Changes in Perceived Learning Assessed in Stages from Mid-stream Academic through Professional Careers

Anita M. Todd, Kimberly A. Barron and Robert N. Pangborn
College of Engineering, Penn State University

Abstract

This paper describes the implementation and initial findings of a new web-based senior exit survey in the College of Engineering at Penn State. The electronic format includes an adaptive feature that accounts for the student's major, and presents the respondent with both a core content and a department-specific component that together meet multiple assessment interests and objectives in the College. It also eliminates the need for respondent entry of information that can be generated automatically by linking to the University's student information system. The approach avoids redundant efforts to acquire students' feedback on their academic experience and provides a consistent set of data with which to compare students in different majors or associated with different programs or activities. When combined with the results from evaluations completed by students participating in the Engineering Cooperative Education Program and from a survey sent to alumni two to three years after earning their degrees, the perspectives on key educational outcomes can now be compared and tracked for various stages in students' academic and early professional careers. Selected comparisons, as well as the potential influence of the co-op or post-graduation experiences on student perceptions of learning and preparedness are given.

I. Origins of the Student Assessment Program

The College of Engineering at Penn State has been querying students and graduates for many years on their perceptions of their undergraduate and early work experiences and future plans. The survey instruments and approaches used to gather this information have varied depending on the particular department and time in which a student or graduate is asked for feedback. For instance, students participating in the College's Cooperative Education Program complete a survey after each work period. The departments have traditionally conducted their own exit interviews of graduating seniors to solicit input on their experiences in the majors. Several years ago, a more formal "Commencement" survey was developed to get more uniform information on students' post-graduation plans, administered as they arrived for the graduation ceremonies. Surveys of recent alumni have also been carried out for over fifteen years to provide information, in retrospect, from former students on impressions of their education and to track their early post-graduate education, professional development and work activities.

Recently, however, the College has moved to develop a more comprehensive and systematic approach to acquiring this information. The reasons for this initiative are many: While the department-specific processes are effective, they do not provide the consistent data that allow effective comparison among students in the different majors. Because there was often little overlap among the various instruments administered at different times, or the information was collected in very different formats, the changes in the perceptions of students or graduates on the

same issues at various stages of their educational or professional careers could not be effectively tracked. On the other hand, students were frequently being asked many of the same kinds of questions, or confronted with multiple and similar surveys at almost the same time, by a department, college or other program seeking their input. The new expectations regarding formative assessment for engineering program accreditation also served as a driver for a change in approach. It simply made sense to reformulate the surveys so that measures would result that could be used to effect change. The challenge was to design the new instruments so that the value of longitudinal comparison to the results of previous surveys was not lost, while introducing the new content in a way that would not make for a time-consuming and ultimately off-putting format.

II. Survey Design and Implementation

The most likely candidate for piloting a new strategy was the survey administered to seniors as they completed their undergraduate programs and prepared for post-graduate studies or jobs. Departments were interested in students' perspectives of particular courses and faculty, the facilities and services provided, and other manifestations of the experience in the major. The College was interested in aspects of their broader educational experience, including the general education curriculum, their participation in student organizations or co-curricular activities, their success in landing jobs or gaining admission to graduate school, the numbers of job interviews students had, what the salary offers were, and other information. Both the departments and programs were interested in the perceptions of students relative to the eleven educational outcomes specified in the general criteria of the Accreditation Board for Engineering and Technology[1] and in gaining insight as to the curricular elements or experiences students equate to their preparation in these areas.

The new Senior Exit survey designed and implemented in the past year strives to satisfy these varied interests while avoiding some of the inconsistencies and redundancies discussed above. First, the survey was developed with input from all the departments and other interested parties, so that agreement was reached on the most important core content. Second, the decision was made to go with an entirely web-based instrument. This provided another advantage – an adaptive feature that permitted part of the survey to be tailored to each particular program. When a respondent was directed to and accessed the survey site, the log-on procedure allowed that the student would see the common core and a section designed specifically by and for that major. Finally, since the system "recognized" the particular respondent, an automatic link to the student information database was established. The respondent therefore did not have to enter information such as major, GPA, gender, ethnicity, the particular Penn State campus at which the student started his or her studies, or other information that is useful in analyzing the results for different factors or groups of students.

