LAKOTA Fall Design Review

December 7th, 2018

EPICS

This work is the combined effort by the students from Purdue, SDSMT and OLC.

Our Projects

- Design and build a cultural education **greenhouse** that will be home to a diversity of traditional cultural plants used as food and medicines

- Design and build a **learning center** to serve as a cultural hub station to strengthen STEM education, Research, Lakota culture, Lakota Language, Science, IT and Engineering

Partnering Universities

SOUTH DAKOTA
SCHOOL OF MINES
& TECHNOLOGY

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Community Partner Information

Food Desert: An area where either a substantial number or share of residents has low access to a supermarket or large grocery store (USDA)

- 80% limited access to grocery stores
- 95% of food from off-reservation sources
- Food cost 10% higher

Stakeholders

Number	*Stakeholder*
1	Residents of the Oglala Sioux Tribe (Pine Ridge Reservation)
2	Students at Oglala Lakota College (Nine OLC Centers)
3	Members of the Lakota Nation located in Rapid City and Kyle, South Dakota.

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Social Context & The Trip to Pine Ridge

Greenhouse

Team Members: Purdue - GH

Marshall Beard
First Year
Engineering

Peter Chung
First Year
Engineering

Bridget Fitzgerald
First Year
Engineering

Bryce Hines
First Year
Engineering

Team Members: Purdue - GH

Katie Johnson
First Year Engineering

Kirit Khanna
Design Lead
Computer Engineering

Thao Nguyen
Project Partner Liaison
Chemical Engineering

Greenhouse Visit

- Visited Purdue College of Agriculture greenhouses
- Toured the facility & gained expert knowledge of running a greenhouse
- Advice:
  - Daily walkthroughs of the greenhouse is necessary
  - Given constrained budget, concrete floors would be too expensive, so material like gravel should be used instead
  - Cheap options to maintain the greenhouse include using a garden timer, ~$50, and soaker hoses or custom drip irrigation lines

Potential Irrigation

Approximate cost of key components:

- timers ($37 each)
- backflow preventers ($10 each)
- pressure regulators ($20 each)
- filters ($20 each)
- tubing adapters ($2 each)
- emitter stakes (100 for $30) **(top right picture)**
- dribble tube dramms ($.59 each) **(bottom right picture)**
- 1 inch tubing ($75 for 250 feet)
- ⅛ inch tubing ($13 for 500 feet)

General idea is connect small lines with emitters to a larger tube running through the beds **(left pictures)**

Frostline and Pipes Freezing

Frostline is 3-5 feet below ground surface.

Ice expands up to 9% by volume, and exerts between 25,000 and 114,000 psi, depending on the specific environment. And if the melting point (or freezing point) is lowered by large increases in pressure, the increase in volume on freezing is even greater (for example 16.8% at -20°C (-4 F)).

The best ways that we could prevent water from freezing is to:

- Keep the water running/dripping
- Insulate the pipes esp. lateral (we will most likely do this with something else)
- Drain water from unused lines

Pipes usually fail when frozen at a connection point as they are generally much weaker that the pipes themselves.

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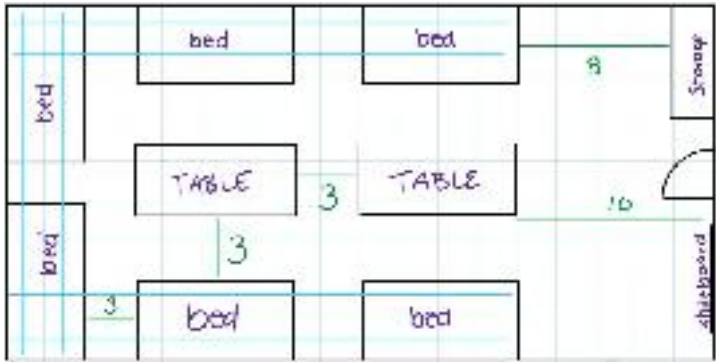
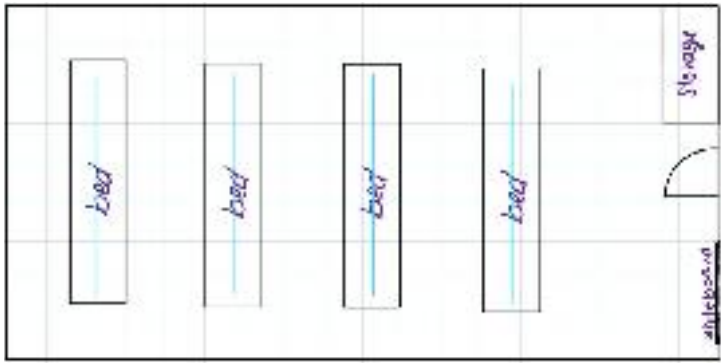
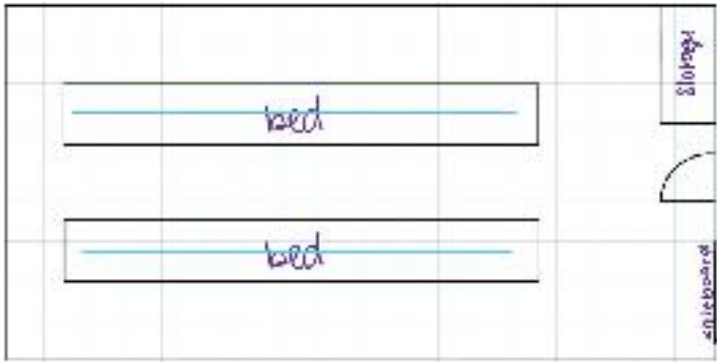
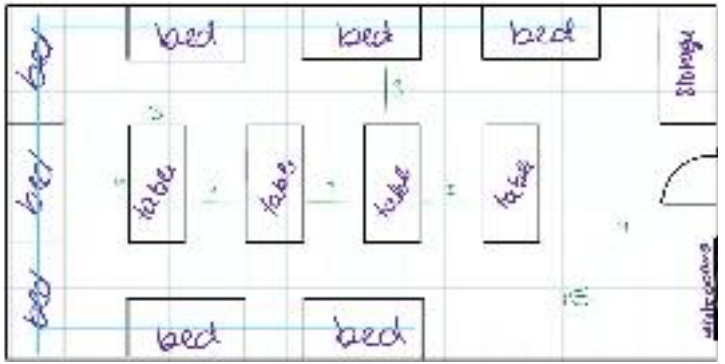
Preliminary Designs









