The 2008 Workshop on the First Year in Engineering

At the University of Illinois at Urbana-Champaign
Sponsored by the Undergraduate Programs Office of the College of Engineering,
Illinois Foundry for Innovation in Engineering Education (iFoundry),
and the Academy for Excellence in Engineering Education (AE^3)

On September 25, 2008, the Workshop on the First Year in Engineering (WFYE) was held at the University of Illinois at Urbana-Champaign, from 8:30-2:30 p.m. Close to 80 faculty members, staff, and students, from within the College of Engineering and across campus, participated in the day's events. The Undergraduate Programs Office of the College of Engineering, Illinois Foundry for Innovation in Engineering Education (iFoundry), and the Academy for Excellence in Engineering Education (AE^3) collaborated on this event, which aimed both to stimulate discussion on the first year in engineering among faculty, staff, and students at Illinois and to create actionable items for moving forward on this process at Illinois. The WFYE 2008 report summarizes the day's keynote addresses, along with the discussions and the top two recommendations (key ideas) from each of the six topical sessions in the afternoon. Like the event itself, the report aims to encourage continued discussion and feedback among all participants in this workshop as well as colleagues and friends engaged in engineering education reform across the country. Email contact information, links, and references are attached to help facilitate this ongoing dialogue.

Dean Ilesanmi Adesida welcomed all attendees to the event. Civil Engineering Associate Head and Professor David Lange introduced WFYE's keynote speakers, Stephen Carr, associate dean for Undergraduate Engineering at Robert R. McCormick School of Engineering and Applied Science, Northwestern University, and Brian Storey, associate professor of Mechanical Engineering at Franklin W. Olin College of Engineering.

Professor Carr's presentation, *Growing into Thinking as An Engineer: Two Courses for Freshmen at Northwestern University,* (accessible at http://www.ifoundry.illinois.edu/index.php?s=Dr.+Stephen+Carr), focused on two specific freshmen year courses, developed at Northwestern, which aim to cultivate the habits of mind engineers need in the 21st century. These are Engineering Analysis I and II, and Engineering Design and Communications.

Professor Storey's presentation, *The Origin and Evolution of Olin College's First Year Engineering Curriculum,* (accessible at http://video.google.com/videoplay?docid=5832491889600206336&hl=en), discussed the evolution of project-based, design-oriented learning at this small, innovative undergraduate institution. Olin College is a formal partner of Illinois in engineering education reform. Professor Storey shared the lessons learned by Olin faculty as they created interdisciplinary courses and design-nature courses for freshmen over a several-year period.

After the speakers concluded and addressed audience questions, session leaders gave brief overviews of the afternoon breakout groups: the Student Experience Beyond the Classroom; Recruitment and Retention; Engineering Design; Advising in the First Year; Humanities and Social Sciences; and Math and Science. Leaders were drawn from College of Engineering faculty and from the academic professional staff of the College of Engineering's Undergraduate Programs Office, led by Associate Dean Charles Tucker. All WFYE participants reassembled after these topical discussions to review the top recommendations for enhancing the first year in engineering at Illinois.

For further information, questions about the workshop, or suggestions for WFYE 2009, please contact Karen Hyman, associate director, iFoundry, at kkhyman@illinois.edu or 217-244-3824.

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Workshop on the First Year 2008 Leadership

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The Student Experience Beyond the Classroom

Moderators: Kay Kappes, Undergraduate Programs, and Leslie Crowley Srajek, **AE^3**

Key Ideas

- Expand mentoring and peer advising in the College of Engineering.
- Provide more information about each engineering major early in the first year, and explore the possibility of an "undeclared" engineering major.

Discussion

Three students and five faculty or staff members participated in this breakout session. Discussion focused on several different aspects of the "student experience." Each of the students also described their experiences in student organizations.

While our conversation touched on several different topics, the two main points we chose to present were:

- The students' wish to see expanded mentoring and peer advising in the COE.
- The students' support for more information about each engineering major early in the first year, and possibly an "undeclared" engineering major.

We started the session by asking the students this question: If there were two things they wished that more faculty members knew, what would they be? One student described an experience in a class where the professor came into the labs when she knew her students were working on problems, and was there to help them. He said that this support and her availability made a big difference for him. Another student said that this was also true in terms of electronic communication—a prompt response from a professor to emails was a sign of the professor's availability and interest.

