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Harvey Mudd Design Conference VI

HUMAN-CENTERED SUSTAINABLE PRODUCT DESIGN: DESIGNING FOR DIVERSITY IN ENGINEERING EDUCATION

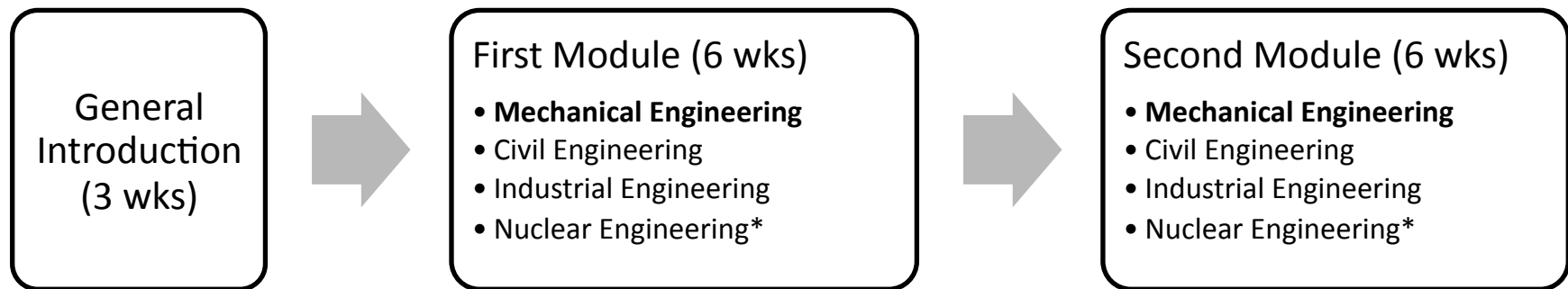
How can we design
engineering courses
that attract and retain
women & ethnic
minorities?

How does { Human-Centered
Sustainability
Service Learning }
content affect

{ Project preferences
A-K ABET criteria } of
confidence

{ Women
Ethnic minority } students

E10: ENGINEERING DESIGN AND ANALYSIS



Mechanical Engineering Module

“Human-Centered Sustainable Product Design”

User
Research

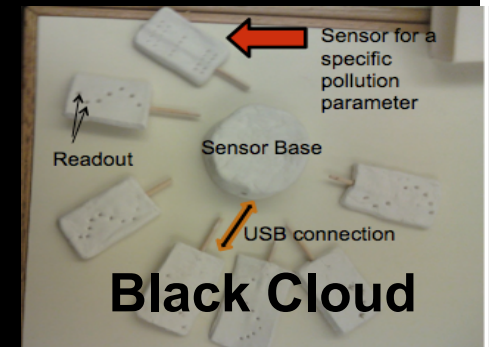
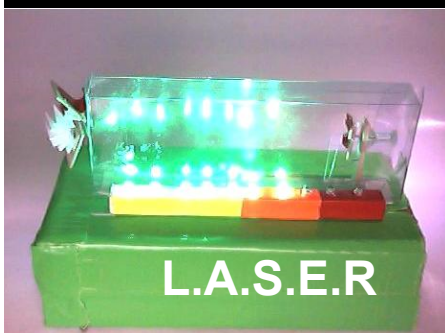
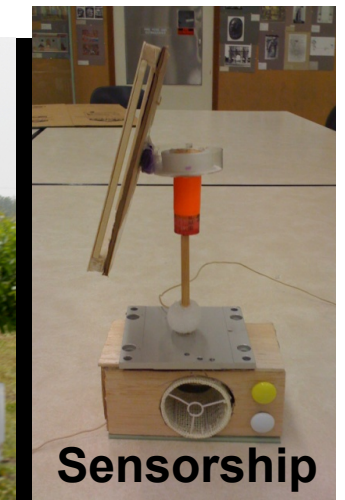
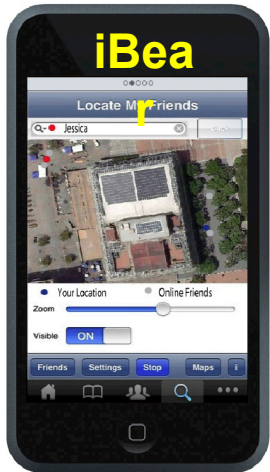
Brainstorming

