

# IPRO 325: Affordable and Sustainable Quality of Life Improvements for the Worlds Poor

## Innovative Roof Design



# The Team

<b>Lulu Al-Awadhi</b>	<b>4th Year Architecture</b>
<b>Louis Fernandez</b>	<b>4th Year Architecture</b>
<b>Dan Rankin</b>	<b>5th Year Architecture</b>
<b>Jacob Williams</b>	<b>5th Year Architecture</b>
<b>Richard Rokita</b>	<b>3rd Year Mechanical Engineer</b>
<b>Maruja Yoshimura</b>	<b>4th Year Chemical Engineer</b>

# The Problem: Fraije

**Winter of 2009**

- State of emergency due to extreme cold**
- Temperatures reached -22 C (-7.6 F)**
- Death of approximately 250 children**
- Thousands suffered from acute respiratory infections and pneumonia**
- Malnutrition intensifies**
- Death of livestock**



# Objective

## **Improve existing shelters Through an innovative roof design**

- Increase insulation of roof**
- Improve roof structure**
- Reduce air infiltration**
- Prevent roof leakage**



# Location: High Altitude, Cold Weather

**Model location:**  
**Mountain Highlands**  
**(i.e. Langui, Peru)**

**Temperature range:**  
**34° – 70° F**

**May – October**  
**Dry Season**  
**Hot days, cold nights**

**November - April**  
**Wet Season**  
**Mild temperatures**  
**Heavy Rain**



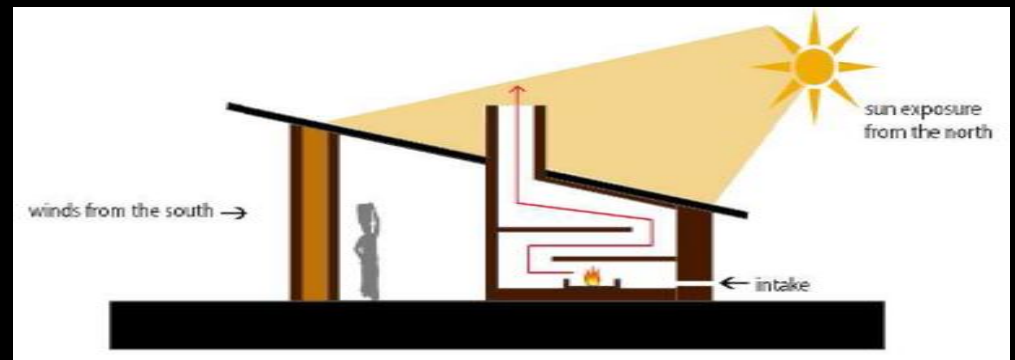
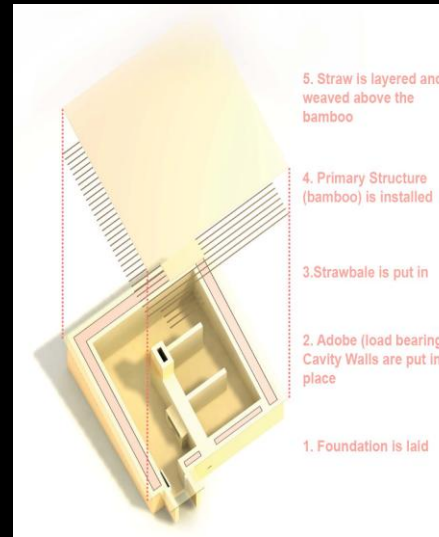
# Last Semesters Project

-Conceptually design a adobe house to withstand friaje

-Uses locally available materials

-Lacked detail

-Project scale to large to implement





# Actions being taken

- Adventist Development and Relief Agency (ADRA)
- United Nations Children's Fund (UNICEF)
- Practical Action
- Poor connections between materials



# Current Roofing Methods

- Single sheet of corrugated metal
- Sometimes a secondary beam structure is included
- No insulation
- Poor connections between materials





# Ethics and Design Constraints

- Inexpensive
- Uses locally available materials
- Design can be taught to locals
- Can be built by unskilled labor
- Requires no special tools
- Design Lifespan



