

AC 2009-1484: FINDINGS FROM THE ACADEMIC PATHWAYS STUDY OF ENGINEERING UNDERGRADUATES 2003-2008 -- OVERVIEW AND PANEL DISCUSSION

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REED STEVENS is an Associate Professor in the College of Education at the University of Washington. He specializes in ethnographic and comparative approaches to studying how people learn, especially in disciplines related to mathematics, science, technology, and design. He is currently co-leading two NSF Centers working on issues related to how people learn—the LIFE Center and CAEE.

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**SPECIAL SESSION:
Findings from the Academic Pathways Study of Engineering
Undergraduates 2003-2008 – Overview and Panel Discussion**

This special session for the ASEE 2009 Conference presents some of the latest results of the Academic Pathways Study (APS), an NSF-funded study of the undergraduate engineering student experience. The APS is part of the Center for the Advancement of Engineering Education (CAEE).

The APS consists of longitudinal and cross-sectional studies of engineering undergraduates' learning experiences and the transition to work. The APS used multiple research methods to look at three separate cohorts of undergraduates over six years. In addition, several smaller groups of newly hired engineers were studied to provide details of the beginning work experience for engineering graduates. This special session is an opportunity to provide an overview of APS results and engage the larger engineering education community in a discussion that develops ways of thinking about the implications of these results for the future of engineering teaching and learning.

APS research questions are focused on student skills and knowledge, identity as an engineer and engineering student, personal and institutional aspects of the students' education, and the skills needed to transition into the workplace:

- **Skills:** How do students' engineering skills and knowledge develop and/or change over time?
- **Identity:** How do these students come to identify themselves as engineers? How do students' appreciation, confidence, and commitment to engineering change as they navigate their education?
- **Education:** What elements of students' engineering educations contribute to changes observed in their skills and identity?
- **Workplace:** What skills do early career engineers need as they enter the workplace? Where did they obtain these skills?

The study relies on multiple methods and data sources including surveys, structured interviews, semi-structured ethnographic interviews, and an engineering design task. Academic transcripts and exit interviews of those leaving the study provided additional data.

Numerous interim results have been reported at previous ASEE Conferences (36 papers and 4 posters in the last three ASEE Conferences, 2006-2008) and various other meetings. The CAEE research team is building a set of compelling results that paint pictures of the engineering student experience not only with a human face, but with a multi-faceted understanding that comes from a rich triangulation of data types and sources.

Goals of the Session

The goals of this special session are to present selected findings from the extensive APS research and to offer audience participants an opportunity to interact with these findings and provide feedback to the CAEE research team.

The expected audience for this session would be engineering education researchers, engineering educators, faculty development practitioners, engineering curriculum developers, and policy makers. The session is designed to engage attendees in developing ways of thinking about these findings that can inform engineering education program planning and classroom practice.

Overview of the Session

- Part 1 (40 min.): The first portion of the session will provide a brief overview of CAEE and APS with a focus on selected findings centered on the APS research questions.
- Part 2 (30 min.): The introductory slide presentation will be followed by an interactive session that will allow audience members to discuss the findings with their neighbors.
- Part 3 (35 min.): The special session will conclude with a panel discussion led by the APS research team.

Details of the Session: Agenda and Content

Part I. The first portion of the session will consist of an approximately 40-minute presentation that provides an overview of the APS and the key research findings based on the research questions centered on skills and knowledge, identity, education, and transition to the workplace. Summaries of several representative findings are listed below; the team will present a broader review of the research during the session.

1. Engineering Needs More Pathways for Inward Migration

When compared to other college students, engineering students in general are:

- more likely to stick with their major
 - equally engaged with their studies and similar in other factors ranging from grades and gains in general education to course-related interactions with faculty and time spent on homework
 - less likely to have migrated into the engineering major from a different major
- These results provide compelling evidence that engineering students do stick with their major (the primary problem is not one of retention), but that fewer students migrate into engineering programs, and fewer begin their college careers in engineering. (Donaldson and Sheppard, 2007; Ohland et al., 2008)*

2. Graduates Often Don't Seek Employment in Engineering

- Today's college graduates think more about their "first job" than about a lifetime career choice.
- 60% of undergraduates anticipate having multiple jobs in different fields during their working life and students who complete a major in engineering are not necessarily committed to careers in engineering.
- Undergraduates' thoughts about career options can be swayed by a single experience such as an internship, interactions with faculty, or advice from a mentor.
- Institutional differences can contribute strongly to the varying levels of commitment to engineering careers.
- Student decisions about their post-graduate plans often take place without the direct influence of engineering faculty and staff, who could conceivably provide valuable insights and guidance.

Recognizing the fluidity of student commitment to engineering, and building more guidance into programs, could ensure that the most qualified, talented students will use their skills in engineering-related careers. (Lichtenstein et al., 2008)

3. Women May See a "Bigger Picture" than Men in Engineering Design Problems

- First-year women engineering students tended to choose a greater number of context-oriented items ("the bigger picture") than men did in selecting from a list of factors important in design.
- These women were more likely than men to associate *seeking information* and less likely to associate *building* and *prototyping* with engineering design.
- Students' fourth-year responses to the same question appear similar to those from the first year: women were more likely than men to choose *goal setting* and less likely to select *building*.

