University of California, Berkeley

DEVELOPMENT ENGINEERING TOOLKIT

Lessons on implementing a new multidisciplinary program uniting engineering and the social sciences

DESIGNATED EMPHASIS
DEVELOPMENT ENGINEERING
UNIVERSITY OF CALIFORNIA, BERKELEY

DEVELOPMENT IMPACT LAB

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Program Overview

Development Engineering (DevEng) represents a new interdisciplinary field that integrates engineering, economics, business, natural resource development and social sciences to create implement and evaluate new technological interventions that address the needs of people living in poverty in low-income areas of the United States and developing regions around the world.

In 2014, with the support of U.S. Agency for International Development (USAID) and in collaboration with the U.S. Global Development Lab, the Development Impact Lab (DIL) at UC Berkeley formalized Development Engineering as a PhD minor open to students in any field, including but not limited to engineering, economics, business, and social sciences at UC Berkeley. DevEng prepares students to create and evaluate technological solutions that improve human development in low-resource settings, integrating the design of technologies with the social and market interventions required to achieve impact. The program features hands-on, interdisciplinary courses and mentorship for projects of global significance.

In addition, in 2016, the DevEng program received additional support from the National Science Foundation to establish an interdisciplinary program investigating the nexus of food, energy, and water (InFEWS) and the effects of those systems on low-resource communities. InFEWS builds on the DevEng foundation and adds several key research and course activities to train students to address challenges faced by low-resourced communities in the food-water-energy space.

The DevEng program is led by an interdisciplinary group of over 25 like-minded faculty across the campus, the Development Engineering Graduate Group (see membership in Appendix E). They represent the following departments: Mechanical Engineering, Computer Science, Economics, School of Information, Public Health, Bioengineering, Civil and Environmental Engineering, Haas School of Business, City and Regional Planning, Global Poverty and Practice, Agricultural and Resource Economics, College of Natural Resources, Architecture, and the Energy and Resources Group. The number of departments involved continues to grow. Faculty in the Graduate Group contribute to the program in many ways, including teaching, conducting research, and mentoring students.

The DevEng program is strategically designed to incentivize students and faculty in various ways. For example, DIL offers small travel grants and larger research grants that allow students and faculty to explore a variety of solutions, importantly in-country, and with local partners. The recently established Development Engineering Journal (Elsevier) helps to add legitimacy to this new field. Interdisciplinary work can be difficult to sustain given the drive to publish in highly-regarded outlets combined with the narrow disciplinary focus of many respected academic journals (e.g. economics journals do not overlap in focus with engineering journals, which is true across most academic disciplines). The DevEng Journal provides exactly the outlet needed for the kind of interdisciplinary work that solutions to poverty require.

Development Engineering builds on a rich heritage of other university programs, such as various engineering-based approaches like Humanitarian Engineering programs at Penn State or Colorado School of Mines and more policy-oriented programs such as Woodrow Wilson School of Public and International Affairs at Princeton and School of Advanced International Study at Johns Hopkins. UC Berkeley's DevEng program is unique in aiming to explicitly combine business with engineering with social science and economics. The interdisciplinary approach is one starting to be modeled at other institutions such as EPFL and University of Canterbury in New Zealand.

Program Structure

The Designated Emphasis in Development Engineering (DE in DevEng) is an interdisciplinary training program for UC Berkeley doctoral students whose dissertation research includes topics related to the application of technology to address the needs of people living in poverty. Students from all departments can apply. Through coursework, research mentoring, and professional development, the program prepares students to develop, pilot, and evaluate technological interventions designed to improve human and economic development within complex, low-resource settings. The DE in Dev Eng in particular serves students across engineering disciplines, quantitative social science disciplines (including public health), business programs, information sciences, and natural sciences. The program builds upon ongoing research in technological innovations, human-centered design, development economics, remote sensing and monitoring, data science, and impact analysis at UC Berkeley. The program is overseen by the Graduate Group in Development Engineering, administered through an existing academic department (in our case, the Department of Civil and Environmental Engineering), and has participating faculty from the following departments (listed alphabetically): Agricultural and Resource Economics, Architecture, Bioengineering, Civil and Environmental Engineering, Economics, Electrical Engineering and Computer Science, Energy and Resources Group, Environmental Science Policy and Management, Public Policy, Mechanical Engineering, Public Health, School of Business, and School of Information.

Administrative/programmatic duties are carried out by the Blum Center for Developing Economies (an interdisciplinary poverty center at UC Berkeley), and academic advising as well as scheduling is performed by an academic unit (Civil and Environmental Engineering). These details are particular to the implementation at UC Berkeley and may vary across institutions, but it is important to note that the main administrative body sits at a center (Blum Center) that is not formally within an academic unit, and thus has the flexibility to work with many different academic units.

Leadership of the program is carried out by the Chair of the Development Engineering Graduate Group (Alice Agogino, Mechanical Engineering), with input from the DevEng Graduate Group, the Dean of the Graduate School, and participating Deans (see programs listed above).

Programmatic Elements

The DevEng designated emphasis will foster intellectual community and provide research support and professional development for doctoral students through four main components:

1. Two newly-developed, required **core courses** that introduce interdisciplinary technology design and evaluation methods plus novel approaches for electronic field data collection and analysis.

2. A set of **elective courses** clustered into thematic modules to ensure the development of depth of knowledge.

3. Independent, mentored **research** including participation in international field research and collaboration with foreign researchers.

4. **Seminars, workshops, and conferences** for presentation of ongoing research and engagement of an interdisciplinary community of faculty and graduate students in discussions about developments and changes in the field. These community activities foster interdisciplinary intellectual growth and professional development.

Core Courses

The Designated Emphasis in Development Engineering requires five courses (two core courses plus three electives). The course requirements are in addition to, but may overlap with, the Ph.D. course requirements of a student's home department. There are no formal prerequisites to apply for the DE in DevEng, however a certain level of experience with quantitative analysis is necessary to succeed in the core course (roughly equivalent to an upper division statistics course). All course work for the DE should be taken for a letter grade.

The pedagogical approach of Development Engineering adopts a Design Thinking framework, and applies several constraints that are unique to low-resource settings. Included in the approach are considerations of scale from project inception, as well as sociological, political, and cultural frames of thought. At the core of all activities is the application of data and technology to measure and understand outcomes and impact. For more on the educational philosophy, see Levine, Agogino, and Lesniewski, International Journal of Engineering Education (2016).

The two core courses are:

DevEng C200: Design, Evaluate and Scale Development Technologies (3 units)
For a sample syllabus - See Appendix A

Dev Eng C200 is co-taught by one technologist and one social scientist. Students in the DevEng DE must complete this course before their qualifying exams. Professors from the pool of faculty in the Graduate Group in Development Engineering rotate as course instructors. The course is offered for three units of credit as DevEng C200, MechEng C200 or MBA 290T. Master's students are permitted to take the core course as space permits and with permission of the instructors. DevEng 200 is organized around analysis and application of case studies by multidisciplinary student teams according to three thematic modules:

1. Understanding the Problem, Context, and Needs (Weeks 1-5) explores, via human-centered design processes, the integration of quantitative and qualitative needs assessment techniques in the process of prototype design.

2. Prototyping Solutions (Weeks 6-8) explores methods of low and medium fidelity prototyping

with attention to hypothesis testing and data evaluation in an iterative continuum.

3. Taking It to the Field (Weeks 8-13) extends the iterative process through examination of pilot tests in the lab and field, assessment of technologies for monitoring and testing, business modeling, impact evaluation, and scaling.

DevEng 210: Development Engineering Research and Practice Seminar (1-2 units)
For a sample syllabus - See Appendix B

This course provides Dev Eng students with a context and community within which their research projects can be refined and developed. The seminar focuses on work-in-progress presentations by students, postdoctoral scholars, and faculty within the Development Impact Lab ecosystem. The research seminar can be taken before or after the qualifying examination, and students can take it more than once.

The objective of the seminar is to prepare students for research and practice in development engineering. Students will give presentations on their research and receive feedback from faculty and peer students in multiple disciplines. The seminar will also provide a community of practice in the new field of development engineering.

DevEng 210 Student Learning Outcomes:
The students will learn to present their research in a scholarly setting. Students will learn how to design human subjects protocols and include user participation in the design of their research. Through peer learning and faculty feedback, students will learn from exposure to a range of different examples and applications.

Assessment of Student Progress Toward Course Objectives:

- 50% on presentation of research
- 20% on attendance and participation in class
- 30% on post-reflection and integration plan for research

Elective Courses

In addition to the core requirements, DevEng students must take three elective courses from at least two thematic modules to focus and deepen their training in the field.

The thematic modules are Human-Centered Design, Evaluation Techniques and Methods for Measuring Social Impact, and Development Technologies. Of the three electives, only one can be from the student's major or field.

Sample courses eligible for electives in DevEng are below: A full list is in Appendix C

(1) Human-Centered Design / Problem Identification and Design (with participant feedback)

- Civil & Environmental Engineering 209: Design for Sustainable Communities
- Information C283: Information and Communications Technologies for Development
- Public Health 290: Designing Innovative Public Health Solutions
- Haas MBA 215.1: Business Strategies for Emerging Markets

(2) Evaluation Techniques and Methods for Measuring Social Impact

- Economics 274: Global Poverty and Impact Evaluation
- Information 272: Qualitative Research Methods for Information Systems and Management
- MBA 296: Applied Impact Evaluation – How to Learn What Works to Lower Global Poverty
- Public Health 252C: Intervention Trial Design

(3) Development Technologies (Appropriate Technologies, Sensors, Data Collection, Data Mining and Analysis)

- Civil & Environmental Engineering 210: Control of Water-Related Pathogens
- Computer Science 289A: Introduction to Machine Learning
- Economics 291/Engineering 298B: Behavior Measurement and Change
- Information 290: Data-Intensive International Development

Research Activities

Examples of research within the DevEng community include those below. The research spans many sectors and types of challenges being addressed, from clean water to energy access to health diagnostic technologies. The research component is critical to the training of DevEng students, and typically students engage with at least 2 faculty on their research in the progression of their dissertation work. There are a number of ways to instill interdisciplinary research skills. One of the ways DevEng has been able to do it is by funding research directly, via the DIL Innovate program, and by funding small travel grants to students, via the DIL Explore program. Samples of research projects undertaken by the DevEng community are below.