The students observed that students and faculty are two "fundamentally different" groups in terms of when they do their work, whether they are "transient" (students) or permanent (faculty), beginners or experts, etc.

A staff member brought up the question of advising, and whether students went to their advisors with questions about their careers. The students said they did not, and overall felt that the quality of faculty advising was fairly low. They said that advisors often seemed disinterested in advising, that they weren't in the research area the student was interested in, and that, in general, they were not particularly useful.

A student brought up the notion of the 10/80/10 rule—that there were always 10% of students who were doing very well academically and are very involved in extracurricular

activities, 80% going along doing fine but involved in very little beyond their coursework, and 10% who are struggling academically. A staff member asked if the "system" was set up in a way to encourage student initiative and the students said "no." Someone asked what kept the 80% from moving up, and the students listed the following barriers: the course load, time constraints, and perhaps not enough motivation/initiative.

Students said that it was important for younger students to learn to take initiative in contacting professors for research opportunities, and in joining student organizations. They pointed out a key difference between high school and college: in high school, students are always accountable to someone; in college students must be self-motivated.

Students said that freshmen don't really know the importance of extracurricular activities. This is learned through job interviews (i.e. interviewers asking what else students are involved in), friends, and Engineering 100 (to some extent), but the importance of these activities is hard to take in early on. One student said that his organization was working hard to build collegiality to encourage participation and that this seemed to be working.

The ECE department currently has activities like Freshmen Fest, Freshmen Fusion, and an Information Fair for its first-year students. Someone asked whether other departments did something similar, and if not, should they?

ECE also has a mentor program, and CS has an informal peer advising/mentoring system.

A faculty member asked about the role of parents in first-year students' lives, and students said that it seemed like some students, often international, were pushed to become engineers by their families. Also, they observed that schools were chosen based on rankings because of the desire for a prestigious degree.

Someone asked how much incoming students knew about organizations, and the FreshStart web board was mentioned. Students said that it worked mostly in the case of international students who had questions about visas and other issues that the students did not know how to answer.

Recruitment and Retention Breakout Group Report

Moderator: Susan M. Larson, Undergraduate Programs, Women in Engineering Program

Key Ideas

Our suggestions can be focused into three main areas: Education, Policy, and Programs. Our two key ideas are:

- A reformed curriculum can be crucial in recruitment and retention of students.
- While recruitment and retention programs can be extremely beneficial, changes in policy have the potential for great impact.

Discussion

Education

The first-year student experience can be crafted both to recruit and retain students by maintaining and building excitement about engineering within the curriculum. Our current first-year curriculum is heavily populated with "weed out" courses that do not easily allow students to gain hands-on engineering experience. Ideally, classes should have a strong relationship to real life and to each other. In addition to design and project classes, undergraduate students should have sufficient exposure to research and opportunities to participate in research. Technical research is a particular strength of Engineering at Illinois and should be included in the education of our undergraduates.

Within our current courses, we should evaluate the student experience beyond information gathered in the traditional ICES surveys. One area of strong concern is TA quality. There should be improved TA training, a continuing instruction and monitoring of TAs, and an effective mentoring program for TAs. Faculty and instructor teaching should be improved and should include training in unconscious bias. A teaching faculty would be a valuable resource for the college, as would be the development of a knowledge center for engineering education. We should recognize that many students take more than four years to complete our curriculum, and we should offer clear examples of course sequences along that path. This could show how students can complete an engineering curriculum even if they begin with lower level-math, physics, and chemistry courses, study abroad, or complete a double major.

We should be willing to develop in new areas—consider new, multidisciplinary majors, ways for our students to develop global credentials, and ways to demonstrate how engineering makes real contributions to society.

Policies

Students can be discouraged by many college and university policies and procedures, small and large. Policies and procedures should be reviewed and their impact on student retention assessed.

Some policies, if changed, could enhance retention and recruitment, for example:

- Keep tuition at the same level for five, not four, years.
- Add an undecided engineering category on the freshman application.
- Expand departments rather than capping enrollment.
- Assess in-state tuition (or tuition close to in-state levels) for underrepresented students from out of state.
- Hire a college recruiter to work with the Office of Admissions and Records.
- Hire a diverse faculty.
- Spread out midterms.
- Develop physics exams with partial credit, not multiple choice.
- The first grade in repeated classes shouldn't count in the Technical GPA.
- Implement block scheduling.

