

The CSM Humanitarian Engineering Minor Program – *Opportunities for Engineering Students Interested in Direct Service to the Underserved*

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Website: <http://humanitarian.mines.edu/>

Youtube: http://www.youtube.com/watch?v=m4hgdwhj_Zc

Thank you

- Faculty Senate and Colleagues for honoring me
- Students
- My family (Wife: Stephanie and children: Lydia and Gabriel)
- Mines community
- Extended Community
- HE colleagues (see following page)

Thank you – HE Colleagues

LAIS: Tina Guianquito, Jon Leydens, Juan Lucena, Carl Mitcham, Suzanne Moon, Barbara Olds, Arthur Sacks, Jennifer Schneider, Jay Straker, Sandy Woodson.

Engineering: Sanaa Azim, F. Edward Cecil (PH), Cara Coad, Joseph Crocker, Joan Gosink, Katie Johnson, Ning Lu, Barbara Moskal (MACS), Junko Munakata-Marr (ESE), Marcelo Simões, Catherine Skokan, Robert (Doug) Sutton, Julie VanLaanen.

Others: David Frossard, Ginny Lee, George (Jerry) Sherk

Students: Elizabeth (Heidi) Bauer, Odon Musimbi, Jill Savage, and Natalie Wagner (and many more).

How did the HE minor get started?

- Initiated in 2003 by a \$1.167 M grant from the William and Flora Hewlett Foundation.
- A collaborative effort between EG, ESE, Math/CS and LAIS. (hopefully expanding to other Depts.?)
- Number of HE minors and ASIs ~50+ students (14 graduates) from four campus departments or divisions (EG, ChemE, Geol Eng, PE).

Rationale for Humanitarian Engineering

- Demand from students

"My name is Nathan Garza and I am a senior in High School in San Antonio, Tx. I am really interested in Civil/Geological Engineering and have been looking at a lot of schools, but this program is the main reason why CSM is at the top of my list. I will surely be involved in this program and hope to take a lot out of it. Thanks for sharing this video."

- Needs of resource and multinational industries

Rationale for Humanitarian Engineering – cont.

- Needs of governmental and nongovernmental organizations

"Only through a shared appreciation of the people's culture, needs and hopes for the future can we hope ourselves to supplant the extremists narrative",

Admiral Mike Mullen, Chairman of the Joint Chiefs of Staff

Quote taken from: Greg Mortenson, *Stones into Schools Promoting Peace with Books, Not Bombs in Afghanistan and Pakistan*, Viking, 2009.

What is the HE Minor Program?

Project Goals

- Create a culture that values community service
- Increase the recruitment of women and minorities
- Increase the number of engineering students entering relevant internships
- Increase the number of engineering graduates entering relevant occupations

Project Goals (cont.)

- Enhance the social and cultural awareness of engineering graduates.
- Attract students with strong aptitudes in math and science and also a strong interest in working with people (these might not have otherwise considered engineering as a career).

What is the HE Minor Program?

- 15 cr. hrs. of focused humanities and social science courses
- One technical elective (3 cr. hrs.)
- Multidisciplinary Engineering Lab (3 cr. hrs.)
- Senior Design – hands-on humanitarian engineering projects (6 cr. hrs.)

LAIS Courses

Required:

- LAIS/BELS 320 Introduction to Ethics (Mitcham and Woodson)

Take two (6 credits) of the Following:

- LAIS 475 Engineering Cultures in the Developing World (Lucena)
- LAIS 402 Writing Proposals for a Better World (Leydens)
- LAIS 412 Literature and the Environment (Guianquito)
- LAIS 375 Engineering Cultures (Lucena)
- LAIS477/577 Engineering and Sustainable Community Development (Lucena and others)

**6 credits from a selection of from 20+ LAIS,
Econ/Business courses**

Technical Electives

- EGGN 486 Practical Design of Small Renewable Energy Systems (Simoes)
- EGGN 498 Groundwater Mapping (Skokan)
- EGGN 447/547 Timber and Masonry Construction (Crocker)
- EGGN 498 Understanding Landslides (Lu)
- EGGN 490 Sustainable Engineering Design (Munoz)
- Any Biomedical Engineering Course
- ESGN460 Onsite Water Reclamation and Reuse
ESGN/EGGN353, 354 Fund. Env. Sci. and Engr I and II; EGGN453
Waste Water Engr. or ESGN/EGGN454 Water Supply Engr.