DIL Demonstration Projects: DIL began with a series of large, several year demonstration projects. These projects were meant to demonstrate the DevEng approach while providing high quality research with real world impact. Examples of these demonstration projects include:

Electrochemical Arsenic Remediation (ECAR)

PI: Ashok Gadgil (UC Berkeley)

Since the early 1970s tens of millions of shallow tube wells have been installed in Bangladesh and India, resulting in a vast yet silent disaster: these wells draw from arsenic-contaminated aquifers.

Through a DIL-funded demonstration project, Ashok Gadgil and his team developed ElectroChemical Arsenic Remediation (ECAR), a robust, and affordable system for filtering arsenic from water within a sustainable and scalable business model. ECAR uses an innovative method: a small electric charge creates rust particles from ordinary steel plates which bind to arsenic, allowing for effective filtration. The technology is designed to be robust and low-maintenance enough to work in deep rural areas with almost no tech backup or support. ECAR's research has not solely focused on the engineering challenges of water filtration, but also on the difficult hurdle of adoption of the technology. A financially viable business model is crucial to ensure continued monitoring and maintenance of the technology, along with education and social marketing to encourage users to pay for added value in what has historically been a free (albeit contaminated) resource.

CellScope

PI: Dan Fletcher (UC Berkeley)

In emerging regions, where healthcare infrastructure is limited, there is an urgent need for greater access to reliable diagnostic testing, particularly for infectious diseases. CellScope's objective is to establish mobile digital microscopy as a platform for disease diagnosis that can be used by non-expert health workers to in remote settings. The mobile phone-based, easy-to-use device can rapidly capture images blood, sputum, or other patient samples and wirelessly transmit the data to clinical centers, allowing the patient to be evaluated remotely and treatment suggested at the point of care. The CellScope project has specific applications to diagnose the Loa Loa parasite, Tuberculosis, and Onchocerciasis. Applications of the CellScope platform are developed in collaboration with local disease experts and technology companies. Integrated with complete disease workflows, the CellScope team has also worked with commercial partners to build corresponding business models and metrics for evaluating impact. Taking this interdisciplinary approach is essential to transition from CellScope's initial proof-of-concept technologies to fielding a platform that provides a sustained and measurable change in healthcare delivery.

Community Cellular Networks (CCN)

PI: Eric Brewer (UC Berkeley)

The project CCN seeks to address the problem that over one billion people worldwide live beyond the reach of cellular networks. Since many live in sparsely populated rural regions, with weak power infrastructure, it prohibitively expensive for most telecommunication companies to invest. To address this challenge, the CCN team developed the Community Cellular Network (CCN), formerly known as the Village Base Station. The CCN is a complete "network-in-a-box", enabling local communities to both own and operate their own cellular systems. The network is designed for the world's most remote communities and can be deployed by people with limited technical skills. At its core is a village base station, or cell phone tower. Each CCN is costs less than 1/10th the price of traditional cellular equipment, and its low power consumption enables it run solely on solar or micro-hydro power. It is also highly efficient, using less than 50W average power draw, which reduces infrastructure and operating costs. The network can provide kilometers of coverage to local communities. This project led to a company, Endaga, which provided this service until the Endaga team joined Facebook to continue their mission to connect the world.

DIL Innovate is a program that funds more advanced research projects, ranging from 40k-300k annually in research expenditures. DevEng students engage in this research as research team members. Examples of projects under this umbrella include:

Haqdarshak

PI:Jennifer Bussell (UC Berkeley)

This project brings together an interdisciplinary team to understand the impacts of a technology platform called Haqdarshak, which identifies eligible families and helps them through the process of receiving entitlements. Locally trained intermediaries, Haqdarshaks, use the technology to guide individuals through application processes and assist in collecting required documents and signatures. The study is a pilot to gauge the feasibility of Haqdarshak in India, with the goal of a subsequent randomized evaluation to measure the effects of differing implementation strategies on political and economic outcomes. The team is also testing the effect of variations in the selection procedure for Haqdarshak agents, the availability of different services, and pricing structures on citizen engagement with Haqdarshaks. They are also testing how citizen engagement with Haqdarshaks

affects the presence of corruption in service delivery, and overall access to public services.

Participatory Road Infrastructure Monitoring

PI: Engineer Bainomugisha (Makrere University)

Uganda's capital, Kampala, has a reputation of poor road infrastructure. Most roads are riddled with deep potholes that contribute to car breakdowns, accidents, and traffic jams. A major challenge Kampala's city government faces is early identification of potholes and road damage. This project is developing a new technology that uses sensors (accelerometer and GPS) embedded in a mobile phone to automatically detect potholes and to provide a visual mapping of potholes. This acts as a warning to motorists and also informs city authorities of the roads that need urgent attention. The research team developed a PotholeSpot mobile app and a visualization of over 1,000 road anomalies in Kampala in selected areas. The research has also led to an increased awareness about road infrastructure monitoring and more participation by citizens in the process.

Cool Joule

PI: Duncan Callaway (UC Berkeley)

Cool Joule aims to design, develop and implement a load-balancing technology (FlexBox: a temperature sensors, door switches, load- and household level-metering and control, and communications infrastructure) that could respond to grid conditions in Nicaragua. Cool Joule can react to conditions such as sudden drops in wind generation and high-energy prices. According to preliminary results, energy information and behavior have proven to be incredibly valuable assets for the pilot users. An early component of the project was to provide monthly energy reports to participants, and unqueued, many of them started asking for more and different kinds of energy information and the team began developing energy data products that would satisfy their needs. DIL has now funded additional work on the Cool Joule project, which will rigorously test a concept the team has denominated the marginal value of energy information (MVEI). Through a randomized control trial on six Managuan low, low-middle income neighborhoods (with 185 total end users in the study: almost 10 times larger than our first pilot) Cool Joule will test the effectiveness of different energy data products to induce behavioral energy efficiency gains, reduce household stress as it relates to the household energy budget and energy costs, and empower households (mainly women) by supporting their intrinsic drive to seek energy savings.

DIL Explore is a small grant, typically around $5000, for a graduate student to conduct the early, exploratory stages of research in the field, in the context where an ultimate solution might be applied. DevEng students directly apply for this opportunity, and their research is typically overseen by a PI, but the travel and research is meant to be student-led. Examples of projects under this umbrella include:

Green Tech for Disaster Relief

PI: Kristina Raube (UC Berkeley)

In 2015, Nepal suffered a 7.8 and 7.3 magnitude earthquake. The quake resulted in over 1,000 health facilities, mostly village health posts in hard- to-reach areas, were destroyed. We Care Solar's 35lb solar suitcase offers an immediately deployable solution for districts that still lack access to basic healthcare and electricity. However, WeCare Solar (a DIL-affiliated team) are yet to develop their disaster strategy. Graduate student Juno Fitzpatrick travelled to Nepal to develop an impact assessment to understand how the Solar Suitcase can meet the current and future needs of emergency responders to minimize the negative health implications of disaster on maternal morbidity.

Lotto-to-Save

PI: Travis Lybbert (UC Davis)

Lottery play is the most familiar and frequent financial transaction for the Haitian working poor. This project will explore how passion for lottery can be harnessed to open more productive financial services. Preliminary research will model financial strategies and lotto behavior in order to characterize the opportunity for lottery- linked micro- savings leveraging existing mobile money platforms.

DevEng Ecosystem, Events, Workshops, Activities

The Development Engineering community is enhanced by a series of high-touch events and innovator support programs offered each year.

Tech Salons are informal small group conversations led by leaders across the technology and development fields. Salons provide a space for students to request candid feedback from peers and external experts. Topics include "Broadband in Developing Countries" (moderated by Bruce Baikie, Executive Director of Inveneo), "Launching and scaling new innovative product and businesses that improve lives" (moderated by Vishal Vasishth, co-founder of Better Ventures), and measuring energy reliability in developing countries (moderated by UC Berkeley economist Catherine Wolfram).

USAID and DIL Conferences have allowed DevEng to showcase research, develop partnerships, and obtain funding. DIL hosts an annual "DIL Research Scientist Meeting," which provides a unique opportunity for DIL-funded researchers, Dev Eng students, and faculty in the Dev Eng Graduate Group to connect and provide feedback on specific projects as well as shared challenges and opportunities in DevEng. DIL's biannual State of the Science event titled, "The Science of Scaling: Building Evidence to Advance Anti-Poverty Innovation" brought together over 100 researchers, policymakers, industry leaders, and academics to exchange the latest findings about scaling anti-poverty interventions, particularly those developed at universities. In November 2016, three DevEng students attended the 2016 USAID Higher Education Solutions Network's Technical Convening to participate in the annual Innovation Marketplace. Katya Cherukumilli and William Tarpeh, both PhD students, won funding through the VentureWell Prize.

Additionally, in Spring 2016, to address a growing need for resources on mobile data collection experts, DIL launched a webinar series with six monthly broadcasts attended by nearly 200 people in 23 countries around the world, including Afghanistan, Brazil, Colombia, Germany, Nigeria, and Pakistan. The series featured one-hour talks with industry experts, demonstrating a range of digital data capture tools and platforms that can be leveraged for field research. This webinar series allowed DIL to respond to research projects lacking data collection expertise. The webinar recordings are now freely available on Youtube and DIL researchers are able to incorporate these training tools into their research design.

DIL also hosted a number of workshops to supplement curricular activities. Writing workshops guided students on articulating their scientific research to a broader audience. Institutional Review Board (IRB) Workshops included an in-depth overview of the IRB process and how to get approval for international research that includes human subjects.

Another important ecosystem opportunity for students is the Big Ideas@Berkeley contest, an Academic Year-long contest which provides funding, support, and encouragement teams of students who have big ideas to improve the world

in a variety of categories like "global health," "IT for society," and "hardware for good." The categories are designed to be as broad as possible to encourage diverse ideas which may seem unconventional at first. The goal of the program is to instill self-efficacy in students in the field of "innovation" (i.e. student transform into people who identify as "innovators"). Big Ideas develops events (i.e. workshops on proposal development, team formation, etc), in-person advising available throughout the academic year, classes (such as the Social Innovator OnRamp, which helps social innovators launch their ideas), mentor-matching for finalist teams, and many other resources intent upon supporting fledgeling innovators. Although it is not required, and is by design an extracurricular activity, DevEng students regularly compete in Big Ideas and tend to place well, due in part to their strong grasp of developing country context, a well-defined social challenge, and on-the-ground field experience.

