

# From Pipeline Thinking to Understanding Pathways: Findings from the Academic Pathways Study



Presentation based on research led by Cindy Atman (Director), Robin Adams, Lorraine Fleming, Larry Leifer, Ron Miller, Barbara Olds, Sheri Sheppard, Karl Smith, Reed Stevens, Ruth Streveler, Jennifer Turns

Partner Institutions: Colorado School of Mines, Howard University, Stanford University, University of Minnesota, University of Washington



Grant No. ESI-0227558

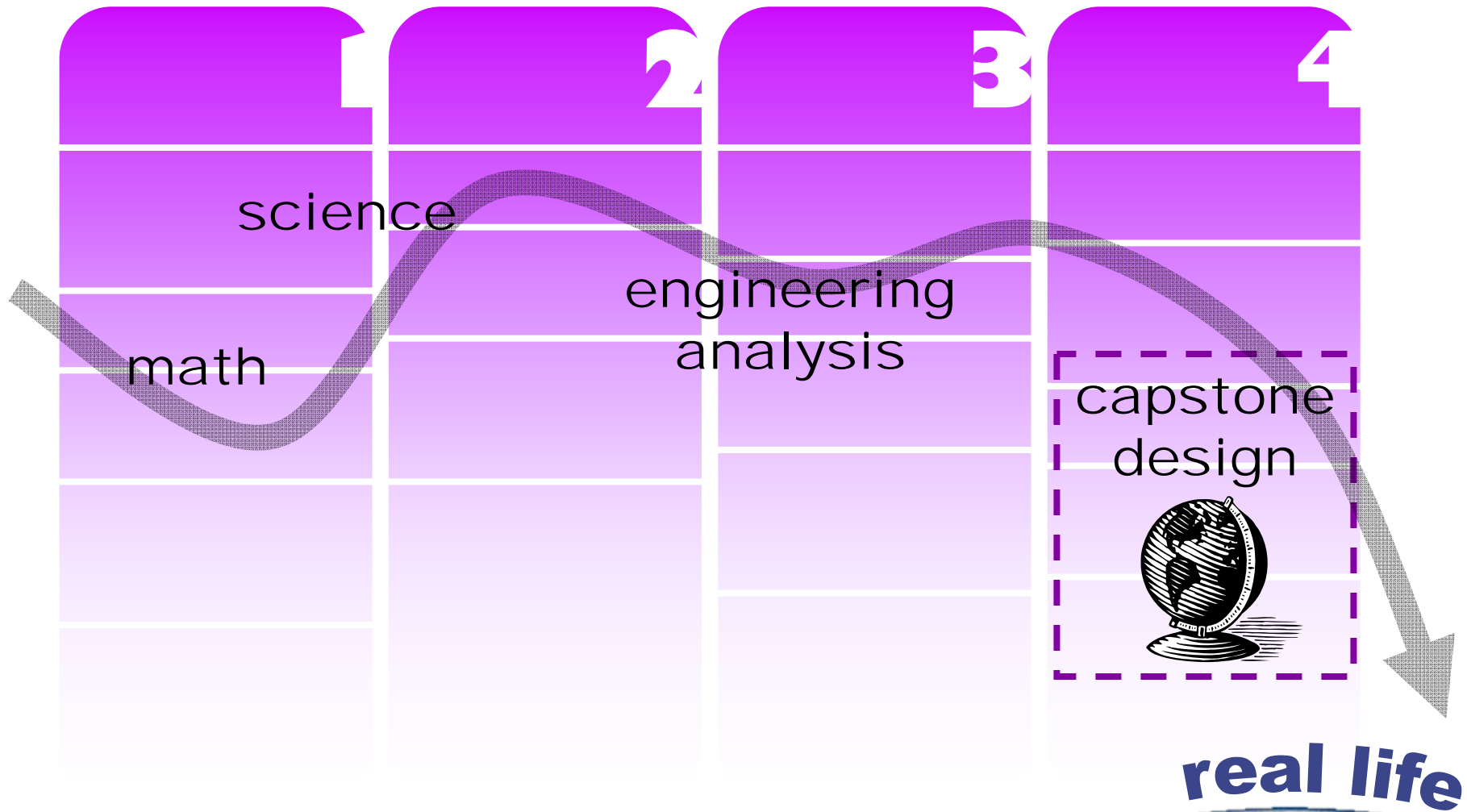
ASEE 2008 Annual Conference: June 22-25, 2008



