



Design, Evaluate and Scale Developmental Technologies DE C200, ME C200 & MBA 290T

Course Number: Development & Mechanical Engineering (C200);
Berkeley-Haas MBA (290T), 3-unit course.

Class Time: Mondays, 6:00-9:30 p.m.

Class Location: N540/N544, Chou Hall (new Haas building).

Office Hours: Mondays, 5:00-6:00 p.m. at N540/544, Chou Hall, or by appointment.

Instructors:

- **Dr. Ashok Gadgil**, Distinguished Professor of Safe Water and Sanitation, Civil and Environmental Engineering, UC Berkeley, and Faculty Senior Scientist, Energy Technologies Area, Lawrence Berkeley National Laboratory.
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- **Dr. Paul Gertler**, Li Ka Shing Professor, Haas School of Business, Professor, School of Public Health, Scientific Director, Center for Effective Global Action.
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- **Dr. Jennifer Walske**, Faculty Fellow, Blum Center for Developing Economies, Social Impact Fellow, Institute for Business and Social Impact, Distinguished Teaching Fellow, Berkeley-Haas. Email: jmwalske@berkeley.edu. Telephone: (510) 664-4383.

Instructor Biographies

Dr. Ashok Gadgil, Distinguished Professor of Safe Water and Sanitation, Civil and Environmental Engineering, UC Berkeley, and Faculty Senior Scientist, Energy Technologies Area, Lawrence Berkeley National Laboratory. He specializes in heat transfer, fluid dynamics, and design for development. He also has substantial experience in technical, economic, and policy research on energy efficiency and its implementation - particularly in developing countries. He is best known for his work with two developing-world technologies: "UV Waterworks" (a simple and effective and inexpensive water disinfection system), and the Berkeley-Darfur Stove (a low-cost stove to that saves fuelwood in internally displaced person's camps in Darfur). https://en.wikipedia.org/wiki/Ashok_Gadgil

Dr. Paul Gertler, Li Ka Shing Professor of Economics at Berkeley-Haas with a joint appointment at UC Berkeley's School of Public Health. Dr. Gertler is also the Scientific Director of the Center for Global Action (CEGA). Dr. Gertler is an internationally recognized expert in impact evaluation. Prior his appointments at UC Berkeley, Dr. Gertler held academic positions at Harvard, RAND, and SUNY Stony Brook. He was also the Chief Economist of the Human Development Network of the World Bank, and the founding Chair of the Board of

Directors of the International Initiative for Impact Evaluation (3ie). He received his PhD in Economics from University of Wisconsin.

Dr. Jennifer Walske, is a Faculty Fellow at the Blum Center for Developing Economies, a Distinguished Teaching Fellow for Berkeley-Haas, and a social impact fellow at Berkeley-Haas' Institute for Business and Social Impact (IBSI). She publishes with Dr. Laura Tyson, Faculty Director of IBSI, with an emphasis on how social startups scale as well as on the topic of social venture funding. She has received the "Best Paper" award at the NYU-Stern Social Entrepreneurship Conference, and has led many sessions on the same topic at the Academy of Management. She received both the Cheit Award for Teaching Excellence at Berkeley-Haas and at University of San Francisco, where she also received an award for research excellence. She sits on the boards of ASSET, Net Impact, Better VC, and San Francisco Ballet.
<https://www.linkedin.com/in/jenniferwalske>

Required Course Materials

1. Kickul, J., & Lyons, T. (2012). *Understanding Social Entrepreneurship: The Relentless Pursuit of Mission in an Ever Changing World* (2nd edition, paperback) Routledge. This is available for rent or purchase from Amazon or through the UC Bookstore.
2. Berkun, Scott (2010), *The Myth of Innovation (O'Reilly, 2010)*. Available Amazon or through the UC Bookstore.
3. Gertler, Martinez, Premand, Rawlings & Vermeersch, *Impact Evaluation in Practice (FREE to download)*
(<https://openknowledge.worldbank.org/bitstream/handle/10986/2550/599980PUB0ID181BLIC1009780821385418.pdf?sequence=1&isAllowed=y>)
4. Harvard Study.net reading packet.
 - a. MBAs: http://www.study.net/r_mat.asp?crs_id=30115895
 - b. Non-MBAs: http://www.study.net/r_mat.asp?crs_id=30115898
5. Various readings posted on bCourses each week.