Concept
Selection

Prototyping

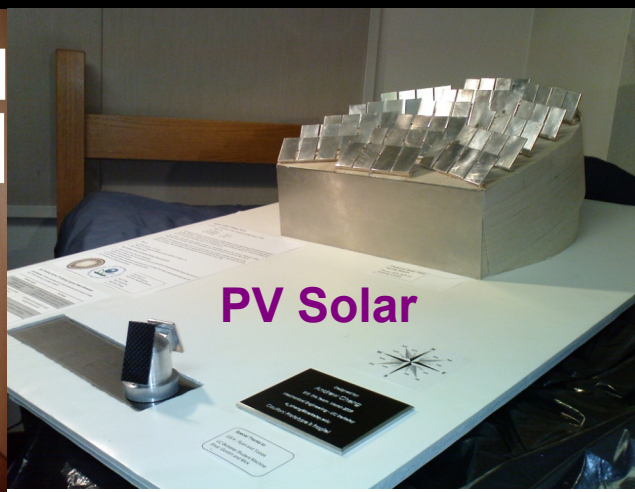
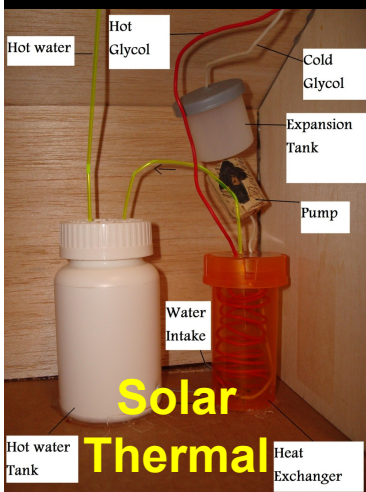
User Testing

Presentation



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charges
portable
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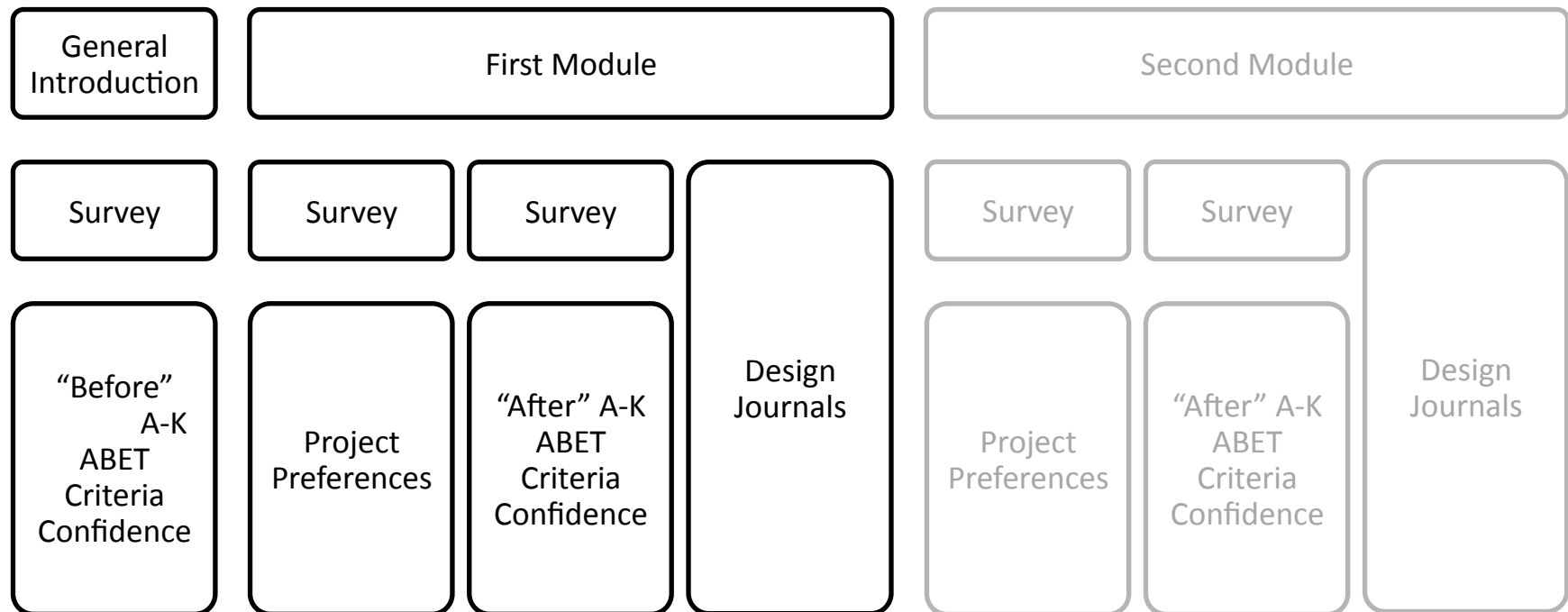
EXAMPLE PROTOTYPES



Pomo
Nation
Sustainable
Culturally-
Sensitive
Housing

Does the ME module affect students' confidence in A-K ABET Criteria skills? Is this different for women and ethnic minority students?

Do women and ethnic minority engineering students prefer different types of design problems?