The content of the exit survey is now aligned well with the surveys administered at other stages: the Co-op Program evaluations and the alumni survey. The former is completed by students at the conclusion of each work rotation -- semesters or summer terms spent working at a company or company, normally interspersed with semesters of study. Co-op students register for at least one credit under the course designation ENGR 295, 395 or 495 for each successive work rotation. The evaluation probes the students' satisfaction with the program and the employer and

the extent to which the co-op experience contributed to various outcomes of the Penn State education, and vice versa (how much the students' education contributed to their preparedness for the co-op tasks). The latter, alumni survey, is conducted every other summer. The surveys are sent to graduates who earned their degrees two or three years prior. In addition to soliciting their views on their education, the survey asks respondents to provide information on the kinds of things they are currently doing, have done or plan to do (including further education and professional development, participation in professional societies, etc.).

The response rate for the co-op evaluation is virtually 100%, since submitting the evaluation is required for the 200 to 400 students who participate annually in each of the three co-op rotations. The web-based senior exit survey has a response rate of almost 60%, such that 410 students completed the survey prior to graduation in Spring 2001, for example. The alumni survey has a response rate of about 20%, with about 350 to 400 respondents for two class years (the survey conducted in summer 2000 was for '97 and '98 graduating classes). Typically about one-third of respondents to the senior exit and alumni surveys are students who participated in the Co-op Program.

III. Analysis and Preliminary Results

It is important to emphasize at the outset that the surveys described in this paper constitute only one part of the overall assessment effort in the College. Although it represents important and useful feedback, much of the information obtained from surveys reflects the perceptions of the respondents, rather than direct measures of educational outcomes. Therefore, a wide variety of assessment practices and new initiatives are underway in the departments and programs that involve evaluation of student work and competencies. The program faculty have, in most cases, recruited external (industry) representatives to partner with them in evaluating students' progress and abilities in various knowledge and skill areas. The College has also engaged in a multi-year study of students' intellectual development, including their ability to engage in critical thinking, understand the dimensions of complex and open-ended technical issues, and recognize other aspects of higher-level problem solving. This initiative, coordinated by the Leonhard Center for Enhancement of Engineering Education and Engineering Instructional Services, has been reported at previous ASEE conferences.[2] A new, similarly structured study, will probe students' progressive development of engineering expertise.

The results reported here are focused mainly on the influence that exposure to the engineering workplace has on students' and graduates perceptions of their education, and specifically on the well-known Criterion 2 program outcomes, a-k. Although not reported in this paper, it should be noted that the alumni survey results provide good evidence of what students can do through their self-reporting of the kinds of tasks and responsibilities in which they are primarily engaged on the job. Both the senior exit and alumni surveys also provide a wealth of information on graduates' career paths and professional development following graduation.

Figure 1 illustrates co-op participants' evaluation of their academic preparation for their co-op assignments and the role of the co-op in enhancing their education. In general, their ratings of the educational preparation they received at Penn State in various areas averages 3.5 or higher, with the highest rankings given to their foundation preparation for applying mathematics and

science and their ability to conduct and analyze experiments, work in teams and solve problems. The contribution of the cooperative education experience to their overall educational experience is uniformly high, with the most significant contributions, relative to their academic studies, coming in the areas of understanding professional and ethical responsibilities, engaging in effective interpersonal communication and their knowledge of contemporary issues. They perceive their academic preparation in some of the less technical, professional areas, and their understanding of the impact of engineering solutions in a global and societal context, as least effective among the various outcomes, but credit their experiences in co-op jobs with enhancing these broader perspectives.