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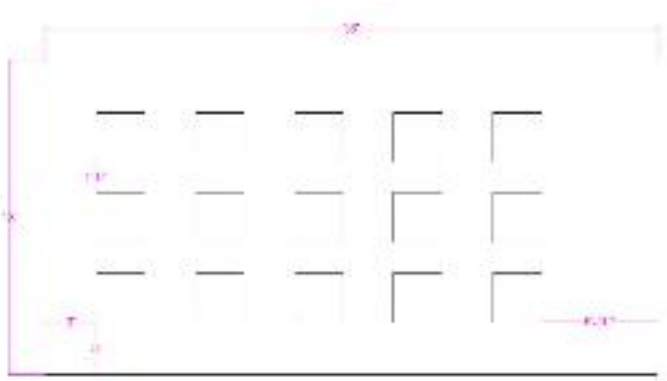
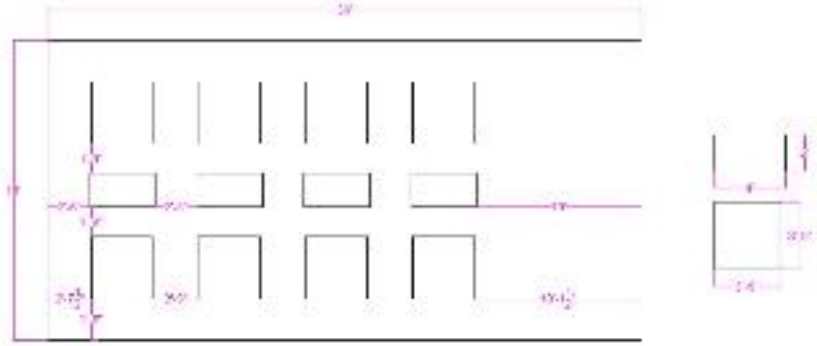
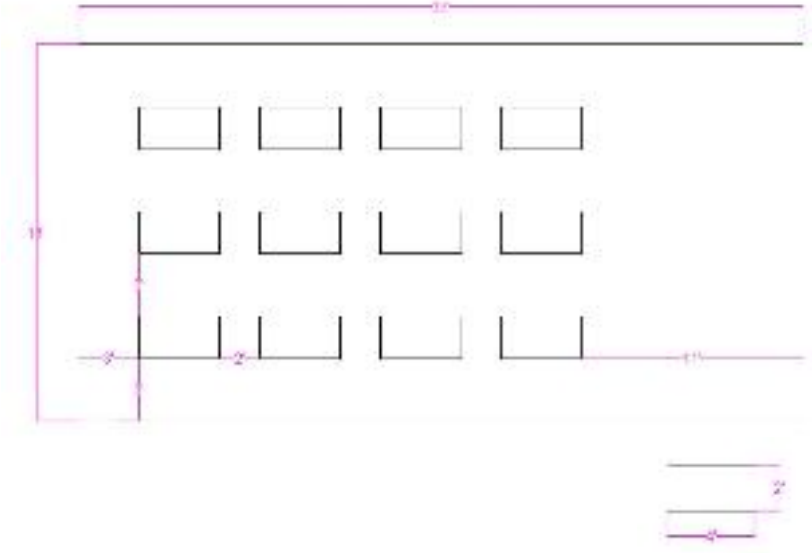
Preliminary Designs by OLC







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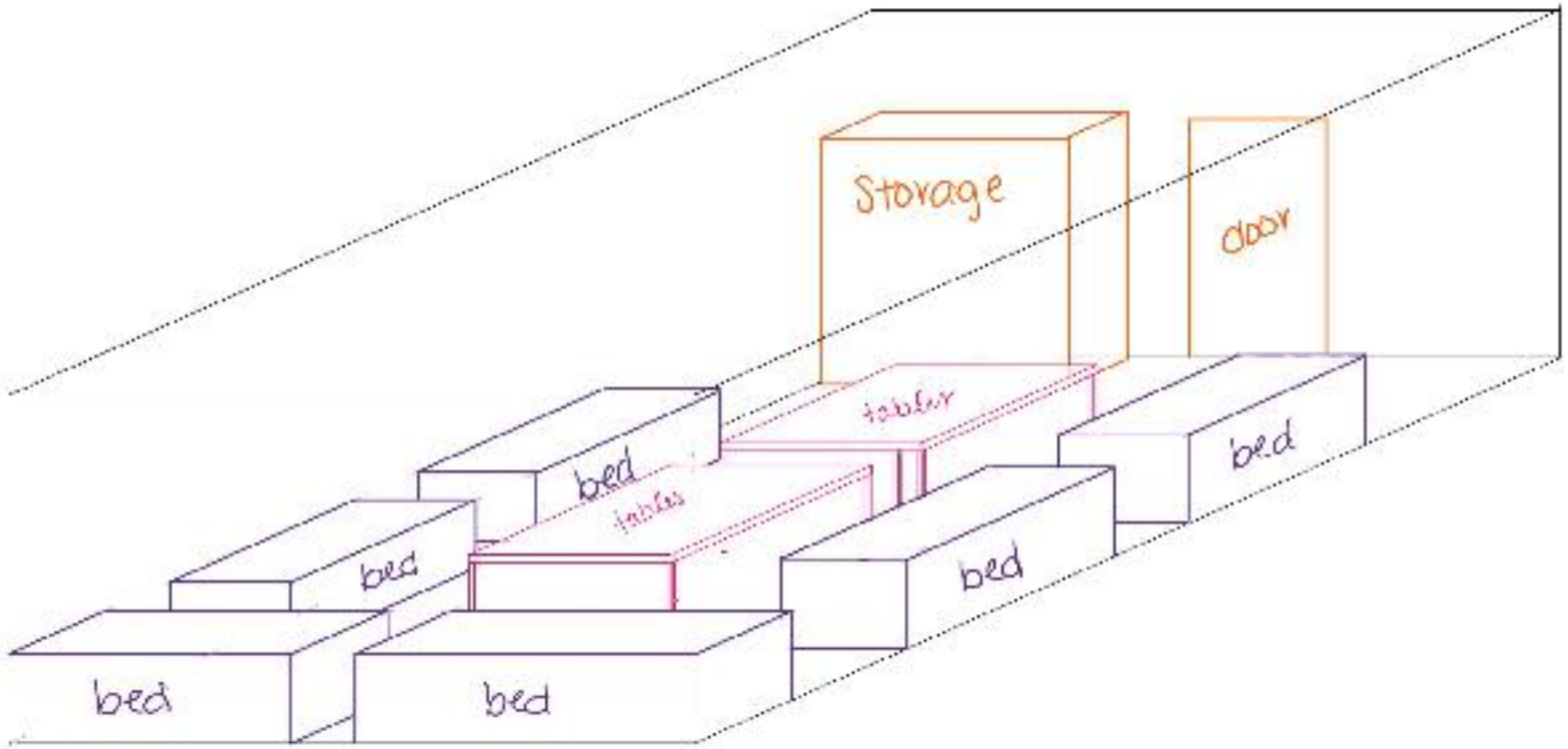
Preliminary Design in 3D