# Overview of Paper

- Provides a broad summary of CAEE work from multiple methods through 2007
- Today's presentation focuses on a few aspects of the students' development of engineering knowledge and skills

# Undergraduate engineering education



# Findings from the Paper

*Large variation in student pathways...*

- Reasons for choosing engineering
- Choosing to stay or go
- Navigation through curriculum
- Experience by gender
- Acquisition of engineering knowledge and skills
- Preparation for the “real world”

# Today focusing on .....

## *Large variation in student pathways...*

- Reasons for choosing engineering
  - Choosing to stay or go
  - Navigation through curriculum
  - Experience by gender
- ➔ Acquisition of engineering knowledge and skills
  - Preparation for the “real world”

# Acquisition of Engineering Knowledge and Skills

- Question: Are students learning to engineer?
- Describing
  - ➔ Conceptions of design
    - “What counts” as engineering knowledge

# Conceptions of Design<sup>1,2,3</sup>

Atman, Kilgore, Morozov, Yasuhara

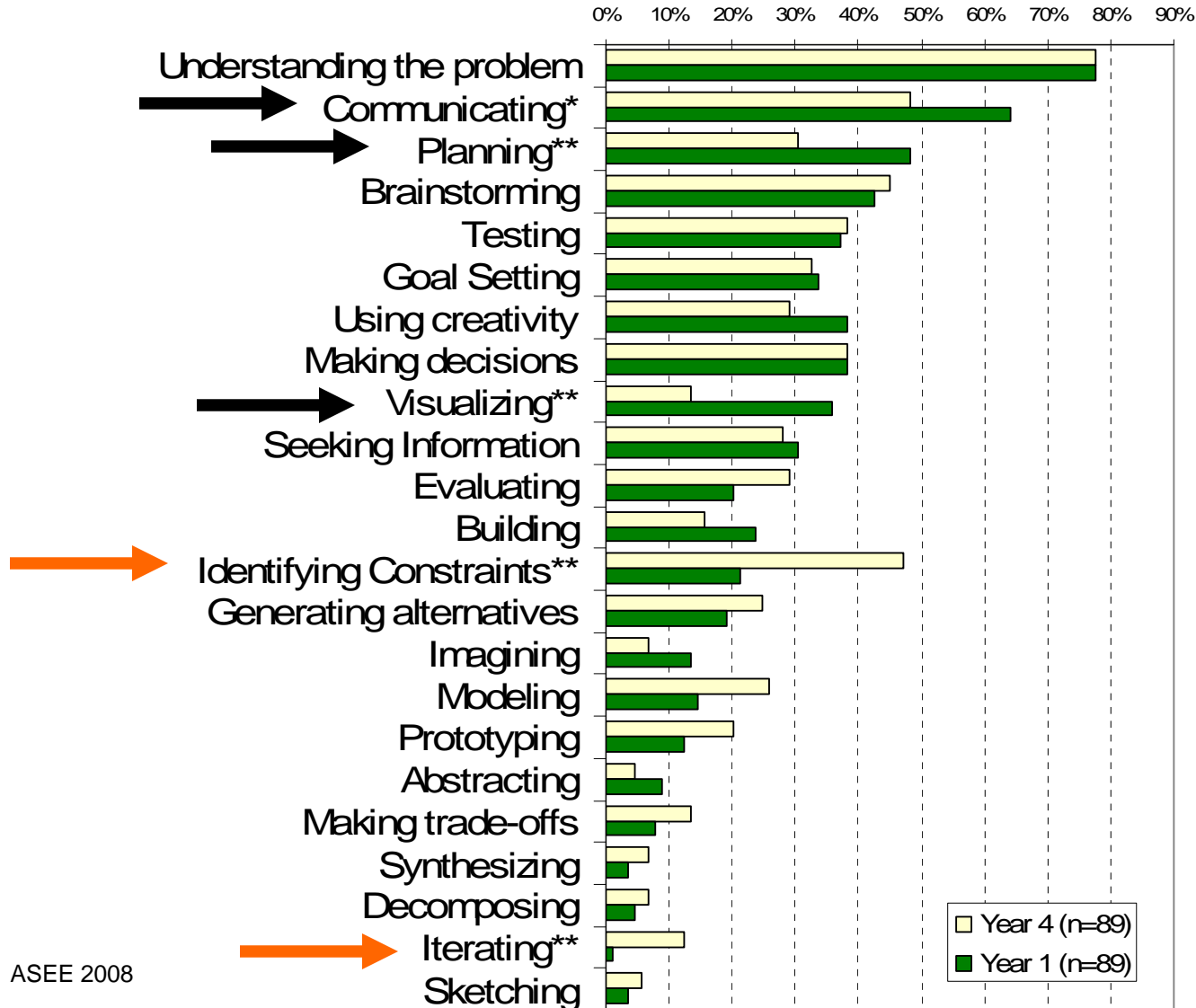
*Of the twenty-three design activities below, please put a check mark next to the SIX MOST IMPORTANT...*