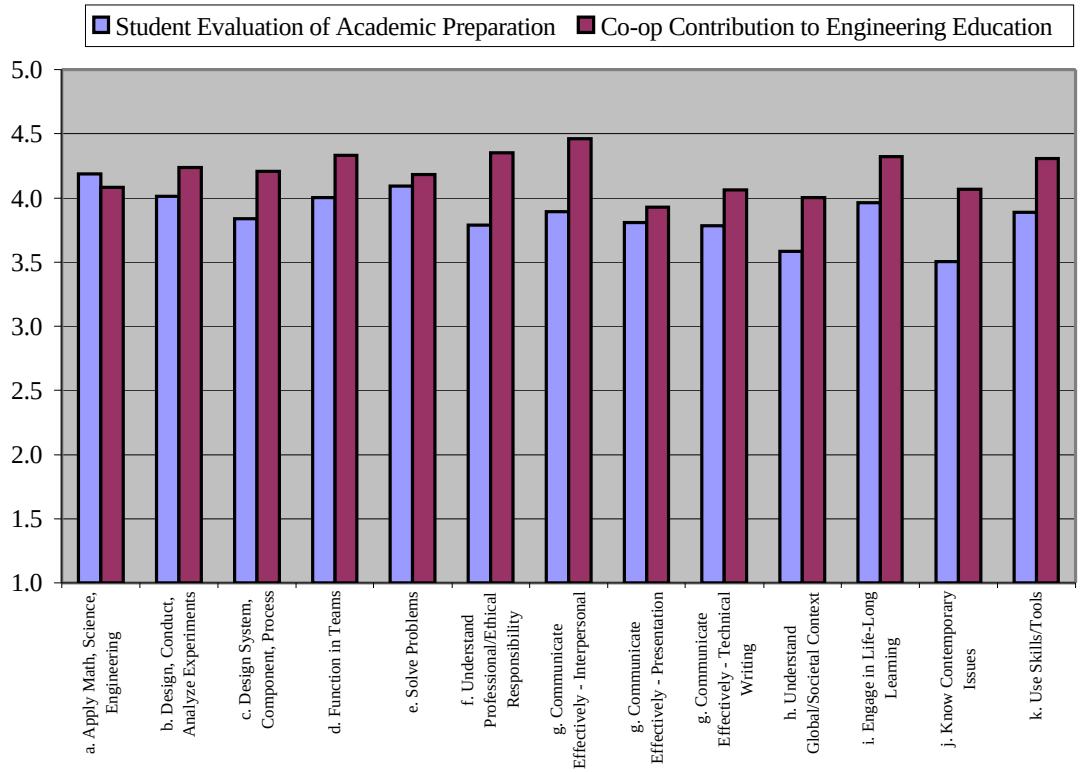

Figure 1. Rankings by co-op participants of the academic preparation for their work assignments and the contribution of the co-op experience to their overall engineering education.

Figure 2 shows how the co-op students view the contributions of the co-op experiences to their education during each successive work rotation, registering sequentially for ENGR 295, 395 or 495 for the first, second and third work periods. In almost every case, students report an increasing value of the experience, presumably as their assigned tasks and responsibilities become more advanced. When evaluating their preparedness for successive rotations, students generally rate their academic experiences progressively better as shown in Figure 3. Exceptions to this trend are in the areas of professional/ethical responsibility and global/societal context. Their supervisors on the job appear to agree, reporting improved levels of preparedness on average for all educational outcomes with each successive rotation, as shown in Figure 4. Interestingly, although the employer ratings are generally higher than the students' self-evaluations, the relative ratings of employers and students for the various outcomes are very similar. In general, the technical knowledge and skills are ranked higher than the less technical, or "professional," aspects and competencies.

