Special Session 2530: Findings from the Academic Pathways Study of engineering undergraduates 2003–2008

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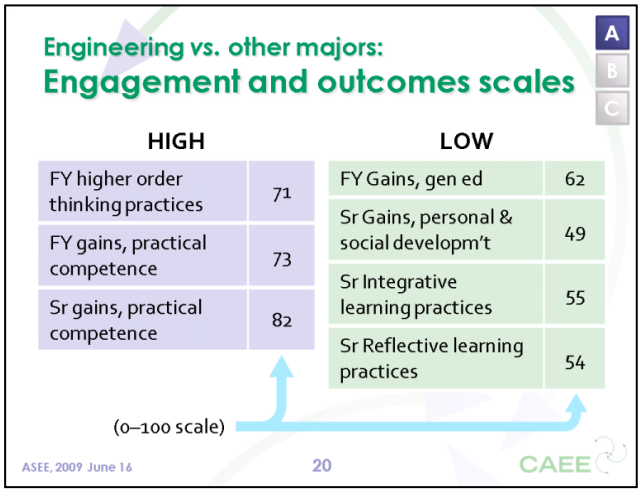
Participants' thoughts on selected Academic Pathways Study findings

Special session participants were asked to reflect on three selected findings presented at the start of the session, summarized below with key slides from the main presentation. They were asked to take the perspective of a role of their choice (educator, student advisor or support services staff, department head or dean, industry, or other) and consider the findings' implications on how someone in their chosen role goes about their work.

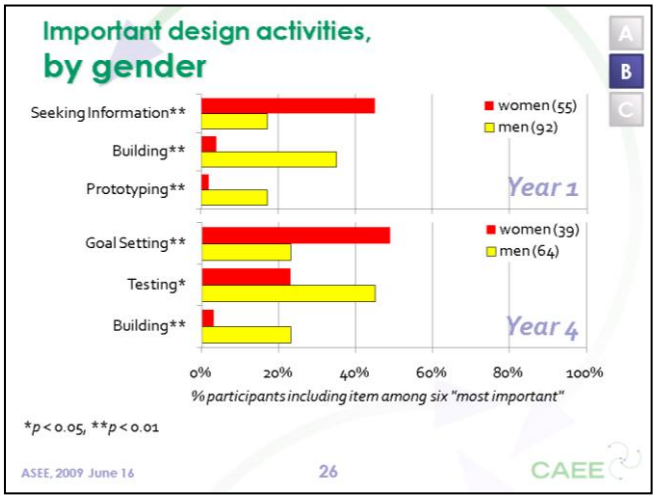
A. Getting in

- Retention is not the issue (>70%).
- Engineering needs more pathways for inward migration.
- Engineering *vs.* other majors
  - Strong: practical competence, higher-order thinking, culminating senior experience
  - Weak: personal and social development, reflective learning, foreign language, independent study



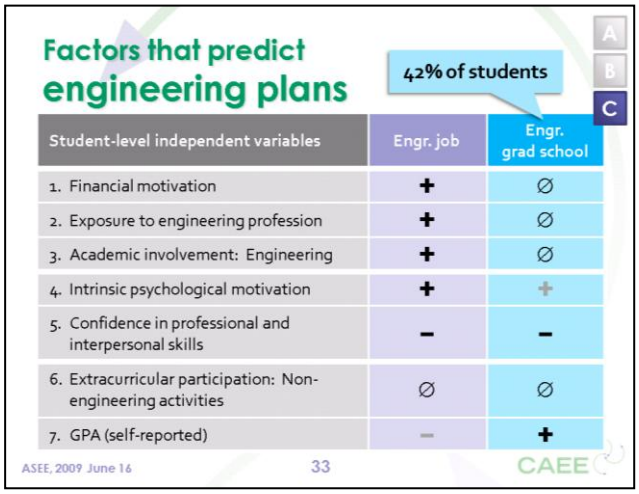
B. Getting through

- Student conceptions of design become more engineering-specific.
- Women's conceptions of design emphasize building less than men's.