Definitions –

Humanitarian and Engineering

- ***Humanitarian***: promotes present and future wellbeing for the direct benefit of underserved populations.
- ***Engineering***: design under physical, political, cultural, ethical, *legal*, environmental, and economic constraints.
- ***Humanitarian Engineering***: design under constraints to directly improve the wellbeing of underserved populations.

New definition – based on an *etymological* investigation

The artful drawing on science to direct the resources of nature with active compassion to meet the basic needs of all — especially the powerless, poor, or otherwise marginalized.

Mitcham, C. and Munoz, D., Humanitarian Engineering, under contract, Morgan and Claypool, 2010.

Early Documented Humanitarian Engineer – Fred Cuny

- Civil Engineer – Texas A&M
- Army Pilot
- Flying eqpt. & mats. into Biafra, 1969
- Developed strategies for emergency response; effective transition from triage to development stage; reducing vulnerabilities
- Disappeared in Chechnya, 1995

Sustainable Development

- "Effectiveness over Efficiency."¹
- "Waste is Food."¹
- "We design for all of the children of all species for all time."¹
- "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."²

Ref. 1. McDonough, W. and Braungart, M., Cradle to Cradle, North Point Press, 2002.

Ref. 2. Our Common Future, Oxford University Press, 1987.

Sustainable Development

(Bridger and Luloff, 1999)

- Increase local economic diversity:
 - *diversify the local economies to ensure community cohesiveness in case of downturns in some industries.*
- Self-reliance:
 - *extension of economic diversification – places more emphasis on growth of labor force and local markets.*

J. C. Bridger, A. E. Luloff, "Toward an interactional approach to sustainable community development", *Journal of Rural Studies*, v. 15, 1999, pp. 377-387.

Sustainable Development

(Bridger and Luloff, 1999, cont.)

- Reduction in the use of energy, management and recycling of waste:
 - *use only what you need,*
 - *reinvest your spent fuels (garbage, plastics, etc.) in local recycling centers or household (grey water) infrastructures.*
- Protection and enhancement of biological diversity and stewardship of natural resources:
 - Human, plant, animal, rock, mineral and organics are interdependent...pursue holistic balance.

Sustainable Development

(Bridger and Luloff, 1999) cont.

- Social Justice

- *Egalitarianism,*
- *Elimination of race and class-based partitioning,*
- *Investment in human capital and*
- *Inclusive decision making.*

Important Questions

- Who benefits and who pays?
- Who stands to gain?
- Who stands to lose?
- Who needs what and when?
- Who decided what was needed?
- How will the project be sustained?
- Who contributed to the planning and execution?

Example Project in Sustainable Development

Sustainable Development (aspects of practice)

- *Identify the Stakeholders*
- *Work w/the Community to Identify Needs/Priorities*
- *Develop Trust/Partnership*
- *Encourage Community Ownership*
 - *Use Indigenous Knowledge*
 - *Find ways to Build Capacity*
 - *Seek Equitable Distribution*

The Project Location:



Goals of the Honduras Project:

1. Deliver clean water to 1600 families (~10,000 people).
2. Consider the entire water cycle.
3. Improve local people's health and economic standards.

The Beginning – Oct. 2004

Mass Meeting with the People for
the First Time



Opportunities

- Identify and get to know the stakeholders
 - Local people (with many specialty groups/perspectives)
 - Local leadership
 - Local NGOs
 - Regional and federal leadership
 - Local universities
 - International NGOs

Stakeholders - Honduras

Villagers &
13 Patronato of
Colinas de Suiza

Governmental,
Non-Governmental
Organizations
(NGOs),
Local Universities
& Industry

Municipality of
Villanueva
(Water &
Sanitation Dept.)

Project Stakeholders - Responsibilities

- Patronato and the villagers
 - Local leadership and communications
 - Manual labor
 - \$80 then later \$100 (finally \$130) per family for the water tank ~ 2+ weeks of wages (total cost estimate for 250,000 gal. water tank ~ \$100K)

Project Lead - Responsibilities

- Municipality of Villanueva
(Dept. of Water and Sanitation)
 - 400' (140 m) well
 - Pump
 - Skilled labor
 - Local water system design, construction and maintenance expertise
 - One backhoe (rented for 6 months w/ operator by municipality)