Course Goals:

This class provides you with key skills to create innovative products or processes, targeted for developing countries, using collaborative, team-based techniques. Unique to this course, you will be working in cross-disciplinary teams composed of the best and brightest across Cal, in top ranked business, engineering, policy, and science graduate degree programs. You will be working together to help advance products targeted for the developing world, with a faculty champion. This course also incorporates design projects and case studies, many of which are related to projects that had their genesis, and still receive support from various labs at UC Berkeley, as a part of our ongoing class discussions. A roster of speakers steeped in the field of developing country product deployment have also been invited to support identified topics.

This course is composed of three modules: (1) Technology Design, (2) Social Impact Assessment and (3) Business Model Development. Within the first two weeks of class, you will be paired with a project (based on your ranking) with a diverse teams of four to six students from business, engineering, policy and/or other disciplines across campus. In each module, each team

will work to address the technical, social impact, and business issues leading to a final presentation to the company/founder in-class on December 4th.

1. **Technology Design.** In the first segment, we will introduce how to define a problem to solve, and how to think about an approach to solve it at scale. We will evaluate technologies that have been deployed in developing countries, and ask, what went well in these deployments and what, in hindsight, could have been gone better. We will also incorporate “lab tours” as part of this first module, to garner a more in depth understanding of the technical issues around social innovation. In module one,
2. **Social Impact Assessment.** Each team will develop a plan for scaling a technology in the developing country context, while ensuring rigorous impact evaluation along the way. This includes developing a theory of change, and assessing the outputs and outcomes that the social idea aims to address. We’ll discuss and debate the merits of impact measurement, including options around various ways to implement data collection.
3. **Business Model Development.** In this segment you will apply many of the principles that have been popularized through the lean startup methodology to the development engineering project that you are working on as a team. We will also discuss developing a partnership strategy as well, considering all of the stakeholders. Further, we will address how the various forms of incorporation for a social enterprise might differ by organizational mission and expected funding sources.

Grading Components

- **15% Class Participation**, this will be composed of attendance and in-class participation.
- **15% Technology Design (Module One)**, in-class and written summary due by 3pm on October 2nd into bCourses.
- **15% Social Impact Assessment (Module Two)**. In-class and written summary due by 3pm on October 30th into bCourses.
- **15% Business Model Development (Module Three)**. In-class and written summary due by 3pm on November 27th into bCourses.
- **40% Final Presentation and Paper**. Final in-class presentation due December 4th by 3pm and paper due December 11th by 3pm into bCourses.

Group Assessment: *After each module and for the final project we will give the group a chance to allocated percentage points for each member of the group, to assess contribution. Lack of contribution can raise or lower one’s grade on that assignment by a full or half grade. It can also increase a grade on one’s assignment by a full or half grade. If all members of the team equally contribute, they will all receive the same grade.*

Weekly Class Participation (15%) In this course we will engage in lively discussions, relying on cases (alternating between technical and business cases), readings, and in-class presentations. For case discussions, we will quickly move through the case details, and engage in a debate on the main challenges impacting the social enterprise under study in that week’s class. Keep in mind the following, which impacts your overall participation grade, as well as the quality of class discussions:

- *There is no make-up work for missed classes.* Because productive class discussions require the full engagement and participation of all class members, tardiness or unexcused absences will have an adverse effect on your grade. *High levels of participation could increase your class grade by a half or full grade.*
- *Introducing a new and dissenting viewpoint in a respectful manner is highly encouraged.* Offering a contrary view often exposes a new perspective and provokes an interesting debate. Others in the class might share your novel perspective, but might not want to be the first one to voice it.
- *We will also post the biographies of expert guest speakers prior to class.* Being prepared by researching the speaker in advance will lead to better quality questions for the speaker, and a more productive use of everyone's time. It also opens the door for contacting the speaker later, further building your network.