- Survey question administered in Years 1 and 4
- All four institutions

# Toward Engineering Design Expertise

Most important design activities, Year 1 vs. Year 4, all APS

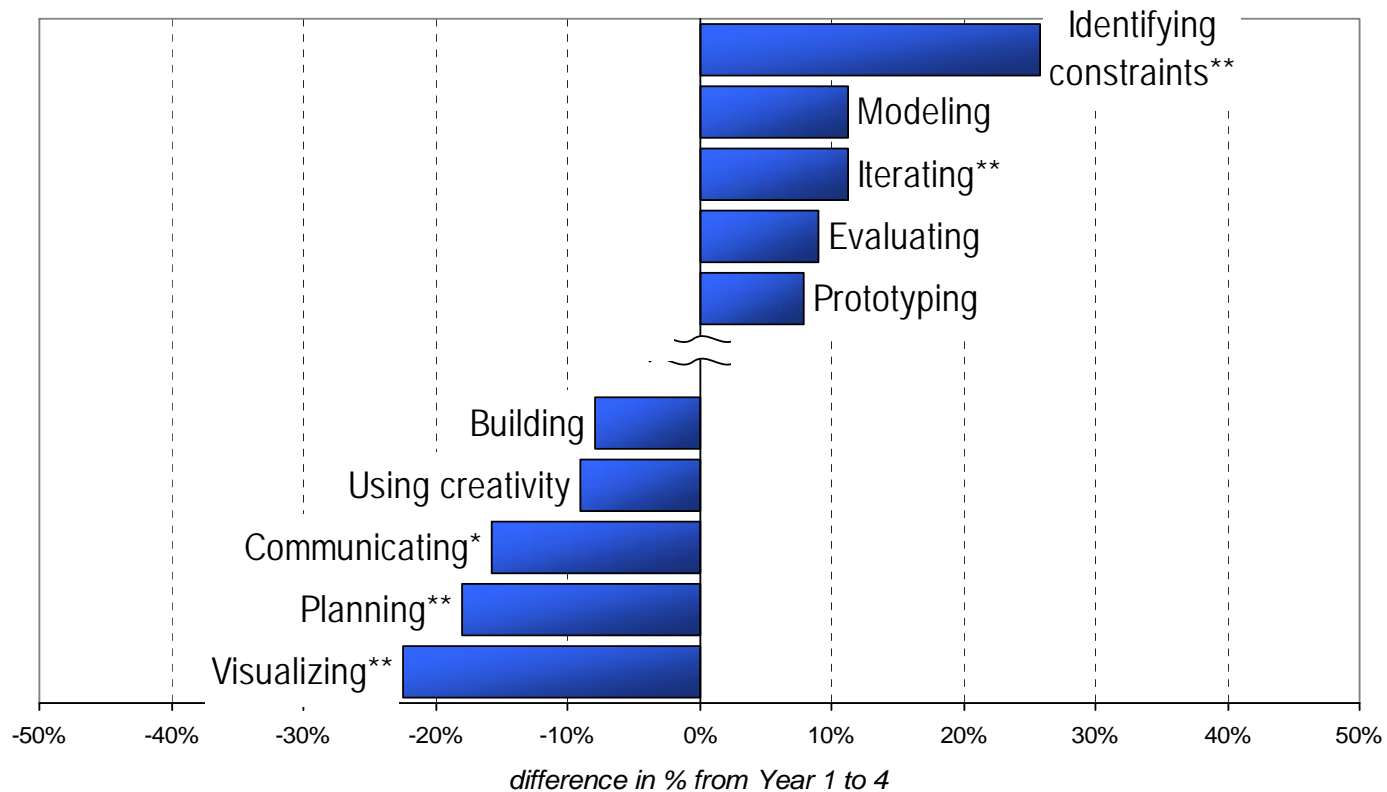
(\*p < 0.05, \*\*p < 0.01; McNemar, two-sided)