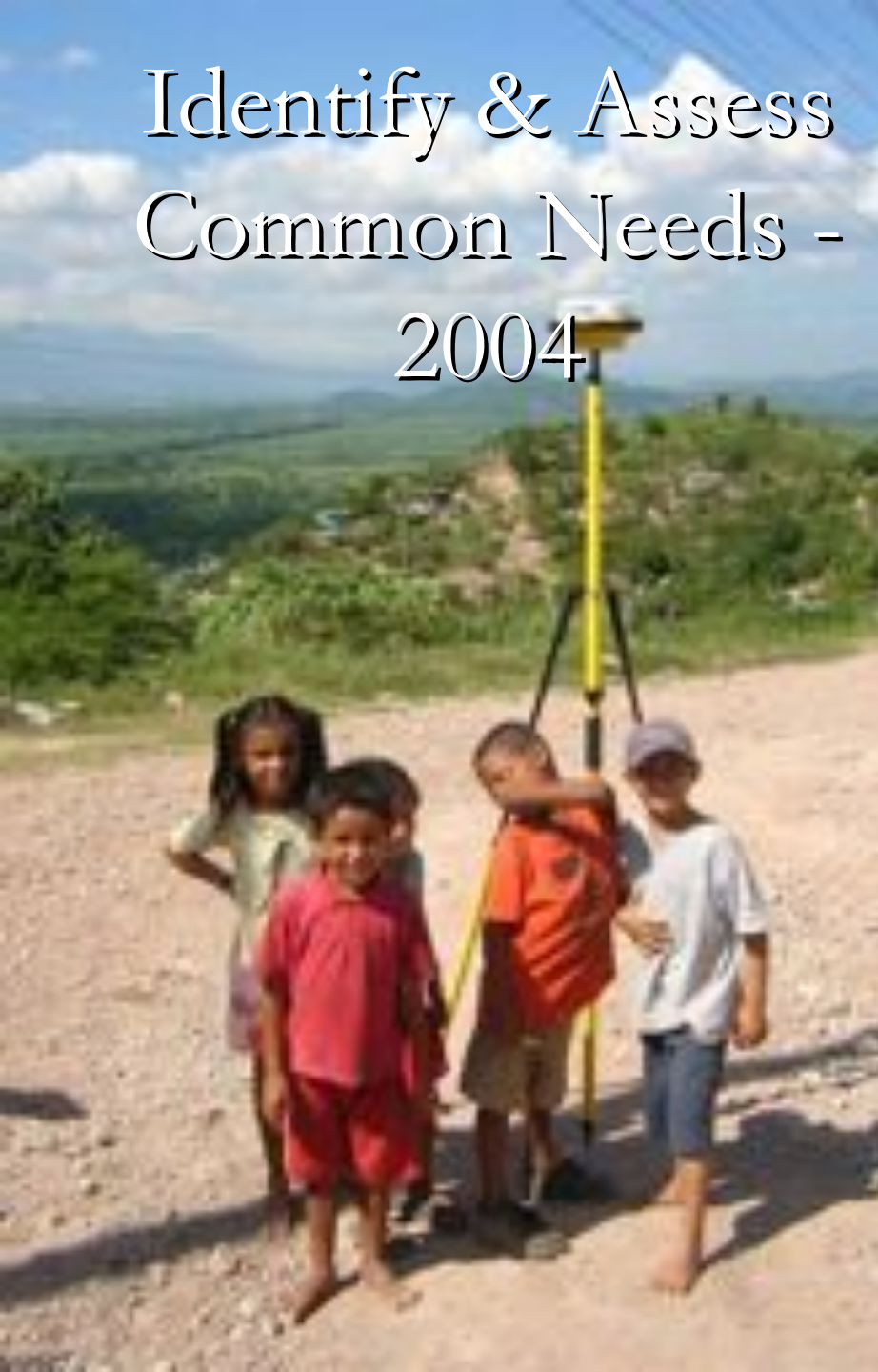
Project Help - Responsibilities

- Colorado School of Mines
 - Measurements (GPS for surface mapping, DC resistivity for subsurface mapping the aquifer)
 - Preliminary and Final Engineering Designs
 - Resource acquisition
 - Research (sanitation alternatives)
 - Education

Challenges to working w/ stakeholders

- Depends on the size of the community – large communities are more difficult. *Communication.*
- Many different groups live within the community.
 - Local and regional elected leaders
 - School teachers (from inside and outside the community)
 - Store owners
 - Pastors and church lay leaders
 - Business owners
- Do these groups have conflicting aspirations?