C. Getting out

- Most graduates consider engineering careers,
- …but many also consider engineering graduate study,
- …as well as <u>non</u>-engineering careers.
- Predictors of plans to continue in engineering include low confidence in professional and interpersonal skills.



Participants were given note-taking forms to record their thoughts before group discussion. The following pages show anonymized transcriptions of these written notes, with findings indicated by letter (A, B, or C).

For more information about the Center for the Advancement for Engineering Education and the Academic Pathways Study, please visit our web site at http://www.engr.washington.edu/caee/.

Role	Finding	Finding's implications on how someone in chosen role goes about their work
Educator	A	Need to look at my program to see if there are things that could help with inward migration (i.e., could we design an "Engineering for Everyone" type of course in Year 1; could we do a summer bridge program after the first year for students who may have prerequisite deficiencies but who want to enter engineering?)
	B	I should ask myself if I overemphasize or overvalue some design aspects based on my gender
	C	This is not a bad thing and could be addressed in courses in a positive way.
Government	A	If >70% is true, there is an enormous implication for government funding.
	B	Surprising – no wonder fewer women in ME and EE
	C	I would like more info on how confidence in professional/interpersonal skills are determined
Department head or dean	A	1. Need to decrease content in the curriculum, more emphasis on skill development, so it's possible to transfer in without starting from scratch and having to complete 100+ credit hours to graduate. 2. Need more focus on pedagogy that promotes skill development (which chalk-and-talk doesn't) 3. Need to incentivize faculty to do (2) and reward those who do it well. 4. An exciting first year engineering course is a good step, but the excitement and social relevance needs to be maintained for the next four years.
National Eng Ed Policy Advocate	A	Policy guidance for community college students and "swirlers" who transfer in and out of multiple institutions.
	B	How to get greater recognition of women's conceptions and diffuse these conceptions to men.
	C	Advocate for greater acceptance of "non-engineering" employment as valuable to engineering as a field.
Industry	A	Work with colleges to develop work programs for non-majors especially at earlier years
	B	Recognize and support multiple solution to problems Sponsor contests that reward creativity and most unique design

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	C	Make sure students know about all possible opportunities within the company Q: How does this compare with other majors, many of which require grad school to get a job in the field? OR compare with nursing, which doesn't? Low interpersonal skills -> grad school -> does this mean we'll have many eng. faculty with low interpersonal skills?
Educator	A	Broaden understanding of impact of STEM. So they see potential opportunities. Better synergy within humanities less requirements emphasis.
	?	Is URM population significant for findings in this population?
Support Services staff	A	First year experiences to explore grand challenges and role of engineers at university Provide instructional design support for faculty to: 1) use technology 2) provide engr. profiles for 'chats' for students
Industry	B, A, C	What are we missing because we have these people we hire have low-self confidence?
	B	Does the weakness matter?
	A, C	Is this why engineers are so hard to manage?
Industry	A	-invest in outreach/recruitment activities to get students to go into eng. from high school -require intensive personal and social development of new eng. hired
	B	-esp. for new hires require intensive training in developing listening and reflective skills
	C	-require new hires to develop professional and interpersonal skills to improve confidence
Industry	A	-need more university, industry support of pre-engineering programs at HS level (or K-12 generally) -many industries want engineers w/ a more interdisciplinary background (mainly a mix of engr majors), this could provide another in road
	B	-connect women earlier on with management, marketing, PR etc. elements of the engineering profession
	C	-That's okay we love to hire engineering majors in other professions – their training is a huge benefit -likely some are considering management/business roles, which also benefit from engr background.