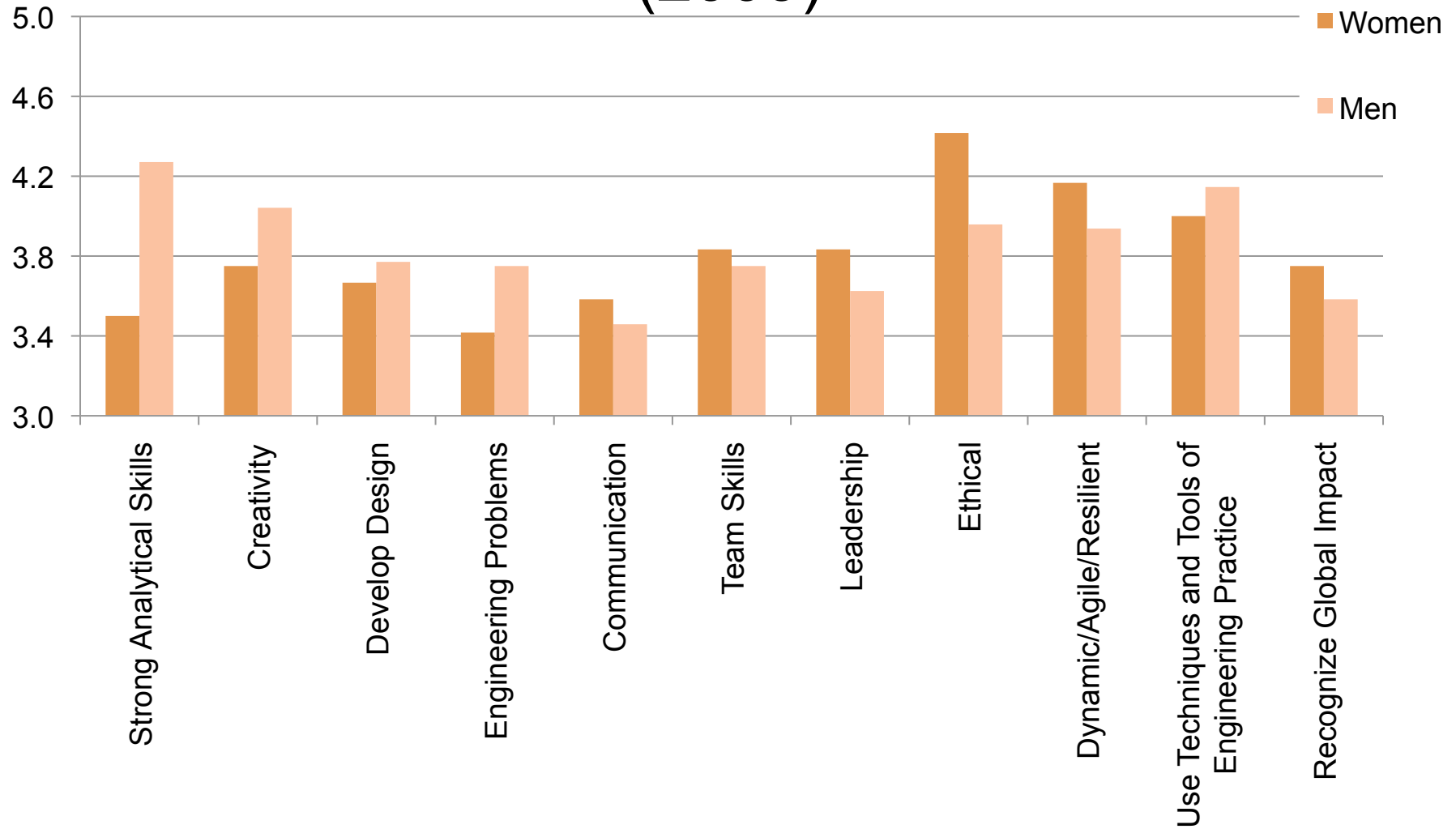
RESULTS

		2008			2009		
		Full Class	Module 1	Module 2	Full Class	Module 1	Module 2
Total Students		174	65	58	142	58	52
Gender	Women	45	17	12	34	13	12
	Men	129	48	46	108	45	40
Ethnicity	African-American	1	1	0	2	1	1
	Chicano	18	6	6	14	2	9

