and to maximize both the amount of plants grown and space useable for the learning/cultural center.

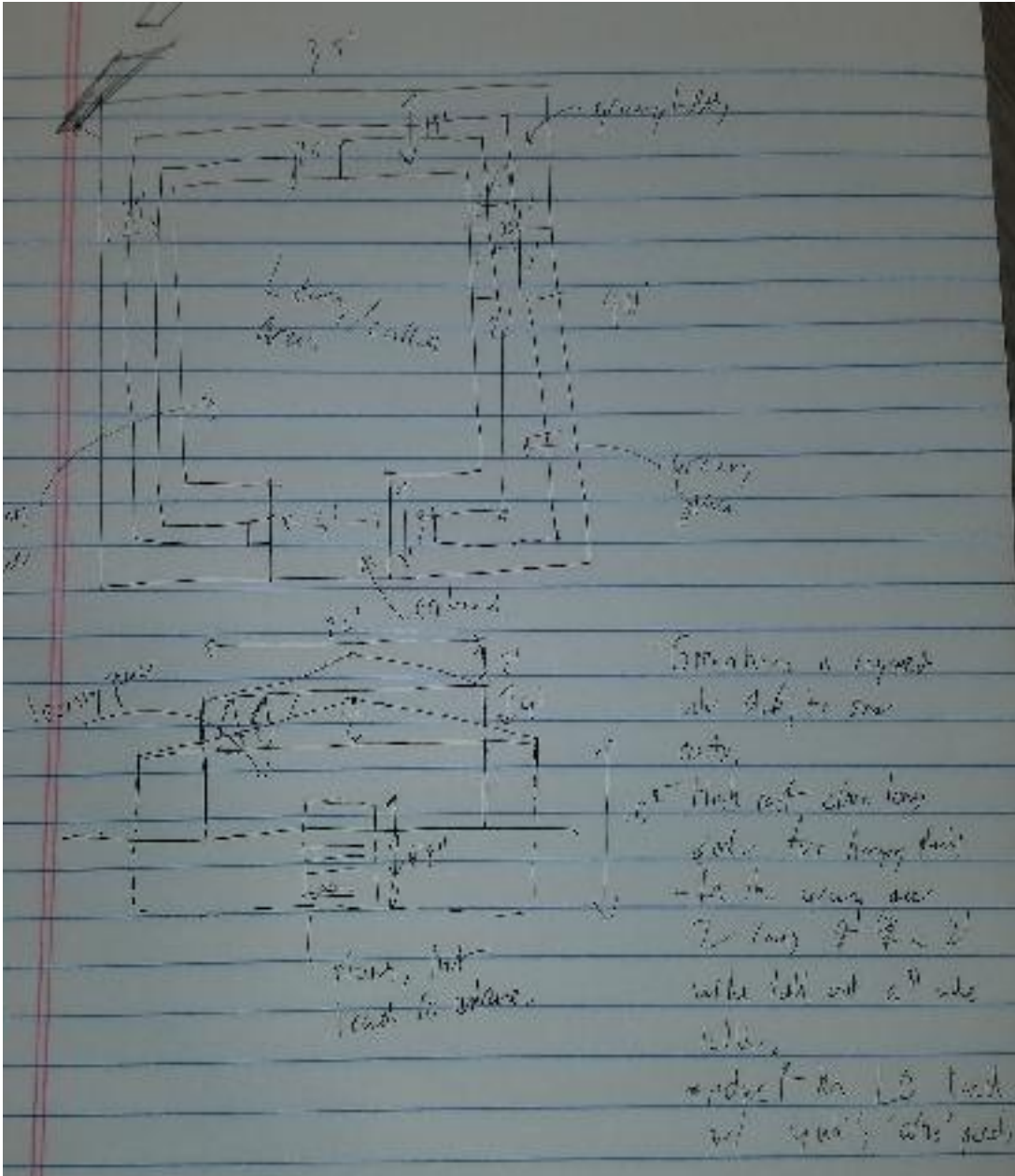


Figure 2 – Possible design of a large greenhouse. Drawn by Brendan

This structure is both a greenhouse and a learning center, with the two sections separated by panels made by a local artist, Yuki. Additionally, plants can be grown in hanging pot above the classroom part, due to the high ceilings. The building is recessed into

the ground to improve heating and cooling.

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
<ul style="list-style-type: none"> • Conduct needs assessment (if need not already defined) 	Complete
<ul style="list-style-type: none"> • Identify stakeholders (customer, users, person maintaining project, etc.) 	Complete
<ul style="list-style-type: none"> • Understand the Social Context 	Complete
<ul style="list-style-type: none"> • Define basic stakeholder requirements (objectives or goals of projects and constraints) 	Complete
<ul style="list-style-type: none"> • Determine time constraints of the project 	Complete

Summary of Project Identification phase of design....

