IPRO 325
Affordable and Sustainable Quality of Life Improvements for World’s Poor

Dorothy Collins - Materials Science and Engineering
Lindsay Drabek - Biology
Jeffrey Hallenbeck - Architecture
Young Jung - Architecture
Mark Kimball - Mechanical and Civil Engineering
William Lange - Architecture
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Yong Jae Park - Architecture
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Professors:
Margaret Huyck
Ken Schug
Timeline

Phase 1  
(February 9 - March 4)

Phase 2  
(March 16 - March 30)

Phase 3  
(March 30 - April 23)
# Work Structure

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<thead>
<tr>
<th>Phase 1</th>
<th>Design</th>
<th>Research</th>
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Huancavelica, Peru

Climate
Oceanic currents create very unstable conditions.

Health
Poisoning from the wood burning stoves is common.

Poverty
80% of Huancavelica is considered in poverty.
Goals

Heating
Provide heat to promote general health.

Knowledge
Teach native Peruvians why this is important (manual).

Cost
Due to extreme poverty low cost and local materials are a must.

Low Emissions
Decreasing mortality rate from poisonous fumes.

Heating Efficiency
Decrease need for fuel to slow deforestation.
Precedents

Ondol
Korean wood burning stove used to heat house.

Wood Burning Stoves
German, Russian, and Chinese designs.

Radiant Heating
Hot water running through pipes to heat a space.

Previous IPRO 325 Groups
Structural development, roof design, and some research into heating.
Adobe Composition

Team’s Adobe Composition = 4 Parts Sand + 2 Parts Clay + 1 Part Water + 1/2 Part Straw + 1/2 Part Soil
Design Intent

**Weak Draft**
- Smoke shelf and damper obstruct and cool exhaust flow, reducing draft strength.
- Turbulent mixing of room air and gases slows draft.

**Strong Draft**
- Removal of smoke shelf and use of a chain-operated damper creates better exhaust flow, increasing draft strength.
- Straighter exhaust path minimizes mixing of combustion gases.

**Poor: Cold Chase**
- Uninsulated exterior chase.
- Chimney temperature lower than house temperature.
- Downdrafting occurs, cold outside air is sucked down by house.

**Better: Insulated Chase**
- Insulated chase ventilated with warm interior air, keeps chimney temperature close to room temperature.

**Best: Central Location**
- Centrally located hearth keeps chimney warm without ventilation and penetrates roof at highest point.
Design Basis
Designs

#1

#2
Testing Objectives

Analysis of stoves was mainly based on

Efficiency
   The amount of time it took to boil water

Heat retention
   Based on frequently measuring the temperature of various points on the stove during and after burning

Effectiveness of smoke exhaust
Results

Design # 1

Showed no problems exhausting smoke, boiled water in 50 minutes, and retained significant heat for over 90 minutes.

Design # 2

Showed significant problems correctly exhausting smoke such that the experiment had to be ended prematurely.

Temperature of various points on stove during test
Wood burn Stove Design #1

Water temperature during test
Design #1
Problems

Scale
Testing at 1/4 scale vs. performance at full scale

Design #1
Must be built into a new structure.

Design #2
Drafting problems cause excessive smoke.

Team Restructuring
First two weeks lost from lack of organization
Ethics

Cost
    People are in extreme poverty.

Local Materials
    Adobe is a commonly used material for current construction.

Integrity
    Honest testing and representation of results.

Team Contributions
    Work was equally divided amongst group members.

Contacts
    Provided cultural information about the region.
Summary

Implementation
  Resources are readily available to accomplish designs.

Health
  Improved IAQ to help prevent illnesses.

Advantage
  Combining stove and heating element.

Knowledge
  Manual will teach Peruvians how to properly exhaust fumes.
Next Step

Rigorous use to determine long-term durability.

Covering the front opening to improve efficiency.

Adjusting the height of the fire to determine optimal height.

Test outside of a laboratory for a less controlled situation.

Full-scale testing to provide more accurate information.

Provide a damper for a more control over the draft.

Improve efficiency for heating, cooking, or both.
Questions?