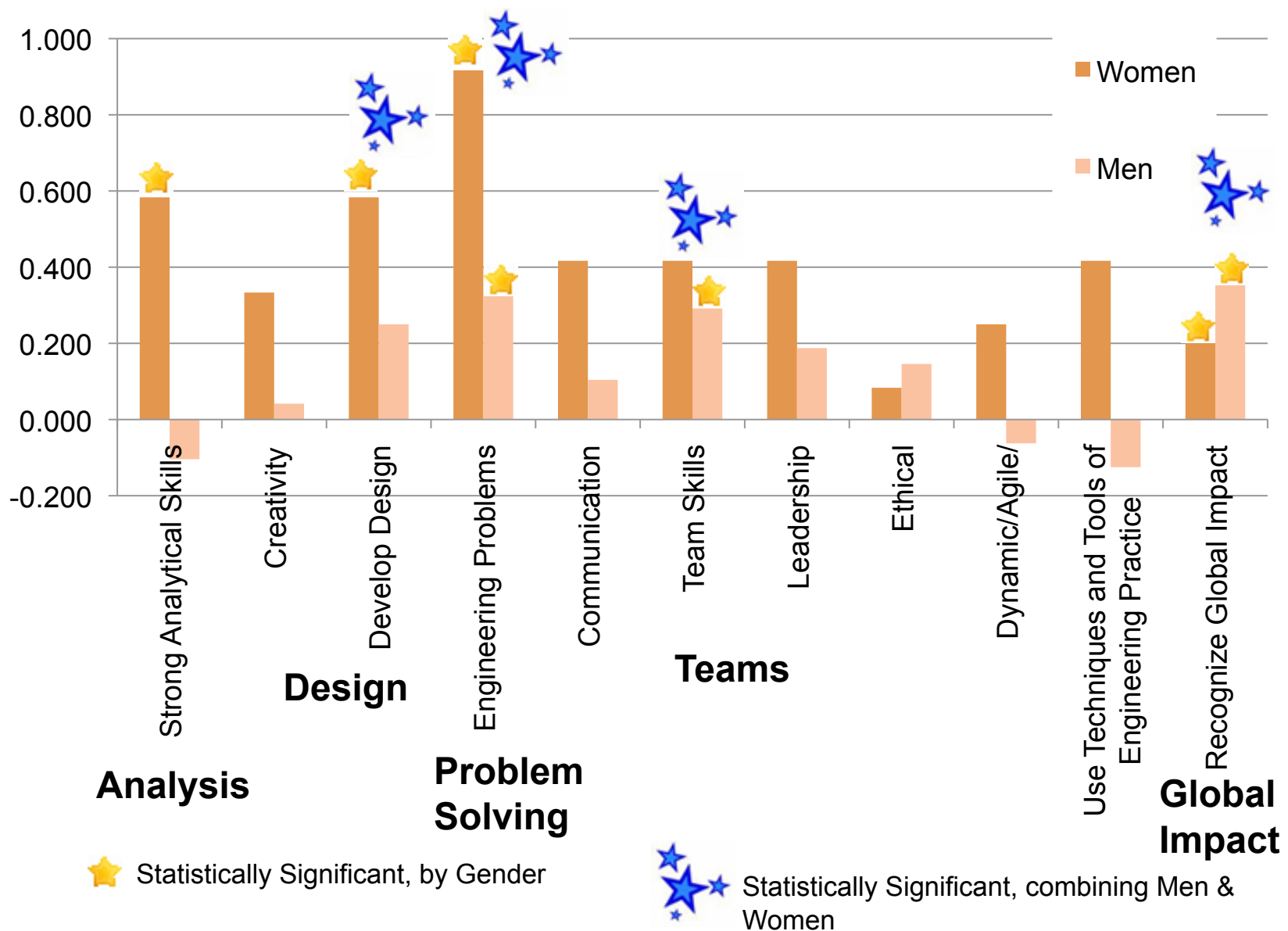
Project Preferences

- Women preferred...
 - projects serving underrepresented communities (Seguro, Pinoleville Pomo Nation)
 - education-related projects (Black Cloud, Mobile Learning)
- Men preferred...
 - “traditional” engineering projects (Bicycle Transportation, Wind Energy, Smart Lighting)

Average Confidence, Before ME Module 1 (2009)



Δ Confidence, after ME Module 1 (2009)



QUALITATIVE RESULTS

“I chose the material testing because **I know people who would actually be affected by these suits.** It would be a great opportunity to aid them in any way.”

“I liked the Pomo Nation project the best because I thought it would be really interesting to design an entirely green building; there are so many options it would be **fun to come up with the best options that would best fit the needs of the nation.**”

SUBJECT MATTERS

“I enjoyed learning and practicing the design process. I absolutely loved **being able to be creative and feeling that I could make a difference in the world around me.**”

“The class was very useful in **getting students' creative natures to come out.** It showed how design is a very important part of engineering. I like the whole design project.”