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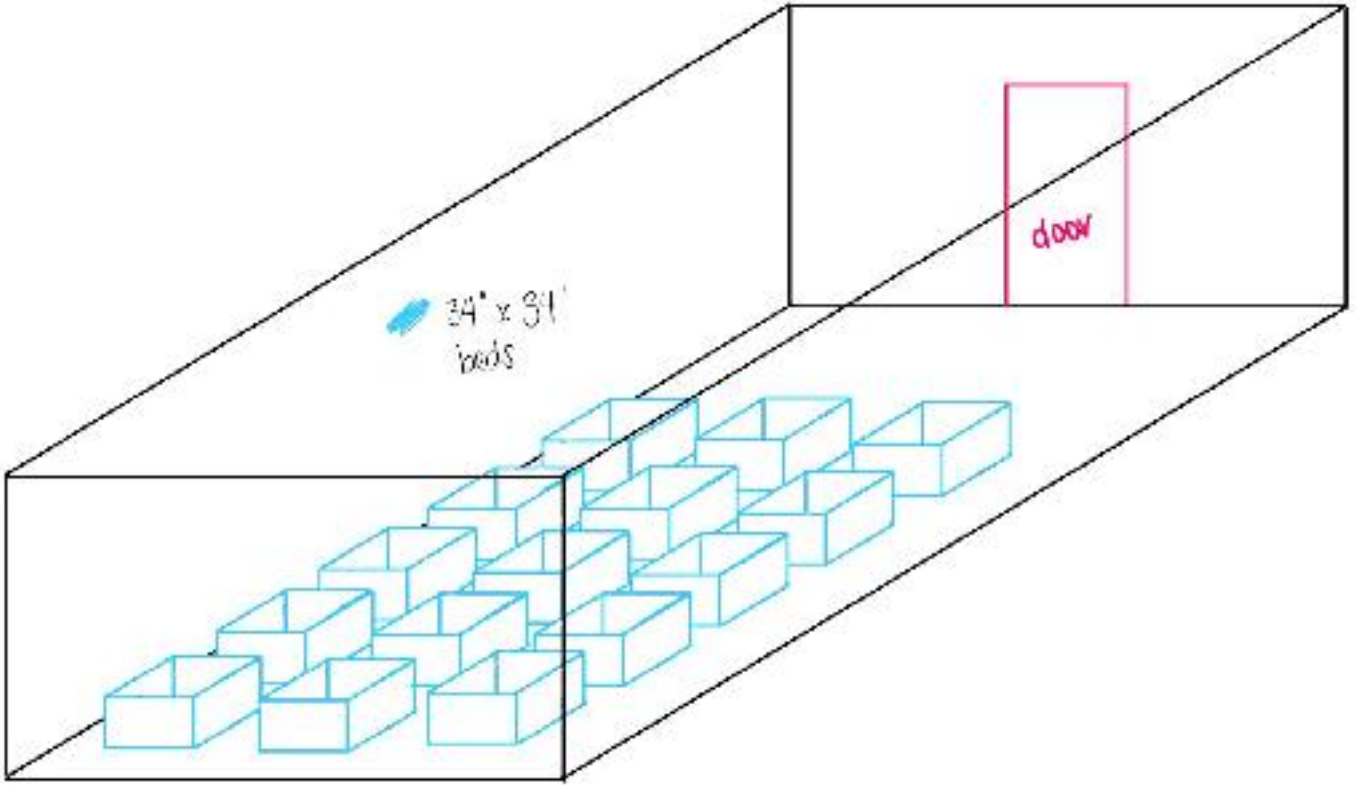
Preliminary Design in 3D



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Bed Cost

BED	Width(in)	Length(in)	Size(ft) / unit	Number	Cost per Unit	Growing Area Total	Total Cost	Price per sqft
Menards								
24x48 only (8" height)	24	48	8	12	85.88	96.00	1,030.56	10.74
34x34 only (8" height)	34	34	8.03	15	29.99	120.42	449.85	3.74
	45	45	14.06	8	29.99	112.50	239.92	2.13
	24	48	8	4	85.88	32.00	343.52	10.74
45x45 and 24x48 combo (8" height)				12		144.50	583.44	4.04
Hand-Built								
24x48 only (6" height)	24	48	8	12	49	96.00	588.00	6.13
Lowes								
20x21 only(10" height)	20	21	3.33	12	29.98	40.00	359.76	8.99
24x24 only(5" height)	24	24	4	18	67.72	72.00	1,218.96	16.93
24x48 only (8" height)	24	48	8	12	85.88	96.00	1,030.56	10.74

