IPRO-325C

Designing Affordable Solutions for the World's Poor

Cooling (Shelter) Subgroup

Introduction: IPRO-325

Overall Team Objective:

To design, test and implement solutions costing $5 or less that can be implemented and maintained by local people using locally available materials.

Overarching Ethical Principle:

To improve the quality of life for the world's rural poor.

Cooling (Shelter) Subgroup

Problem & Background

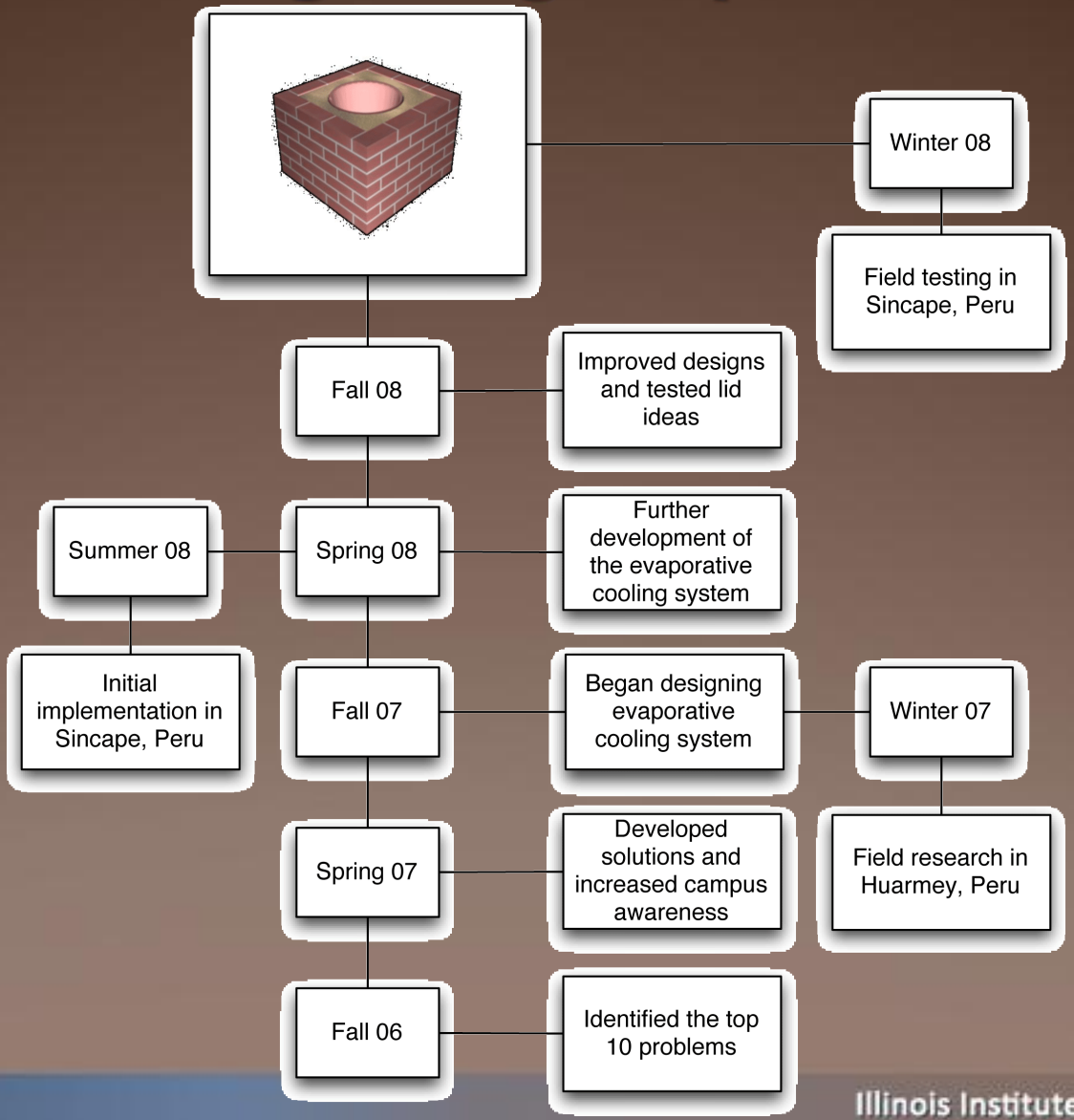
•*Micro-Nutrient Malnutrition (MNM)* is a medical condition resulting from insufficient consumption of nutrients

•792 million people worldwide suffer from malnourishment

•Many of the rural poor are forced to buy their food in bulk or store their own produce for extended periods of time because they do not live near the market

•20% of their fruits and vegetables are lost due to rotting during storage

Cooling Subgroup: Milestones



Cooling Subgroup

Goals & Objectives for Fall 2008

"Design a cooling system that will help combat malnutrition by enabling the storage of fruits and vegetables for longer periods of time before decaying."