Women in engineering can often provide a different and broader perspective on the approaches to, and details of, a design. (Atman et al., 2008; Chachra et al., 2008; Kilgore et al., 2007)

4. Newly Hired Engineers Must Adjust Quickly to the Workplace

- Newly hired engineers reported they encountered a very steep learning curve when beginning their new jobs.
- These new engineers mentioned that math was essentially done for them in the workplace, either by spreadsheets or other software applications.
- Newly hired engineers learned that the social context of the engineering workplace is a major driver of their roles as engineers and how they conducted their work.
- The problems faced by engineers in practice are extremely complex, ill-structured, ambiguous, and often dependent on the social and organizational contexts.

Newly hired engineers experience a steep learning curve not only in their engineering work but in learning how they fit into the social and organizational contexts of their workplace. (Korte et al., 2008; Stevens et al., 2008)

The presentation will set the stage for the interactive session.

Part II. Part II consists of a 30-minute interactive session designed to engage participants with the APS data in a discussion and feedback format. The APS team will provide a handout with selected findings to serve as a guide for the interactive session and following discussion. Participants will discuss with their neighbors and develop feedback on a selected finding from the presentation and will be asked to consider the following questions:

- What are the implications of these findings for your campus?
- In the context of these findings, are engineering students on your campus similar to or different than the study's students?

Part III. Part III is a 35-minute discussion in the larger group led by the co-Principal Investigators. The small-group discussions of Part II will provide the basis for a summary of the research and possible uses of the results by different audiences.

One expected focus of discussion will be the use of the findings about undergraduates by engineering teaching faculty. This discussion thread will build on the research framework and findings on faculty teaching decisions that have been described by the Studies of Engineering Educator Decisions (SEED), a related part of CAEE's research.

The summary discussions of Part III will examine the broader implications of APS results and possible future research questions based on the APS data. The audience will be encouraged to share their thoughts on how the findings might impact them as engineering education researchers and/or as teachers. They will also be asked to think broadly about the implications for engineering deans and department chairs, student advisors and support team members, and policy makers in general. The session will conclude with discussion focused on the question: "What questions are left unanswered?"

References

The APS team is presenting other papers about specific findings from the research during the 2009 ASEE Conference. For details, please consult the CAEE website or the handout (available at the CAEE booth during the Exposition) that provides a schedule of the APS papers during the conference. In addition, there are over 77 papers on emerging findings from the Academic Pathways Study listed on the CAEE website at www.engr.washington.edu/caee/publications.html.

The following papers contain specific findings related to this special session including insights into engineering skill development, engineering student persistence, and faculty consideration of learners in their engineering teaching decisions.

Atman, Cynthia J., Deborah Kilgore, and Ann F. McKenna. 2008. Characterizing Design Learning Through the Use of Language: A Mixed-methods Study of Engineering Designers. *Journal of Engineering Education*, July 2008, Vol. 97(3): 309-326.

Chachra, Debbie, Deborah Kilgore, Heidi Loshbaugh, Janice McCain, and Helen Chen. 2008. Being and Becoming: Gender and Identity Formation of Engineering Students. In *Proceedings of the American Society for Engineering Education Annual Conference, Pittsburgh, PA, June 22-25, 2008*.

Donaldson, Krista and Sheri Sheppard. 2007. Exploring the Not-So-Talked-About Undergraduate Pathway: Migrating Into Engineering. Paper presented at the *2007 International Conference on Research in Engineering Education*, Honolulu, Hawaii, June 23-24, 2007.

Kilgore, Deborah, Debbie Chachra, Heidi Loshbaugh, Janice McCain, Marcus Jones, and Ken Yasuhara. 2007. Creative, Contextual, and Engaged: Are Women the Engineers of 2020? In *Proceedings of the American Society for Engineering Education Annual Conference, Honolulu, Hawaii, June 24-27, 2007*.

Korte, Russell F., Sheri D. Sheppard, and William C. Jordan. 2008. A Qualitative Study of the Early Work Experiences of Recent Graduates in Engineering. In *Proceedings of the American Society for Engineering Education Annual Conference, Pittsburgh, PA, June 22-25, 2008*.

Lichtenstein, Gary, Heidi Loshbaugh, Brittany Claar, Helen Chen, Kristyn Jackson, and Sheri Sheppard. 2008. An Engineering Major Does Not (necessarily) an Engineer Make: Career decision-making among undergraduate engineering majors. *Journal of Engineering Education*, in press.

Ohland, Matthew W., Sheri D. Sheppard, Gary Lichtenstein, Ozgur Eris, Debbie Chachra, and Richard A. Layton. 2008. Persistence, Engagement, and Migration in Engineering Programs. *Journal of Engineering Education*, July 2008, Vol. 97(3): 259-278.

Stevens, Reed and Andrew Jocuns. 2008. Unpublished data based on interviews with early career engineers.

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