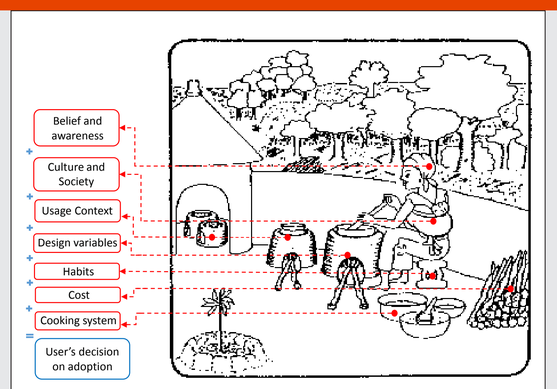
HUMANITARIAN ENGINEERING

An interdisciplinary approach to meet needs for clean water and renewable energy in low-resource communities



ABOVE: Factors influencing users decision-making process regarding cookstove adoption.
BELOW: Conducting usability testing in Uganda.

TECHNOLOGY ADOPTION AND USABILITY

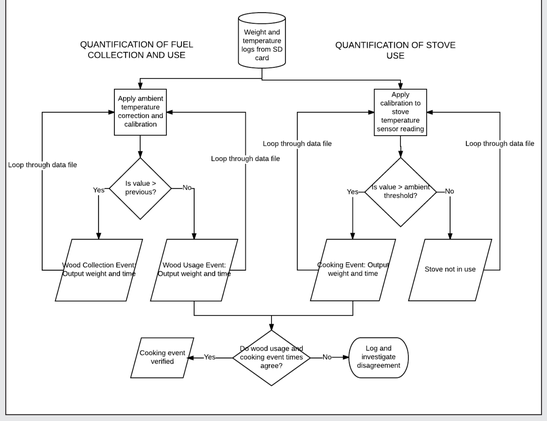
What drives consumers to choose to adopt products that protect common pool resources rather than continuing with current inefficient and/or polluting methods? And how can designers create products that encourage adoption despite social and financial barriers? Understanding and modeling of user choice and behavior is common in engineering design efforts to predict market share, user preference, and optimal design for consumer products where purchase motivation is plentiful. Yet these valuable tools are less commonly, and notably less easily, applied to the design of products where user uptake is key to meeting public social, environmental, economic, and security goals. Research is underway to understand and model the decision-making process users follow regarding energy-efficient practices.

Perhaps even more important than the willingness to adopt a new technology is the usability of that device itself. If technologies are not efficent, effective, engaging, error tolerant, and easy to learn from the user's perspective, then they will not be adopted and the desired programmatic impacts will not be acheived. To draw more attention to this critical issue during the design phase, we are developing a usability testing protocol to incoporate into the ISO standards for biomass cookstoves.

DR. NORDICA MACCARTY

Dr. Nordica MacCarty is an Assistant Professor of mechanical engineering with research focused on understanding the relationships between energy, technology, and society through application of integrated systems modeling, sensor-based monitoring, and user-centered design. She has a 20 year background in the design and monitoring of biomass cookstoves and currently serves as Associate Editor for the journal "Energy for Sustainable Development" and chair of the ASME IDETC "Design for the Developing World" symposium.

ABOVE: Cookstoves in Uganda equipped with sensors. BELOW: Example analytics



SENSOR-BASED ADOPTION AND IMPACT MONITORING

Manageable monitoring and evaluation is essential for humanitarian aid projects that require knowledge of the impact of their investments. In particular, household energy efficiency projects must be able to quantify technology adoption and energy savings in order to receive results- and carbon credit-based financing and refine designs. Sensor-based monitoring and the emerging Internet of Things provides an opportunity to monitor and evaluate more easily and accurately than ever before.

The OSU Fuel Usage and Emissions Logger (FUEL) system was developed to quantify and correlate fuel consumption and usage of clean cookstoves over extended periods of time. The system will easily and quickly transmit, analyze, and report results using novel transmission and analytics technolgies specially designed for data scarce remote areas. These capabilities can provide actionable feedback about user adoption and accurately determine the reduction of greenhouse gas emissions provided by displacement of cooking over an open fire.

Additional monitoring technologies for other sectors are under development and we welcome ideas for new applications and collaborations.

ABOVE: Instituational Cookstove equipped with pasteruization unit showing major components: (A) Inlet pipe, (B) heat exchanger, (C) Heating coil, (D) Thermostatic valve, (E) Kill chamber, and (F) Outlet pipe. BELOW: Microbiological testing supplies.

WATER PURIFICATION AND MEDICAL STERILIZATION

OSU researchers have partnered with the NGO *Institutional Stove Solutions* to develop and test highly efficienct systems for cooking, water purification, and medical tool & waste sterilization for rural communities and humanitarian response situations. These systems are available as interchangeable accessories for the instituional biomass cookstove shown above.

The water pasteurization system can produce 4,500 liters of safe drinking water per day at minimal cost to the users and the environment. This flow-through system uses a combination of a heating coil, thermostatic valve, fixed volume kill chamber, and heat exchanger for heat recovery immersed in a pot of heated water. Laboratory and field testing revealed a production rate of 6.7 Lpm of clean water with an energy input of only 175 kJ/L -- 97% less than boiling on a three-stone fire. Water initially inoculated with >200,000 bacteria/ml of E. coli had no colonies remaining after treatment, for a 99.999% reduction in contamination.

The system can also be equipped with an autoclave to efficiently sterilize medical tools and waste before disposal, helping to reduce the spread of disease. We hope to apply and evaluate this system in a variety of global settings.

ENGINEERING FOR COMMUNITY GOOD

Oregon State University's Humanitarian Engineering program is an academic offering like few others. We offer an undergraduate minor as well as core graduate-level coursework in humanitarian engineering, science and technology (HEST). We involve faculty across the university, and offer our students local and global field research opportunities and graduate fellowships.

CORE PHILOSOPHY:

We define humanitarian engineering as the use of science- and technology-based solutions to address basic human needs and improve quality of life particularly for those in underserved communities.

PROGRAMMATIC GOALS:

We provide opportunities for our students to practice engineering in context, going beyond the technical to include social, cultural, environmental, political, and economic factors. Our programmatic goals are to:

- Enable students to develop global competencies and transferable skills, such as communicating with diverse audiences and working on multidisciplinary teams.
- Benefit local and global communities through research, community engagement, and experiential learning.
- Grow interdisciplinary and international research programs in humanitarian engineering and global development at Oregon State University
- Embody the principle that there is strength in diversity, where striving for inclusivity is the norm.

Oregon State University