- Expand on Research from Previous Semesters
- Test In-Ground System vs. Existing Precedents
- Test Lid Designs
- Test Fruit Preservation in System vs. Out of System
- Make Recommendation on Most Efficient System Design
- Modify & Translate Construction & Use Manual
- Find Implementation Location, Connections, & Funding

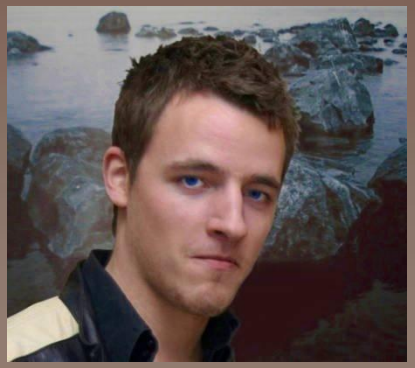
Individual Roles

August Sylvain
4th year
Biology Major

Casey Franklin
5th year
Architecture Major

Carl Ekstrand
4th year
Civil Engineering Major

Amber Heinz
5th year
Architecture Major



Mark Chiu
4th year
Architecture Major

Justine Banda
4th year
Architecture Major

Planning

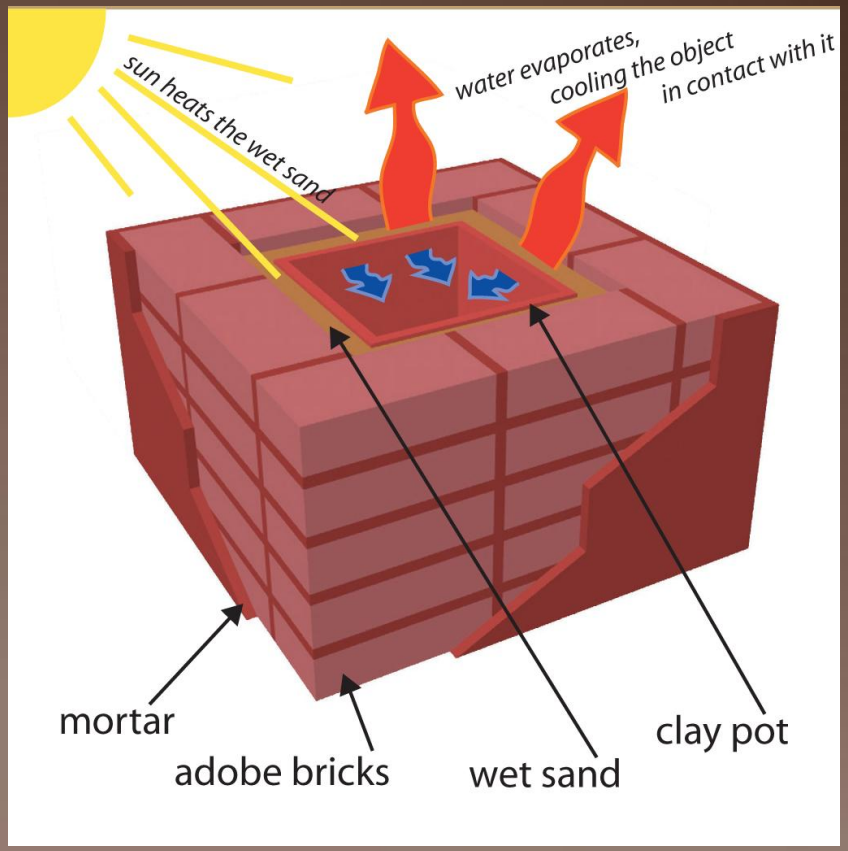
Developing an Evaporative Cooling Refrigeration System

Research	Design	Construction	Testing	Analysis	IPRO Day
Previous Semesters	**Prototype**	**Construction I**	**Test I**	Results of Test I	Poster
Precedents	In-ground system	Dig holes	Pot-in-ground	Results of Test II	Prototype
Local Materials	Lids	Buy pots	Pot-in-pot-in-ground	Results of Test III	Manual
Culture		Buy sand	Pot-in-sand-in-ground	Previous semesters	Abstract
Manuals	**Manual**	Fill hole w/sand	Pot-in-pot		Project Plan
		Set up pots			Engineering Notebook
		Construction II	**Test II**		Presentation
		Buy fruit	Fruit in zeer pot		
		Set up pots	Fruit in open		
			Fruit in zeer pot w/lid		
		Construction III	Fruit in refrigerator		
		Buy lid materials	**Test III**		
		Construct lids	Lids- material varying		
		Set up pots	Lids- size varying		
		Construction IV			
		Manual			

Research

Evaporative Cooling

- Theory:
  - Air temperature decreases as water evaporates
- Effect:
  - Objects or liquids that are in contact, become cooler



Research

Precedents

Zeer Pot System

Static Cooling System

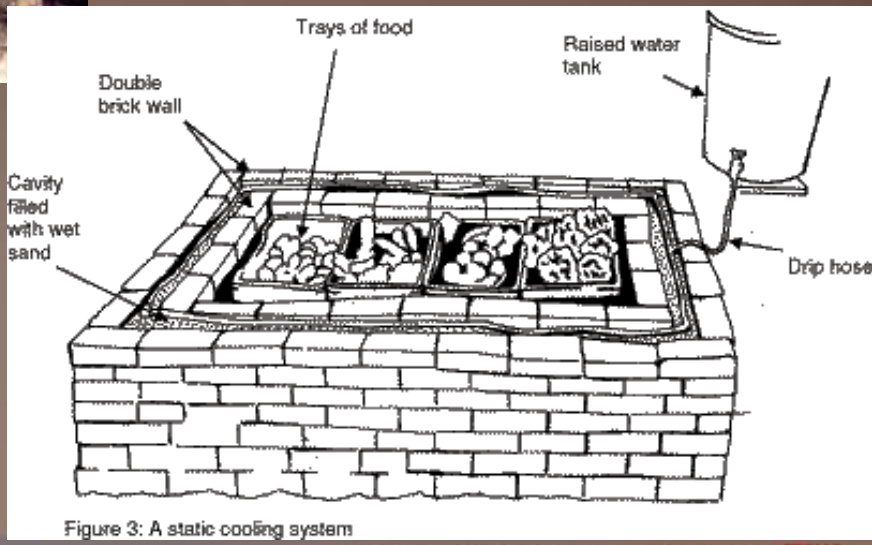
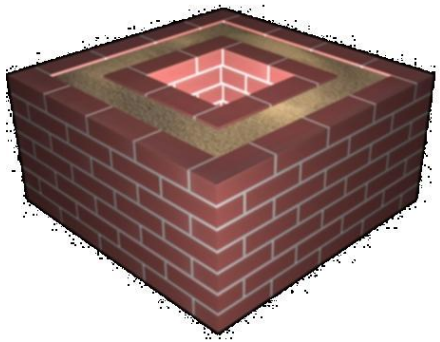