Student Progression Through Program

Application Process

Students must apply at least one semester before their Ph.D. qualifying examination. Admission to the Designated Emphasis in Development Engineering is determined by the Dev Eng Faculty Advisors on a rolling basis throughout the academic year. Their admission is processed by the Registrar's Office by means of procedures established and implemented by the Graduate Division. Candidates are encouraged to apply early in their degree, to maximize benefits from participation in the Dev Eng community.

Before applying, interested Ph.D. students are required to arrange a consultation meeting with one of the Development Engineering Faculty Advisors (2-3 designated faculty members in the Graduate Group), and it is recommended that students also speak with the Development Engineering Graduate Student Affairs Officer (at UC Berkeley, this person serves in the Department of Civil and Environmental Engineering).

After initial consultation meetings, a candidate must submit (via email) an application packet to the Development Engineering Graduate Student Affairs Officer in the Department of Civil and Environmental Engineering, to the relevant Dev Eng Faculty Advisor, and the Development Engineering Chair (Alice Agogino). The application packet must contain:

- Application for Admission to the Designated Emphasis in Development Engineering (see Appendix D)
- Letter of intent summarizing research interests and any educational or employment background
- Letter of recommendation from a member of the Development Engineering faculty graduate group (or the student's graduate advisor)
- Graduate Petition for Change of Major or Degree Goal if applicable. This Graduate Division Form officially communicates the student's interest in adding the Designated Emphasis to the student's degree.

Normative Time Impact on Affiliated Doctoral Programs

If a student enrolls in a designated emphasis, no adjustments will be made to the normative time of the student's major. However, there is much flexibility in the requirements to allow for differing requirements in participating departments. The core course (Design, Evaluate, and Scale Development Technologies) must be taken prior to the qualifying examination, but the required research seminar can be taken before or after the qualifying examination. It is also expected that at least one of the electives, but not all, will be taken prior to the qualifying examination. Lastly, it is expected that at most one of the elective courses will count towards the student's major.

Advising and research

The structure for student advising and appointment of faculty to the qualifying examination and dissertation committees:

The student's PhD Qualifying Exam Committee must include at least one member of the DevEng faculty graduate group who will evaluate the student's knowledge related to the Designated Emphasis. The student's dissertation must include topics related to development engineering and the student's Dissertation Committee must include at

least one member of the Dev Eng faculty graduate group who can evaluate the dissertation from that perspective.

Student Advising: Graduate students will be advised by the DevEng Graduate Student Affairs Officer (GSAO) and faculty advisor before admission to the designated emphasis to ensure that each student understands the requirements and has the approval of their PhD advisor. Once admitted to the designated emphasis, it is recommended that the student work with at least one DevEng affiliated faculty member from outside his or her department who could serve as an outside member on the student's Qualifying Exam.taken prior to the qualifying examination. Lastly, it is expected that at most one of the elective courses will count towards the student's major.

Examination requirements

All students must be admitted to the DevEng Designated Emphasis before the qualifying examination. The qualifying examination must include examination of knowledge within Dev Eng. At least one faculty member of the DevEng graduate group must participate in the qualifying examination as approved by the DevEng Head Graduate Advisor in consultation with the Head Graduate Advisor in the primary Ph.D. program. Satisfactory performance on the qualifying examination for the Ph.D. will be judged according to the established rules in the affiliated program.

Dissertation requirements

The student's dissertation must also examine issues related to development engineering and the Dissertation Committee must include at least one member of the DevEng faculty graduate group who can evaluate the dissertation from that perspective.

Final Report for Designated Emphasis

When all course work and designated emphasis requirements have been completed, a final report must be submitted to the Graduate Student Affairs Officer for verification of completion of the designated emphasis at the latest one month prior to filing the dissertation.

Final Report for Designated Emphasis

Designated emphasis conferral process: The DevEng Designated Emphasis will be awarded solely in conjunction with the doctoral degree and will be signified on the student's transcript. It will also appear on the student's diploma by following the major designation ("...have conferred upon [student's name] having demonstrated ability by original research in [major name] with a designated emphasis in Development Engineering the degree of doctor of philosophy...").

Sample Student Population

The first cohort included students from the below fields:

- Mechanical Engineering
- Civil and Environmental Engineering
- Sociology
- Environmental Health Sciences
- Agricultural and Resource Economics
- Energy and Resources Group

In addition, many students across the whole campus participated in DevEng program events such as workshops and other activities (listed above). Additional departments participating included Environmental Science Policy and Management, Electrical Engineering and Computer Science, Economics, Public Health, Bioengineering, Business School, and many others.

DevEng's focus on direct impact work in conjunction with its consideration for human and environmental impacts attracts a more diverse pool of students than a typical technical program (e.g. Engineering at UC Berkeley has about 20% women, 7% URM):

- >50% women – enrolled in the program and in courses
- >20% Underrepresented Minority students – enrolled in the program and in courses

Typical DevEng students have a technical or social science background and are looking to augment their education by targeting at least a part of their dissertation work toward low- resource communities. They work to develop a technology or policy intervention or might evaluate the effects of prior development projects.

The types of students and experiences within the DevEng program are varied.

Examples:

- A Mechanical Engineering student conducting research on challenges associated with manufacturing in developing countries as well as the social impacts of global supply chains.
- An Energy and Resources Group student conducting research on novel human waste management systems.
- A Sociology student using large data sets to evaluate garment labor markets in Southeast Asia.

DevEng students have been very active outside typical lab and classroom settings - some serve on the editing teams for journals (e.g. Annual Review of Environment and Resources), others start companies and nonprofits, while yet others lead student groups (e.g. Engineers for a Sustainable World). Many are passionate about improving the world and come to DevEng with experiences in doing international development project in undergrad, while others are eager for the chance to learn about a new target for their creative efforts and are coming to development for the first time.

Student Perspectives

"One of the boxes I needed to check when choosing a grad program was combining lab work and fieldwork. The other was combining engineering with development."

"The designated emphasis is really meaningful because it recognizes the interstitial space that otherwise just isn't recognized."

The initial feedback from the DevEng students has been enthusiastic; students have found the DevEng to be a "positive force for good" in the PhD experience, and a key reason for their attendance at UC Berkeley.

Throughout the semester, Blum Center staff regularly engage DevEng students in conversation to get their feedback on the program. Students have regularly found the program to be positive and have highlighted the following as points that are valuable to them:

DevEng is...

- Very good at fostering a collaborative environment
- Very good at teaching people to work in diverse teams
- A good platform to hear from different disciplines
- A good platform for networking to identify and secure employment post-graduation

The coursework advanced students' dissertation research in meaningful ways. One student generated his thesis idea in a project-based course that uncovered a need for sensors and understanding technology use; he pivoted from developing a new cookstove to deve-loping new sensors to evaluate whether cook-stoves were really being used as intended. He ultimately developed a suite of new sensors, including the advanced stove use monitor, published in the DevEng Journal, and ulti-mately launched several companies to make the technology widely available.

DevEng courses offer a community of practice around difficult, complex topics in development. Many courses focus on creating valuable products and evaluate whether people use them and whether they actually improve lives. Most students' course work prior to engaging in DevEng is very technical (heat transfer, etc.), but "monitoring adoption or assessing user needs were not things [they] learned until [they were] in DevEng coursework." Combination of students and faculty from disciplines such as Agricultural and Resource Economics, Business School, Public Health, and others is consistently noted as a positive.

Many students are interested in development but are worried about employment after graduation. With the DevEng minor and journal, the field has started to develop and gain legitimacy. This program allows students in more technical fields to pursue entrepreneurial activities (in creating new technologies and subsequently launching businesses) or going into academia as a professor of development engineering. With tenure track positions opening up at universities such as Colorado State University, students are feeling more confident to pursue development as a core pursuit.

Students find that one element that was particularly valuable is the small travel grants which are expressly designed to be very flexible (See, DIL Explore Grants, in the "Research" section). High productivity work was done on $5-10k grants with low barriers to access (short applications and review periods). Students have noted that some of the most high impact (and most well-published) work were a result of these small grants which allow students to travel for several weeks to conduct needs assessments and co-design with communities or interview stakeholders. Researchers recognize that it is hard to do field work with rigid grant structure, and flexibility early in research projects allows for projects to get on the right trajectory early, particularly in a high-risk (high failure rate) field such as development. Students value DIL's ability to disseminate small grants to students and trust that the work will be beneficial to the field.

Operations

Several inputs were necessary to ensure the successful launch and continued operation of the DevEng program. The original concept for the program evolved from a series of conversations and applications contributed to by leaders - both professional staff and faculty - from the social sciences and engineering departments. Development Engineering was conceived as part of a USAID grant that supported the creation of a multi-university research enterprise to create new technologies for development. Recognizing that universities need to play a larger role in innovating for low-resource settings and that the knowledge generating machinery at world-class universities could be better trained toward the needs of low-resource communities, USAID established the Higher Education Solutions Network and funded the Development Impact Lab consortium spanning UC Berkeley, University of Washington, Portland State, UC San Diego, IIT Bombay, and Makerere University (Uganda). This grant helped to support the launch of Development Engineering at the UC Berkeley campus.

Institutional support for the initial launch of Development Engineering included coordinating faculty involved in the program and hiring a Graduate Student Affairs Officer (GSAO), as well as professional staff to manage student experience and recruitment. Faculty in the Development Engineering Faculty Group (see appendix D) meet once a semester to discuss the program and its evolution. Staff maintain student records, create and manage (auxiliary) events and workshops, keep abreast of student experience, and maintain regular communications streams (emails, social media, etc).