Greenhouse Inclusions

- Tool chest/shelf
  - Hand spade, shovel, gloves
  - Watering Cans
  - Whiteboards
  - Books
  - Instruction Manual
- Bulletin Boards
  - Plant information
  - Greenhouse conditions
- Workspace
  - Tables, chairs
  - Pathway

Error Instruction Manual

- The Error Instruction Manual (EIM) will be decided once we've specified the plans of the greenhouse, which includes irrigation and plant layout
- There will be both an electronic and paper manual.
  - The electronic manual will be in PDF form and will be accessible to everyone associated with the project. We will continue to update this on our end, and because it's electronic it'll be updated at the greenhouse location as well.
  - There will be two paper manuals: one will be situated inside the greenhouse itself at an easy-to-access location and the other will be at the closest workspace, to serve as a backup.
- The contents of the manual will be about some common errors that may occur in the greenhouse and methods to solve them
  - For example, if there are any irrigation problems that may occur during the winter, those will be mentioned in the manual

Final Greenhouse

Junior Teaching Package Greenhouse

- 18 ft x 36 ft x 10.5 ft
- Comes with:
  - Fan
  - Fan shutters
  - Heater
  - Insulated door
  - Thermostat
- Utilities to be connected
  - Gas
  - Electric

CEM Greenhouse Overview

- **Selection**
  - 2 Proposals sent to OLC
  - OLC requested different option
  - Junior Teaching Greenhouse Selected
- **Installation**
  - **Greenhouse Megastore**
    - Foundations (Concrete Piers)
  - **OLC Vocation Education**
    - Assembly of Structure
    - Electrical Hookup

Budget	
Line Item	Cost
Greenhouse	$15,396
Foundations	$16,700
Electrical	$3,000
Gas	$2,000
Contingency	$1,500
Total	$38,596
Available Funds	$65,000

Existing Site

Greenhouse Site Plan

Final Review Feedback

- Movable beds
- Parameters about number of people that could fit
- Lil Dan

Learning Center

Team Members: Purdue - LC

Jacob Lundgren
Civil Engineering

Abigail Thompson
First Year Engineering

Team Members: Purdue - LC

Aimee Atakere
Chemical Engineering

Sami Bijonowski
Civil Engineering

Russell Kim
Financial Officer
First Year Engineering

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Project Direction

- Working with Purdue CEM Senior Design to design a structure on OLC's Rapid City Campus
- Purdue EPICS team:
  - Past Semesters- gather specifications from partners
  - Relay info to CEM Team
  - Focus on interior's seating/heating
    structure: Rocket Mass Heater

Purdue NAECC and other Benchmarks

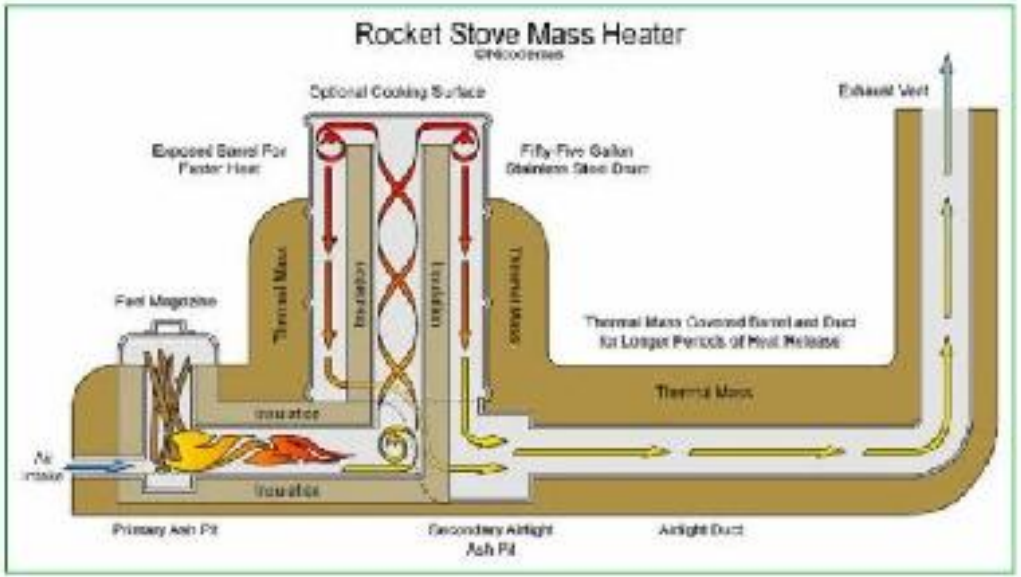
Native American Educational and Cultural Center

- Meetings, classes, studying, events
- Coded backdoor when no staff working

Interior Design: Talking Circle

- A bench in a semicircle shape
- Centralized location in building design
- Permanent Seating Structure that is heated by the Rocket Mass Heater
- Use: small classes, gatherings