Project Grades

Most of your class grade is based on your team's project grade, which you will complete through-out the semester, and in multi-disciplinary teams. These are all technologies and products focused on a developing country context. There will be three main aspects to the final project, including: technical feasibility, social impact assessment, and business model analysis. You will be handing in three "mini" reports based on each module, and with feedback, merge these three modules into a holistic final report, to present to the company contact in-class on December 4th, and in a written summary on December 11th into bCourses.

- **Module One: Technology Design (15%):** Due a three to five-page paper and slide deck to be used in class into bCourses by 3pm on October 2nd. This is an opportunity to assess the feasibility, ease of use and durability of the technology that is part of your group's final project. This is also the point at which the team will have been formed, and you will have your first team deliverable.
- **Module Two: Social Impact Assessment (15%):** Due a three to five-page paper and slide deck to be used in class into bCourses by 3pm on October 30th. You will develop an overarching theory of change for assessing social impact, and discuss detailed measurement tools that support this theory of change.
- **Module Three: Business Model Development (15%):** Presentation and three to five-page paper due November 27th by 3pm. In this section we will be discussing how (a) the business model maps to the Lean Launch canvas (b) the type of legal entity the social enterprise should be (i.e., non-profit, for-profit, or hybrid), and (c) the funding mechanisms most appropriate for the social enterprise.
- **Final Project (40%):** Presentation slides due December 4th at 5 pm and final paper of ten to fifteen pages due December 11th, 5 pm, submitted through on bCourses.

Group Projects. Solving real-world problems is based on collaborative activities, and the ability to contribute effectively as a team is a vital skill. In addition, active learning in groups has been shown to lead to better long-term learning than working alone. If there are difficulties with any group member, discuss the matter within your group, and seek resolution. If you cannot resolve the problem, immediately contact either professor, so that we can make an appointment

to discuss the situation with the entire group. At the end of class, you will also submit a confidential evaluation form asking you to rate each member of the group including yourself. This is group' grading. **Your final project grade will be adjusted, higher or lower, if you are contributing more or less than those within your group.**

Honor Code. We expect the students to act with honesty, integrity, and respect for others. Note the following link to UC Berkeley's principles of community (<http://diversity.berkeley.edu/principles-community>). Also read compiled honor code summary on bCourses

Incomplete Grades. In this program, incompletes are very rare, and are only granted in extraordinary circumstances when you are unable to complete a course. If you experience life challenges that make it difficult or impossible to accomplish your work, please contact one of the instructors to set-up a game plan ultimately completing the class.

Disabilities. Students needing extra time for exams or other accommodation must present a letter stating the accommodations required no later than 2 weeks prior to the exam date or date when consideration is required. Note the following information outlining accommodations to be made in the event of a disability

<http://www.dsp.berkeley.edu/about/policies-guidelines/accommodations>.

Week-by-Week Schedule

Week 1: August 28 – First Class, project presentations, and pizza mixer.

Prepare:

- Chapter 1 & 2, *Understanding Social Entrepreneurship: The Relentless Pursuit of Mission in an Ever Changing World* (USE)
- Social Enterprise: Private Initiatives for Common Good (Study.net)
- “Introduction to Ten Faces of Innovation”: Chapter 1 (bCourses)

Discussion Questions:

1. What is social entrepreneurship? Why is this a new, pivotal, and important field?
2. Reference “Ten Faces of Innovation Chapter 1”. In your team (yet to be formed) which roles you feel comfortable, which roles you think out of your skill set? Think of examples.
3. What is the most important question for YOU about social innovation / invention that you want addressed in module 1 (led by Dr. Gadgil).

Invited Speakers: Project advocates will give an overview of each potential project. This will be followed by tabling sessions, so that you can get more information on each project, and so that those running those projects can get a sense of you.

Due: Vote on projects of your choice, listing your 1st, 2nd and 3rd choice using survey monkey.

Week 2: *September 4 – Labor Day (No Class!)***

Module One: Technology Design

Week 3: September 11 - Challenges in Technology Design

(Example: Berkeley-Darfur Stove)

Lecture: Berkeley-Darfur Stove: Fuel efficient cook stoves for developing countries

Prepare:

- Chapters 1, 4, and 5 of *Myths of Innovation*
- “Stove Solutions: Improving Health, Safety, and the Environment in Darfur with Fuel-Efficient Cookstoves.” (bCourses)
- “Lessons learned from a comparison study of charcoal stoves for Haiti” (bCourses)
- NYT Article: *Design That Solves Problems for the World’s Poor* (bCourses)

Guest Speakers: Dr. Daniel Wilson, Research Scientist, LBNL.