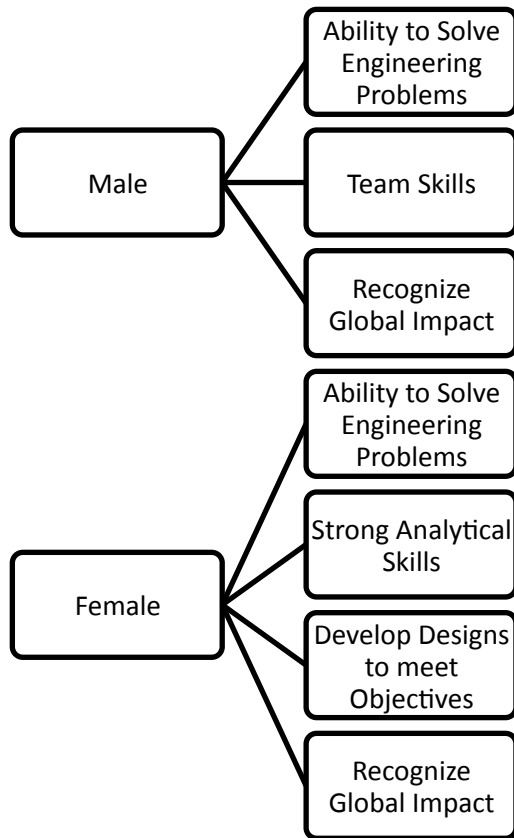
CREATIVE IMPACT

“I hated this module [...] **It communicated what Human Centered Design is, but that is not what all of Mechanical Engineering is.** I would actually be turned away from Mechanical Engineering if this module was my first introduction to it and I hadn't competed in over 20 robotics seasons and had years of experience in outside of High School that taught me what Mechanical Engineering can be.”

(FEW) EXCEPTIONS

Summary & Questions

Before/After Skill Improvement




Discussion Questions

- How do we frame the design problems that engineering students tackle?
- How could this extend to K-12 education to recruit better engineering diversity?
- How are we defining “engineering”? How is this reflected in engineering curricula?
- Which of the A-K criteria are most important for sustainable design?

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Renewable Energy and Sustainability

Grade/Audience
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CARES: Open Source Portal for Sustainable Solutions.

Our mission is to enable consumers and stakeholders to make informed decisions about sustainability and renewable energy technologies.



Sustainable solutions meet the needs of the present without compromising the ability of future generations to meet their own needs. Our view is that access to the latest data, models and solutions will accelerate adoption of sustainable solutions.

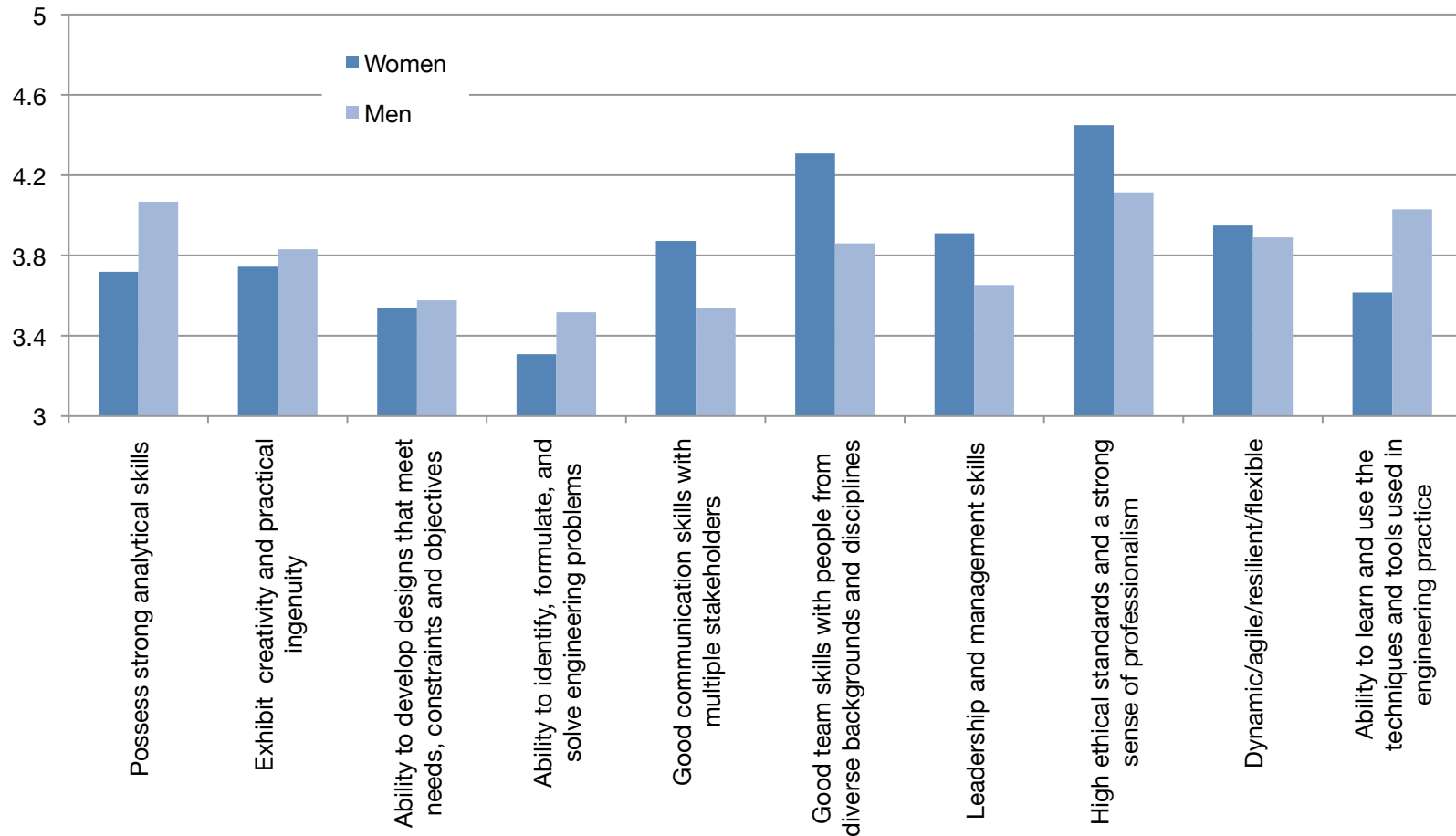
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[High tech starts to manufacture green - Many companies have sophisticated methods of recycling](#)
May 28, 2009