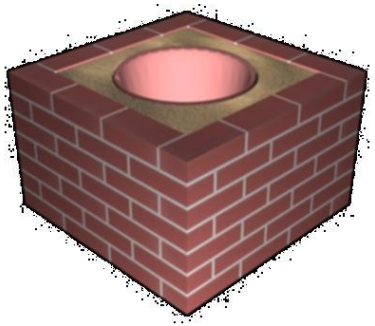
Figure 3: A static cooling system

Research

Past Semesters Precedents

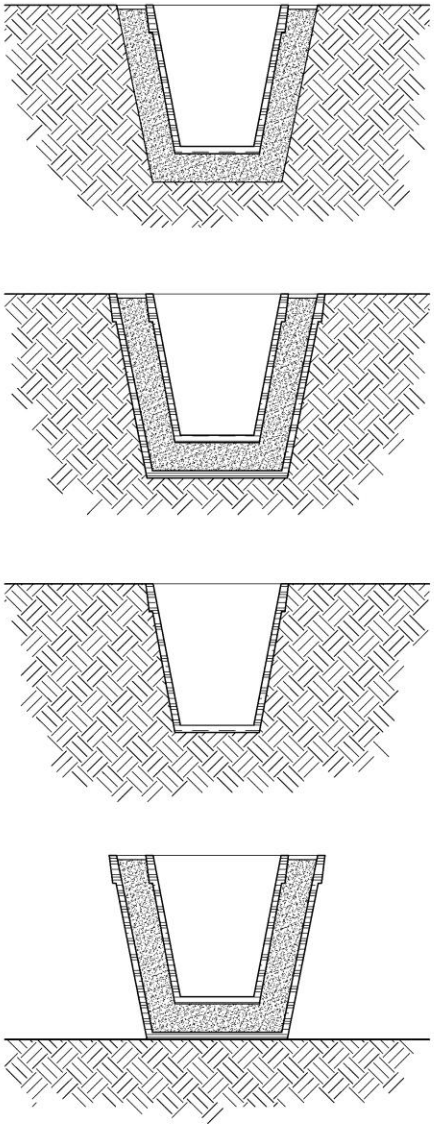


Brick-in-Brick



Pot-in-Brick

Pot-in-Pot



Design

Pot (In Sand)

Pot-In-Pot (In Ground)

Pot (In Soil)

Pot-In-Pot (Above Ground)

