Village Energy Systems Project Conceptualization

The purpose of this document is to help you get started on thinking about your projects. Several references have been placed on Blackboard on the subjects of engineering and entrepreneurship in the developing world, and within these documents literally hundreds of ideas are described. In addition, the faculty have a few projects that we are interested in. First, there is a need to attempt to ferment and distill ethanol from biomass with very low concentrations of sugar. Second, there is a need to develop an orange juice pasteurization system for a village in Ghana. (In particular we would like to run a modern pasteurization machine on photovoltaic power.)

There are many ways to look for opportunities for developing products and solutions for extremely poor people. On method is to break the market apart into loosely defined sectors, such as the following list that is a slightly modified version of the table of contents of the Delft University report:

1. Health
2. Energy
3. Transportation
4. Food/Agriculture
5. Water/Sanitation
6. Housing
7. Materials
8. Connectivity
9. Education
   a. Resources for schools
   b. Education for adults in technology, business and entrepreneurship. For example, see:

This class is called Village Energy Systems, a name that reflects the roots of the GlobalResolve initiative at ASU, and almost all of the categories listed above are dependent on the availability of a convenient form of energy. However, the class has evolved as the initiative has grown and we also embrace projects and ideas that have little to do with energy. A list of projects that have been undertaken over the last few years in this class (with a little spillover from GIE and Capstone) follows. Those that are highlighted in red are ideas/technologies that are on the ground in the developing world.

- Thermoelectric lighting
- Gelfuel production system (Biomass treatment, fermentation, distilling, gelling.)
- Three generations of gelfuel stoves
- Solar cell phone charger
- Pyrolizer for production of Bio-Char
- A GlobalResolve “Do-Tank”
- Educational curricula:
  o Framework and methodology for education of villagers in maintenance and upkeep of technologies “dropped off” in villages
  o Grade School science curriculum using indigenous materials
• Personal water filter designed for small children (charcoal based)
• Improved construction materials
  o Expanded plastics
  o Locally available materials
  o $100 house prototype
  o Structural components from waste paper and cardboard.
• Solar powered battery charging "kiosk" with battery exchange. (Netflix for batteries.)
• Micro-scale biogas digester
• Mosquito repelling system
• Solar Ovens
  • "Breeder stove" that generates charcoal while cooking.
• Pacifier imbedded inside of particle filter mask
• Solar hot water system (for heating and personal use)
• Replacement of batteries by super-capacitors charged by thermoelectric devices
• Lantern based on ultra-clean combustion of animal fat
• Cell phone app for Nokia that included English language tutorial
• Soap manufacturing
• Wind turbines:
  o Wind turbines constructed from local materials
  o Miniature turbine from coffee can
  o Wind turbine powered treadle pump
  o Savonis wind turbine for village use
• Automatic solar actuated drip irrigation system with measurement of soil moisture content.
• Jatropha Oil Furnace (Almost burned the place down so be careful with this one!)
• Orange Juice Pasteurization system
  o Thermal pasteurization
  o Packaging
• Kinetic Energy harvesting device
• Sewage treatment “wheel” (Acara challenge, spring 2010)
• Food preservation (Pineapple)
• Pot-in-pot evaporative cooler
• Charcoal powered refrigerator
• Potential energy generator (bag of rocks, a stick, and a motor from a toy car)
• Attachment for treadle pump for processing food.
• Gorlov turbine (water turbine)
• Stirling generator

Many of these ideas can be improved upon and some of the students that previously worked on them are still at ASU.
ALT 494/598: Village Energy Systems

Course Description: Development of entrepreneurial ideas that lead to products for Base of the Pyramid (BoP) markets.

Prerequisites: Instructor Approval

Instructor: Brad Rogers (Santan 230A)

Grading: Based on engagement, participation and projects

Text: Handouts and reading assignments based on individual projects

Course Learning Objectives:

- Increased awareness and understanding of the nature of poverty and methods of addressing poverty related issues, especially through sustained economic development at the village level and among the urban poor.
- Develop increased appreciation of lifestyles and challenges of those living in extreme poverty.
- Understand the fundamental principles of product design for Bottom of the Pyramid markets, including Design for Extreme Affordability.
- Understand technologies, and be able to develop new designs that simultaneously address challenges of village life and sustained economic development.
- Understand the role of the engineer and technical expert on the enterprise development team.
- Be able to critically evaluate technological solutions as to their appropriateness for a village setting.
- Learn to characterize and improve upon technologies that are developed for markets that serve extremely poor people.
- Develop one creative solution using the principles of design for extreme affordability that addresses an identified village problem.
Class Project Description

The basic format of the class is that of Problem Based Learning. In this case, it is better described as “Extreme Problem Based Learning.” There will be very few lectures that last for more than 20 or 30 minutes, and often there will be no lecture at all – class periods will be largely devoted to developing and working on projects, with the instructors serving as a “consultants.”

The primary focus of this class is a project of your choosing. Specifically, you must complete a project in which you research the needs of people living at the base of the pyramid and develop a solution that simultaneously addresses both challenges that these people face and their need for economic development. Solutions may involve products, services, or even programs. There is no requirement whatsoever that your idea work out – most ideas will not be successful, especially in the short time that we have. The requirement is that you do your best to develop and evaluate your idea.