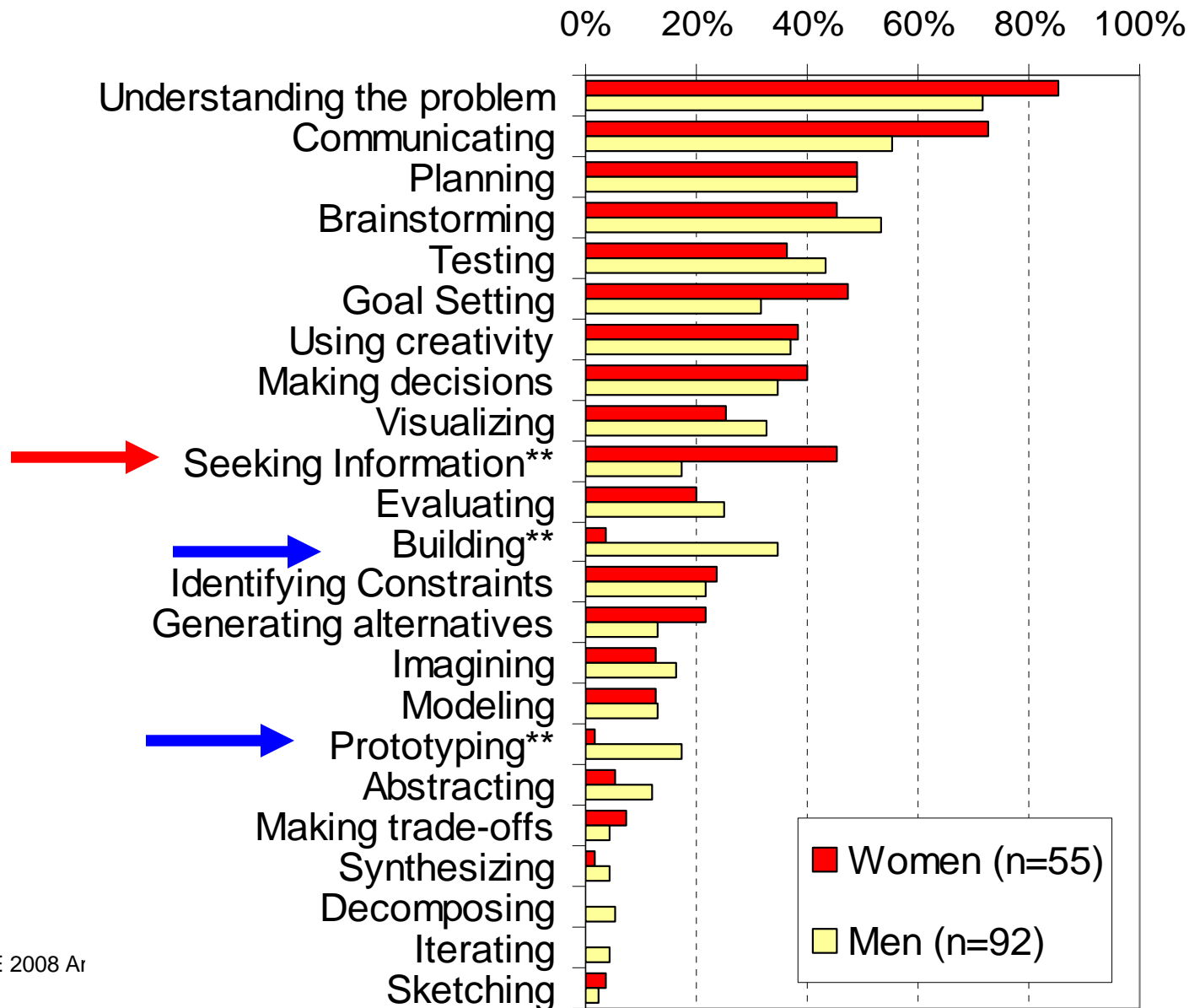
# Most Important Design Activities

## Changes from Year 1 to 