Design

Wood Lid

Small Cloth Lid

Cloth Lid Over All

Cardboard Lid

Design

Terra Cotta Lid

Plastic Lid

Fan vs. No Fan

Construction

In-Ground Testing

Construction

Lids

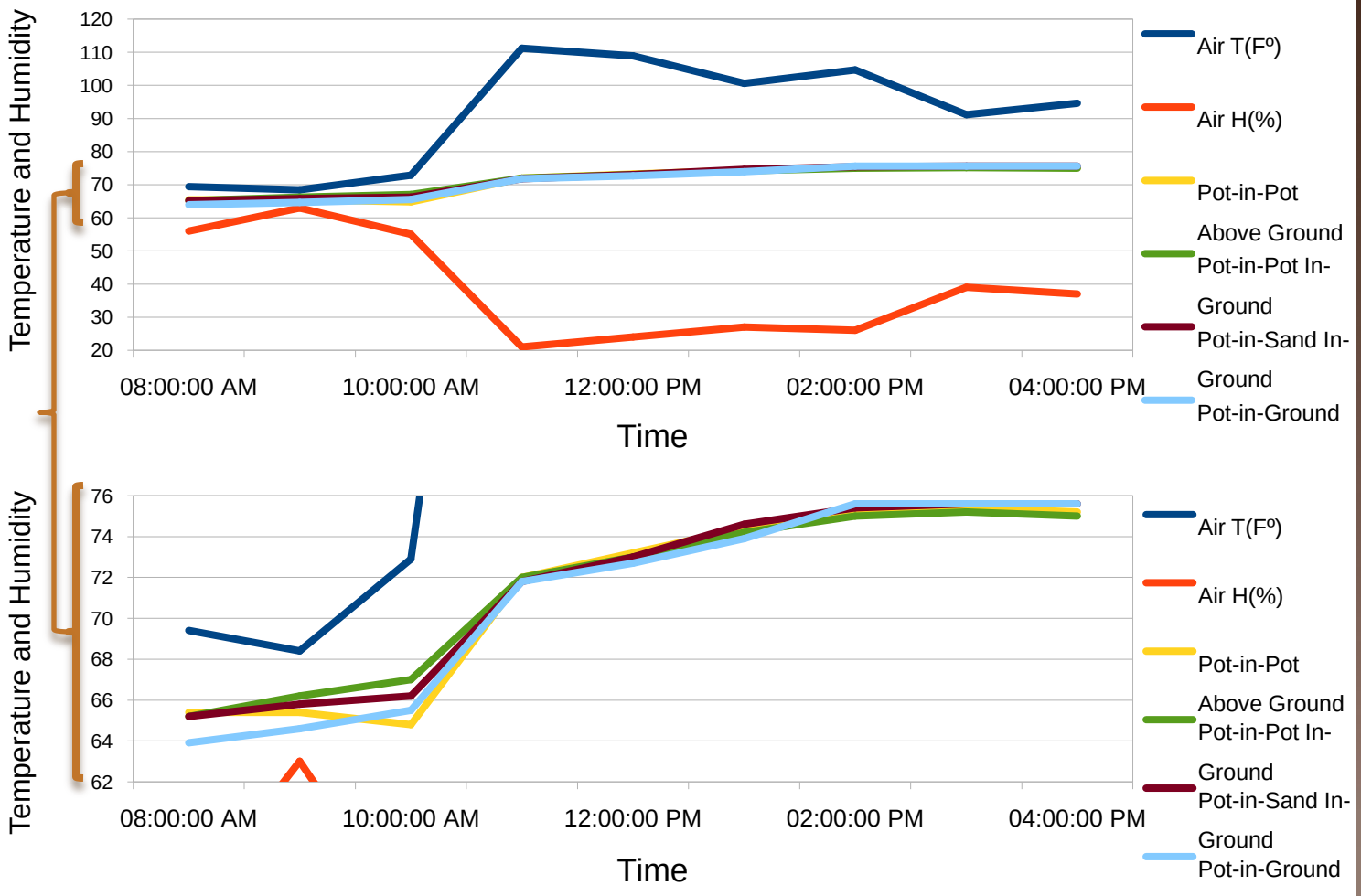
Construction

Lids

Testing

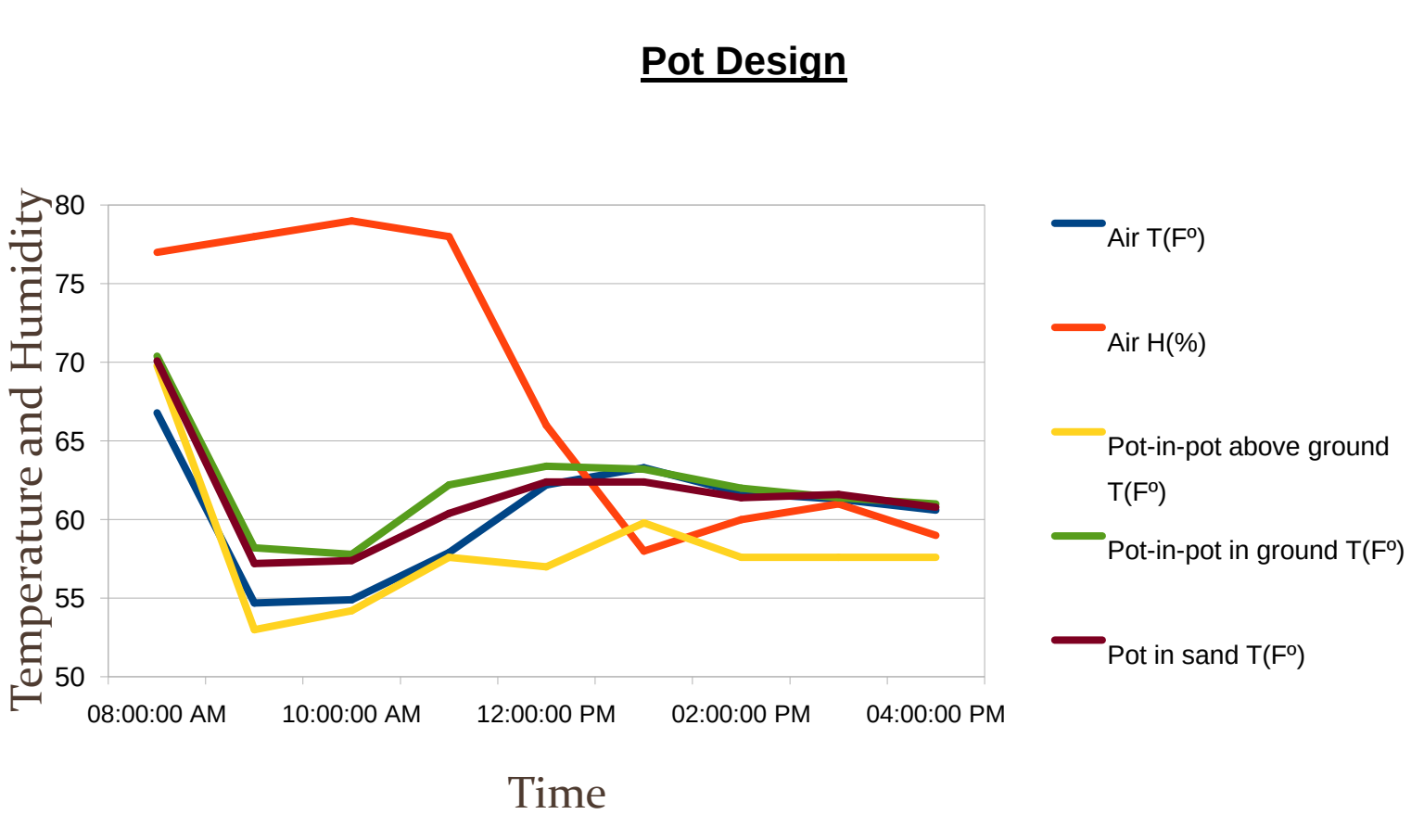
Analysis

9/23/08: In-ground Testing (Hot Day)