Faculty and staff will also continue to apply to grant opportunities to support the students and the research in the development engineering ecosystem. For example, in 2016, the DevEng Faculty Group along with support from Blum Center staff applied for and were granted an NSF Research Traineeship (NRT) to support graduate student training in this unique interdisciplinary field. The grant supports a new direction of research and training at the intersection of food, water, and energy systems ("InFEWS"), and will aid in the continued growth and sustainability of the Development Engineering program as a whole. The InFEWS NRT included a budget for a 50% Project Coordinator who fosters relationships with partner organizations and assists in matchmaking mentorship and internship opportunities with InFEWS trainees. To assist the Project Coordinator, the Blum Center provides personnel to perform financial and administrative functions. The Blum Center also provides plaza-level space for students with state-of-the-art communication equipment, movable furniture, and plenty of white boards will be made available to encourage collaboration, innovation, and inspiration. Shared desks will also be made available to InFEWS students. In addition, the Graduate Dean has supported the program by offering one Regents' or Chancellors' Fellowship, which are normally only open to academic departments.

Lastly, the Blum Center continues to leverage and grow the "ecosystem" on campus for DevEng and InFEWS by bringing together students, faculty, curricular programs, and external speakers/events. This includes incorporating InFEWS into the Practitioners in Residence Program (providing one-on-one consultations and advice), Development Salons (small, themed events with subject-matter experts), and InFEWS Workshops (technical convenings/trainings) that DIL and DevEng already had established.

Key Insights

In the course of launching and implementing the DevEng program at UC Berkeley, we have learned several lessons which might be useful to other institutions. Here are 10 insights we have learned, and hope to hear from others who follow this path.

1. **Interdisciplinary courses**
   Structuring classes across departments can be a challenge, particularly if institutions require cross listing. In particular for the courses that are co-taught, the instructional faculty benefit from having a portion of the class reflected in their home department for teaching credit. This cross listing might be an administrative challenge however. One approach we have found to work is "co-locating" - for example, a business-listed DevEng 200 (MBA 290) that is scheduled in the same location and time as a mechanical engineering-listed DevEng 200 (ME C200). Successful resolution of these concerns requires cooperation between departments, which can help to strengthen the ties between DevEng faculty.

2. **Faculty incentives**
   Due to the nature of new programs, faculty might be asked to contribute to co-teaching new classes like DevEng 200. Often, faculty will have a hard time being relieved from their home department teaching duties for a brand new program like DevEng. Having either institutional support or other financial support that can fund faculty contribution to co-teaching will go a long way to increase participation and faculty buy-in. In addition, providing reassurance to early-career faculty that their participation in research and teaching in a new field will be recognized and valued by campus tenure and promotion committees is critical for their participation and contribution to the growth of the field.

3. **Cohesive cohorts**
   Since students are coming from many departments, it is critical to build a cohort in other ways beyond common classes. DevEng 200 and 210 are the only mandated common classes in DevEng, so events that are social or educational in nature, or other extracurricular activities, can help to build a sense of community.

4. **Institutional structure**
   Creating an academic unit like the Development Engineering Graduate Group allows for the program to make educational and administrative decisions similar to academic departments. Regular meetings maintain momentum and buy-in from affiliated faculty.

5. **Institutional support**
   Having upper administration champions, such as deans or chancellors, advocate for and support the program is critical in providing the institutional support necessary for new programs. Leadership can support tenure cases and new class types where existing regulation might pose hurdles. Also, student advisors to oversee student progress are required and must be funded either through outside funds or institutional agreements.

6. **Student travel**
   Providing avenues for students to work in the field is critical. DevEng has been able to do this with some funding via the USAID-supported Development Impact Lab and the NSF-supported InFEWS. Students regularly cite field work as a critical component of their education. DevEng recommends that

fieldwork be research-based (rather than service-based), generating knowledge that is shared widely, including with the community it aims to benefit. For DevEng, $2000-$5000 small grants early in the research progression have enabled large leaps in understanding, and ultimate solution development.

7. **Competing initiatives on campus**
   Being aware of the evolving landscape of opportunities available to students is important to crafting a program that is cohesive and effective. At UC Berkeley, for example, there is a Master's program called "Master of Development Practice" which sounds similar to "Development Engineering," and both programs have worked collaboratively to provide programming that differentiates.

8. **Leveraging networks**
   The Blum Center takes advantage of all the programs in its ecosystem to provide resources to students. For example, the Big Ideas@Berkeley contest has hundreds of judges and mentors in its network to help early-stage innovators develop their ideas. These same judges and mentors get involved in guest speaking, providing one-on-one office hours/advising, and other engagements across other Blum Center programs such as Development Engineering.

9. **Funding for project-based classes**
   Providing small amounts of funding (i.e. $2000/project) allows for projects within classes like DevEng 200 to make substantial gains - teams can prototype potential solutions, potentially travel to meet with stakeholders, and purchase other necessary supplies. Otherwise, projects will tend to remain more consultative in nature.

10. **Extracurricular activities**
    Encouraging students to participate in activities such as the Big Ideas contest or other social innovation contests builds innovation and entrepreneurship skills, and provides crucial external feedback and validation to students early in their project trajectories. In addition, the prize money from such endeavors, typically in the low $1000s, helps with initial prototyping and exploratory research costs that might otherwise be difficult to fund. Almost all DevEng students have benefited from Big Ideas funding or other initiatives such as CGI U, GSVC, and others.

APPENDIX A: Example DevEng 200 Syllabus

Design, Evaluate and Scale Development Technologies
Dev Eng C200, Mech Eng C200, MBA 290T
Fall 2015

General Information

Faculty

Alice M. Agogino, Department of Mechanical Engineering, 415 Sutardja Dai Hall (CITRIS Building), (510) 642-6450, https://twitter.com/agogino, agogino@berkeley.edu

David Levine, Haas School of Business, F671 Haas, (510) 642-1697, levine@haas.berkeley.edu

GSI: redacted.

GSRs: Two GSRs will be joining the class in support of research on development engineering. [Name/email redacted] will focus on the course projects and evaluations. [Name/email redacted] will focus on DevEng software and sensors (e.g., ODK workshop and the Cook Stove experiment)

Class Meetings

11:00 am -12:30 pm M W (110 Cheit Hall on M and I-Lab on W, Haas School of Business)

Optional (but highly recommended) workshops noon-1:00 pm F (I-Lab, Memorial Stadium or Cal Design Lab). Schedule and location on bCourses Page

Office Hours and Optional Discussion/Workshops

Agogino: Th 2:30-4:00, 415 Sutardja Dai Hall (CITRIS Building) or after class
Levine: M 1:30-3:00 in F671 Haas or by appointment

Class Representatives

One student from the technical side and one from the Economics / Business side will be invited to help with class feedback.

Course Description

This course provides students with a set of skills that will allow them to address complex problems and design challenges in development engineering. Students will learn to participate in and lead innovation and creativity in collaborative settings. This course includes design projects and case studies, many related to projects at UC Berkeley.

Student teams will work with preliminary data to define the problem. They will then collect and analyze interview and survey data to learn about user needs. Students will explore how to use novel monitoring technologies, experiments, and large datasets both to understand user needs and to provide rapid feedback for product improvement. Students will use a variety of tools to analyze their data, ideate potential solutions, and prototype. The teams will use their projects to develop plans for rapid improvement, scaling, continuous

improvement and a rigorous impact evaluation.

Topics Covered

1. Project Design (including human-centered design with participant observations and interviews using qualitative research and survey data collection).
2. Development Technologies (including wireless sensors, mobile data collection, and prototyping);
3. Measurement and evaluation techniques (including design of experiments, statistical analysis for impact analysis). Methodologies for collection and evaluation of data to improve projects in the field, and eventually scaling projects and conducting a rigorous evaluation.
4. Developing and evaluating social impact (including sustainability and scaling of projects). Going beyond rigorous evaluations to look at broader impact on people and communities.

Class/Laboratory Schedule

- 3 hours lecture per week and one hour optional workshop/discussion.
- Assessment of Student Progress Toward Course Objectives
- 25% on homework assignments & group exercises
- 25% class participation
- 10% final class presentations on capstone project
- 40% on capstone USAID DIV Letter of Interest

Class Participation

Students are co-producers of each class. Students will need to come to class prepared by completing the required reading, preparing the discussion questions, completing any homework, and reading relevant current events. Class participation makes up 20% of the grade, but it is also a requirement to pass. There are multiple measures of class participation:

- Be present and prepared at the start of each session;
- Post good questions, comments, articles, or suggested links on bCourses
- Presentations of team work
- Peer Reviews: For most assignments students should review each others' work. That way, professors receive better assignments and students get used to pre-testing every work product and to helping each other.

Class Preparation and Participation

Readings are meant to guide your thinking about the class assignments. Readings are given in the class schedule; we expect you to come to class prepared to discuss the readings and the suggested questions. In any given class session, a handful of students may be called upon specifically to speak about the readings and answer questions about them. If you have prepared in advance according to the syllabus, you will have no problem responding when called upon. Your individual class participation grade will be based upon your

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in-class remarks during discussions and will be judged by the teaching staff.

Assignments
We have periodically assigned exercises to have you experiment with some of the concepts we are teaching. These are due at the start of each class, unless otherwise noted. Late assignments are discouraged but accepted, heavily penalized at 20% of the total score (20 points out of 100) for each day late.
Submit assignments on the bCourses "assignments" tab under the appropriate heading prior to the start of class on the day they are due. Bring one copy of your homework to class, as we will frequently ask you to share your results (Digital sharing is fine).

bCOURSES Website
We will make extensive use of the course Website both to communicate information to you and to converse with you about your readings, homework and your projects. You will find the course on https://bcourses.berkeley.edu.

Laptop, Tablet and SmartPhone
MBA courses do not allow general use of laptops, tablets, smartphones or other computer devices during class time. Our class time will focus almost entirely on in-class exercises to bring to life project-based learning. You will need to give your full attention to your teammates, to the work you are being asked to do together, and to what you are taking away from that work. Please do not use your laptops or smart phones in class, unless it is for a class exercise or to take notes (no email, texting, web browsing, Facebook, etc.) Any violation of this policy will lead to a reduction in your participation grade. We love the way Adaptive Path, one of the design firms we work with, describes its policy along these lines:
Honor the gathering. In this ever more interrupt-driven digital world, it's a challenge to bring together all the right people at the same time to think, make and solve problems that are too complex for just a few people to figure out. Gatherings of this magnitude need opening ceremonies to acknowledge the value of the time we are about to spend together. Typically these ceremonies don't include marching bands or fireworks (although that would be cool), but there are small and simple actions that help us all recognize that this is a sacred time. These small things include sending out invitations ahead of time, providing food and drink, creating an environment where people can focus without laptops or smart phones, welcoming and orienting people to our day together, and having the client sponsor begin the workshop with essentially an opening blessing for the people gathered and the work we will accomplish.