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Researcher	C	Find out if the students with increased confidence in social skills are leaving engr because they're (a) not excited about engr practice or if they're not excited about working with others who they perceive to have inferior social/interpersonal skills. (a) seems much less discouraging than (b) and I'm sure there are also reasons (c), (d), (e) etc.
	A	Might be interesting to look at the variance of retention data (across institutions) compared with the same data from other majors – if eng. has an increased variance, it implies that the "best practices" at the high retention institutions should be adopted (wherever possible) at other institutions.
Industry	A	In visits to campus to recruit students/conversations with faculty/advisory board meetings, communicate the opportunities available for engineers to use foreign language skills, personal/social skills -> provide motivation for student to learn these skills. Sponsor opportunities for student to change majors
	B	Partner with researchers -> more research on what skills are important for engineering practice Partner with researchers -> learn from studies like APS to understand engineering graduates and prepare themselves (as companies) to know what to expect from (how to interact with new hires and know how to help the new hires with the transition -> more people stay in the profession? 2) Is there any engineering content that is really essential? -> should we instead focus on teaching students how to think, how to learn, how to communicate 1) how to add in foreign language, interpersonal skills, reflective skills without ADDing another course to set of courses required -> layer these skills in other engr courses. ->similar to adding engineering to elementary classes without ADDing more content that needs to be included by connecting engineering to the science, math, social students, language arts that the teachers are already teaching. -changing the context of some of the activities which still focusing on more "traditional" subject matters.
Educator, Department head or dean		More engineering ed in K-12. Faculty are resistant to cutting content knowledge in favor of these other skills You can layer these skills into exiting classes

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Industry (feedback from non-traditional industries) Other (Sophomore physics/calculus instructor)	A	What tools would I use to help bring students who are disillusioned with physics/math into engineering? I often bring students out of engineering into physics or engineering physics. This is possible because physics is a gateway course. You might want to bring non-engineers into first-year engineering courses using Gen Ed courses to do so. Weak personal development can be greatly changed by looking at our own (profs and admins) skills in this area and developing them.
Educator, student advisor or support services staff, department head or dean	A	Need to cooperate with other advisors. Rather than trying to convince students to stay, we would all be better off if we helped students find the right major.
	B	Need to consider that perhaps males do gather information and set their goals by trial-and-error building and testing activities. Learning by doing.
	C	Start bragging about those people who pursue the non-engr. jobs as well as the engr jobs.
Student	A	Search for a program that allows for courses to be taken to develop those skills that Engineering majors are usually weak in.
	B	Spend more time studying a traditional engineer's concept of design.
	C	Make sure to get into internship to understand what engineer actually do, to decide as early as possible whether to complete the major.
		P.S. I'm a computer science major and have very little idea of what engineering actually is, from my coursework. I'm under the impression that I can't take any courses in engineering at my school unless I'm an eng. major, despite wanting to and possibly being interested in engineering, especially computer engineering.
Grad. Student	C	I think seeking position in non-engr area is far different from finally ending up with a job in non-engr area. It should make more sense if graduate students are offered position from both engr and non-engr and see which one they choose

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Educator	A	Increase reflective and integrate learning practices as part of curriculum. Include more opportunities for personal and social gains – clubs? Dealing more with clients? GE includes rigorous math and science for inward migration. Encourage Com. College curriculum to focus on math and science.
	B	Tell student's results of study and discuss.
Education Research	B	I would be interested in learning more about the details of students' conception of design (generally), how they learn about design and how we can design instruction to support student learning. In the presentation, we saw that student's decreased in particular design activities (visualizing etc). It would be interesting to learn more about instructional supports to help students in those areas. How could we leverage what students come in with to develop components of engineering knowledge/practice.
Ed researcher	B	Important to think about what aspects of design students (and engineers) value and how these ideas change.
Math Edu researcher	B	Interested in the low student initial rank of "drawing" Decrease in visualization, though recognize the changes of characterization of engineering as involving design constraints.
Educator	A	Work out transfer solutions for required courses.
	B	Do some research with women in the literature about what constitutes design and interests women.
	C	This is positive and needs to be encouraged on a daily/weekly basis especially developing foreign language capability.
Department Head	A	What kind of collaborations between engineering faculty and non-engineering faculty can I orchestrate to create and opportunity for some of the weaknesses in engineering to be addressed. Would I – disciplinary projects help? How to create and manage these opportunities?
	B	How do we train faculty to see the nature of both perspectives?
Department head of dean	C	Very interesting findings on correlation of interpersonal skill confidence with whether students stay in eng. after graduation I would hope that at the Dean's level interactions between eng. faculty and other colleges encouraged – cooperative content and modules...
Senior Research Fellow, ALTC Project, Sydney	A	-Explore and articulate pathways, bridging courses, credit transfer -Work with marketing, publications