[New Carbon Footprint Calculator Launched](#)

BACKUP SLIDES

Combined Initial Skill Confidence



A-K ABET General Criteria

Analytical Skills

Creativity and Practical Ingenuity

Develop Designs that meet needs, constraints and objectives

Ability to identify, formulate, and solve engineering problems

Communication skills with multiple stakeholders

Team skills with people from diverse backgrounds and disciplines

Leadership and management skills

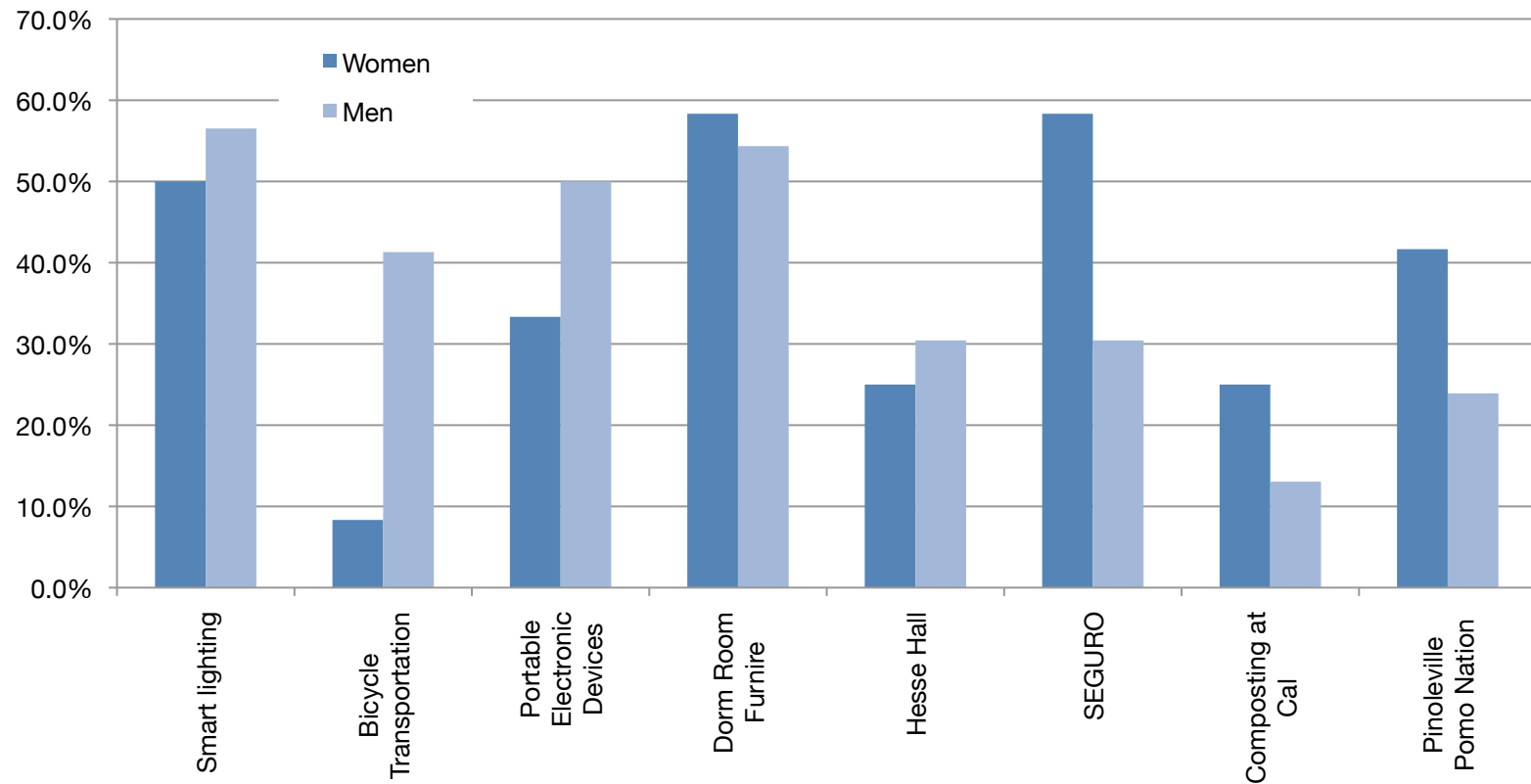
High ethical standard and a strong sense of professionalism