4, all APS



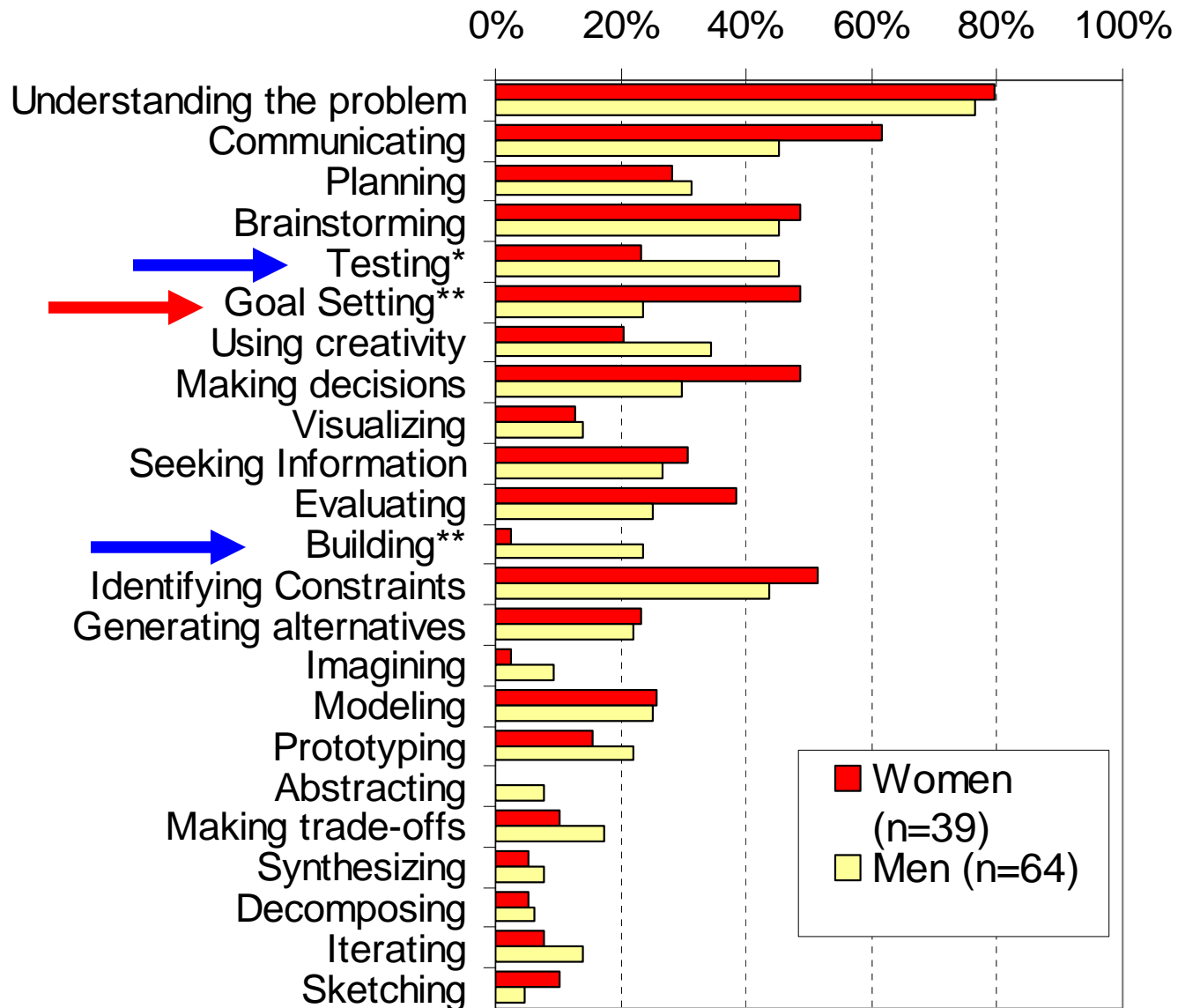
# Most Important Design Activities by Gender

