DESIGN FOR SOCIAL IMPACT: MULTIPLE DIMENSIONS OF DIVERSITY IN STEM

Alice M. Agogino
Professor of Mechanical Engineering
Founder, Product Design, MEng
Chair, Development Engineering Graduate Group
Education Director, Blum Center for Developing Economies

Berkeley
UNIVERSITY OF CALIFORNIA

BLUM CENTER
FOR DEVELOPING ECONOMIES

DEVELOPMENT ENGINEERING
UNIVERSITY OF CALIFORNIA, BERKELEY
Defining Engineering

ENGINEERING: (1) To lay out, construct, or manage as an engineer (2a) To contrive or plan out usually with more or less subtle skill and craft (b) To guide the course of

on your own terms

Dr. Catherine Newman
MEASURING DIVERSITY & SOCIAL IMPACT


Social Impact Requires Diverse Teams

Diversity & Inclusion Matters to Millennials: http://www.tru-access.com/tru-access-blog/diversity-inclusion-matters-to-millennials
If you were to draw a bell curve of performance, you’d find the more diverse teams at the two tails of the distribution: either the very high end, or the low end. Homogeneous groups occupy the middle.

David Thomas, Harvard Business School
Leveraging Differences: See, Question, Listen

Low-performing Diverse Teams
- Blind to differences
- See the differences but stereotype

Homogeneous Teams

Hi-performing Diverse Teams
- See the differences
- Ask questions and listen
- Leverage

Team Performance
Full Report:
http://www.nap.edu/openbook.php?record_id=18810
Comparison of the women who leave with those who stay in engineering revealed four trends:

- **No difference** in self-confidence in performing tasks, navigating work politics, or managing non-work roles
- **No difference** in terms of interest in engineering
- **Differences** in experiences with supportive workplace environment
- **Differences** in level of commitment and satisfaction with the engineering profession. Women who are still in engineering report higher level of satisfaction.
The Elephant in the [Silicon] Valley

- **Double Standards**: 84% have been told they are too aggressive (with half hearing that on multiple occasions)
- **Implicit Bias**: 88% have experienced clients/colleagues addressing questions to male peers that should have been addressed to them

https://www.elephantinthevalley.com/
The Elephant in the [Silicon] Valley

- 60% of women in tech reported unwanted sexual advances
- 65% of women who report unwanted sexual advances had received advances from a superior, with half receiving advances more than once
- >30% did not report
- 60% who reported sexual harassment were dissatisfied with the course of action

https://www.elephantinthevalley.com/
CONCLUSIONS

What is needed to create environments where all people feel comfortable, rather than just one group?

- A change in paradigm, from gender neutrality, which often means the environment favors men, to a paradigm of inclusion.
- Action taken by leadership to define success by taking gender into consideration.
- An understanding that diversity & inclusion brings value to every field.
Women in the U.S. purchase 50% of computers, 50% of cars and 80% of consumer goods.
Women control 80 percent of consumer decisions but design only 10 percent of IT products and services.

Gender Diversity Improves Products and Business

- **Improves innovation and problem-solving**: Draws on broader diversity of experiences.

*Femme Den is here to save good women from bad products*
Winning Mustang Design: High Gear Designed and Voted by Woman

40 women designers and engineers
Early Air Bags Tested on Male Crash Dummies Exclusively
Gender Diversity Improves Products and Business

• **Increases the Bottom Line:** Fortune 500 companies women in leadership have a return on sales increases by at least 42%.

Anita Borg Institute: Innovation by Design
http://anitaborg.org/insights-tools/white-papers/innovation-by-design/
Women in Company Leadership Tied to Stronger Profits

"As I've progressed in my career, I've come to appreciate — and really value — the other attributes that define a company's success beyond the P&L: great leadership, long-term financial strength, ethical business practices, evolving business strategies, sound governance, powerful brands, values-based decision-making."  - Ursula Burns, Chairman and CEO

What Does This Mean in K-12?
The Making of a ‘Lifetime Mentor Award’ Winner

https://newscenter.berkeley.edu/2013/01/28/alice-agogino-wins-aaas-lifetime-mentor-award/

Barbie Liberation Organization,
Shopgiving: Deadman tell no lies

“...In 1992 Mattel actually included the line “Math is Hard” with one of its first talking Barbies. Some clever hackers set up a website telling members how to hack into the Barbie and GI Joe voice boxes in a project called “Operation NewSpeak.”