Rocket Mass Heater: Definition



- Cost efficient
- High burning efficiency
- Designed to eliminate smoke

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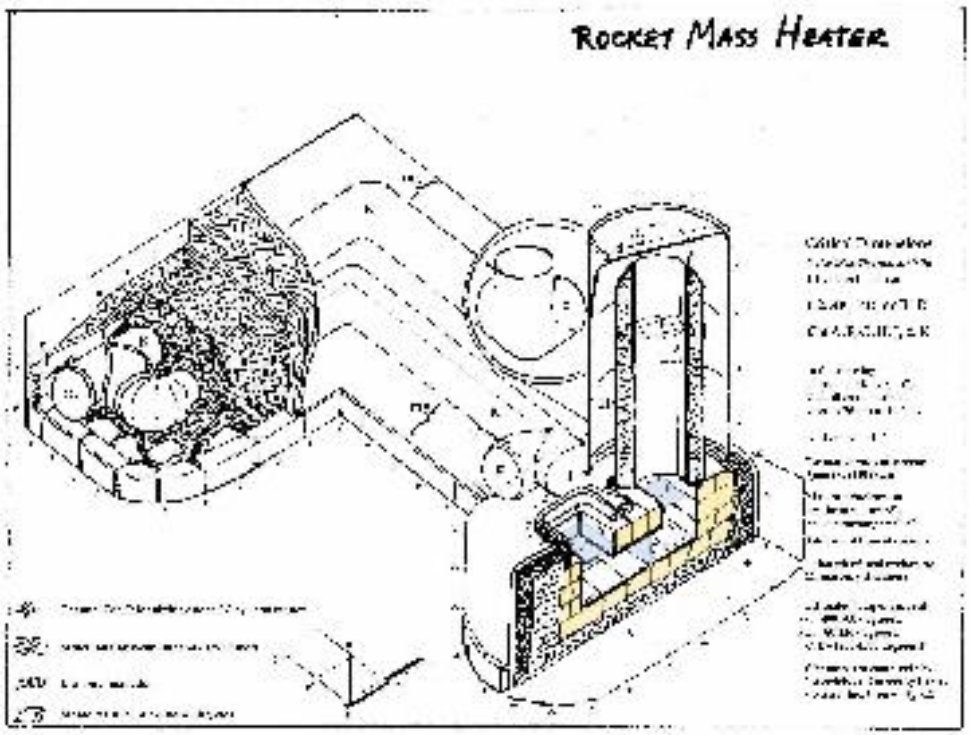
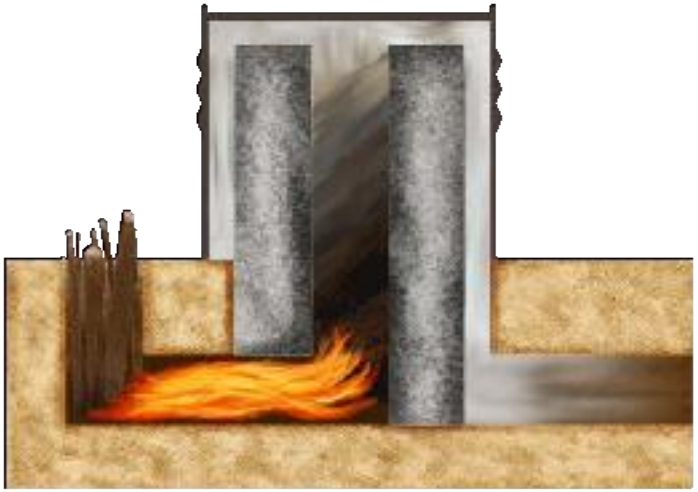
Rocket Mass Heater: Basic Structure





Parts:

- Metal Barrel
- Cob*
- Horizontal flame
- Standing sticks
- Chimney
- Core*
- Clean out
- Burn tunnel

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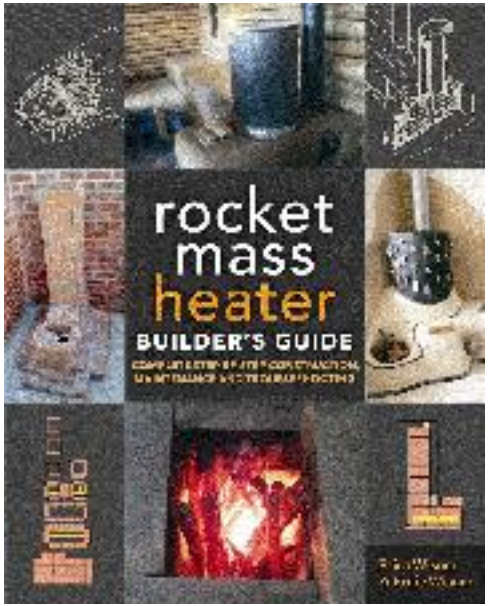
Rocket Mass Heater: Design Process

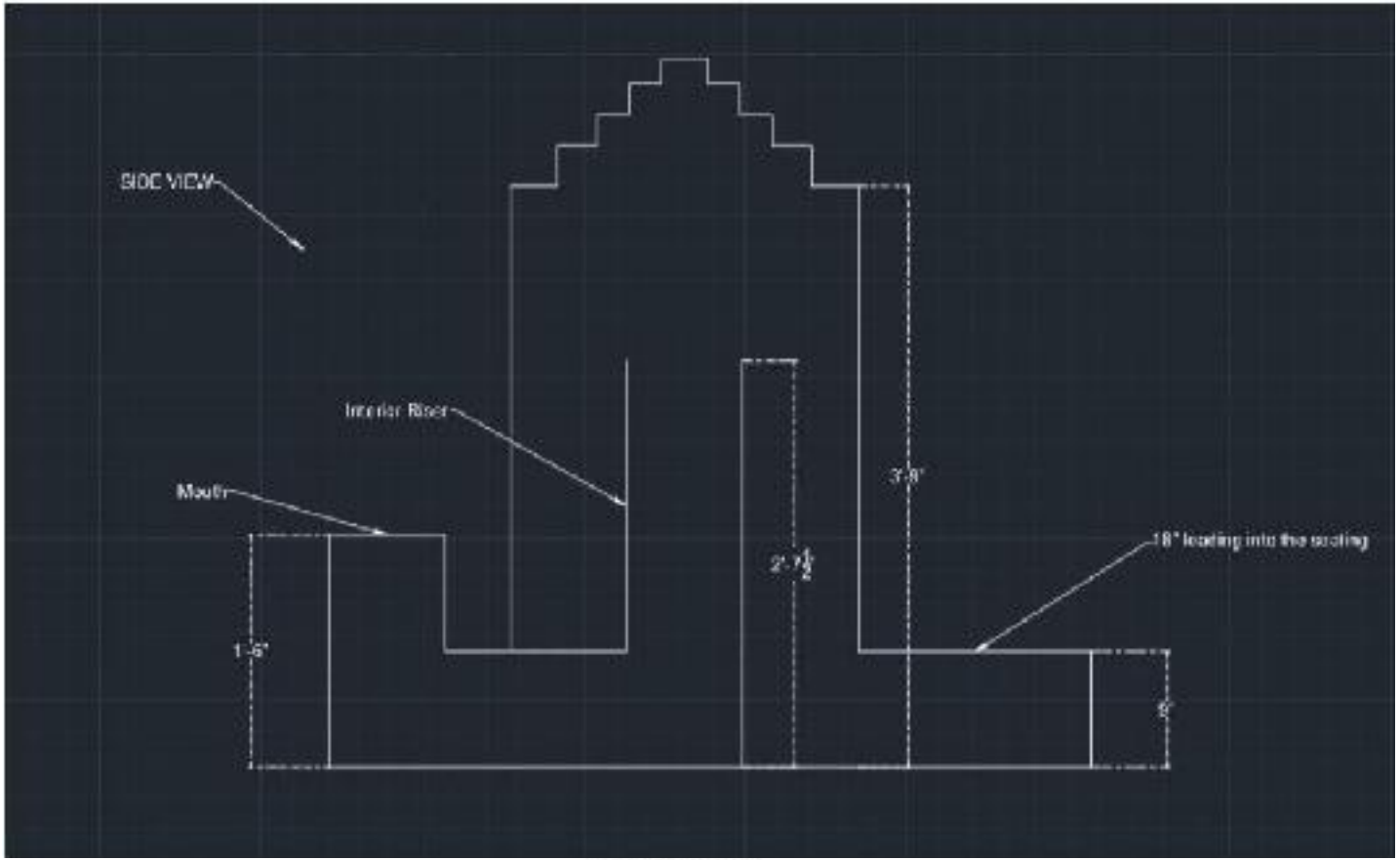
- Initially considering
  - Barrel
  - Slanted feed tube
  - Piping
  - Double-back piping
- Research
  - Rocket Mass Heater Builder's Guide