Year 1, all APS (\*p<0.05, \*\*p<.01, Fisher's Exact, 2-sided)



# Most Important Design Activities by Gender

Year 4, all APS (\* $p < 0.05$ , \*\* $p < .01$ , Fisher's Exact, 2-sided)



# Acquisition of Engineering Knowledge and Skills

- Question: Are students learning to engineer?
- Describing
  - Conceptions of design
  - ➔ “What counts” as engineering knowledge

# “What Counts” as Engineering<sup>4</sup> Knowledge

Stevens, Amos, Garrison, Jocuns

- Ethnographic observations and interviews in Years 1 - 4
- At Large Public University

# “What Counts” Changes Over Time

During students' first two years:

- Technical subject matter prerequisites (mathematics, physics, chemistry) outside of engineering
- Little exposure to engineering coursework
- Lecture-based teaching, individual-based problem sets (except labs)

During final two years:

- Coursework is in students' respective engineering majors.
- Problems shift to open-ended problems.
- Students' relationship to data changes from mathematical “puzzle solvers” to data collectors and users.
- Biggest changes observable in Capstone project courses

# Examples of changes in “What Counts”

Two students navigating these changes at Large Public University:

- Adam struggled to adjust as problem-set based mathematics (school math) was displaced by group work and open-ended problems.
- Simon came into his element with the capstone project.
  - Drew on his experience as a student leader in stress testing lab
  - Demonstrated expertise in some of the tests (even in relation to the professors/instructors)

# Today focusing on .....

## *Large variation in student pathways...*

- Reasons for choosing engineering
  - Choosing to stay or go
  - Navigation through curriculum
  - Experience by gender
  - Acquisition of engineering knowledge and skills
- ➔ Preparation for the “real world”



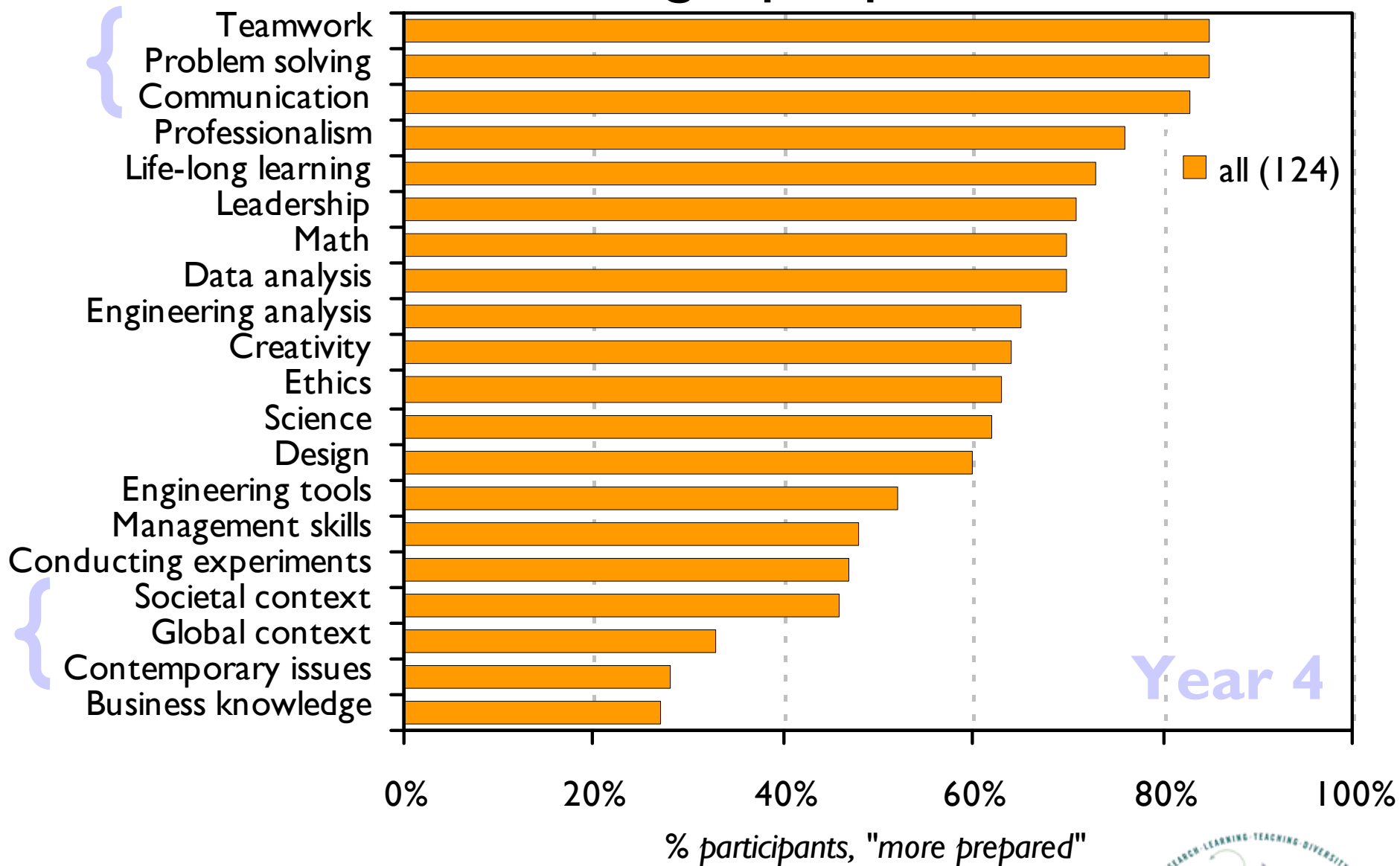
# Preparation for the “Real World”<sup>1,2,3</sup>