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	C	-Assist seniors to explicitly articulate the skills and competencies they have developed alongside technical knowledge - Some advisors are aware that self efficacy may be a factor in thinking need to go to non-engineering -Provide info about other career options that positively include engineering competencies, e.g., patent law, teaching, policy, operations mngmt, logistics…
Student Advisor or support services staff	A	As a student – transferring into engr is notoriously difficult (sets you back a year or more + high GPA requirement) Advisors have suggested that unsure students start in engr & transfer out if they don't like it; this may affect what you see
	C	I really like Cindy's comment about non-engr careers also being valid; what is our end-goal? – 100% retention?
Educator	A	-We need more flexible curricula for those in-migrants to get into most engineering majors -increase study abroad opportunities in flexible curricula that gets accredited
	B	-first year experiences have to be re-designed to be more balanced for women & men in order to be of value and attracting to both
		-why the high confident students don't want to stay as much as the low confident bothers me a lot! I'm not sure of how to deal with it, may be make more challenging (for confident ones) its last year experiences, so that they are related to real world engineering projects
Student advisor or support services staff	A	Actively reaching out to undeclared students to discuss opportunities in Engineering. (Curriculum, career path, and Reframing engineering field to make it more attractive, so that students can envision themselves in the majors/programs. (e.g., problem solving for humanity) Helping engineering students see/understand value of Foreign/language and explicitly showing pathways to specific EAP experiences, service learning in a community.
	B	Encourage diverse teams of students to work together and maximize positive aspect of differing perspectives
Educator	B	Modify pedagogical approach. Possibly group students to facilitate end use these differences to an advantage
	C	Note this while teaching. Realize that students plans change and that students go into engineering
	A	Make course more receptive for non-engineers
Educator	B	Be more attentive to specialization that is likely taking place among women and men in engineering design teams. (Will we accept lesser project outcomes to gain more equity in student learning outcomes & development?) Have conversations w/ faculty about indiv. vs team learning & outcomes

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	A & C	Integrating personal & social development across the 4-year curriculum (inc. professional & interpersonal skills).
Educator/faculty developer	A	Curriculum/course design for diverse background Fac. dev for Engr faculty to teach differently & engage students Have
	B	Again creative course design & faculty development
	C	Workshops for students about how to be successful in diverse job searches & career pathways Exposure to how to use their engr. education is other areas An engineering graduate going and another field is <u>not</u> a failure – it is enriching these fields
educator	B	Motivation patterns stay same from 1st to 4th (page 6 of report) This says that students don't see their coursework as engineering. Extrinsic motivators tend to drive out intrinsic motivators. (see Deci, Koest, & Ryan, Review of Ed Res V71(1) pp 1-27). Though students tend to be highly extrinsically motivated (for grades), it appears that those reaching senior status have "compartmentalized" their views of coursework & engineering. The coursework is NOT "doing engineering" (?). Or they may have internalized the goals of the courses. This is an interesting area to explore, especially if we consider & measure the motivation of these who left, (low intrinsic). Maybe many students leave because of high extrinsic motivators in courses. Also, in less extrinsically motivated programs does the motivation pattern stay the same? Implication – Explore reducing ext. motive systemically
	A	Need to educate jr high & high school on the role of engineers in modern society. Let them know they can be engineers. Present role models they can relate to.
	B	Expose design early and often. Use teamwork design. Everybody reports on design presentations Most male students have worked before going to college, which give experience seeing how things go together (construction, etc.) Also develop self-confidence and team work & leadership. Most women have not worked in groups before college entrance.
	C	Why not make big money instead of staying in engineering?
Educator, researcher	B	I am a new faculty in a brand new eng. Program (JMU) with a focus on design & sustainability. I am curious to see what things to focus on in our 10 credit design sequence. Gender differences are very important in the development & implementation of our design sequence.
Educator	B	Women may need role models to break old perceptions. Design typically requires some exposure to practical activities and not sure if women are encouraged to participate based on the environment in which they brought up.
	C	In my opinion it is good they seek employment in non-engineering is credit to engr. programs for the confidence instituted in them