...As a response to criticism Mattel introduced changes: ...Barbie’s breasts were reduced to better represent the shape of actual young women. Different multicultural Barbie’s were also been introduced, along with career-oriented Barbies in the “I can be ...” series.

I must admit that I very much enjoyed my Barbies as a young girl. I think she inspired me to think about fashion and design. I designed my own clothes as a teenager and I used a sewing machine to make them. I do think the sewing machines and design patterns (perhaps in CAD today) are important tools in a design engineer’s tool box.

– Alice Agogino, on Engineering Pathway’s ‘Today in History’ blog
How Would a Real Woman Look with Barbie’s Proportions?

- Barbie (not to scale)
- Average woman
- If a woman was 5’6” tall with Barbie’s proportions
- If a woman had a waist of 28” with Barbie’s proportions
Entrepreneur Barbie
From Doghouse To Penthouse: The Remarkable Recovery Of The RealReal's Julie Wainwright

Computer Engineer Barbie
Playing with Barbie dolls and girls’ career choices, a study

• Girls ages 4 to 7 were randomly assigned to play with one of three dolls:
  • a fashion Barbie with dress and high-heeled shoes;
  • a career Barbie with a doctor’s coat and stethoscope;
  • or a Mrs. Potato Head with accessories such as purses and shoes.

“Playing with Barbie has an effect on girls’ ideas about their place in the world,” said Aurora M. Sherman, an associate professor in the School of Psychological Science at OSU.
Playing with Barbie dolls could limit girls’ career choices, study shows

• After a few minutes of play, the girls were asked if they could do any of 10 occupations when they grew up. They were also asked if boys could do those jobs. Half of the careers were traditionally male-dominated and half were female-dominated.

• Girls who played with Barbie thought they could do fewer jobs than boys could do.

• But girls who played with Mrs. Potato Head reported nearly the same number of possible careers for themselves and for boys.
Bungee Barbie
Bungee Barbie

![Bungee Barbie](image)

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Proved Results: Increased Knowledge of Elasticity, Physics, Design
Development Engineering:
Designing products & services that improve poor people's lives at scale

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on your own terms
Development Engineering: fields & goals

A new interdisciplinary research field that integrates:

– Engineering, physical sciences, energy & resource development

– Economics, business & social sciences

to develop, implement, evaluate & scale technologies to benefit people living in poverty in developing regions and low-income areas of the U.S.
I have the audacity to believe that peoples everywhere can have three meals a day for their bodies, education and culture for their minds, and dignity, equality, and freedom for their spirits.

Martin Luther King, Jr.

Nobel Peace Prize acceptance speech • Oslo, Norway, 1964
Design for Social Impact

Scaling for Impact

Framework (Insights)

Imperatives (Concepts)

Observations (Contexts)

Solutions (Prototypes)

Qualitative & Quantitative Data

Development Goals & Constraints & Opportunities
21st Century Skills

- Open Minded
- LOCAL
- KIND
- Multidisciplinary
- Creative
- Humble
- Empathetic
- Thoughtful
- Flexible
- Curious
- Practical
- Passionate
- Adaptive
21st Century Skills

- **Humility**
  - & listening & learning from others, reflection

- **Communication & Team Skills**

- **Cross-Cultural/Multidisciplinary Skills**
  - & problem framing

- **Ability to understand complexity & Think in Systems**

- **Contextualize Technology**
  - & apply appropriate technology

- **Flexibility & Agility**
  - learn, prototype feedback, iterate

#TechCon2016  #NextGen
21st Century Skills: Ability to Reframe Problems & Solutions

- Role of Gender
- Mobile phones/Smartphones
- Community Groups and NGOs
- Complex household structures
- Groups facing discrimination
- Isolation
- Seasons
- Donors, government & diaspora
- Liquidity constraints
- Social norms
- Pollution
The Role of Gender

Motivation:
Gender roles affect almost every facet of life, and in turn affect almost every product and service.

Illustration:
Individual pay-per-use for public toilets appears perfectly fair at first glance. However, it often requires women to pay more than men (due to menstruation, pregnancy, and taboos against women exposing themselves in public). A possible solution is family membership.

What stage are you in?

Just beginning (pre-prototype):

Ideation Questions:
1) Make a projection: What would happen if women and men used the same product?
2) Are there any roles or customs your product could take advantage of to empower women in ways the community understands and accepts?
3) Can you design a solution just for women? Just for men?