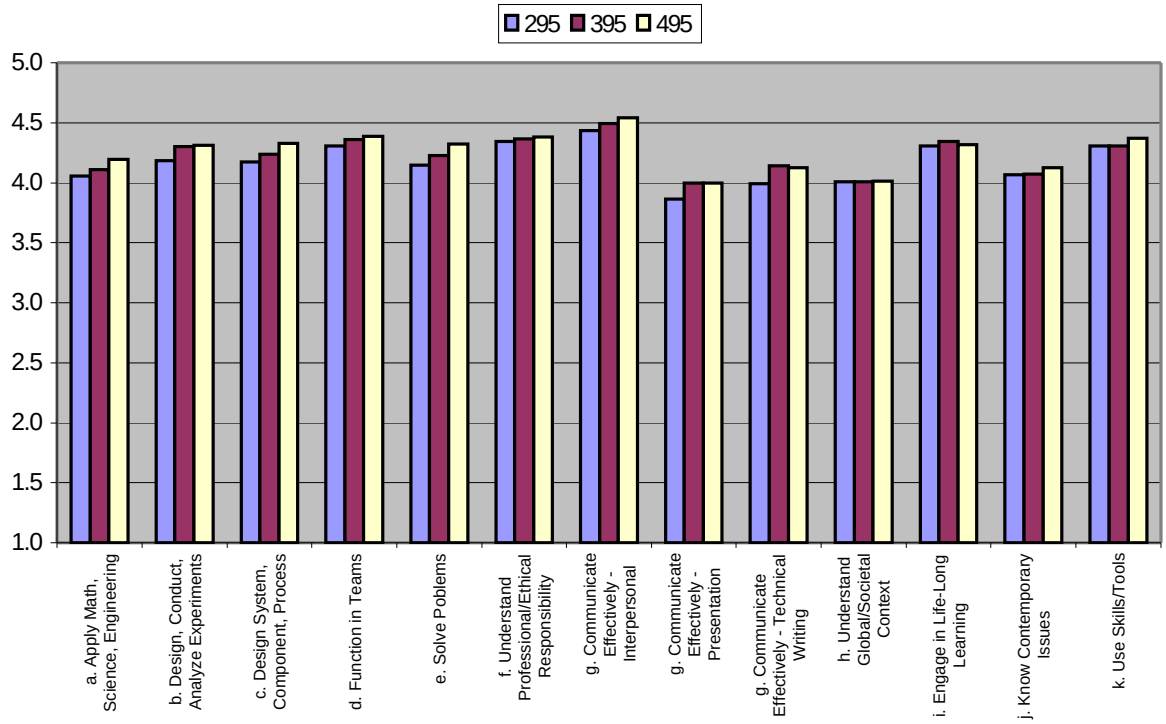

Figure 2. Co-op students' rankings of the contribution of successive work rotations to their engineering education.
(ENGR 295, 395, 495 correspond to the first, second third work assignments, respectively)

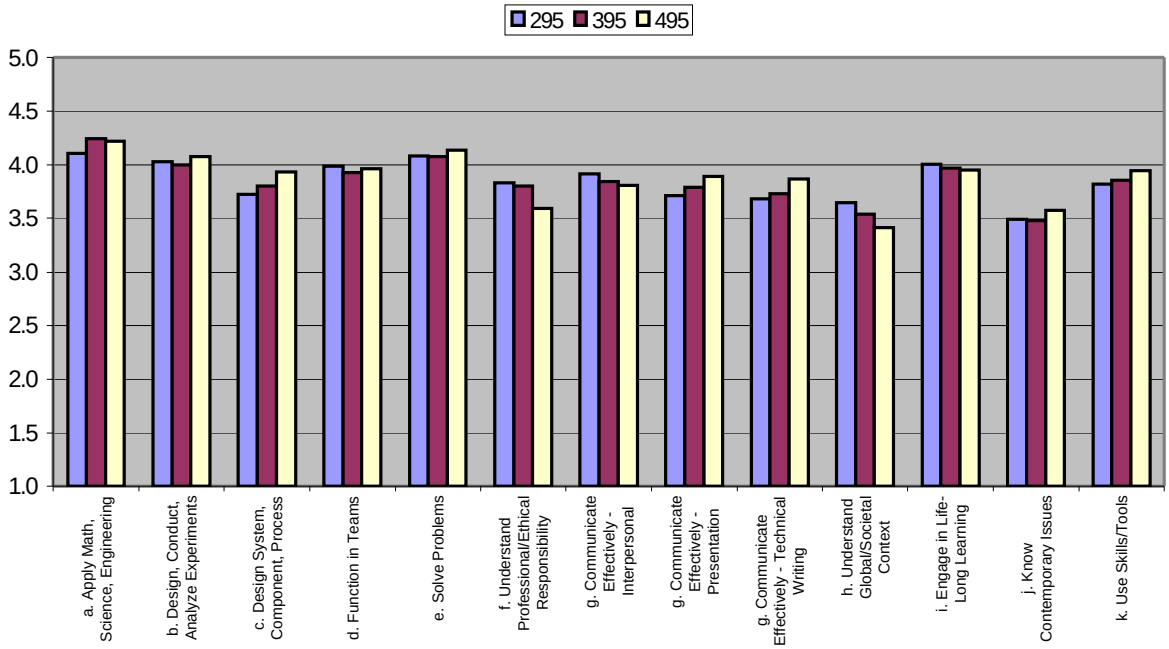

Figure 3. Co-op students' perceptions of their level of preparedness, from their academic studies, for the successive work rotations during their junior and senior years.