Masonry Advisement

- Representative from the Masonry Heater Association of North America
- Great amount of experience with combustion heaters
- Providing Design considerations and alternatives to our original conceptual design

Rocket Mass Heater: Final Design



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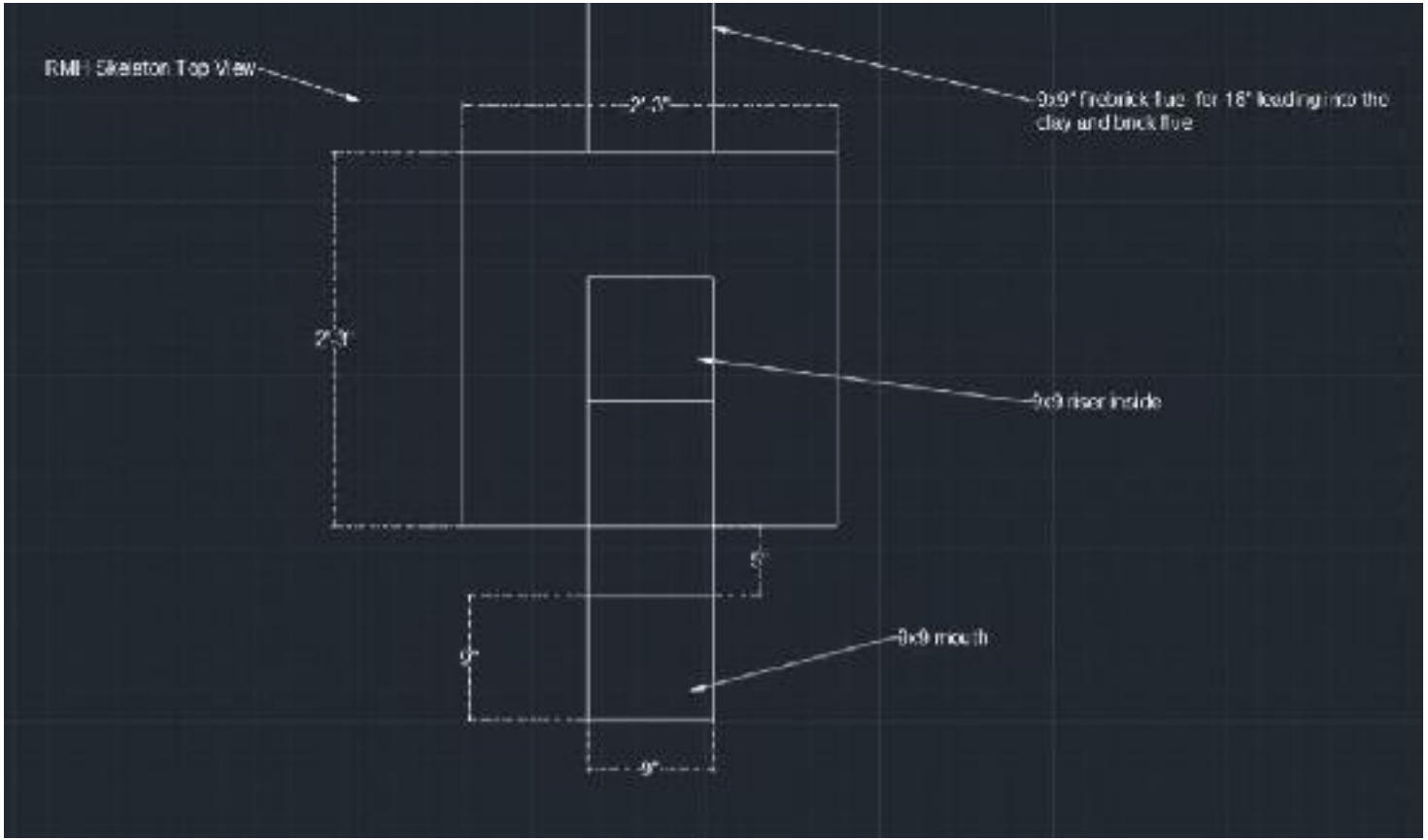
Rocket Mass Heater: Final Design