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	A	Motivate students from young age to pursue engr. by providing role models and engaging them in activities.
Educator, dept head or dean	B	Examine student team roles and process to discern whether these shape students' perspectives on engineering design.
	C	Develop program/curricular change to develop self-confidence in engineering work
Dept head or dean	A	-provide minors in engineering which may lead students to complete a major -reduce credit hours to allow for more flexibility -cross-disciplinary courses with non-engr majors (art, psychology, business) -important for high school students to understand engr professions so they make informed choices -Intro to engr courses satisfies gen science requirement
	C	-more coop/internships ops, even starting freshman year require an internship experience for the degree
Student advisor or support services staff	A	We need to emphasize to students that engineering needs good communicators
	B	Many freshman & capstone design projects focus on building something which automatically creates a bias
Department head or dean	A	-create a general engineering degree w/ elective options -> students don't have to "go backwards" to become engineer ? Do we want competition between colleges to pull in students from each other
Student advisor or support services staff	A	Encourage students from non-engineering to consider in-migration to engineering…
	B	OK for men and women to be different and to stay in engineering. OK to become better without becoming excellent.
	C	Encourage confidence & consider non-engr roles The strengths and weaknesses suggest that we want to appeal to a different personality type(s) than traditionally go into engineering.
Industry	A	Would prefer to increase # of students starting in eng rather than in-migration. Don't want to see time to degree increase. Like the strengths & not too bothered by the weaknesses
	B	Women are on the right track
	C	Want students with more confidence. It's a poor reflection on industry that we may be the safe choice
Educator	A	-need more pathways for inward migration: - More faculty-student interaction to help students understand the difference in eng. majors - Great a more friendly process for students to transfer from one major to another within Engineering - Allow students to explore major in eng. in systematic way (seminar course, rotation, …)

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	C	-low confidence in prof & interpersonal skills - Improve the confidence level through coop/internship experience
Department head or dean	A	It is important to separate undecided students into potential STEM students vs. humanities & social sciences. The common advice to take gen ed. does not work for engr.
Department head or dean	A	-challenges the one-semester per year (limited) course offerings and the rigid first two year curriculum -challenges the system of applying to eng. as part of college admission, rather than giving students more time to decide These implications affect curricular changes for all eng. departments
	C	For engineer grad school, there is the negative press that the finding regarding confidence in prof & interpersonal skills
Industry	A	How can industry internships for first year students be structured to encourage non-engineering students to consider engineering careers
	C, B	Encourage students to use interpersonal/teamwork skills, demonstrate need/value of these skills for engineering jobs
Industry	A	-Community outreach to peak interest -Make need for engineers apparent -Market your company as "cool" -Industry is where the $ is -> they need to continue to support innovative programs with universities -Mentor programs. "Real engineer" can mentor K-12 student.
Educator	A	Inward migration – more relevant courses with improved contemporary pedagogy week. Team based activities, promote study abroad, research for undergrads promote community service, service overseas to needy countries, Engineers without Boarders
Department head or dean	A	I need to look @ curriculum/various iterations. ->Must be more active during orientation sessions ->courses must have contemporary relevance -find overseas sister school where transfer credits are guaranteed – process made more user friendly - Must have advisors to willingly assist in study abroad experiences - Must have support staff help w/ -outreach, designing indep. Study
Educator	B	1st year to 4th year and gender differences are very interesting and this, impacts curricular decisions. 1. These findings can be used to scaffold first-year engr students' design & problem solving skills 2. These findings also have implications on "collaborative teamwork" because gender differences are evident (they are similar to your findings when students work in teams)
	C	I can encourage my students to pursue co-op opportunities