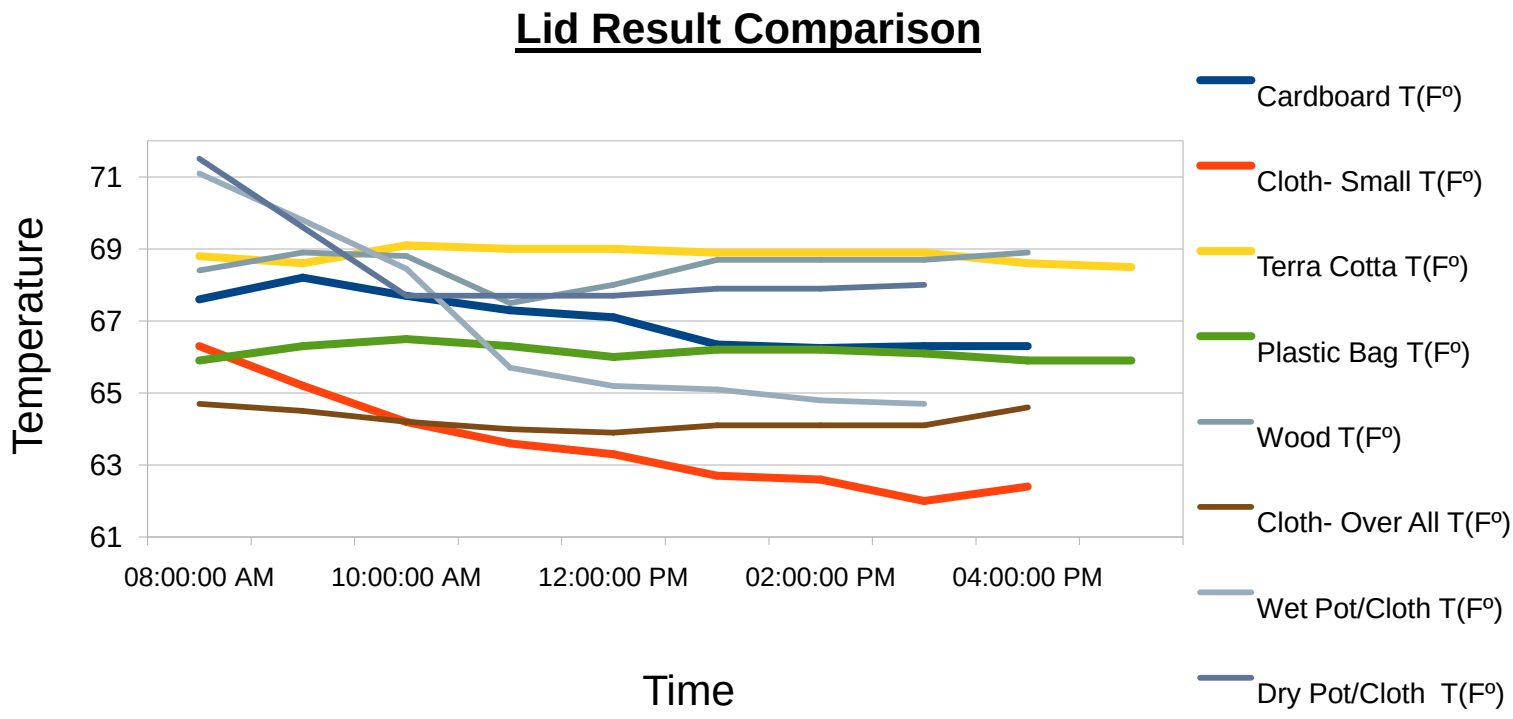
Analysis

9/30/08: In-ground Testing (Cool Day)