# Structural Concerns

- Snow loads
- Heavy wind
- Supporting roof on existing adobe walls



# Materials

**Materials that are locally available**

**Framing Materials:**

**Bamboo or Eucalyptus**

**Fastenings:**

**Leather Strips, Rope, Nails**

**Roof Covering:**

**Corrugated Sheet Metal, Clay tiles**

**Insulation Materials:**

**Straw with Clay Binding**

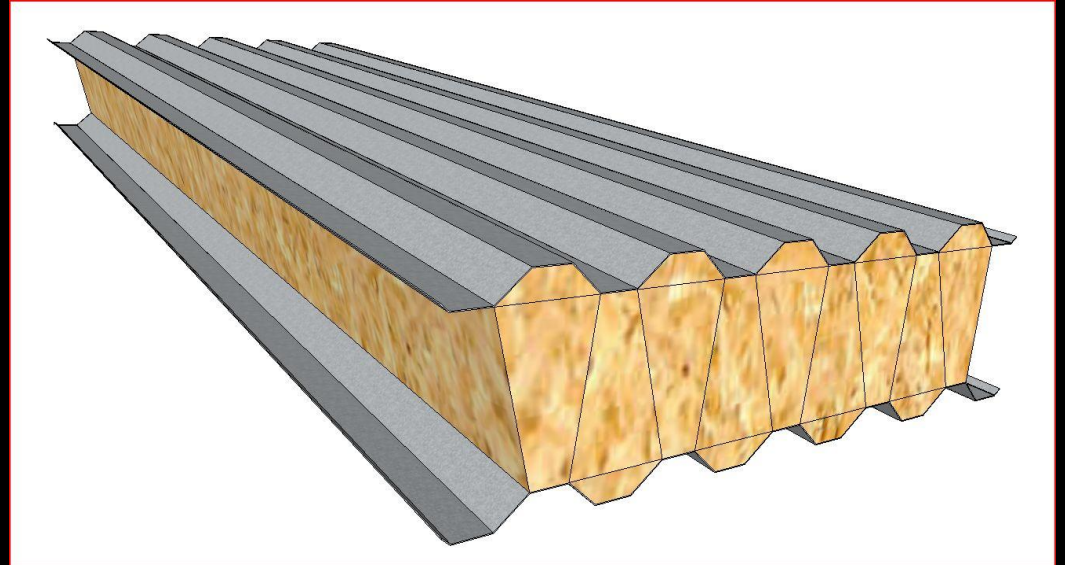
**Waterproof Patching:**

**Bitumen (tar-like petroleum base), animal fat**



# Insulation

- Straw bale
  - Good insulator
  - Flammable
- Adobe clay
  - Serves as a binder
  - Fire resistant
- Corrugated sheet metal
  - Waterproof
  - Fire proof
- Utilize all materials in a sandwich panel





# Detailing Concerns

- Attachment to wall structure
- Point of overlap between materials
- Weatherproofing connection points





# Integration with other systems.

- Design must be compatible with existing adobe houses
- Chimney
- Natural lighting
- Rain Catch