Class Activity: (1) Team exercise. (2) Understanding need for both Exploration vs. Implementation. (3) Team Collaborative Plan (begin discussing and complete by the following class).

Discussion Questions:

1. What is the myth of the lone inventor? Why has it persisted? How does innovation gain adoption?
2. What are the challenges addressed by Cookstoves researchers in Haiti and Darfur?
3. Role of institutions to fill the gaps related to the “soft” side of technologies

Week 4: September 18 - Challenges in Technology Design

(Example: UV Waterworks)

Lecture: UV Waterworks: Safe drinking water at affordable prices.

Prepare:

- Chapters 3, 9, and 13 Myths of Innovation
- The Design of Everyday Things: Chapter Six “Design Thinking.” pp 217-257. (bCourses)
- (Optional Reading) Case: Acumen Fund and WHI International: The role of venture philanthropy (bCourses)
- (Optional Reading) What is the Theory of Change. 10 pages. (bCourses)
- Watch: https://www.youtube.com/watch?v=qxVySgXPC_8 (2 minutes)
- <https://www.youtube.com/watch?v=BXOX7-cjegY> (6 minutes)
- <https://www.youtube.com/watch?v=CPQ2IIajySk> (5 minutes)

Optional Readings:

- Water-Energy-Food Nexus Rapid Appraisal Methodology- FAO
(<http://www.fao.org/energy/water-food-energy-nexus/en/>)

- Water and Energy Footprint of Irrigated Agriculture in Mediterranean Region (good comparison case to CA ag)- <http://iopscience.iop.org/article/10.1088/1748-9326/9/12/124014>
- UN Water definition of the nexus and report on The State of the World's Land and Water Resources for Food and Agriculture
<http://www.unwater.org/water-facts/water-food-and-energy/>
<http://www.fao.org/docrep/017/i1688e/i1688e.pdf>

Guest Speaker: Chinmayee Subban, <https://www.linkedin.com/in/chinmayee-subban-1bb30046/>

Discussion Questions:

1. Explore how each of these applies to the UVWaterWorks case: (i) Design Thinking, (ii) Myths of Innovation, (iii) Ten faces of Innovation, and (iv) Theory of Change
2. What is the problem your team (or the social entrepreneur your team works with) is trying to solve?
3. What is (your best guess at) the theory of change underlying your team's social innovation?

Week 5: September 25 – Challenges in Product Deployment
(Example: Efficient Electric Lighting)

Start of Class: Water Lab tours (6:15 PM to 7:20 PM)

Guest Speaker: Rachel Scholes (<https://www.linkedin.com/in/rachel-scholes-07341126/>)

Topic: Engineered Open Wetlands for wastewater treatment

Post Lab Tour Lecture: Energy Efficient Lighting in Developing Countries

Prepare:

- Chapters 6, 7, and 8, *Myths of Innovation*
- What is innovation by Andrew Hargadon (bCourses)
- NYT Article: Edison ...Wasn't He the Guy Who Invented Everything? (bCourses)
- Watch: (38 minutes lecture by Prof. Hargadon at LBNL; *optional*)
<https://www.youtube.com/watch?v=xmPSsK2diSk>

Discussion Questions:

1. What are the three core things to consider while evaluating ideas? (ref. Myths of Innovation). Do you agree?
2. What are the challenges for managing an innovation? (ref. Myths of Innovation)
3. Why secondary factors of innovation matter for best ideas to win? (ref. Myths of Innovation)
4. How have design thinking, and ten faces of innovation, influenced the success of energy efficient lighting?

Week 6: October 2 –Technology Design

****Last day of Module One. All assignments due into bCourses by 3pm (October 2nd). Team presentations at the start of class.**

Guest Speaker: Matt Podolsky, UC Berkeley Managing Director, TIER Research Group.
Topic: (Tentative) Design a Village Base Station for remote regions – how and why.

Lecture: Closing lecture on technology design for social innovations. (Prof. Gadgil)
If time permits, we will discuss another invention example.