Atman, Kilgore, Lund, Morozov, Yasuhara

*Please rate how well prepared you are to incorporate each of the following items while practicing as an engineer...*

- List of 20 engineering skill/knowledge items based on...
  - ABET outcomes
  - *Engineer of 2020* (National Academy of Engr.)
- Survey question administered in Year 4
- All four institutions

# Skills/knowledge preparedness



# What Are We Finding?

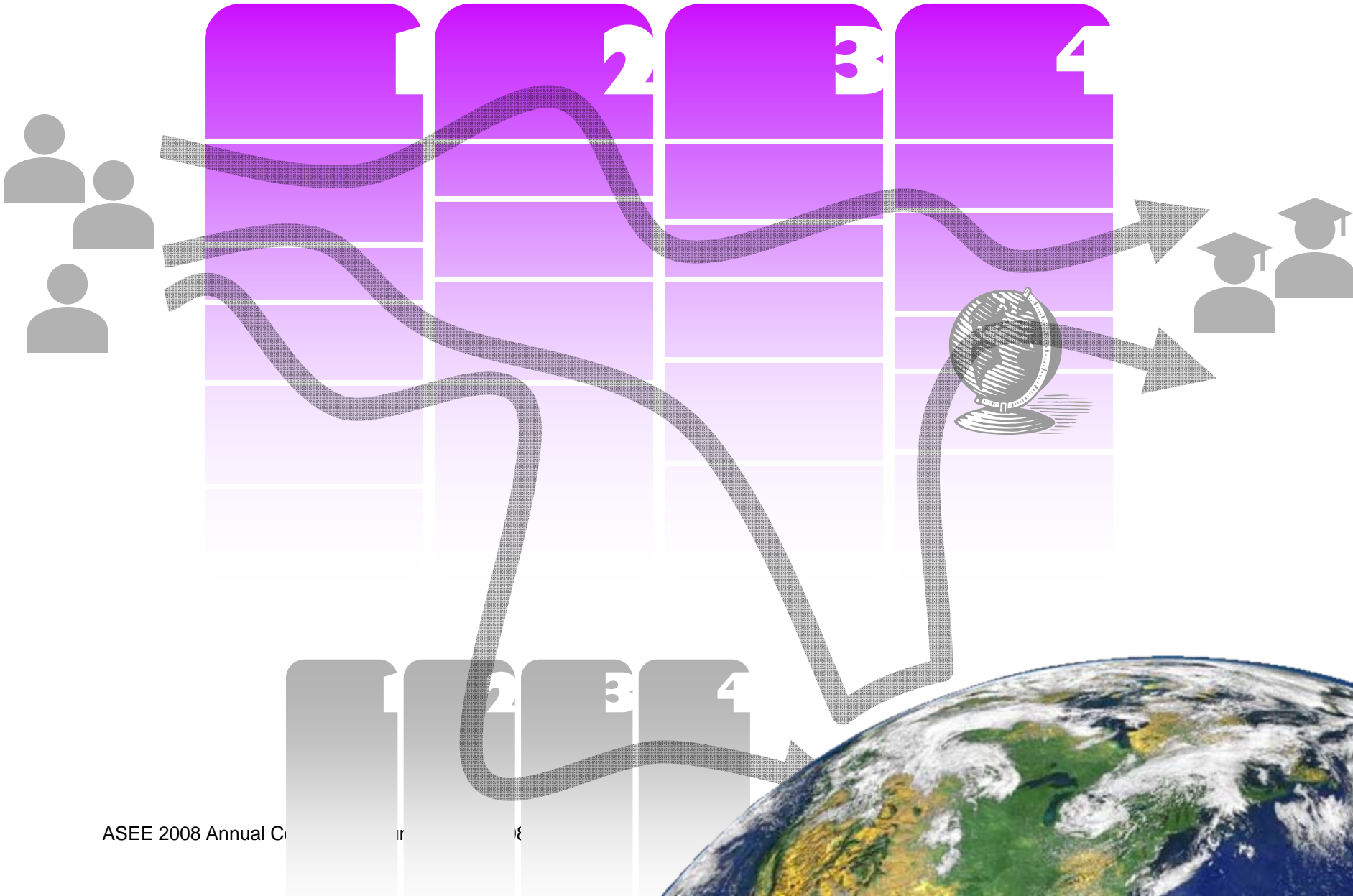
- Data on student learning from surveys and a more in depth look at a smaller number of students
- Good news: students are learning, becoming more expert-like
- But some gaps remain
  - Not all students shift easily to new “what counts”
  - Low importance of global/societal context

# Summary of Findings

*Large variation in student pathways...*

- Reasons for choosing engineering
- Choosing to stay or go
- Navigation through curriculum
- Experience by gender
- Acquisition of engineering knowledge & skills
- Preparation for the “real world”
- Details on more findings in remaining papers of session #1531 and #2531 tomorrow....

*Stay tuned – The stories continue to unfold...*



# Acknowledgement

This material is based on work supported by the National Science Foundation under Grant No. ESI-0227558, which funds the Center for the Advancement of Engineering Education (CAEE). Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.