The original project focused on the development of a large greenhouse to provide food sustainability to the people of Pine Ridge and specifications for this specific project focused on the production side of the greenhouse. Later in the semester the project shifted the Purdue team to focusing on small scale greenhouses and the partners at OLC and MINES focused on a large scale greenhouse. The small scale greenhouses were for individual use and were supposed to be easily made and rather inexpensive. Then we shifted focus to the exterior of a large scale greenhouse, size unknown, and making sure it could survive the harsh weather at Pine Ridge. Since knowing about the final direction, we intended to show designs to our partners to get feedback and gather more specifications.

9.2 Specification Development

Phase 2: Specification Development	Status:
<ul style="list-style-type: none"> • Understand and describe context (current situation and environment) 	Completed
<ul style="list-style-type: none"> • Create stakeholder profiles 	Completed
<ul style="list-style-type: none"> • Create mock-ups and simple prototypes: quick, low-cost, multiple cycles incorporating feedback 	Completed
<ul style="list-style-type: none"> • Develop a task analysis and define how users will interact with project (user scenarios) 	To Be Done
<ul style="list-style-type: none"> • Identify other solutions to similar needs and identify benchmark products (prior art) 	Completed
<ul style="list-style-type: none"> • Define customer requirements in more detail; get project partner approval 	To Be Done
<ul style="list-style-type: none"> • Develop specifications document 	To Be Done
<ul style="list-style-type: none"> • Establish evaluation criteria 	To Be Done

Summary of Specification Development phase of design....

Many of the specifications from these first three directions also carried over to the final project direction, the design of an entire larger greenhouse that focuses more on being an educational and cultural center for the people of Pine Ridge. The size of this greenhouse is still not 100% locked into place but the dimensions of 40'x40' have been discussed and implemented into early design sketches. The trip to Pine Ridge greatly improved our knowledge of the specifications for the greenhouse which we now know not to be heavily focused on growing plants and providing food to the people. Instead the primary focus of the greenhouse 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:
<ul style="list-style-type: none"> ● Complete functional decomposition 	To Be Done
<ul style="list-style-type: none"> ● Brainstorm several possible solutions 	In Progress
<ul style="list-style-type: none"> ● Prior Artifacts Research 	Completed
<ul style="list-style-type: none"> ● Create prototypes of multiple concepts, get feedback from users, refine specifications 	In Progress
<ul style="list-style-type: none"> ● Evaluate feasibility of potential solutions (proof-of-concept prototypes) 	To Be Done
<ul style="list-style-type: none"> ● Choose "best" solution 	To Be Done

Summary of Conceptual Design phase of design....

After settling on the large scale greenhouse/learning center idea we looked at the Thunder Valley greenhouse as a benchmark for design. While coming up with the specifications we need to keep in mind the harsh weather conditions and that it needs to be relatively simple to build. At this point, we are still coming up with the exact numerical specifications required and brainstorming different features, though we have created a few low- resolution sketches to assist with the brainstorming process and allow us to make progress before the smaller details are known.

9.4 Detailed Design

Phase 4: Detailed Design	Status:
<ul style="list-style-type: none"> ● Bottom-Up Development of component designs 	To Be Done
<ul style="list-style-type: none"> ● Develop Design Specification for components 	To Be Done
<ul style="list-style-type: none"> ● Design/analysis/evaluation of project, sub-modules and/or components (freeze interfaces) 	To Be Done
<ul style="list-style-type: none"> ● Design for Failure Mode Analysis (DFMEA) 	To Be Done
<ul style="list-style-type: none"> ● Prototyping of project, sub-modules and/or components 	To Be Done
<ul style="list-style-type: none"> ● Field test prototype/usability testing 	To Be Done

9.5 Delivery

Phase 5: Delivery	Status:
<ul style="list-style-type: none"> ● Complete deliverable version of project including Bill of Materials 	To Be Done
<ul style="list-style-type: none"> ● Complete usability and reliability testing 	To Be Done
<ul style="list-style-type: none"> ● Complete user manuals/training material 	To Be Done
<ul style="list-style-type: none"> ● Complete delivery review 	To Be Done
<ul style="list-style-type: none"> ● Project Partner, Advisor, and EPICS Admin Approval 	To Be Done

9.6 Service/Maintenance

Phase 6: Service / Maintenance	Status:
<ul style="list-style-type: none"> ● Evaluate performance of fielded project 	To Be Done
<ul style="list-style-type: none"> ● Determine what resources are necessary to support and maintain the project 	To Be Done

10 Transition Document Components

10.1 Cultural Importance of the greenhouse

From our South Dakota trip we gained a better understanding to what OLC wanted from this greenhouse. After hearing OLC discuss their culture and the greenhouses important they stated that rather than focussing on the actual food production aspect they wanted the greenhouse to be more of a learning classroom environment where they could teach the children of their community about the Lakota ways (things like traditions foods that they grew). They also wanted the classroom space to double as a sort of community meeting area for the elders to give speeches.

10.2 Description of Location



- This greenhouse is expected to be placed next to the OLC campus in rapid city.
- There is a church next to the campus that has assumed this land to be theirs for sometime and are not too willing to part with it at the moment.
- A survey is going to be held to figure out the ownership of the land. OLC believes the church should finance the survey.
- A survey marker was found on site and the surveyor was contacted. OLC later received documentation of the past survey that was done on the property showing that the land did in fact belong to them.