Programs

The Women in Engineering Program and the Morrill Engineering Program offer support for underrepresented students. These efforts can be expanded, as can support programs for all students. Some programs that should be considered include:

- Undergraduate research opportunities from the summer before freshman year to senior year.
- On-line resources, e.g., a monitored, supported portal for tutoring, study groups.
- Mentoring and improved advising.
- Increased support at the department level.
- Advisor training.
- Service learning and engagement.

Engineering Design Breakout Session

Moderator: Victoria Coverstone, Graduate and Professional Programs

Key Ideas

Big Idea #1 —Offer Engineering 198 with following characteristics:

- Focus on needs and themes to build a story.
    - societal needs—civic engagements
    - engineers want to make the world a better place; this is why students go into engineering
    - civic and societal themes help to attract women and minorities to engineering
    - civic and societal themes help create general excitement amongst students
- Students should come from all parts of campus—make effort to reach south of Green. Arts and Design can bring a lot to the table.
- All students must receive credit.
- Determine common requirements—computer-aided design.
- A course must count toward degree requirements to be sustainable—become part of curriculum.

Big Idea #2—Scalability—need to shift to an active learning model:

- User-centered theme—students find own problems. This also takes burden off of faculty to identify a hundred-plus problems.
- Utilize peers—students who have taken the course.
- Perhaps consider a graduate student requirement of mentoring.
- Early exposure to research is connected with user-centered design—students learn to ask questions.

Discussion

In introducing the Engineering Design session, moderator Victoria Coverstone noted that the objective of engineering design courses is to provide a positive and creative design experience in the first year. A few key questions should be considered in creating such an experience:

- What student abilities do we want to exercise in the engineering design experience?
- What are the desirable engineering traits we wish to see as outcomes?
- What are our current best practices?
- What can we learn from other engineering colleges?
- What are the challenges—e.g., limited knowledge areas—to overcome?

In considering Engineering Design improvements, the group will also look at how entrepreneurial qualities can be developed via these courses, and how service learning

can be incorporated as well.

Participants:
Emad Jassim, MechSE
David Weightman, SA&D
Mike Philpott, MechSE
Brian Storey, Olin College
Jillian Roettiger, MechSE
Jim Leake, IESE
Geoffrey Herman, ECE
Harrison Kim. IESE
Lis Hsiao-Wecksler, MechSE
David Lange, CEE

Advising in the First Year Breakout Session

Moderator: Umberto Ravaioli, Undergraduate Programs

Key Ideas

- Substantial reward needs to be put in place to achieve good advising.
- Training opportunities need to be developed for advisors, including students involved with peer advising activities.

Discussion

One faculty member noted that students often complain about faculty advising. This is due to the fact that faculty aptitude and interest for advising varies widely among individuals. In MatSE, for instance, not all faculty are selected as student advisors, based on advising abilities, and some trade off is made between teaching load and advising load. Still, good advising is not sufficiently rewarded to make it appealing. While peer-to-peer advising is useful, it is usually not ranked highly by students, probably because it may not be formally organized in many instances and quality of advice is very uneven.

Professor Stephen Carr noted that at Northwestern there is an Advisor of the Year Award to provide some reward.

General discussion—The role of the faculty advisor should be to help with career plans and to inspire. There is the need for more quality time with faculty advisors. Time is needed to establish the faculty–student relationship. The nitty-gritty of course selection and other rules may be left to department chief advisors and the college advising office.

Recommendation 1—Substantial reward needs to be put in place to achieve good advising. For implementation, a critical element is to put in place an evaluation plan. Not all faculty members may be suitable or effective as advisors, although lack of reward may have to do with lack of interest. Adjustment of load should be a useful tool in part to reward and motivate. Faculty advisors do not have full access to the student record (DARS, for instance). Expanding access would be useful, provided there are safeguards for confidentiality of information.

General discussion—Advising model must be reconsidered. Professional advisors may be more suitable to deal with the nuts and bolts of curriculum. Experience and training are important to recognize special student needs/problems. For incoming freshmen, a particular question is: How can summer advising be improved? Already, progress has been made in improving the registration process but there are logistic challenges to doing more. Even so, it is important to keep following up. ENG 100 may be a good vehicle to improve information flow to students throughout first semester. Research experience may be a good way to improve the freshmen experience where appropriate, but

information has to be appropriately provided.