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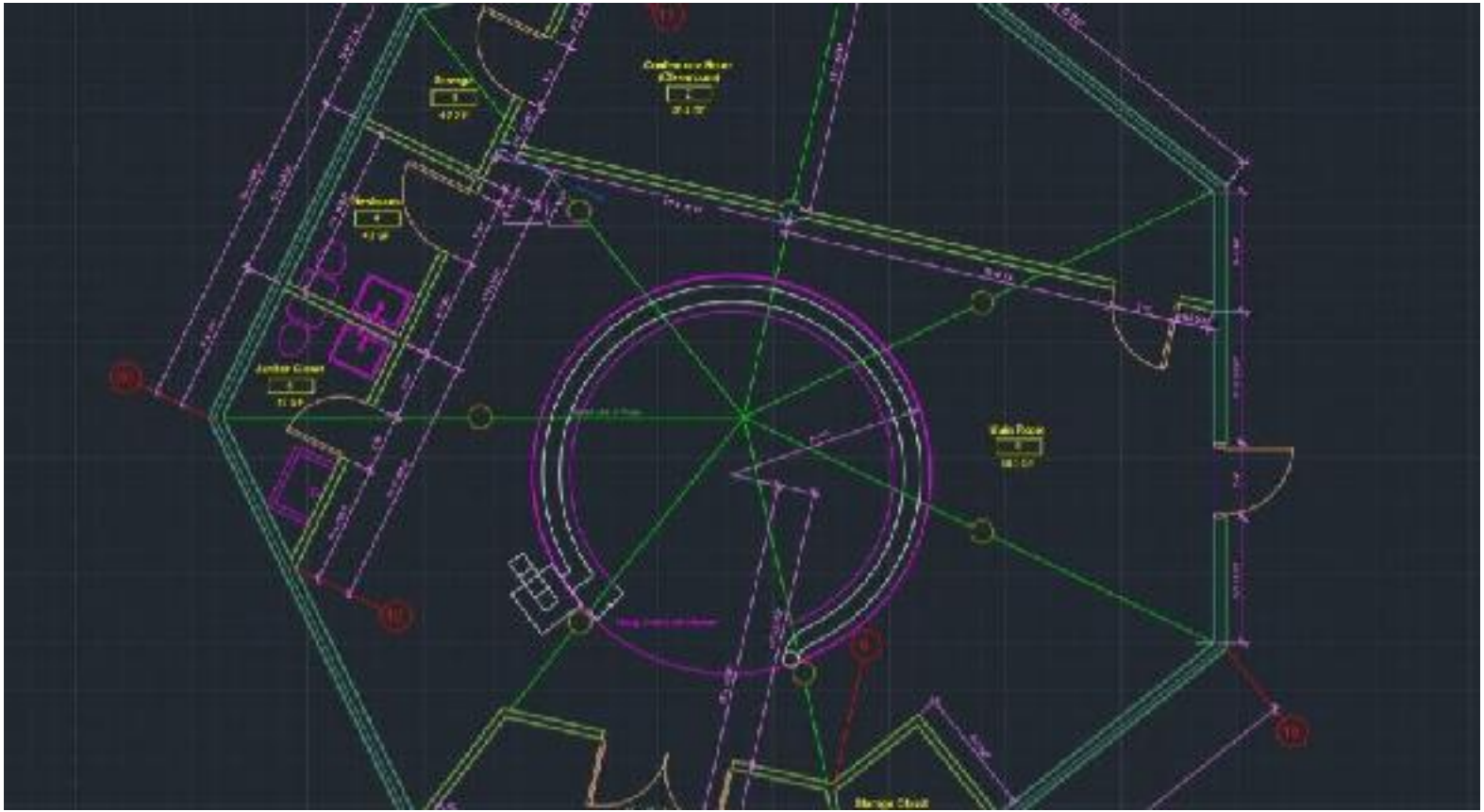
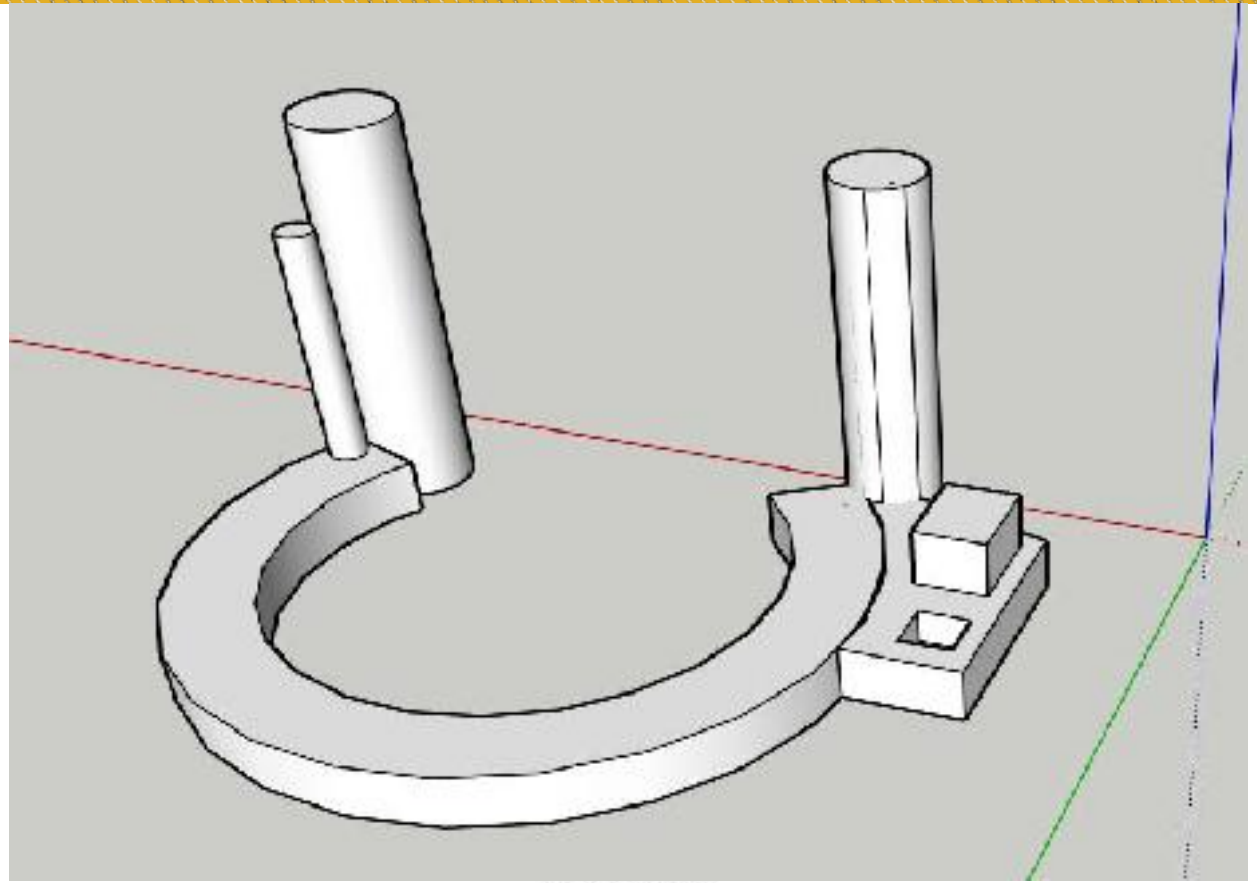
Rocket Mass Heater: Final Design