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	A	Be an effective teacher / good curriculum. Students can recruit other students. – make field change (into engr.) easier? (administrative)
Educator	C	If confidence in interpersonal skills is negatively correlated w/ both EGR job & grad school, how much is that forward feedback loop? People with low confidence go to grad school & become engr. faculty who have low confidence & hence low ability to help students' confidence. Those students become engr & faculty, etc. Do engineers really constitute the ideal pool of future faculty?
educator	A	Need to run outreach activities for primary and secondary schools, teachers, also students in first year at some tertiary institutions. [Our freshman year is 100% engineering].
	B	Appoint women Teaching Assistants. Promote women-in-engineering activities. Choose design activities that are known to be relevant to women in particular. Also: focus on real-world application, creativity.
	C	Require students to undergo work experience activities
All	C (blended into A)	This finding has implications for all parties involved in the process. I'm having difficulty squaring this finding with that found it part A. If retention is not the issue, then Finding C really shouldn't concern us. But Finding C presents at least in my mind, a failure of retention. Why do these students choose different paths? Why did they leaving engineering? I will need to further explore the upcoming report concerning retention specifically. I understand that is an extremely large study with much data, so presenting this in such a short time may be problematic.
Other	C	The findings on "predictors of plans to continue in engineering include low confidence in professional and interpersonal skills" is a little discouraging and at the same time extremely interesting. I'd like to know more evidence this finding. Cultural differences?
Educator	A, B, C	We as educators must change the perception of engineering not only in our classroom but in K-12 outreach. Provide easy articulation agreements from other departments or community colleges. Career potential
Educator	A	Low integrative and learning practices can be addressed by curriculum changes w/in courses and between courses with relatively low cost. Needs to be done early and consistently throughout program.
	B	Rubrics and team structure need to be constructed with different approaches by gender. Is there a possible synergy with diverse teams? What are best practices to promote and avoid conflict?
	C	Confidence & interpersonal skills -> reflective of curriculum?
Educator	C	C is not really a problem

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	B	I am more concerned about how women's design experience in classes is being experienced. What is happening that leads to these and other differences
	A	I agree. But this is a challenge for places like PSU where a majority of students don't have math & science skills to get into or move into engineering
		-22% who report study abroad looks much too high compared to other data I have seen. -It was hard for me to interpret the (+) (-) 0 table without any indication of how much variance the variable accounts for. Is the effect big or small? -retention is not the only? issue
Educator	A	-more flexible programs, courses (more) including design activities (at different levels). -other forms of getting credits for study abroad, internships
Educator	A	Need to look at my program to see if there are things that could help w/ inward migration (i.e. could we design an "Engineering for Everyone" type of course in year 1; could we do a summer bridge prog. After the 1st year for students who may have prereq. Deficiencies but who want to enter engr)
	B	I should ask myself if I overemphasize or overvalue some design aspects based on my gender
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Gov't	A	If > 70% rate is true, there is an enormous implication for government funding
	B	Surprising – no wonder fewer women in ME and EE
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Department head or dean	A	1. Need to decrease content in the curriculum, e.g. more emphasis on skill development, so it's possible to transfer in without starting from scratch and having to complete 100+ credit hours to graduate 2. Need more focus on pedagogy that promotes skill development (which chalk & talk doesn't) 3. Need to incentivize faculty to do (2) & reward those who do it well. 4. An exciting 1st year engr. course is a good step, but the excitement & social relevance needs to be maintained for the next four years.