Professor Carr noted that at Northwestern there are two-hour-long sessions to train faculty in advising. The focus is on how to get points across besides mere information. They collected information on questions from faculty over a period of time.

General discussion—DARS is a powerful tool for students, there should be training sessions on DARS and computer systems in general, perhaps in ENG 100. U. Ravaioli had proposed DARS online training sessions to help new students, including transfer students. Campus may be working on this. Peer advising has potential, but many students may not know requirements well. Getting good advice from peers may be a random process. Student organizations may be a good vehicle to corral efforts since they are, in general, interested. Team intervention may be useful to optimize advising.

Recommendation 1—Training opportunities need to be developed for advisors, including students involved with peer advising activities.

Participants:
Suhail Barot, ECE, Illinois (Graduate Student)
Stephen Carr, Northwestern University
Michael Loui, ECE, Illinois
Manssour Moeinzadeh, IESE, Illinois
Umberto Ravaioli, Engineering and ECE, Illinois
Angus Rockett, MatSE, Illinois

Humanities and Social Sciences in the First Year in Engineering

Moderator: Ray Price, Industrial and Enterprise Systems Engineering

Key Ideas

- The aim of the General Education requirements is to build critical thinking skills and habits of mind. These intellectual skills ultimately aim to cultivate engineers who are able to build things for other people. Basic methods to concentrate on over the next year include:
  - Develop a list of courses that build habits of mind necessary and valuable for engineers.
  - Adapt, modify, and build the list with new and modified courses.
  - Recommend a start for Fall 2009 with core recommendations that will build enthusiasm amongst the students.
  - Over time—Fall 2010 and beyond—craft guidelines that focus on themes within humanities and social science, but still give choice and flexibility to students.

- Efforts to group courses across multiple disciplines into coherent HSS themes for engineering students are ongoing and will contribute to enriching the first-year in engineering improvements. (See discussion for list.)

Discussion

The breakout session focused on how the college should use the Humanities and Social Science credit hours to educate engineers for leadership roles in business and society. To answer this question, the group employed two strategies: focus on already extant courses and experiences that could fulfill these requirements now, and focus on how courses and credits can be grouped together to create a richer engineering education, especially with an eye toward a Fall 2009 "iFoundry class." Moderator Ray Price noted in preliminary remarks that a richer engineering education meant cultivating engineers who were true "change agents," skillful in problem-solving and communicating.

Keeping in mind the need to create a few "take-away" points, we concentrated on the means and the ultimate aims of the Humanities and Social Science requirements. We created a list of all possibilities in multiple disciplines that could fulfill the 18-hour requirement. That general list is attached. After examining the considerable breadth of courses that could fulfill these requirements, we focused on the following question: "What are the ultimate aims of the general education requirements?"

The group agreed on the following formulation: *The aim of these General Education requirements is to build critical thinking skills and habits of mind. These intellectual skills ultimately aim to cultivate engineers who are able to build things for other people.* The group discussed the importance of thinking broadly about how humanities and social

sciences help educate engineers for the 21st century by bringing their skills, capabilities, and intellect in line with a much-changed, and rapidly changing world. Humanities and Social Sciences contribute to intellectual development of students by helping them ask the right questions, categorize, and understand how things work.

It was stressed that engineering education should endeavor to create engineers who are true change agents and citizens of the world, and that we should think more concretely about the thinking skills we are trying to cultivate, rather than just deploying HSS requirements as "breadth for the sake of breadth." In this regard, a liberal arts education is key to developing the critical questioning, thinking, and categorizing intellectual skills in our students.

Most importantly, we think that our size is our strength in this regard: We should be able to bring to bear the breadth and diversity of the University of Illinois at Urbana-Champaign to enrich the thinking skills and habits of mind of engineering students. Our strength as a university feeds into this process. Current efforts to group courses across multiple disciplines into coherent HSS themes for engineering students are ongoing and will contribute to enriching the first-year in engineering improvements.