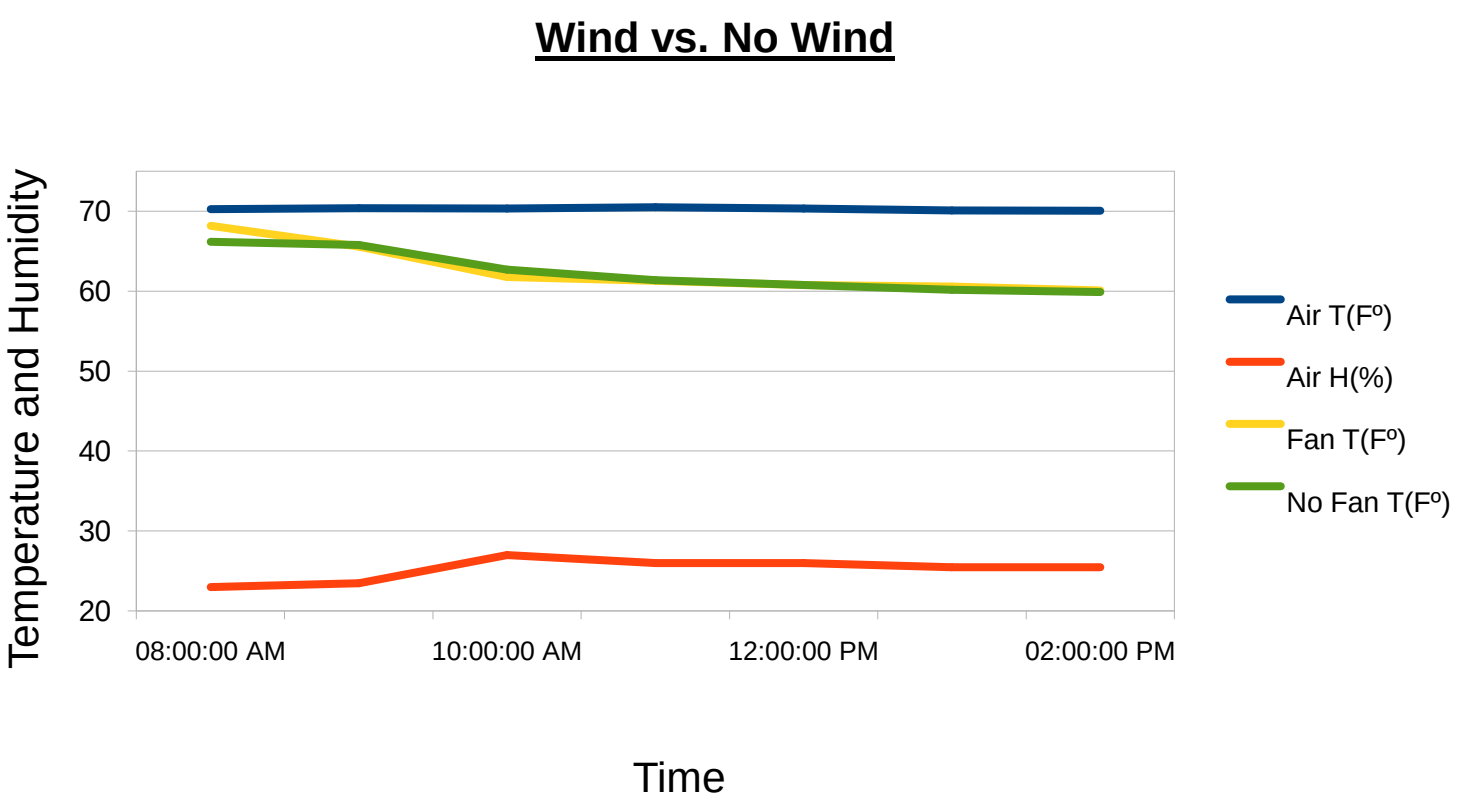
Analysis

Lid Result Comparisons



Analysis

Wind Simulation: Fan vs. No Fan



Analysis
Fruit Testing

- **Food Tested:**
  - Mango, grapes, green beans, chile pepper, and carrot

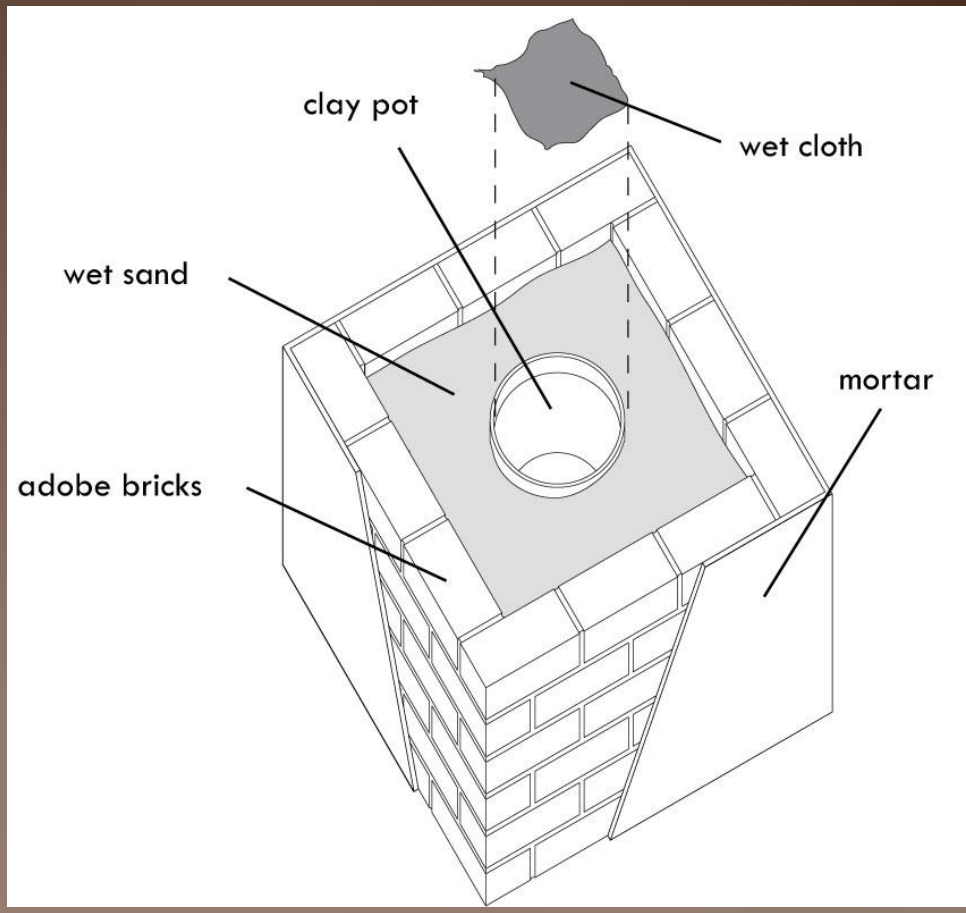
- **Food is placed in four separate testing environments:**
  - Evaporative cooling system
  - Air tight un-refrigerated containers
  - Open air
  - Standard refrigerator

- **Results:**
  - Open-air: 3-5 Days (Shriveled)
  - Containers: 5-6 Days (Shriveled & Mold)
  - Evaporative Cooling: 6-7 Days (Mold)
  - Refrigerator: 11 Days (Partially Edible)