Intermediate (post-prototype):

Reframing Questions:
1) How do existing gender roles affect what your product needs to do? How it will be used? Barriers it will face?
2) Will your product or service interact with existing gender roles in harmful ways?
3) Can your product advance desirable norms?
How do we measure success of social impact?

- deveng.berkeley.edu
- blumcenter.berkeley.edu
DESIGNING FOR DIVERSITY

Efficient Cook Stove

JustMilk – HIV Mothers

Zimba – Clean Water

Visualize an end to cervical cancer

CARES: Community Assessment of Renewable Energy & Sustainability

Tribal InFEWS
Enabling information-rich sustainable community development

Culturally-sensitive sustainable buildings, energy, water systems and native plants, Pinoleville Pomo Nation
Co-Designed

Co-Built
Renewable energy-efficient systems were co-designed and built by tribal citizens.

Rainwater catchment and grey-water systems reduce vulnerability to water shortages.

Smithsonian’s Museum of American Indian Case Study
Luce Foundation Video

• Sustainability in Products & Practice: http://vimeo.com/35283830
Train a new generation of global innovators

Transform ideas into inventions and action

Drive discovery & innovation

Innovative education: Classroom + Practice

Mentorship, resources, and training for student innovator teams while in school

Global Technology Solutions At Scale

10 years of launching social enterprises & securing >$200M additional funding

Supportive ecosystem
Undergraduate Minor: “Global Poverty and Practice”

A model for how the 21st century university can train students to tackle the urgent problems of the new world.

- Largest Minor on campus
- With students from 70 majors (engineers, biologists, economists, etc.)
- Sample of Courses:
  - Entrepreneurship for Poverty Alleviation
  - Water & Development
  - Women, Poverty & Globalization
  - Human Trafficking
  - Evaluating Global Action
  - Poverty & Technology
  - Field Reporting in the Digital Age
  - Law & Development
- Experiential learning in 54 countries:
  a) Self-identified work experience
  b) Bookended by pre-departure training and post-reflection

“Global Poverty: Challenges and Hopes in the New Millennium.” More than 1000 students hope to enroll each semester - but only 300 students can be accommodated in the classroom, the largest on campus.
METRICS: WHO PARTICIPATE?

Participating in Undergraduate “Global Poverty & Practice” Minor:
Students from 52 different majors on campus:
82% of students in the minor are female
30% are 1st generation college students
22% are underrepresented minorities
80% are 1st or 2nd generation immigrants

Participating in Graduate “Development Engineering” Minor:
24 affiliated faculty from 14 departments.
30 PhD students (50% female, 20% URM, education, engineering, public health, sociology, energy resources, college of natural resources).
>100 students have taken our required courses.
“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.”

**Will Tarpeh, PhD 2017, Environmental Engineering**

**Project: Electrosan**
redesigning sanitation systems that improve public health and the environment by converting human waste into income-producing by-products (fertilizer, sanitizers). The process applies electrochemical cells to recover nitrogen from human urine and to disinfect feces, bringing affordable sanitation to poverty-stricken communities.

“The designated emphasis is really meaningful because it recognizes the interstitial space that otherwise just isn’t recognized.”
2016-2017 Timeline & Categories

Metrics: from 5 projects in 2007... to over 135+ projects in 2017

Big Ideas @ Berkeley is a campus-wide annual competition that provides funding, support and encouragement to interdisciplinary student teams.
METRICS: WHO ARE THE SOCIAL ENTREPRENEURS?

Participating in Big Ideas Competition:

Since 2012 (when we added the support ecosystem): 50% of participants are now female, compared with only 39% pre-2012

Last year, of the male participants, more 62% had already entered an innovation contest before Big Ideas, while only 38% of women had entered a contest before Big Ideas— we are seeing the ecosystem we’ve built attract and support women!
Interviews suggest that women students are motivated by their empathy for and connection with project beneficiaries.
More men are needed to join into the conversation on gender equality.

“I learned to understand a woman’s perspective on issues - it’s not a binary thing - it’s a process and spectrum...okay I’m going to try to learn as much as I can. I think that is the role of a man in this space. There are things biologically that I won’t understand, but I need to empathize the best I can.”
example topics:

- Engineering research in response to unique constraints imposed by poverty.
- Novel technologies or tools for measuring behavioral, economic and social outcomes in low-resource settings.
- Technology markets and the role of innovation in economic development.
- Assessment of technology solutions, including field performance, consumer adoption and end-user impacts.
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DEFINING THE ACADEMY ON OUR OWN TERMS