Begin discussion around social impact assessment. (Led by Prof. Paul Gertler)

Prepare:

- When Innovations Meet Institutions: Edison and the Design of the Electric Light (bCourses)
- Chapter One of *Impact Evaluation in Practice*, Introduction to Impact Evaluation.
- Chapter Eight of *USE*, Measuring Social Impact.

Discussion Questions:

1. What are your most important two or three take-aways regarding technology innovation for developing economies?
2. What institutions play a positive or negative role in technology design and innovation in poor countries? Give examples.
3. Introduction to Module 2 (led by Dr. Gertler).
 - What is impact evaluation (IE) and why evaluate?
 - What are the uses of IE in policy, business and social impact investing?

Module Two: Social Impact

Week 7: October 9 – Preparing an Impact Evaluation and Identifying Causal Impact

Prepare:

- Chapter 2: Preparing for an Evaluation. (Gertler et al. text)
- Chapter 3: Causal Inference and Counterfactuals. (Gertler et al. text)
- Chapter 4: Randomized Assignment (Gertler et al. text)
- Glennerster R. and K. Takavarasha “Advantages and Limitations of the Experimental Approach,” Chapter 2.4 in Running Randomized Evaluations, 2014, pp. 47-59.

Discussion Topics:

- Types of evaluation questions
- Theory of change
- Articulating hypotheses for impact evaluations
- Choosing outcome indicators
- The central role of the counterfactual and counterfactual counterfactuals
- Individual and Cluster Random Assignment
- Internal and External Validity

Week 8: October 16 – How Big is Big?

Prepare:

- In this class we will also review some statistics. There are no required readings for this component, but you may want to brush up on the following:
Stine, R and D Foster. Statistics for Business: Decision Making and Analysis, Chapter 13, 14, 16 and 18

Topics:

- Where in the World?
- Random Sampling
- Estimating population means
- Hypothesis testing
- Setting up testable hypotheses from research questions
- T-tests and P-values
- Testing whether 2 means are equal

Discussion Topics:

Guest Speaker: Josh Gruber, UCB “Adoption and Impact of WASH Technologies by Low Income Populations”

Week 9: October 23 - Impact at Scale – Measuring and Staying True to Social Mission

Prepare:

- Chapter 5: Instrumental Variables (Gertler text)
- Chapter 9: Addressing Methodological Challenges pp. 161- 169 (Gertler text)

Discussion Topics:

- Encouragement Designs
- Does chocolate make you happier?
- Spillover
- Non-Compliance

Week 10: October 30 – End of Module Two

Due by 3pm the presentation and report into bcourses.

In Class:

- Present Module Two Presentations (first half).
- Feedback on team (led by Haas coaches), and midterm class feedback (led by Haas class rep.).
- Intro to business issues and business modeling

Prepare (Launch of Module Three):

- Hypothesis-Driven Entrepreneurship: The Lean Startup (Study.net)
- Udacity lectures 1, 1.5a,1.5b, Lean method & value prop

Discussion Questions:

1. Review of topics for the last module.
2. What is the most important aspects of business modeling that YOU want to know, for module three (led by Dr. Walske), building on your initial survey (likely by this time, things have changed).

Module Three: Business Modeling

Week 11: November 6 – Business Modeling

Prepare:

- Chapters 3 & 5, *USE*, Recognizing Social Opportunities, and Developing a Strategic Plan for a Social Venture.
- “Creating Successful Business Models; Lessons from Social Entrepreneurship” (Study.net)
- Watch:
https://www.ted.com/talks/jane_chen_a_warm_embrace_that_saves_lives?language=en
- Cases: Embrace (Study.net) and Better Ventures (bCourses)

Guest Speakers: Linus Liang (https://en.wikipedia.org/wiki/Linus_Liang) and Wes Selke, Partner and Co-Founder, Better Ventures.

Discussion Questions:

1. What challenges did Embrace face in their efforts to fundraise, both as a non-profit, and as a for-profit?
2. When looking at venture investors, what type of corporate form do they invest in? What are important investment criteria?
3. What are some of the challenges around early stage investing, both for the social entrepreneur seeking capital, and for the social investor (like Better VC) that has to balance the size and number of portfolio companies that they are investing in?