Conclusions/Results

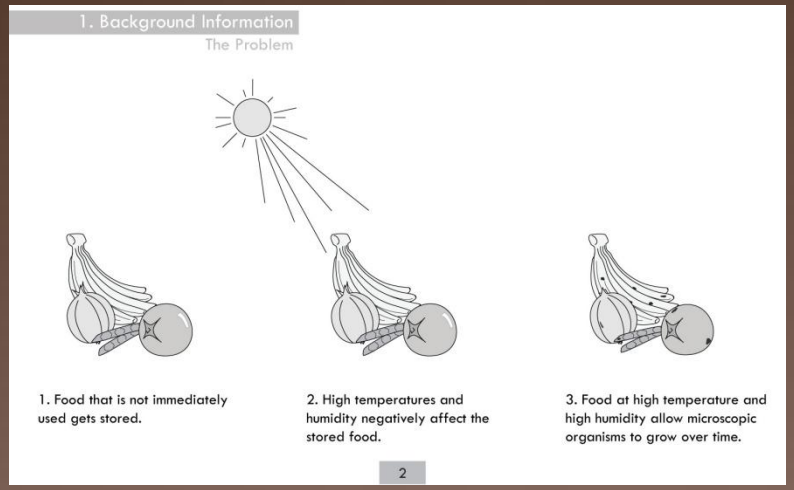
***Best Overall System Based On All Semesters:**

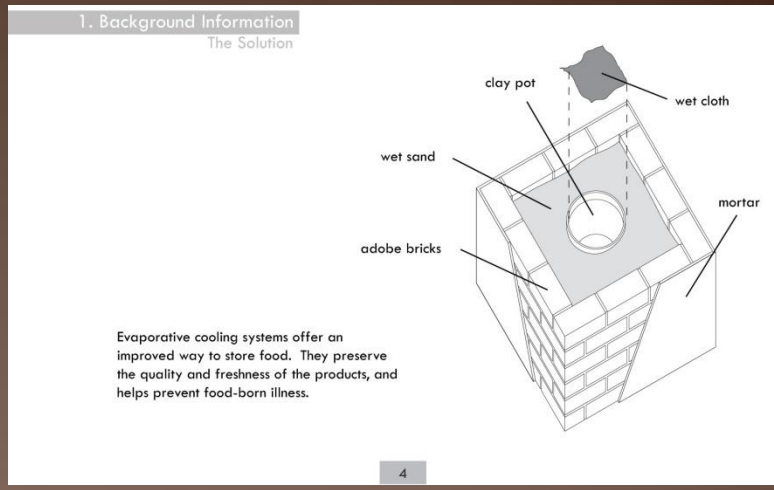
- Pot-in-Brick System
- Wet Cloth Lid
- Shaded Area
- Wind