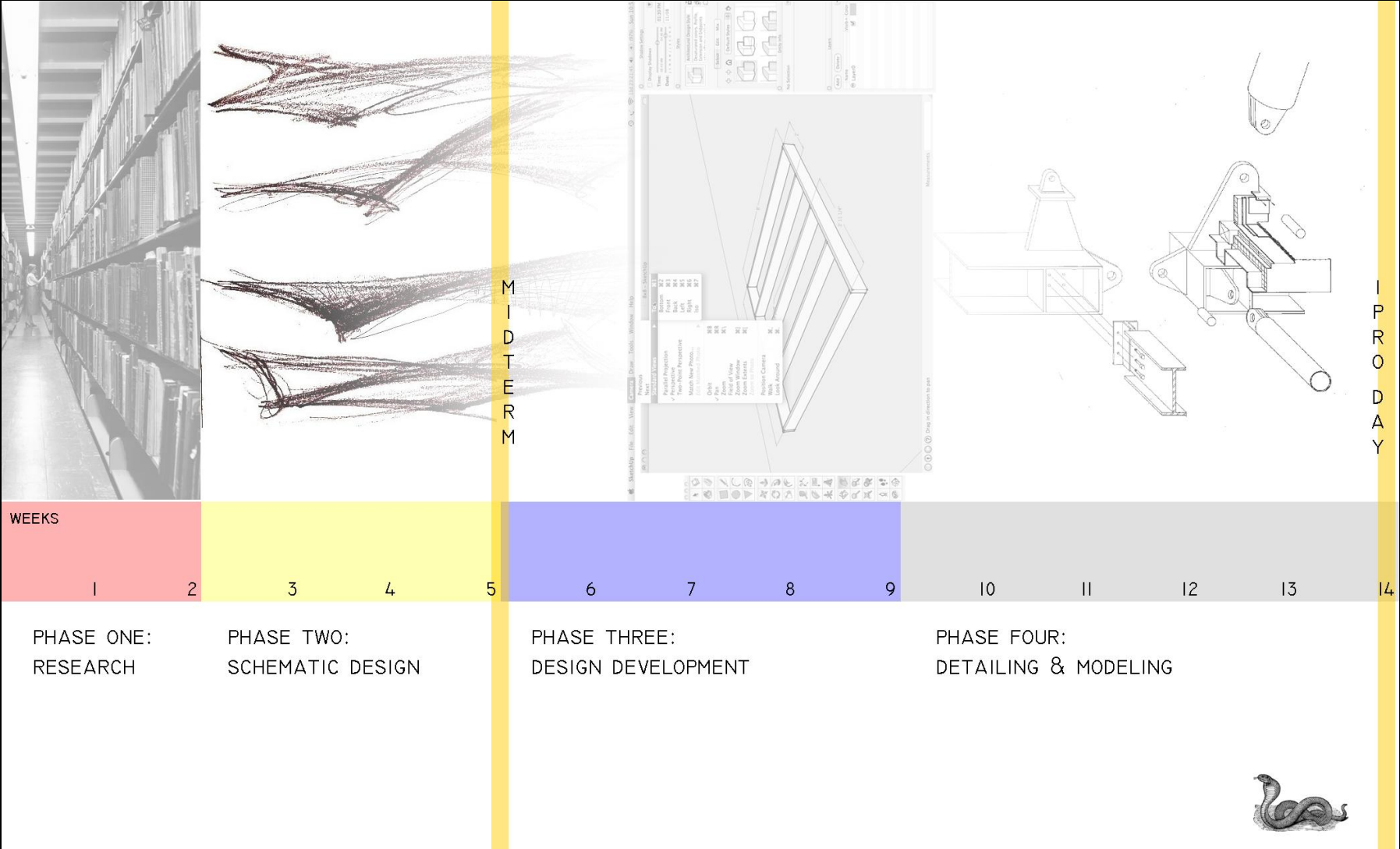


# Implementation: Deliverables

- Produce detail drawings of roof design
- Build a physical model of roof
- Test insulation value
- Create a design manual
- Go to Peru and demonstrate the roof design



# Timeline





# Sources

1. "Surviving the FriaJe". Practical Action. 03 Oct 2009  
<[http://practicalaction.org/climatechange\\_friaJe](http://practicalaction.org/climatechange_friaJe)>.
2. Collyns, Dan. "Children Die in Harsh Peru Winter". BBC News, Lima. 03 Oct 2009 <<http://news.bbc.co.uk/2/hi/8146995.stm>>.
3. "Peru Declares State of Emergency Due to Record- Breaking Cold Spell". Andean Air Mail and Peruvian Times . 03 Oct 2009  
<<http://www.peruviantimes.com/peru-declares-state-of-emergency-due-to-record-breaking-cold-spell/>>.
4. "Puno Regional President Accused of Negligence in Child Deaths From Cold ". Andean Air Mail and Peruvian Times . 03 Oct 2009  
<<http://www.peruviantimes.com/puno-regional-president-accused-of-negligence-in-child-deaths-from-cold/>> .
5. "Deadly Cold Wave Brings Misery to Southern Peru". Adventist Development and Relief Agency (ADRA) International. 03 Oct 2009  
<<http://www.adra.org/site/News2?page=NewsArticle&id=10259>> .
6. "Peru: Cold Weather Deadly for Children". UNICEF. 03 Oct 2009  
<[http://www.unicef.org/infobycountry/peru\\_27539.html](http://www.unicef.org/infobycountry/peru_27539.html)>.
7. "Climate change: intense cold front has killed 20,000 alpaca in Puno ". Andean Mail and Peruvian Times. 08 Oct 2009  
<<http://www.peruviantimes.com/climate-change-intense-cold-front-has-killed-20000-alpaca-in-puno-so-far-this-year/>>.
8. <<http://www.andeantravelweb.com/peru/tips/weather.html>>.

# Questions