Schedule

The schedule below provides learning goals for each session, along with required readings and assignments. The assignments are listed chronologically in order of the date assigned. We have made every effort to provide you all course details in this syllabus, but we sometimes have to make changes due to unexpected circumstances, such as a change in the visit date of a guest lecturer. Please check bCourses announcements and assignment updates for changes to the schedule.

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The assignments are listed chronologically in order of the date assigned. We have made every effort to provide you all course details in this syllabus, but we sometimes have to make changes due to unexpected circumstances, such as a change in the visit date of a guest lecturer. Please check bCourses announcements and assignment updates for changes to the schedule.

DAY	TOPIC
1 W 8/26 C110	**Phase I: Understanding the Problem, Context and Needs** **Unit 1: Introduction to Development Engineering** Our first day of class will be on W 8/26 with an introduction to the course and the field of development engineering. What are the key issues and challenges? Who are the stakeholders? We will also discuss capstone project options. **Required Readings:** Hans Rosling, "New insights on poverty". TED talk, March 2007: http://www.ted.com/talks/hans_rosling_reveals_new_insights_on_poverty.htmlhttp://www.ted.com/ Amy Smith, "Simple designs to save a life," Feb. 2006: https://www.ted.com/talks/amy_smith_shares_simple_lifesaving_design Wong, Kristine, 2014: "Cleantech in the developing world: from solar power to refrigeration," http://www.theguardian.com/sustainable-business/2014/jun/13/cleantech-developing-world-solar-power-refrigeration
HW 0: Due 8/31	**Pitching a Project.** Your interest may be quite general or focused on one or two specific domains or problems. If you are particularly interested in pitching a capstone project for a class team, describe it in a few sentences (and how far along the project is). One of the student-initiated class projects last year won 1st place in the Big Ideas competition for global health. We will make time to pitch ideas on the Friday workshop on Sep. 4 at noon.
2 M 8/31 C110	Preview the iterative design thinking processes in the context of development engineering, associated research methods and their roles in needs assessment. Cover theories of persistent poverty. **Required Readings:** Banerjee, Abhijit V., and Esther Duflo. 2007. "The Economic Lives of the Poor." Journal of Economic Perspectives, 21(1): 141-168. (bCourses) Whitesides, George, 2012. "The Frugal Way: The promise of cost-conscious science," Science, pp. 154. (bCourses)

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	T. Brown and J. Wyatt. "Design Thinking for Social Innovation (SSIR)," 2010: http://www.ssireview.org/articles/entry/design_thinking_for_social_innovation/ **Optional Readings:** Abhijit Banerjee and Esther Duflo. Poor Economics: A Radical Rethinking of the Way to Fight Global Poverty, Public Affairs, 2011. Amartya Sen. Development and Freedom. Anchor. 2000 Voices of the Poor by World Bank, http://bit.ly/worldbank-voices-of-poor
HW 1 Due: 9/9	**Individual Homework:** Spend at least 30 min. observing hand washing practices in a restroom, dining room or restaurant. Do you see different results when subjects know you are observing them? Take photos of the associated hand washing facilities, along with related signage. Document your observations and photos. Interview at least one person asking about their hand washing habits. Bring hard copies to class on Sept. 9. Also identify one study on hand washing practices in the U.S.
3 W 9/2 I-Lab	Unit 2: Needs Assessment with Primary, Secondary & Tertiary Sources Review of needs assessment methods in development engineering and introduction of one case study. Where are problems in different locations? To design a "Safe water solution" you have to know more than water. The solution to a development challenge must be based on knowledge of: Market segments (urban/rural, high/low education), ability to pay (levels and timing of income; access to credit and costs of credit), information sources for consumers, household decision making structures (role of women), existing social groups (e.g., formal, informal, NGO government), distribution channels, and so forth. We will first discuss research methods using tertiary data (e.g., published data) and secondary sources first (e.g., individuals or organizations working in the area, organizations that work in similar areas). **Required Readings:** Luby, Stephen P., et al. "Difficulties in maintaining improved handwashing behavior, Karachi, Pakistan." American journal of tropical medicine and hygiene 81.1 (2009): 140 http://www.ajtmh.org/content/81/1/140.full.pdf+html Curtis, Val, et al. "Hygiene: new hopes, new horizons." The Lancet infectious diseases 11.4 (2011): 312-321. (bCourses) Rose George, "Let's talk crap. Seriously." http://www.ted.com/talks/rose_george_let_s_talk_crap_seriously.html (Ted Talk, 2013). Optional Readings:

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	Mathers CD, Loncar D (2006) Projections of Global Mortality and Burden of Disease from 2002 to 2030. PLoS Med 3(11): e442. doi:10.1371/journal.pmed.0030442. http://www.plosmedicine.org/article/info%3Adoi%2F10.1371%2Fjournal.pmed.0030442
4 W 9/9 I-Lab	We introduce a range of research methods for performing primary data collection for needs assessments, including observations, interviewing, focus groups, and embedding/empathic design. We will discuss trade-offs across the various methods, issues in reducing the distance between researchers and subjects (novices/experts, local/distant geographies, wealthy/poor, etc.), and how to communicate user needs research within your team. **Required Readings:** Sandhu, Jaspal S. "Measure early, measure often: rapid, real-time feedback in design for social innovation". Jan. 2013: http://poptech.org/e3_jaspal_sandhu "Designing For Humans: an Ethnography Primer," IDSA, 2010: http://www.aiga.org/ethnography-primer/ The Design Toolkit, IDEO.org, http://www.designkit.org/ Getting People to Talk: An Ethnography & Interviewing Primer, http://vimeo.com/1269848 David Levine, "Advice on doing research interviews," (bCourses) **Optional Readings:** Ware NC, Idoko J, Kaaya S, Biraro IA, Wyatt MA, et al. (2009) Explaining Adherence Success in Sub-Saharan Africa: An Ethnographic Study. PLoS Med 6(1): e1000011. doi:10.1371/journal.pmed.1000011 http://www.plosmedicine.org/article/info%3Adoi%2F10.1371%2Fjournal.pmed.1000011 **Class Exercise:** In-class exercises on observations and interviewing based on your hand washing data.
HW 2 Due: 9/14	**Individual Homework:** Conduct one interview associated with your capstone project. When you have completed your observation and interview: Write up a one-page summary of your key findings including quotes from those you observe or interview. Don't over-generalize at this point, as you want to keep the people you learned about "alive" for your classmates. Include a short description of the person you interviewed and the circumstances in which you interviewed him or her to set the context for your findings.

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	Create a one-page document that captures the best story you observed or heard to highlight one of your key insights. The story should not rehash the entire interview, but should bring alive a particular insight for your study team members. o Start with a catchy headline o Include a picture or drawing o Write a one-paragraph story that captures the essence o Close with the "moral" of the story – one line that captures the insight Upload your work – one-page summary and one-page story to bCourses before class. Bring a copy of your story to class to share with your teammates
5 M 9/14 C110	**Unit 3: Capstone Launch and Analyzing Qualitative Data** Building on qualitative research methods, this unit will focus on analyzing data from design research. Students should consider which methods will be of value to their projects (data on customer and user needs– interview notes, photographs, etc.) and how to access your customers and other stakeholders. We'll also use this class time to work with students on applying some of the framing and reframing tools to a case or on real data. Techniques will include personas, scenarios, 2x2 matrices, and journey maps. **Class Exercise:** Launch capstone teams of 4-5 people, each with at least one technology and one social science student for your Capstone project. Develop a draft problem definition and begin your user research plan. **Required Readings:** Weiss. Robert S. Learning From Strangers. Chapter 4: Interviewing, pp. 61-119. The Free Press, 1995. (bCourses) Scan Research Methods on theDesignExchange, https://thedesignexchange.herokuapp.com/ An Introduction to personas and how to create them, http://www.steptwo.com.au/papers/kmc_personas/index.html Optional Readings: Jenkins, Carol, and Peter Howard. "The use of ethnography and structured observations in the study of risk factors for the transmission of diarrhea in highland Papua New Guinea." Medical anthropology 15.1 (1993): 1-16. Note on Observation on bSpace. Note the value of failure stories! Aarthi Rao & Sandra McCoy. "Fostering Behavior Change for Better Health." Stanford Social Innoation Review blog, Aug. 17, 2015. http://ssir.org/articles/entry/fostering_behavior_change_for_better_health

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HW 3 Due: 9/21	**Team Homework:** Turn in your "problem definition" file, http://diytoolkit.org/tools/problem-definition-2/ to bCourses project site. It is fine to change your group's project focus as the semester proceeds. Also turn in your collaborative plan and draft assessment plan (target audience, methods for qualitative/ quantitative user needs, prototype testing) for your capstone project. (Note: Individualize Learning Style profile is due earlier by 5:00 pm 9/15 Tues. This will be done by individualized email with title: DEV ENG: HOMEWORK DUE TUESDAY, 9/15 by 5:00 PM)
6 W 9/16 I-Lab	**Framing and Reframing the Problem with Insights from Research** Work with your team to go over interviews, complete a collaborative plan for your team and develop a draft user research plan. **Required Readings:** Scan: OpenDataKit: magnifying human resources through technology. http://opendatakit.org Scan: Rebecca Smith, Kendra Leith (2014) D-lab Scale-Ups: User Research Framework. (bCourses) Bansal, Sarika. August 21, 2014. "Innovation Within Reach," New York Times, Opinion, http://opinionator.blogs.nytimes.com/2014/08/21/innovation-within-reach/ Staus, Tamara, "Berkeley Lab Water Technology "Boomerangs" from Bangladesh to California," http://blumcenter.berkeley.edu/news-posts/berkeley-lab-water-technology-boomerangs-from-bangladesh-to-california/ **Class Exercise:** Continue teamwork, needs assessments and framing exercises. **Optional Readings:** Vechakul, Jessica, and Alice M. Agogino. 2013. "A Comparison of Two Transdisciplinary Human-Centered Design Approaches for Poverty Alleviation". Proceedings of The Future of Transdisciplinary Design (TFTD13). (bCourses) Schaeffer, N.C. and Presser, S. (2003). The science of asking questions. Annual Review of Sociology, 29, 65-88. http://www.ssc.wisc.edu/~alang/357/Schaeffer%20and%20Presser_Science%20of%20Asking%20Questions.pdf **Class Exercise:** Work on team assignments and create a persona for your project.