Dynamic/agile/resilient/flexible

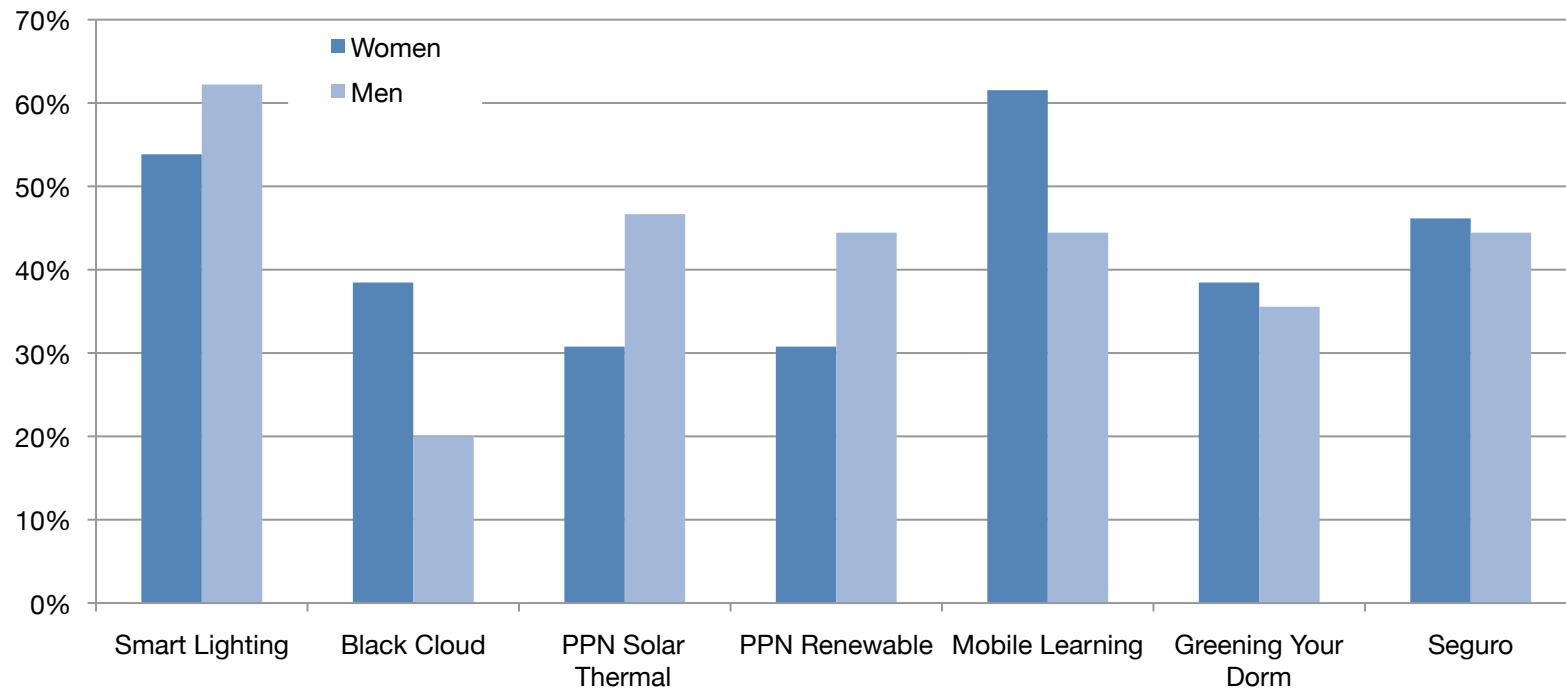
Ability to learn and use the techniques and tools used in engineering practice

Ability to recognize the global, economic, environmental, and societal impact of engineering design and analysis