Identify & Assess Common Needs - 2004



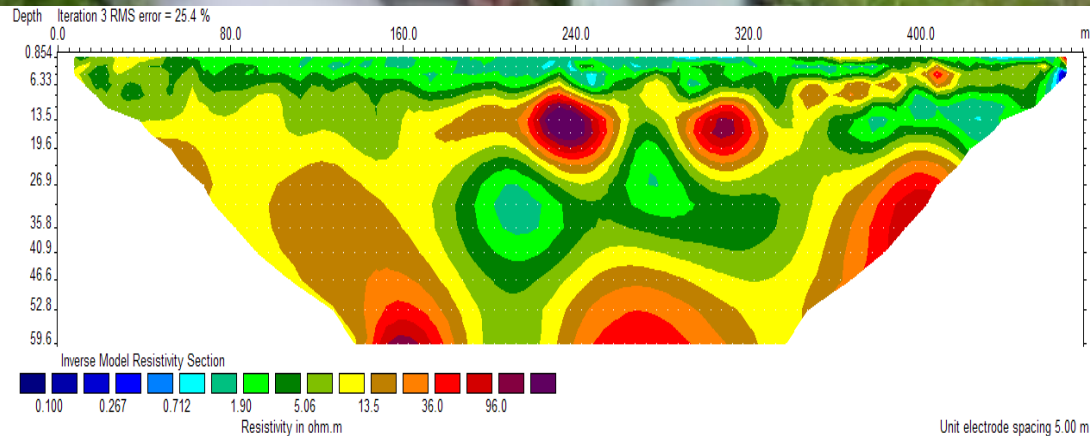
Problem Identified (2004):

- Water for 10,000 people
 - To reduce living expenses
 - Improve health



2005 - Groundwater Mapping

2006 - GPS Surface Mapping



June 2007 Meeting with People



People Were Unhappy

- Further investigation revealed misinformation originating from a local mayoral candidate
- Required action to defend basic tenants of the project
- Meet with smaller groups of people from various locations around the village.

Challenges to identifying & assessing *common* needs

- "*Common pool of resources or commons* are those in which the exclusion of beneficiaries is difficult or costly, and exploitation by one user reduces resources to others."
- The history of how the "commons" was previously treated by "outsiders" can leave an artifact that may be difficult to overcome.

Opportunities

- Small group meetings give local people an opportunity to learn and voice their opinions.
- It gives the HE a chance to learn of the local history and knowledge base.
- Look for opportunities to spend more time with the local people
 - Seek numerous projects with the same people

Small Group Meetings – August 2007



Listen -
Communicate

Challenges to developing trust

- Requires commitment
- Requires time to develop relationships
 - Does not fit the traditional academic course scheduling

Opportunities for building local ownership

- Participatory Action Research (Design)
 - Theoretical
 - Practical (sweat and monetary equity)
- Capacity Building
 - work with local educational institutions

Participatory Action Research (*Design*)

- Flexible (attitude)
 - Plenty of room for creativity and innovation, depends upon specific community opportunities and circumstance. Ill-suited to rigid prescription.
- Reflective
- Iterative
- Implies a realignment of power/control
 - Who is the ultimate decision maker?

Levels of Participation (Biggs continuum of control)

- Contractual
 - Local people are contracted to work with engineers.
- Consultative
 - Engineers ask local people for their opinions.
- Collaborative
 - Local people and engineers work together on projects designed, initiated and managed by the engineers.
- Collegiate
 - Engineers and local people work together as colleagues with different skills to offer, in a process of mutual learning where local people have control over the process.

Advantages

“Affirming that people’s own knowledge is valuable; people [become] agents rather than objects; capable of analyzing their own situations and designing their own solutions”

...

“Ideally...the initial agents of change become redundant...that is, the transformation process continues without the physical presence of external agents, animators and cadres.”

Challenges

- Objectivity - Community engagement with outsiders often requires simplification of shared experiences that are intelligible to the outsider but yield an inaccurate representation of community dreams.

The People's Project – Water Tank

June 2007



August 2007



March 2008



June 2008



The People's Project – Monetary (March 2009)



The People's Project - Laying Pipe

March 2008



Building Capacity



Opportunities

- Student and faculty exchange programs.
- Invite participation of interdisciplinary faculty and students from
 - Local universities,
 - Technical and High Schools or
 - Elementary schools.

Challenges to building capacity

- Lack of communication infrastructure (internet, phones, etc.) – Funding \$\$

Project Summary in SCD

SCD Criterion (Bridger & Luloff)	Honduras Impact
Increase local economic diversity	Reduction in water cost (by ~1/50)
Self reliance	People built the water tank, becomes a symbol of "community"
Reduction in the use of energy	Estimated 95% reduction in energy used to deliver water
Protection of biological diversity	Encouraging the use of composting toilets, integrated into gardens
Social justice	Water tap at each home, small consensus meetings allowed people to have a voice

Take Away

- Indigenous knowledge is a valuable asset in the humanitarian engineering design process.
- Seek an environment where we can learn from each other. We stand to gain too!
- Requires patience and a different type of control than engineering community has been educated to even recognize.
- Seek opportunities to innovatively develop capacity.