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7 M 9/21 C110	**Unit 4: Quantitative and Mixed-Methods Needs Assessment** Review and compare quantitative and mixed (qualitative and quantitative) methods in research design: surveys, phone, and internet tools. Reflections and instruction on human subjects and ethical considerations. **Required Readings:** Survey Research, Research Methods Knowledge Base, 2006. http://www.socialresearchmethods.net/kb/survey.php Albert, Jeff, Jill Luoto, and David Levine. "End-user preferences for and performance of competing POU water treatment technologies among the rural poor of Kenya." Environmental science & technology 44.12 (2010): 4426-4432. http://faculty.haas.berkeley.edu/levine/papers/Albert_et_al_EST_2010.pdf Checklist for good survey questions (on bCourses) **Optional Readings:** Dillman, Don A., Mail and Internet Surveys, second edition (updated), 2007. Schaeffer, N.C. and Presser, S. (2003). The science of asking questions. Annual Review of Sociology, 29, 65-88. http://www.ssc.wisc.edu/~alang/357/Schaeffer%20and%20Presser_Science%20of%20Asking%20Questions.pdf **Class Exercise:** Write an outline for an open-ended, semi-structured interview and then have a classmate review it. Use this interview to inform your next homework assignment.
HW 4 Due: 9/28	**Team Assignment:** Write and pilot a section of survey you could use to learn about your capstone project. Also submit a revised assessment plan (target audience, methods for qualitative/quantitative user needs, prototype testing) for your capstone project. List names and job titles of at least 3 people you intend to interview in the next 3 weeks.
8 W 9/23 C110	**Unit 5: Integrating Needs Assessment Findings to Develop Solutions** The goal is to gain insights from the qualitative and quantitative data from the needs assessment. This is sometimes called "Telling today's story" to understand the context and users' most important challenges and needs. **Required Readings:** Sherwin, David. September 23, 2013. "A Five-Step Process for Conducting User Research. http://www.smashingmagazine.com/2013/09/23/5-step-process-conducting-user-research/

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	Wood, Amy E. and Christopher A. Mattson. 2014. "A Method for Determining Customer Needs in the Developing World." Proceedings of the ASME 2014 International Design Engineering Technical Conference, DETC2014-35357. **Class Exercise:** Bring in your projects customer research to date for use in a class exercise.
9 M 9/28 C110	**IT for Development:** Guest speaker Tapan Parikh is on the faculty of our I-School and studies the design and use of information and communication technologies for sustainable development. More at: http://people.ischool.berkeley.edu/~parikh/ **Required Readings:** Neil Patel, Krishna Savani, Paresh Dave, Kapil Shah, Scott R. Klemmer and Tapan S. Parikh. 2013. Power to the Peers: Authority of Source Effects for a Voice-based Agricultural Information Service in Rural India, Information Technologies and International Development (ITID), Vol. 9, No. 2.
10 W 9/30 I-Lab	**Use of Big Data and New Sensors:** Lab experiments and experiments in the field. This lecture will involve hands-on use of sensors for data collection and a case study. Thought question: How might you obtain sensor data that would help your capstone project? **Required Readings:** Wilson, Daniel, Mohammed Idris Adam, Omnia Abbas, Jeremy Coyle, Angeli Kirk, Javier Rosa, and Ashok Gadgil, 2014. "Comparing Cookstove Usage Measured with Sensors Versus Cell Phone-Based Surveys in Darfur, Sudan". CoDev (Center for Cooperation and Development), http://cooperation.epfl.ch/page-107182-fr.html Albert, Jeff, Jill Luoto, and David Levine. "End-user preferences for and performance of competing POU water treatment technologies among the rural poor of Kenya." Environmental science & technology 44.12 (2010): 4426-4432. http://faculty.haas.berkeley.edu/levine/papers/Albert_et_al_EST_2010.pdf
HW 5 Due 10/5	**Individual Assignment:** Submit 10 or more ideas or concepts related to your capstone. This is a brainstorming phase, so there are no bad ideas. We'll refine later. Upload digital version to Assignments and bring in hard copy for class exercise

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12 W 10/7 I-Lab	**Unit 6: Expanding Design Concepts** After reviewing your teams' original 50 individual concepts, double the number through brainstorming and structured methods (e.g., for a team of 5, you should strive for a total of 100 concepts). After class in your next team meeting, expand your concepts using both brainstorming and structured methods and update your spreadsheet with the new concepts generated. Upload to bCourses before the next class. **Required Readings:** 10XE Principles", Rocky Mountain Institute, http://www.rmi.org/rmi/10xE+Principles "Morphological Charts", http://www.ifm.eng.cam.ac.uk/dmg/tools/concept/morph.html "Creax Function Database", http://function.creax.com/ Scan "Biomimicry Institute", http://www.biomimicryinstitute.org/ This class will focus on structured methods for concept generation, such as Morphological Matrices, Functional Decomposition, Biomimetic Design, etc.
13 M 10/12 C110	**Unit 7: Prototyping & Testing Early Concepts** Techniques for low and medium fidelity prototyping; using prototypes to generate new concepts; "building to think", prototypes for communicating concepts and testing concepts; hypothesis testing, evaluating data, and selecting concepts. The goal: Fail fast, get rich feedback, and improve. Think forward a few steps: o Prioritize concepts that are more likely to fit with a business model o Simulate the impact under different assumptions o Evaluation of ideas depends on the setting. For example, in one problem the apparent right answer might be "Kill all the animal disease vectors" – except the target consumer group is Buddhist. **Required Readings:** "Prototyping Is The Shorthand Of Design", http://bit.ly/ep-84086B33-F723-4B8A-A609-D766810B0329 **Class Exercise:** Prototype solutions.
HW 6 Due 10/14	**Team Assignment:** Expand your concepts to at least 100 using concepts used in class on 10/7 Upload digital version to Assignments and bring in hard copy for class exercise

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14 W 10/14 I-Lab	**Phase III: Taking it to the Field** **Unit 8: Pilot and Field Testing – Qualitative** Phases II and III are iterative, in a spiral of continuous improvement that should be taken into account in your assessment plan. How do you get your prototype to work in the lab. Pilot test with nearby experts and role playing. Once it works in and near the lab, design plan to test in target settings.
15 M 10/19 C110	**Unit 9: Technologies for Monitoring & Testing** Case study of technologies for monitoring and testing. Guest speaker Ashok Gadgil, Area Deputy for Science and Technology for the Energy Technologies Area of Lawrence Berkeley National Laboratory, and a Professor of Civil and Environmental Engineering at UC Berkeley. **Required Readings:** Re-read: Staus, Tamara, "Berkeley Lab Water Technology "Boomerangs" from Bangladesh to California," http://blumcenter.berkeley.edu/news-posts/berkeley-lab-water-technology-boomerangs-from-bangladesh-to-california/ Galitsky, C, Gadgil, AJ, Jacobs, M & Lee, YM. "Fuel Efficient Stoves for Darfur Camps of Internally Displaced Persons. -- Report of Field Trip to North and South Darfur, Nov. 16-Dec. 17, 2005". LBNL-Report 59540 (Lawrence Berkeley National Laboratory, Berkeley, 2006). http://eetd.lbl.gov/sites/all/files/lbnl_59540_feb-24-2006.pdf Ashok Gadgil, Andrée Sosler, Debra Stein, "Stove Solutions: Improving Health, Safety, and the Environment in Darfur with Fuel-Efficient Cookstoves," Solutions for a sustainable and desirable future (bCourses).
16 W 10/21 I-Lab	Guest speaker Laura Stachel will speak on how she decided solar suitcases were important in Nigerian labor and delivery clinics (even though solar lights were not related to the obstetric medical skills she intended to disseminate). **Required Readings:** WECARESolar, http://wecaresolar.org and http://dil.berkeley.edu/technology-portfolio/current-projects/we-care-solar/
HW 7 Due 10/26	**Team Assignment:** Turn in notes from at least 10 interviews that will inform your capstone. List a few other names and job titles you will speak with (unless you can make the case against more interviews.)

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10/23 HW 7 iLab Due: 11/3	**Friday Workshop (2 hours, required)** **Team exercise:** Analyze data from stove usage monitors (SUMs). How well do the data from the SUMs line up with the observations? We will examine some or all of: · Envirofit wood-burning stove · Berkeley-Darfur wood-burning stove · Ugastove charcoal-burning stove · Solar Household Energy's HotPot solar oven
17 M 10/26 C110	Analyzing large datasets for insight. In this class we will explore the integration of large qualitative and quantitative data sets to gain insight for development projects. We will be joined by cook stove doctoral student Danny Wilson (Mechanical Engineering) and Angeli Kirk (Agricultural Resources and Economics) and will go over the Friday cook stove experiment. **Required Readings** TBA
HW 8 Due: 11/3	**Individual Assignment:** Turn in your analysis of the data from the stove observation and stove sensors. How well do the data from the SUMs line up with the observations? Submit as homework. Note the cooks and design researchers are to turn in their homework earlier on 10/26 to make your data available for the data analysts.
18 W 10/28 I-Lab	**How to use large datasets for your project.** **Team exercise:** Consider data sources such as: • Administrative data such as electronic health records, school test scores, or government purchases • Operational data such as all mobile phone calls in a nation, every sale by Amazon, or every search by Google • Large-scale sensor data such as GPS on phones or cars and satellite observations of land use • Low-cost sensors you can put with some or all of your products, especially if the sensors can communicate with you. Assume you had access to one or more of these large datasets (or another data source that might be available in a few years). How would you use those data to improve the functionality of your solution and/or speed the design, ongoing improvement, or monitoring and evaluation of your solution?