This class is called Village Energy Systems, and most of the projects that have been completed over the last two years have related directly or indirectly to energy. However, this is not an absolute requirement. For example, students have worked on agricultural products, sanitation and water, and production of services such as cell phone apps.

Some of you will be part of a team, and others will work individually. (This will be your choice.) Some of the teams will be made up only of students in the class, while others will include students in the parallel Global Impact Entrepreneurship class, and some will be multi-university, and even multi-national. Consequently the first few weeks of this class will be a bit chaotic as projects are conceived and proposed, and you decide on your project.

To help you get started, several references have been placed on Blackboard that describe engineering and entrepreneurship in the developing world. A list of projects that have been undertaken in this class over the last few years follows:

- Thermoelectric lighting
- Gelfuel production system (Biomass treatment, fermentation, distilling, gelling.)
- Three generations of gelfuel stoves
- Solar cell phone charger
- Pyrolizer for production of Bio-Char
- A GlobalResolve “Do-Tank”
- Educational curricula:
  - Framework and methodology for education of villagers in maintenance and upkeep of technologies "dropped" off in villages
  - Grade School science curriculum using indigenous materials
- Personal water filter designed for small children (charcoal based)
- Improved construction materials
  - Expanded plastics
  - Locally available materials
- Solar powered battery charging "kiosk" with battery exchange. (Netflix for batteries.)
- Micro-scale biogas digester
- Mosquito repelling system
- Solar Ovens
- “Breeder stove” that generates charcoal while cooking.
- Pacifier imbedded inside of particle filter mask
- Solar hot water system (for heating and personal use)
- Replacement of batteries by super-capacitors charged by thermoelectric devices
- Lantern based on ultra-clean combustion of animal fat
- Cell phone app for Nokia that included English language tutorial
- Soap manufacturing
- Wind turbines:
  - Wind turbines constructed from local materials
  - Miniature turbine from coffee can
  - Wind turbine powered treadle pump
  - Savonis wind turbine for village use
- Automatic solar actuated drip irrigation system with measurement of soil moisture content.
- Jatropha Furnace (substituted Canola oil)
- Orange Juice Pasteurization system
  - Thermal pasteurization
  - Packaging
- Kinetic Energy harvesting device
- Sewage treatment “wheel”
- Food preservation (Pineapple)
- Pot-in-pot cooler
- Charcoal powered refrigerator
- Potential energy generator (bag of rocks)
- Attachment for treadle pump for processing food.
- Gorlov turbine (water turbine)
- Stirling generator
Course Expectations

- You are expected to attend and actively participate in this class. Even though your primary deliverable for this class is a completed project, much of which will be done outside of class, the classroom dynamic is critical for learning and sharing ideas. This semester there will be approximately 40 students from many different disciplines in the Peralta studios on Monday nights working on aspects of problems at the BoP. As we will discuss, these are some of the most difficult problems in the world. No single person, or even single disciplinary area, can hope to understand all aspects of these problems, and an interdisciplinary team is required. Consequently, as your projects evolve you will need to consult with other students in the class as well as the faculty.

- There will be reading assignments throughout the semester. Some of these will depend on your specific projects, so reading assignments may not be identical for all students.

- A short proposal for your project is due by February 7th. This proposal will be reviewed by the instructor to ensure that it is feasible. (It is understood that your project will likely evolve throughout the semester.)

- Every class period you will turn in a short written progress report on what you have accomplished during the previous week, and each student will be interviewed to discuss this progress.

- At the end of the semester you will turn in a formal final report/portfolio that details your project. In most (but not all) cases this will include a prototype.

Probable Grading Breakdown

<table>
<thead>
<tr>
<th>Item</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekly written and oral project updates showing sustained progress</td>
<td>30%</td>
</tr>
<tr>
<td>Final Report, including prototypes</td>
<td>60%</td>
</tr>
<tr>
<td>Final Presentation</td>
<td>10%</td>
</tr>
</tbody>
</table>

Grades:

- 90 and above A
- 80 – 89 B
- 70 – 79 C
- 60 - 69 D
Village Energy Needs and Resources

Village Energy Requirements – What is energy needed for?

- Food
  - Preparation
    - Mixing, kneading, shelling, etc.
  - Cooking
  - Storage
- Lighting
- Transportation
- Water
  - Treatment
  - Transport
- Communication
- Farming
  - Tilling
  - Irrigation
  - Planting
  - Fertilizing
- Construction
  - Materials (Bricks, lumber, . . .)
  - Building
- Communication
- Heating
- Drying
- Manufacturing
  - Clothes
  - Tools
  - Consumer goods
  - Art
- Education
- Health
- Recreation

What energy resources might be available in a Village?

“Traditional” Resources.

- Biomass
  - Wood
    - “refined” wood – Charcoal
  - Dung
  - Human waste
  - Crop residues
  - Harvested biomass such as Jatropha seed pods, palm fruit, and so on
  - Grasses, other monocots
  - Refined biomass
    - Oils
    - Alcohols
- Basic Solar
- Basic Wind
- Food – ATP to ADP reactions resulting in muscle power
  - Food to fuel
  - Humans
    - Basic labor
    - Labor saving devices that provide mechanical advantage
  - Animals
- Water

“Modern” Resources

- Public Transportation
- Internal Combustion Engines
  - Generators
  - Shaft power
- Modern Solar
- Modern Wind Turbines
- Water Treatment facilities