Once we reached some consensus on the goals of the humanities and social sciences requirements, we were able to articulate some basic methods to concentrate on over the next year:

- Develop a list of courses that build habits of mind necessary and valuable for engineers.
- Adapt, modify, and build the list with new and modified courses.
- Recommend a start for Fall 2009 with core recommendations that will build enthusiasm amongst the students.
- Over time—Fall 2010 and beyond—craft guidelines that focus on themes within humanities and social science, but still give choice and flexibility to students.

Humanities and Social Sciences Areas and Courses to Consider for First-Year Students:

- GE 361: Interpersonal Skills and Engineering
- ECE class in ethics
- Bruce Litchfield class on creativity
- TEC business plan classes
- GE 161: Introduction to Entrepreneurism
- Organizational behavior courses
- Human resource organization
- Cognitive psychology
- Industrial psychology
- Engineering psychology and human performance
- Philosophy courses—introductory courses that would help students think, make arguments, (Plato 101, Socrates 101)

- Applied health sciences—kinesiology
- History of technology (Lillian Hoddeson and Ray Fouche)
- Journalism and communications—business technical writing; digital literacy; courses on narrative and storytelling
- Significance of social networking to communications—look at CS, HCI

Math and Science in the First Year

Moderator: Doug Beck, Department of Physics

Key Ideas

- Develop a multidisciplinary TA area for first-year students—a common room with graduate students in math, physics, and chemistry to assist and provide a first-class mentoring experience.

- Scrutinize the weakest links in the math sequences, viz., Math 241 and Math 285.

Discussion

Doug Beck notes that the Executive Committee of the College of Engineering did a rapid review of undergraduate programs in 2007, and examined closely the freshman class for AY '05. A relevant statistic is that approximately 300 out of 1250 entering students drop engineering or transfer out of engineering in the first two years. Of these, 45% drop in the first year. No information was given on what percentage of the 300 exit the University of Illinois system entirely.

It was noted that math and science courses are among the most difficult in the university, but that efforts are under way to undertake changes in the math course by encouraging more math/LAS and COE collaborations and more group problem-solving work amongst students. In particular, efforts have been made to port these changes to the first-year calculus courses.

Some of the relevant issues and questions to address are the differences in learning between high school and university, with standardized tests perhaps overemphasized in high schools at the expense of actual learning. Key questions to consider include the following:

- Can our students use what we teach them?
- What do we really expect them to remember? What is the take-away knowledge?
- Are we teaching with the take-away knowledge aims in mind?
- Are we testing with the take-away knowledge aims in mind?
- What is the role of repetition in the math-science sequences?
- Is the level of sophistication rising quickly enough—i.e., are we cultivating students who can do analysis at high levels and think through problems?

Special attention needs to be given to educating students effectively in the use of English. Thinking and communication are inextricably bound. Math-science education needs to focus on educating students to clearly articulate, in English—with attention to formalities of grammar, word choice, and style—mathematical ideas and problem-solving.

Recommendations:

The Math and Science in the First Year session divided the issue, and proposed solutions, into two pieces:

- Math-Chemistry-Physics are regarded as the "weed out, killer" courses. What can we do to alter this phenomenon?
- What should we do to help our students become better as they progress through their undergraduate program?

The top idea to address changing the culture of the early "weed-out" courses was to develop a multidisciplinary TA area for first-year students—a common room with graduate students in math, physics, and chemistry to assist and provide a first-class mentoring experience. This not only aids first-year students significantly, but it also has the salutary benefit of helping train our graduate students who are interested in becoming faculty members in math, science, and engineering education.

The top idea to address educating students "down the line" is to scrutinize the weakest links in the math sequences, viz., Math 241 and Math 285. Reducing the material covered in those courses will help students deal with "cognitive load" problems and enable us as educators to teach these materials for transference—i.e., to teach math, physics, and chemistry as they will relate to students' future careers in engineering.

Additional specific methods that would serve this goal would be to emphasize the use of multimedia and physical examples in the classroom; to stress "learning by doing;" to emphasize getting students to understand material rather than marching through large amounts of content for the sake of content.

Links for Further Information

iFoundry: http://ifoundry.uiuc.edu
YouTube: www.youtube.com/illinoisfoundry
SlideShare: www.slideshare.net/ifoundry
Eng & Tech Studies: http://www-illigal.ge.uiuc.edu/ETSI
Phil & Eng: http://www-illigal.ge.edu/wpe
Blog: www.entrepreneurialengineer.blogspot.com