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	Required Readings (Read quickly, as these are examples.) Tatem, Andrew J., et al. "The use of mobile phone data for the estimation of the travel patterns and imported Plasmodium falciparum rates among Zanzibar residents." Malaria Journal 8 (2009): 287. http://www.biomedcentral.com/content/pdf/1475-2875-8-287.pdf Reread: Neil Patel, Krishna Savani, Paresh Dave, Kapil Shah, Scott R. Klemmer and Tapan S. Parikh. 2013. Power to the Peers: Authority of Source Effects for a Voice-based Agricultural Information Service in Rural India, Information Technologies and International Development (ITID), Vol. 9, No. 2.
19 M 11/2	**Unit 10: Pilot and Field Testing – Quantitative** Quantitative methods for pilot testing. Dimensions to test include: product features, messaging to motivate purchase and usage, pricing, sales offers (free trial, lay-away, credit, etc.), channels. Determine the effect of a customer's types on demand and willingness to pay, usage and satisfaction. At each stage, feed the results back to the development team. **Required Readings:** "The Effect of Marketing Messages, Liquidity Constraints, and Household Bargaining on Willingness to Pay for a Nontraditional Cookstove," David Levine, Theresa Beltramo and Garrick Blalock. UC Berkeley: Center for Effective Global Action. 2014. http://www.escholarship.org/uc/item/4vj3w941 Rob Bailis, "The Kitchen performance test (KPT)," 2007. http://www.pciaonline.org/files/KPT_Version_3.0_0.pdf "A/B testing," Wikipedia, http://en.wikipedia.org/wiki/A/B_testing **Optional Readings:** Ludwig, Kling and Mullainathan. "Mechanism Experiments and Policy Evaluation", Journal of Economic Perspectives, Summer 2011, pp 17-38. Bandiera, Barankay and Rasul, "Field Experiments in Firms," Journal of Economic Perspectives, Summer 2011, pp 63-82.
20 W 11/4 I-Lab	**Unit 11: Business models** **Required Readings:** The Social Blueprint, http://www.socialblueprint.org/ Social Blueprint Impact Canvas: http://www.socialblueprint.org/wp-content/uploads/2015/02/ISA_The-Social-Blueprint_-Impact-Canvas_v3.21.pdf

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	Levine "Notes on sales offers for stoves and filters" David I. Levine, Theresa Beltramo, Garrick Blalock, and Carolyn Cotterman, "What Impedes Efficient Adoption of Products? Evidence from Randomized Variation in Sales Offers for Improved Cookstoves in Uganda," 2013. **Optional Readings** (but highly recommended if business models are new to you): Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers, by Alexander Osterwalder and Yves Pigneur, 2nd Edition, 2010, pages 1-50. http://www.businessmodelgeneration.com/downloads/businessmodelgeneration_preview.pdf A nice slideshow by Osterwalder introducing his version of the Business Model Canvas http://www.slideshare.net/Alex.Osterwalder/business-model-innovation-matter
HW 9 Due: 11/9	**Team Assignment:** Design an experiment to speed product improvement for your capstone project. Your experiment could measure product usage, product effectiveness, consumer willingness to pay, etc. It can study variation in marketing messages, product offers, product features, distribution channels, etc. It can examine how the product's is used differently by different types of users (urban vs. rural, high vs. low literacy, etc.).
21 M 11/9 C110	**Team Exercise:** Business Model Canvas / Social Blueprint You have 6 minutes to present one segment of your canvas that you would like to get feedback on for a peer review. Be sure to give a clear statement of assumptions and how you will learn to answer critical questions. At this early stage, it is fine if your sketch is largely related to supply-side issues (what the Social Blueprint calls "Root Strategy", how you will deliver your social venture or program) or to demand-side issues ("Business Base"). You are welcome to use Osterwalder's Business Model Canvas, as long as you can address the additional questions: What is my anchor purpose? Is the challenge big? How big is the potential paying market?
22 W 11/11	Instructional Holiday
HW 10 Due: 11/16	**Team Assignment:** Design part of a business model for your capstone project. (You may choose another product with instructor approval.) You can work on one portion of a business model such as: Supply chain · Determining demand and consumer willingness to pay

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	· Distribution · Finance, Etc.
23 M 11/16 C110	**Unit 12: Rigorous Impact Evaluation** Guest Speaker: Paul Gertler, Director, UC Berkeley Clausen Center for International Business and Policy. He is considered an early pioneer in the randomized evaluation of social programs in developing countries. http://facultybio.haas.berkeley.edu/faculty-list/gertler-paul **Required Readings:** Esther Duflo: Social experiments to fight poverty (TED Talk) David Levine "Template for evaluation design." bCourses. Scan Paul J. Gertler, Sebastian Martinez, Patrick Premand, Laura B. Rawlings and Christel M.J.Vermeersch, Impact Evaluation in Practice, pages 1-79. https://openknowledge.worldbank.org/bitstream/handle/10986/2550/599980PUB0ID-181BLIC1009780821385418.pdf?sequence=1 **Optional Readings:** Edward Miguel, Michael Kremer. "Identifying Impacts on Education and Health in the Presence of Treatment Externalities," Econometrica 2004 vol. 72(1), pp 159- 217.
24 W 11/18 I-Lab	**Unit 13: Rigorous Evaluation Studio** After a brief lecture to follow up with the topic of rigorous evaluation, you will have time to work with your team on evaluation in the I-Lab. **Required Readings:** Read Gertler, et al., Impact Evaluation in Practice, "When Can Randomized Assignment Be Used?" (pp. 55-56) and "Two Variations on Randomized Assignment" (pp. 64-79). https://openknowledge.worldbank.org/bitstream/handle/10986/2550/599980PUB0ID-181BLIC1009780821385418.pdf?sequence=1 **Class Exercise:** Sketch an impact evaluation for your capstone project.
HW 11 Due: 12/1	**Team Exercise:** Design an impact evaluation for your capstone project. (You may choose another product with instructor approval.) If your capstone project is not sufficiently advanced to merit a rigorous impact evaluation, assume preliminary stages go well enough to justify a large-scale study.
25 M 11/23 C110	**Cellscope Case Study** Guest speaker: Dan Fletcher, Professor and Chair of Bioengineering

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	Required Readings: · D'Amrosio, Michael V., Matthew Bakalar, et al., "Point –of-care quantification of blood-borne filarial parasites with a mobile phone microscope," 7 (286) Science Translational Medicine, May 6, 2015. (bCourses) · Cellscope case study. (bCourses)
26 W 11/25	Holiday
27 M 11/30 C110	**Unit 13: Scaling & Understanding Impact at Scale** A discussion of scaling and impact at scale. We will discuss the DIV final report and give the class time to work with their team in the I-Lab. **Required Readings:** · Prahalad, C.K. and Hart, S.L "The Fortune at the Bottom of the Pyramid." Strategy+Business 26: 54-67. · Polak, Paul, YouTube video: TEDxMileHigh-the Future Corporation https://www.youtube.com/watch?v=ezVxt7TkyeM **Optional Readings:** · Karnani, Aneel. "The Mirage of Marketing to the Bottom of the Pyramid." California Management Review 49.4 (2007): 90-111. Class Exercise: Sketch an impact evaluation for your capstone project.
HW 12 Due: 12/1	**Team Capstone:** Turn in a completed draft USAID DIV letter of interest and presentation. Share both with another group for peer review.
28 W 12/2 I-Lab	**Unit 14: Class Summary** Summary of class. Provide pointers to recommended classes in the Development Engineering Designated Emphasis.
HW 13 Due: 12/5	**Team Capstone:** Share your peer review with the group whose project you reviewed and turn in your review on bCourses.
29 W 12/9 I-Lab	**Capstone Group Exercise:** Final presentations (in lieu of a final exam) based on your USAID DIV letter of interest. Special two-hour session during RRR week. 10:30 am -12:30 pm (10:00-10:30 am will be set-up time). You are welcome to use your foam core boards along with a slide presentation. Turn in your final USAID DIV letter of interest and presentation on bCourses before class.

APPENDIX B: Example DevEng 210 Syllabus

Development Engineering represents a new interdisciplinary field that integrates engineering, economics, business, natural resource development and social sciences to develop, implement and evaluate new technological interventions that address the needs of people living in poverty in developing regions and low-income areas of the United States. This seminar, offered each spring term, will focus on work-in-progress presentations by the students, as well as faculty and guest lecturers. This seminar is a required course for the Designated Emphasis in Development Engineering.

The faculty members co-teaching the required Development Engineering Research and Practice Seminar will be the faculty advisors for the Dev Eng graduate students presenting their research in the seminar. This term, the overarching focus of discussion will be on Innovation at the Nexus of Food, Water, and Energy Systems (InFEWS, a new training program in the development engineering ecosystem).

See current participating faculty in the Dev Eng Graduate Group and those with Innovations in Food, Energy and Water Systems (InFEWS).

Course Objectives
The objective of the seminar is to prepare students for research and practice in development engineering. Students will give presentations on their research and receive feedback from faculty and peer students in multiple disciplines. The seminar will also provide a community of practice in the new field of development engineering with a focus on food, energy and water systems.

Course Prerequisites: Graduate level standing.

Student Learning Outcomes
The students will learn to present their research in a scholarly setting. Students will learn how to design human subjects protocols and include user participation in the design of their research. Through peer learning and faculty feedback, students will learn from exposure to a range of different examples and applications.

Assessment of Student Progress Toward Course Objectives
50% on presentation of research
20% on attendance and participation in class
30% on post-reflection and integration plan into research

Textbook (s) and/or Other Required Readings:
No formal textbook. Each speaker will be asked to provide one reading in preparation for his/her session. For more detail see our page on lecture topics and required readings.

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Sample Guest Speaker schedule:

January 23: Alice Agogino, Chair of the Development Engineering Graduate Group and lead faculty on InFEWS, joined by InFEWS faculty

January 30: Paolo D'Odorico, Environmental Science, Policy, and Management, UC Berkeley

February 6: Catherine Wolfram, Chair of the Economic Analysis and Policy Group, Cora Jane Flood Professor of Business Administration, and Faculty Director of the Energy Institute at Haas

February 13: Zoe Bezpalko, Impact and Design Lead at Autodesk Foundation

February 20: No Seminar: President's Day

February 27: Daniel Kammen, Class of 1935 Distinguished Professor of Energy at UC, Berkeley and a climate Science Envoy for the U.S. State Department

March 6: Amos Winter, Assistant Professor of Mechanical Engineering and Director, Global Engineering and Research (GEAR) Lab at MIT

March 13: Amit Bandopadhyaya, Senior Director of Water and Energy, Winrock International

March 20: Clair Brown, Professor Emeritus of Economics

March 27: Spring Break

April 3: Daniel Wilson, Postdoctoral Fellow at Lawrence Berkeley National Lab

April 10: Khanjan Mehta, Vice Provost for Creative Inquiry, Director of the Mountaintop Initiative at Lehigh University & Sangeeta Chowdhry, Program Director of Economic and Political Empowerment, Global Fund for Women

April 17: Ryan Shelby, Foreign Service Engineering Officer, Office of Energy & Infrastructure, USAID

April 24: Ashley Muspratt, Founder and CEO, Pivot Co.