Week 12: November 13 - Finding your MVP and Corporate Form

Prepare:

- Udacity Lectures 2&3
- Chapters 4 & 6 in *USE* The Lean Start-up for Social Enterprises and Organizational Structure.
- Case: Sanergy (bCourses)

Guest Speakers: David Auerbach, CEO and Co-founder, Sanergy; Hash Zahed and Ryan Shaening Pokrasso, SPZ Legal.

Discussion Questions:

1. How did Sanergy’s association with MIT, and access to investors (based in the U.S.) benefit the organization during its scaling up phase?
2. Why was access to both grant and equity funding important? How did funding and/or mission impact Sanergy’s choice of corporate form?
3. In order to successfully launch its sanitation and fertilizer business, Sanergy had to invest in its value chain. What are the opportunities and risks that come with such an approach? How did this inform their partnership strategy?

4. For the social enterprise that you are paired with, do you have just one MVP? Two MVPs? And if there is more than one, how should the social enterprise think about allocating its resources accordingly?
5. The article and book chapter discusses three corporate forms. What are they?
6. How do these forms impact an organization's focus on mission, possible avenues for financial support, and its potential attractiveness to leaders (both within and external to the organization)?

Week 13: November 20 – Funding the Social Enterprise and the Political Economy

Prepare:

- Chapter 7, USE, Funding Social Ventures.
- Article: Bannick, Matt and Goldman, Paula, “Embracing the Full Investment Continuum.” https://ssir.org/articles/entry/embracing_the_full_investment_continuum
- Article: Investing in Society: Why We Need a More Efficient Social Capital Market – and How We Get There. by Derek Kilmer Meehan and Maisie O’Flanagan, http://www.ssireview.org/articles/entry/investing_in_society
- Article: The True Cost of Capital. by Timothy Ogden http://www.ssireview.org/blog/entry/the_true_cost_of_social_capital
- Case: Bridges Ventures (bCourses)

Guest Speaker (confirmed skype): Brian Trelstad, Partner, Bridges Fund Management

Discussion Questions:

1. What are some of the risks associated with this emerging field for investors, social entrepreneurs and social venture capital firms?
2. What are some pros and cons in impact investing, versus issuing grants, for both the investor and the recipient of the funds?
3. What role does public policy play in the impact investing markets, in the U.S. and U.K.? how might public policy either help or hinder the deployment, acceptance and funding of your entrepreneur's technology/product? How would you quantify this political risk?

November 27 - End of Module Three.

****Due 11/27, 3pm into bcourses.**

Your team will be presenting the result of your work on business model development. This is *not an investor pitch* – this is a *summary of your team's recommendations on the project/service* evolved over since this module. As such, your team will present all relevant aspects of the business model, corporate form, and fundraising.

Wrapping it up! Balancing mission and growth.

- Chapter 9 & 12, *USE - Scaling the Social Venture and The Social Entrepreneurship Support Ecosystem*
- Walske & Tyson (2015) “Built to scale: A comparative case analysis, assessing how social enterprises scale.” *Entrepreneurship & Innovation*, 16 (4), pp. 269-281. (bCourses)

Guest Speaker (invited): Dr. Laura Tyson, Faculty Director, IBSI, Berkeley-Haas

Discussion Questions:

1. What are some of the issues with “scaling” the social enterprise? Including product expansion strategy, and this expansion’s impact on both the initial business model, and the organization’s social impact, going forward?
2. What do you think some of the issues that the company you are working with might have as it expands? What are its plans for funding, value chain build-out, media management (and brand building), as well as hiring?

December 4 – Final Presentation

**Presentations due into bCourses by 3pm on 12/4.

Final presentation (15 minutes each team) should sum up the three modules, discussing the challenges, and recommendations around: technology deployment, social impact assessment, and business modeling.

At the close of class, we’ll discuss: What was your main take away from the class? If you could go into the field in the winter recess, what would you investigate, change, etc.

By 11:59pm on December 11th (into bCourses)

Final project due addressing recommendations along three areas: technical feasibility, social impact and business model development.

Ensure by 12/13, you must turn in your final team evaluation form in order for you and your team to receive your final project grade!