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

Innovative Roof Design
The Team

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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 too 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

**PHASE ONE:** RESEARCH

**PHASE TWO:** SCHEMATIC DESIGN

**PHASE THREE:** DESIGN DEVELOPMENT

**PHASE FOUR:** DETAILING & MODELING
Sources

Questions