A Sustainable Low-Energy Cooling System for Hot Dry Climates

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The University of Texas at Austin
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• Outline of Presentation
  – Project Overview
  – Technical solution
  – Project Challenges/Concerns
  – Final Thoughts
• Capstone Class for Engineering Students
  – Engineering Design Clinic
    • Global Service Learning

• UST Mission
  – Challenge Yourself, Change the World
    • Professional careers integrated with service
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- Integrated education
  - Combine liberal arts and professional education
  - Reflect on social, political, ethical & technical issues

- Introduce students to
  - Issues related to international development

- Encourage students to have ‘the courage to make a difference’
• Development Project
USAID/Mali
  – “Accelerate development by making information accessible through innovative communication techniques and appropriate tools”
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- Project CLIC
- Community Learning and Information Centers
- 21\textsuperscript{st} century libraries
  - Computers, printers, VCR, television, cameras, DVD player, radio, copier and fax.
- Supported by US government for first year
- To be sold & managed as a business by Malians
• **UST CLIC Cooling Project**

**Design Requirements:**

- Minimize energy usage
- Cool a one room building
- Operates in a hot and dusty environment
- Manufactured in Mali
- Easy to use
- Easy to fix
- Raw material cost as low as possible
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• Technical Approaches:
  – Modify existing evaporative cooler
  – Pre-cool inlet air (geothermal duct)
  – Add strategic shading

• Experimentally verified on-site and in UST labs
Micro-Geothermal Duct

- Ground in Mali- basalic rock
- Interesting thermal characteristics
- Difficult to lay deep duct
- Well temperature (85°F)
• Ground & Air Temperature
Principles of Evaporative Cooling

- $T = 100^\circ F$
- $RH = 10\%$
- $P = 1$ atm

- $T(w) = 85^\circ F$

- $T$ decreases
- RH increases
- $P =$ 1 atm
- **Combined Solution:**
  - A geothermal duct with a modified evaporative cooler

<table>
<thead>
<tr>
<th>Engineering Specification</th>
<th>Original Evaporative Cooler</th>
<th>Modified System (Duct + Cooler)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water usage</td>
<td>3 gallons per hour (GPH)</td>
<td>1 GPH</td>
</tr>
<tr>
<td>Power consumption</td>
<td>303 Watts</td>
<td>146 Watts</td>
</tr>
<tr>
<td>Temperature decrease from ambient (inlet to room)</td>
<td>$\Delta T = 15^\circ F$</td>
<td>$\Delta T = 30^\circ F$</td>
</tr>
<tr>
<td>Air flow</td>
<td>105 cubic feet per minute (CFM)</td>
<td>240 CFM</td>
</tr>
</tbody>
</table>
• Project Challenges

  – Technical concerns
  – Language barriers
  – Cultural barriers
  – Communication barriers
• **Evaporative Cooler Pads**
  – Hold water and act as air filter
  – Made from aspen chips

• **No Maintenance Procedure**
  – Pad replacement schedule unknown
  – No blow-down system

• **Culturally Acceptable?**
  – Needs clean good quality water
  – Uses ‘gallons per hour’

• **Safe?**
  – Potential of harmful biological growth
• Purchase of Evaporative Coolers not well thought out
  – Need clean water
  – Replacement Pads
  – Employee Training

• No indigenous talent or knowledge involved
Language & Cultural Barriers

• Institute of Engineering (ENI), Bamako, Mali
  – Dr. D. Coulibaly
  – Dr. A. Coulibaly

• Spring Break – Easter Holy Week!
Communication Barriers

- Organizational Complexity
- Test site 3 hours from capital
• Test site: Largest CLIC (atypical)
• Interior dimensions given to students
• Evaporative cooler could not be installed
• Bars on windows

• Bolts on Roof
Additional Concerns

- Retrofitting existing buildings not effective strategy
- Not built with local materials or considering local conditions
  - Ouéléssébougou CLIC faces SW
• Costs $4.00/hr to use computers
• Most people seen checking their e-mail
• To be sold and run as a for-profit learning center
Final Thoughts

• Project CLIC provides foundation for hope because it gives
  – Knowledge of the challenges of engineering in the developing world
  – Prospects for establishing lasting relationships; genuine solidarity
  – Opportunities for Malians to become agents of their own development
• Acknowledgements
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Questions?