CAEE is a collaboration of five partner universities: Colorado School of Mines, Howard University, Stanford University, University of Minnesota, and University of Washington.

For further information see the CAEE Web site at <http://www.engr.washington.edu/caee> or contact Cindy Atman at [caee@engr.washington.edu](mailto:caee@engr.washington.edu)

# Citations

1. Deborah Kilgore, Debbie Chachra, Heidi G. Loshbaugh, Janice McCain, Marcus Jones and Ken Yasuhara. 2007. Creative, Contextual and Engaged: Are Women the Engineers of 2020? In *Proceedings of the 2007 American Society for Engineering Education Annual Conference*.
2. Cynthia J. Atman, Deborah Kilgore and Ann McKenna. 2008. Characterizing Design Learning Through the Use of language: A Mixed-methods Study of Engineering Designers. In preparation for the Journal of Engineering Education.
3. Andrew Morozov, Deborah Kilgore, Ken Yasuhara and Cynthia Atman. Same Courses, Different Outcomes? Variations in Confidence, Experience, and Preparation in Engineering Design. 2008. To be presented at *2008 American Society for Engineering Education Annual Conference*.
4. Reed Stevens, Kevin O'Connor, Lari Garrison, Andrew Jocuns and Daniel Amos. 2008. Becoming an Engineer: Toward a Three Dimensional View of Engineering Learning. In preparation for the Journal of Engineering Education.