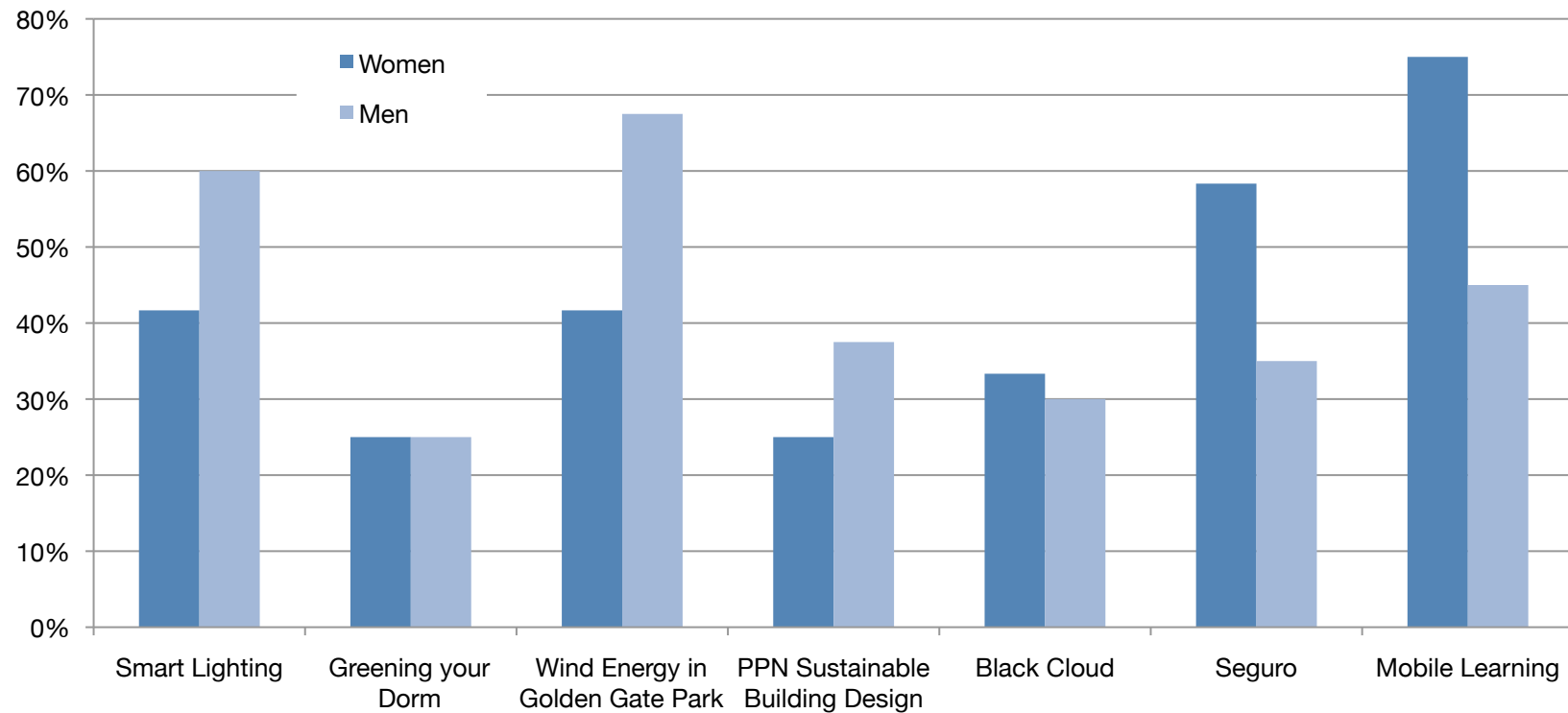
2008 Module 2 Preferences



2009 Module 1 Preferences



2009 Module 2 Preferences



Project Preferences

- 2008 ME Module 2
 - *Seguro Materials Testing ($M < W$)*
 - *Bicycle Transportation ($M > W$)*
- 2009 ME Module 1
 - *Mobile Learning ($M < W$)*
- 2009 ME Module 2
 - **Mobile Learning ($M < W$)**
 - *Seguro Materials Testing ($M < W$)*

Project Choices

2008 Module 2	2009 Module 1	2009 Module 2
Smart Lighting Seguro Materials Testing for Pesticide Protection Pinoleville Pomo Nation (PPN) Sustainable Building Dorm Room Furniture Bicycle Transportation Humanizing Hesse Hall Composting at Cal	Smart Lighting Seguro Materials Testing for Pesticide Protection PPN Solar Thermal Energy PPN Renewable Electricity Greening Your Dorm Black Cloud – Art and Technology for Sustainability Mobile Learning	Smart Lighting Seguro Materials Testing for Pesticide Protection Pinoleville Pomo Nation (PPN) Sustainable Building Greening Your Dorm Black Cloud – Art and Technology for Sustainability Mobile Learning Wind Energy in Golden Gate Park

Qualitative Comments

- Not just a benefit to the minority...
 - *“Today, we had our innovation workshop at the PPN reservation in Ukiah. Man-where to begin! Overall, I'd have to say the experience was a positive one. I mean yes, it was a bit of a hassle getting there and it was certainly a very long day, but I feel that the knowledge gained about the PPN people and their needs . . . It was a productive/ informative day, and I look forward to beginning the design process with my team mates.” (Asian Male Student, PPN)*