APPENDIX C: List of DevEng Elective courses

In addition to these two core courses, students must take **three electives** from at least two of the three thematic modules within the DevEng program. The three modules are: Project Design; Evaluation Techniques and Methods for Measuring Social Impact; and Technology Development. Of the three electives, only one can be from the student's home department. Students are encouraged to take one elective prior to the qualifying examination, but this is not required.

Module 1: Problem Identification and Project Design
This module includes topics such as human-centered design, participant feedback, project management, needs and usability testing.

Civil & Environmental Engineering 209: Design for Sustainable Communities
Development Practice 225: Innovation, Marketing, and Entrepreneurship
Development Practice 232: Foundations of Public Health
Energy and Resources 273: Social Science Research Methods
Information 213: User Interface Design and Development (Instructor: Marti Hearst)
Information 214: Needs and Usability Assessment
Information 272: Qualitative Research Methods for Information Systems and Management
Information C283: Information and Communications Technologies for Development
Information 287: Information and Communications Technologies for Social Enterprise
Mechanical Engineering 290H: Green Product Development – Design for Sustainability
Mechanical Engineering 290P: New Product Development – Design Theory and Methods
Public Health 290: Designing Innovative Public Health Solutions
Haas MBA 215.1: Business Strategies for Emerging Markets

Module 2: Evaluation Techniques and Methods for Measuring Social Impact
This module includes classes spanning topics such as large data analytics, statistical analysis for impact assessment, and design of field experiments. It also includes coursework on sustainability and scaling of projects, and on the broader impact on people and communities.

Development Practice 228: Strategic Planning and Project Management
Development Engineering 290: Special Topics in Development
Economics 219B: Applications of Psychology and Economics
Economics 240A/B: Econometrics
Economics 274: Global Poverty and Impact Evaluation
Economics 270A/B: Microeconomics of Development
Economics 271: Seminar in Development Economics
Energy and Resources 275: Water and Development
Energy and Resources 276: Climate Change Economics
Haas MBA 292: Social Sector Solutions
Information 272: Qualitative Research Methods for Information Systems and Management

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MBA 296: Applied Impact Evaluation – How to Learn What Works to Lower Global Poverty
Public Health 235: Impact Evaluation for Health Professionals
Public Health 252C: Intervention Trial Design
Public Policy/ Agricultural and Resource Economics 253: International Economic Development Policy

Module 3: Development Technologies
(contextualized technologies, sensors, data collection, data mining, and analysis) This modules spans work on prototyping and technology R&D, as well as the use of novel sensors.

Bioengineering 168L: Practical Light Microscopy
Civil & Environmental Engineering 290: Advanced Special Topics - Control Market and Privacy Tools for Participatory Sensing
Civil & Environmental Engineering 210: Control of Water-Related Pathogens
Civil & Environmental Engineering 271: Sensors and Signal Interpretation
Computer Science 289A: Introduction to Machine Learning
Computer Science 294-1 Behavioral Data Mining
Economics 291/Engineering 298B: Behavior Measurement and Change
Energy and Resources C200: Energy and Society
Energy and Resources 221: Energy, Climate, and Development
Energy and Resources / Public Policy C271: Energy and Development
Information 271B: Quantitative Research Methods for Information Systems and Management
Information 283: Information and Communication Technologies and Development
Information 290: Data-Intensive International Development

APPENDIX D: Application form for students

DESIGNATED EMPHASIS
DEVELOPMENT ENGINEERING
UNIVERSITY OF CALIFORNIA, BERKELEY

Designated Emphasis in Development Engineering | Application for Admission

Eligibility:
The Designated Emphasis in Development Engineering (DevEng) is open to all UC Berkeley PhD students in good standing in any field, with a focus on engineering, physical sciences, natural sciences, social sciences, business, education, I-School, or public health.

Applications are reviewed on a rolling basis, but interested students must apply at least one semester before their Ph.D. qualifying examination. Interested students are encouraged to apply early in their degree to most benefit from being a part of the DevEng community.

First Step in Application Process:

Before submitting this application packet, interested Ph.D. students are required to arrange a consultation meeting with one of the Development Engineering Faculty Advisors (Dan Fletcher or Clair Brown), and it is recommended that students also meet with the Development Engineering Graduate Student Affairs Officer in the Department of Civil and Environmental Engineering (Shelley Okimoto).

Application Packet Requirements

1. This cover form, completed.
2. Letter of intent summarizing research interests and educational or employment background in issues related to development engineering and/or development economics (500 word limit).
    a. For InFEWS, your statement should highlight your interests at the intersection of Food, Energy, and Water.
3. Letter of recommendation from a member of the Development Engineering faculty graduate group or your graduate advisor in your home department
4. A list of courses you expect to use to satisfy the elective requirement

Please send an electronic version of your application packet, as a single PDF attachment, with all required materials to these individuals: Shelley Okimoto (okimoto@ce.berkeley.edu), the Development Engineering Faculty Advisor who advised you prior to this application, and to the Development Engineering Chair (Alice Agogino, agogino@berkeley.edu). The subject line of this email should read: "Application for DE in Dev Eng."

Applicant Info: *All fields are required*

Name: _____ Email: _____

Home Department: _____ Phone: _____

Faculty Advisor: _____ Student ID: _____

Expected Date of Qualifying Exam: _____ & of Degree Completion: _____

For InFEWS concentration only:
☐ I am interested in the Food-Water-Energy systems concentration of DevEng ("InFEWS")

Signature of Applicant: _____ Date: _____

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APPENDIX E: Development Engineering Faculty Graduate Group

CHARISMA ACEY | Assistant Professor in City and Regional Planning

ALICE AGOGINO | (Chair of DevEng, Executive Committee Member) Roscoe and Elizabeth Hughes Professor of Mechanical Engineering

SARA BECKMAN | Earl F. Cheit Faculty Fellow at Haas School of Business

JOSHUA BLUMENSTOCK | Assistant Professor in School of Information

ERIC BREWER | Professor of Electrical Engineering and Computer Science

CLAIR BROWN | Professor Emeritus of Economics

JENNA BURRELL | Associate Professor in School of Information

JOHN CANNY | Paul and Stacy Jacobs Distinguished Professor of Engineering in Electrical Engineering and Computer Science

JACK COLFORD JR. | Professor of Public Health

DAN FLETCHER | Purnendu Chatterjee Chair in Engineering Biological Systems Bioengineering

ASHOK GADGIL | Andrew and Virginia Rudd Family Foundation Professor of Safe Water and Sanitation in Civil and Environmental Engineering

PAUL GERTLER | Li Ka Shing Foundation Chair in Health Management at Haas School of Business

M. PAZ GUTIERREZ | Purnendu Associate Professor of Architecture

DANIEL KAMMEN | Professor in the Energy and Resources Group and Public Policy, Director of Renewable and Appropriate Energy Laboratory (RAEL)

DAVID LEVINE | (Executive Committee Member) Eugene E. and Catherine M. Trefethen Chair in Business Administration at the Haas School of Business

KARA NELSON | Professor of Civil and Environmental Engineering

KAMESHWAR POOLLA | Professor of Mechanical Engineering

MATTHEW POTTS | Associate Professor of Environmental Science, Policy, and Management

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MICHAEL RANNEY | Professor of Graduate School of Education

ELISABETH SADOULET | Professor of Agricultural and Resource Economics

SHANKAR SASTRY | Dean of College of Engineering and Faculty Director of Blum Center for Developing Economies

S. LEONARD SYME | Professor Emeritus of Epidemiology and Community Health

LAURA TYSON | Professor of Business Administration and Economics at Haas School of Business

CATHERINE WOLFRAM | Cora Jane Floor Professor of Business Administration at Haas School of Business

DAVID ZILBERMAN | Professor of Agricultural and Resource Economics

APPENDIX F: Example Course Evaluation Form

UC Berkeley regularly solicits feedback from students about courses they take. The adoption of end-of-term evaluation question items helps to ensure that instructors or schools solicit informative feedback which can be used for teaching improvement and evaluation. When adoption occurs across a department, it allows for robust analysis and reporting that can further inform both course-level pedagogy and program-level curriculum. Example questions across four categories are below. A full list of possible questions is available at http://teaching.berkeley.edu/course-evaluations-question-bank

Questions allow for a scale of 1-7 as well as open ended response.

CATEGORIES

1. Instructor/GSI*-Specific Question Themes
    - Presentation: The instructor (or GSI) explained concepts clearly
    - Clarity: The instructor (or GSI) was helpful when I had difficulties or questions
    - Helpfulness: The instructor (or GSI) provided clear constructive feedback
    - Participation: The instructor (or GSI) encouraged student questions and participation
    - Overall Effectiveness: Considering both the limitations and possibilities of the subject matter and the course, how would you rate the overall effectiveness of this (graduate student) instructor?

2. Course-Specific Question Themes
    - Content: The course (or section) was effectively organized
    - Skill Development: The course developed my abilities and skills for the subject
    - Theory: The course (or section) developed my ability to think critically about the subject
    - Overall: Considering both the limitations and possibilities of the subject matter and the course, how would you rate the overall effectiveness of this course?

3. Student Self-Evaluation Questions
    - How many class (or section) sessions did you attend?
    - On average, how many hours per week have you spent on this course (or section), including attending classes, doing readings, reviewing notes, writing papers, and any other course-related work?
    - How satisfied were you with your effort in this course (or section)?

4. Open-Ended Questions
    - Please identify what you consider to be the strengths of the course (or section).
    - Please identify area(s) where you think the course (or section) could be improved.
    - Feedback for other students: What advice would you give to another student who is considering taking this course (or section)

*GSI: graduate student instructor

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