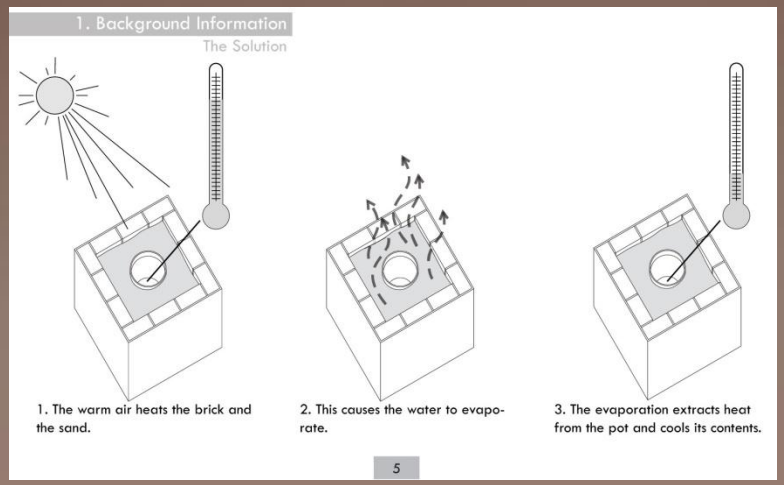


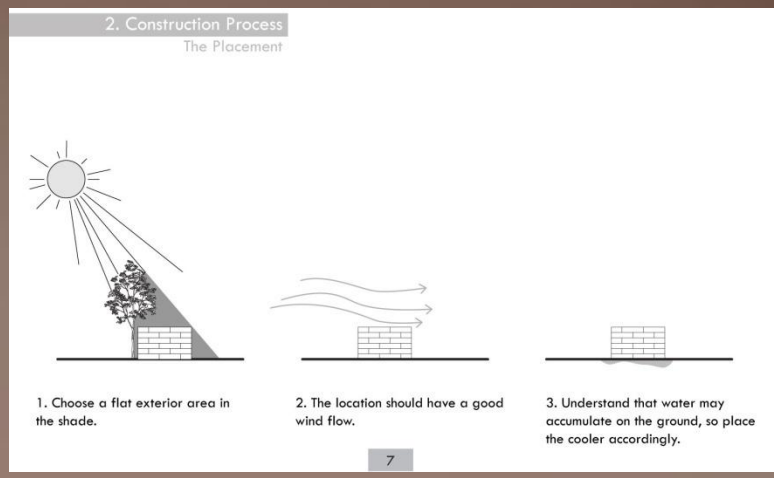
Conclusions/Results

Manual





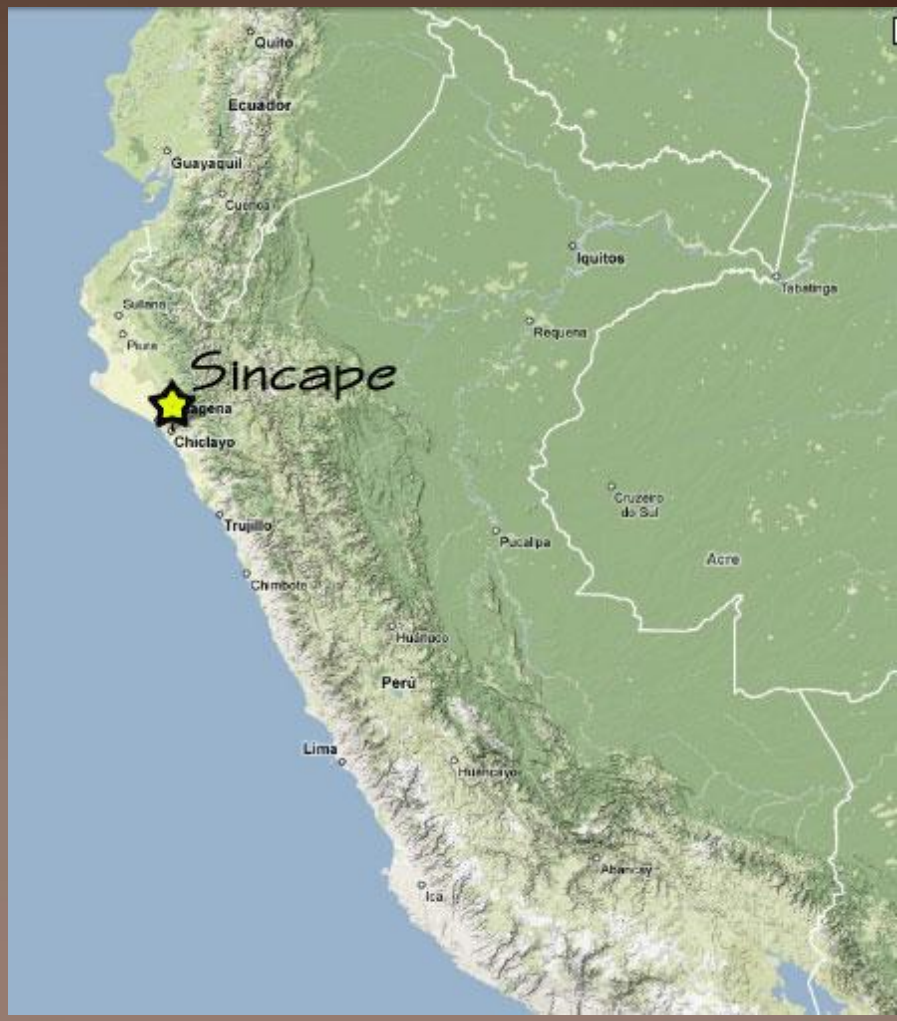




Conclusions/Results

Implementation

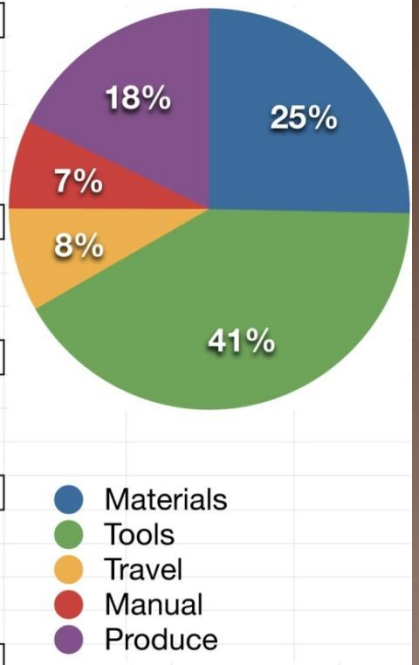
- Ideal climate:
  - High temperature
  - Mid to low humidity
  - Breezes
- Most suitable regions of Peru for testing:
  - Coastline
  - More tropical areas.
- Sincape, Peru
  - First visit in Summer 2008
  - 4 group members from Cooling Subgroup going in January 2009



Conclusions

Budget/Hours

Materials				
	Pots	Qty	Unit Cost	Subtotal
	12"	3	$10.00	$30.00
	8"	4	$5.00	$20.00
	Sand			
	50 lb bags	3	$5.00	$15.00
	Lids			
	Terracotta	1	$6.00	$6.00
				$71.00
Tools				
	Hand Trowel	1	$6.00	$6.00
	Thermometer	5	$22.00	$110.00
				$116.00
Travel		Miles	Mileage Rate	
	Made Trips	40	$0.59	$23.40
				$23.40
Manual				
	Printing	2	$10.00	$20.00
				$20.00
Produce				
	Fruits		$25.00	$25.00
	Vegetables		$25.00	$25.00
				$50.00
			TOTAL	$280.40



- TOTAL HOURS: 482.7

Obstacles

- Problem: Climate Differences Between Chicago & Peru
  - Temperature
  - Rainfall
- Resolution: Relocating Testing to Indoors

- Problem: Locating Previous Semesters' Work
- Resolution: Increase Communication with Members from Previous Semesters

- Problem: Variance in Testing Results
- Resolution: Establish a Baseline & Do Multiple Tests

- Problem: Stolen Equipment
- Resolution: Replace Equipment and Restart Testing

Future Recommendations

- **Testing**
  - Base Design
  - Adobe Deterioration- Solutions
  - Sand Grain
  - Sand vs. Dirt vs. Other
  - Temperature Ranges
  - Humidity Problem
    - Pot Liners
    - Air circulation
- **Incorporate research from other teams found online**
- **Implementation**
  - Work on establishing micro-businesses
  - Further testing in target region
  - Research other potential implementation locations

Acknowledgements

Terry Frigo : *Head of Facilities*

Richard Nelson: *Building Manager of Architecture Facilities*

Luis Minambres: *Spanish Translation Help*

Enrique Fernandez Gonzalez: *Spanish Translation Help*

Ana Untiveros: *Peru Advice*

- IPRO-325 Introduction
- Cooling Subgroup
- Individual Roles
- Planning
- Research
- Design
- Construction
- Testing
- Analysis
- Conclusions
- Obstacles
- Recommendations
- Acknowledgements
- Questions/Comments

Questions/Comments?