Where is HE going?

- HE minor adopted by Valparaiso U.
- EWB-USA has recognized the need for academic preparation for student design teams
- At CSM, we seek opportunities for sustained funding
- Develop a summer practicum to accommodate the need for additional time with local people.

Acknowledgements

- William and Flora Hewlett Foundation (*Major Funding to initiate the Humanitarian Engineering minor program*)
- Shell Corporation (*Travel funding*)
- Plastic Pipe and Fitting Association
[*11 member companies donated 72 tons (44 km) of plastic pipe, fittings and glue*]
- Food for the Poor/CEPUDO
- Society for Exploration Geophysicists (SEG)/ Geoscientists without Borders (GWB)
- Rotary Club

*"We must be silent before we can listen.
We must listen before we can learn.
We must learn before we can prepare.
We must prepare before we can serve.
We must serve before we can lead."*

William Arthur Ward (American, dedicated scholar,
author, editor, lay pastor and teacher)

Thank you for your attention



References

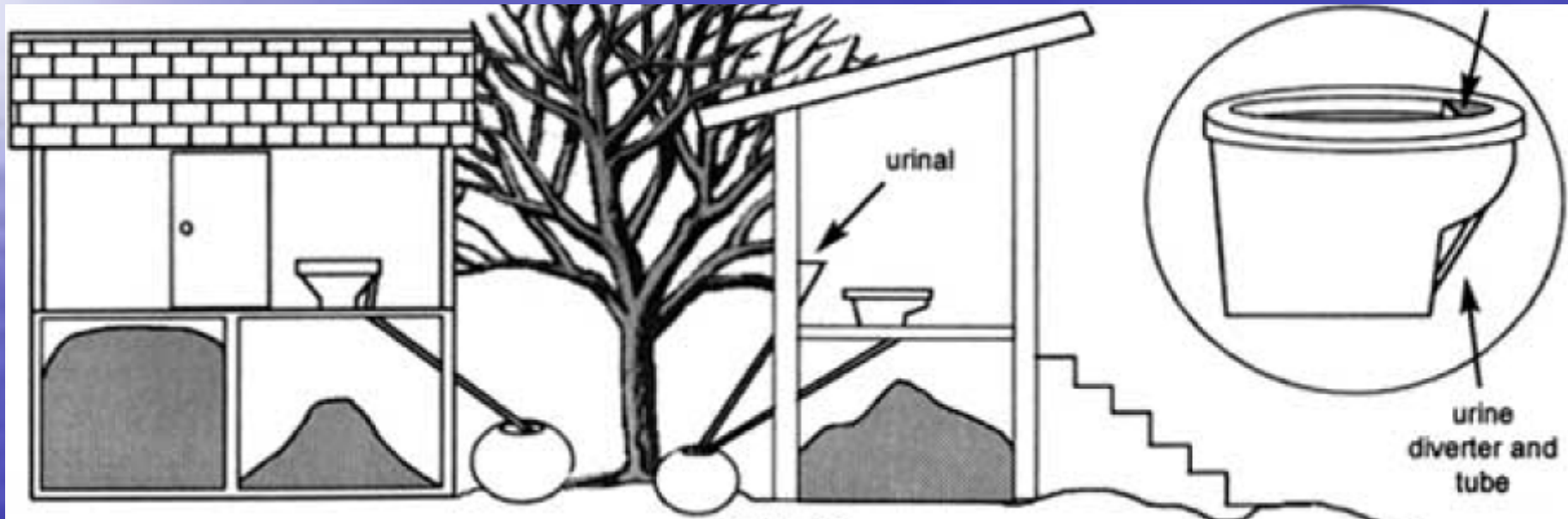
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Future Plans - Honduras

- Celebrate the completion of the Colinas de Suiza water supply project
- Continue working with the village to assess system functionality
- Share information w/surrounding villages
- Develop stronger ties with local universities (foster student and faculty interaction)
- Maintain relationships with NGOs (Rotary, Water for People, Food for the Poor, CEPUDO, etc.)

Phase 2

Introduce Eco-Toilet by example
(Guatemalan Double Vault)



Phase 2

- Work with 4 - 5 families to integrate toilet into a flower and/or vegetable garden.
- Strong interest in community gardens.

Eco-toilet Implementation – w/Honduran Public Univ. students July 2008



Passive Gray Water System Implementation March 2008