Rocket Mass Heater: Final Design Model

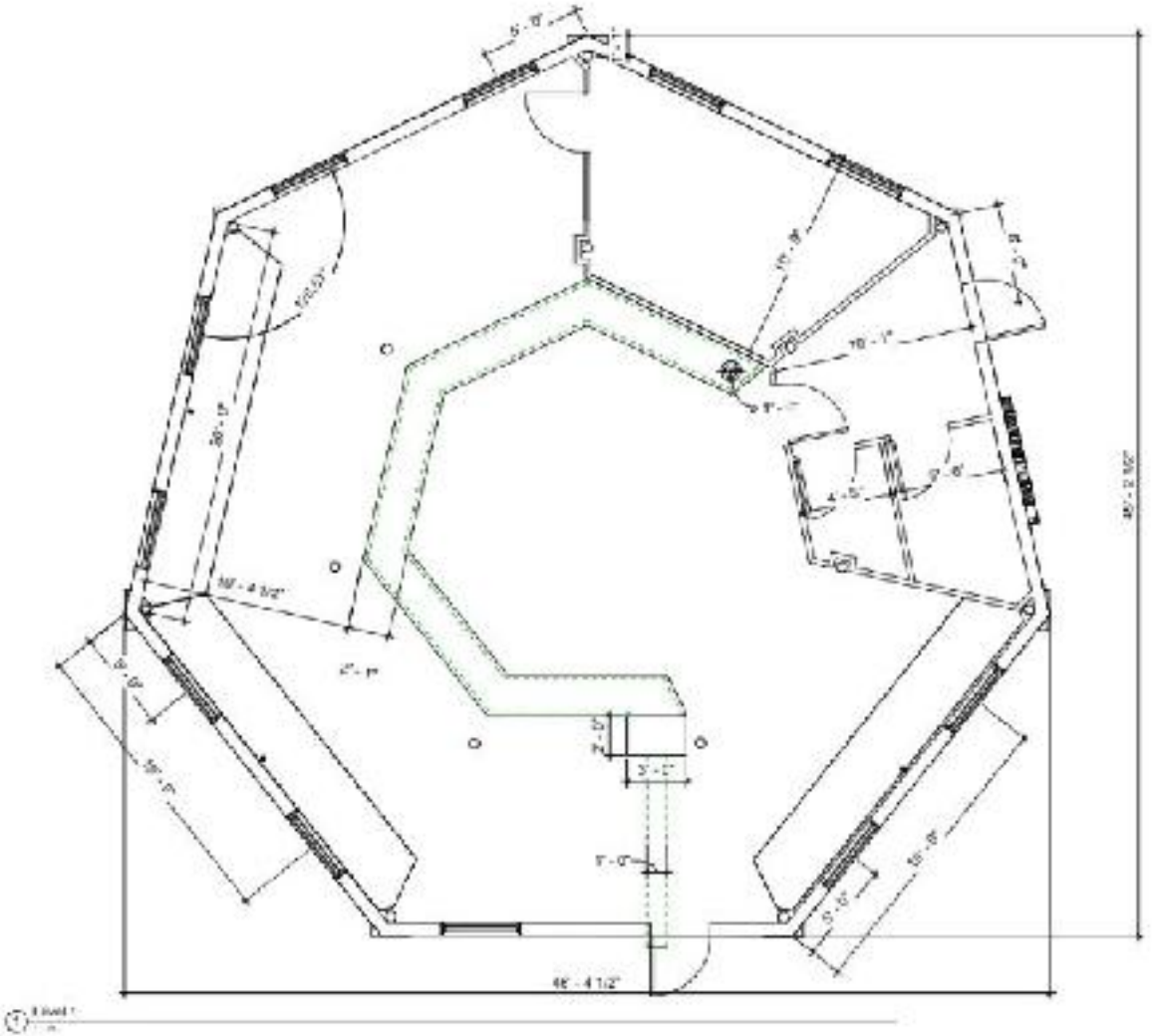


Rocket Mass Heater: Next Semester

- Technical design improvement and approval
- Evaluate life and maintenance
- Cost Estimate
- Aquaponics - addition to the seating structure

CEM Learning Center Progress

- Developed programming to assess OLC's needs
- 2 detailed designs for OLC to choose between
  - Structural / Architectural ready for PE review
  - Remaining scopes due to be completely early next semester
- ~70% Construction Budget for both designs



CEM Outlook for Next Semester

- **Greenhouse**
  - Finish greenhouse permitting process
  - Coordinate the installation of the greenhouse / accompanying utilities
  - Substantial Completion on track for March of 2019
- **Learning Center**
  - Learning Center to 100% design
  - Complete permitting documentation for Learning Center

Questions?