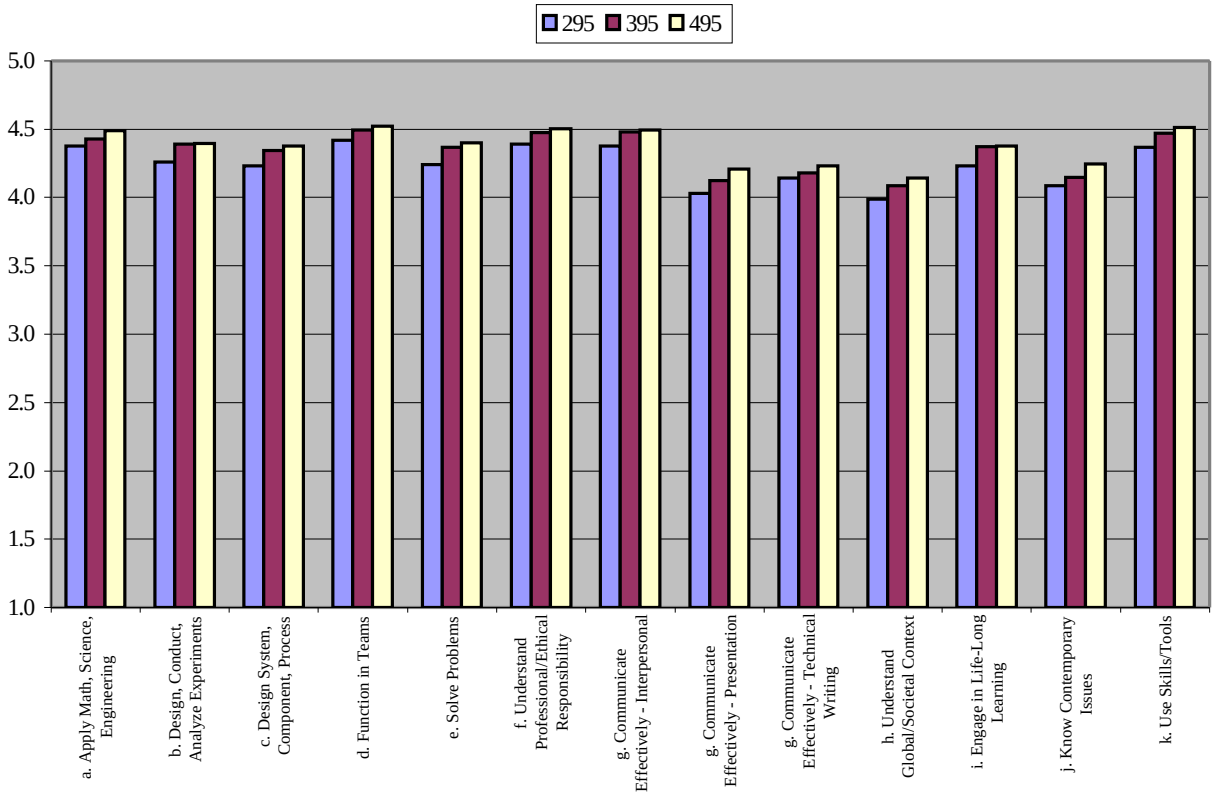

Figure 4. Ratings of co-op participants' preparation for their work assignments, as evaluated by their supervisors after successive periods of employment.

Using the senior survey results, a comparison can be drawn between students who participated in co-op versus those that do not have this formal work experience. (The latter group, however, may include students who have participated in internships or summer jobs that are engineering-related.) The students with co-op experience, as shown in Figure 5, generally rate their education slightly lower than the students who did not have this formal exposure to the workplace. Although the differences are not significant, they are consistent enough to suggest that the co-op students may have realized, as a result of their work experiences, that they still have a lot to learn. Figure 6, comparing the alumni with two to three years of work experience or graduate study, with students just completing their undergraduate studies, appears to bear this out. In almost every category of outcome, the alumni rate their preparedness levels below those reported by graduating seniors. Only in terms of developing competency in using methods, skills and modern tools of engineering (outcome k) do the alumni rank their educational experiences significantly higher than soon-to-be graduates do. Since the data portrayed in Figure 6 come from different graduate cohorts, it is unclear whether the differences can be interpreted as changes in perspective that follow from experiences gained after graduation, or whether they are attributable to curricular or other changes that may have influenced the educational experience of the 2001 class of graduates in comparison with alumni from the ’97 and ’98 graduating classes.

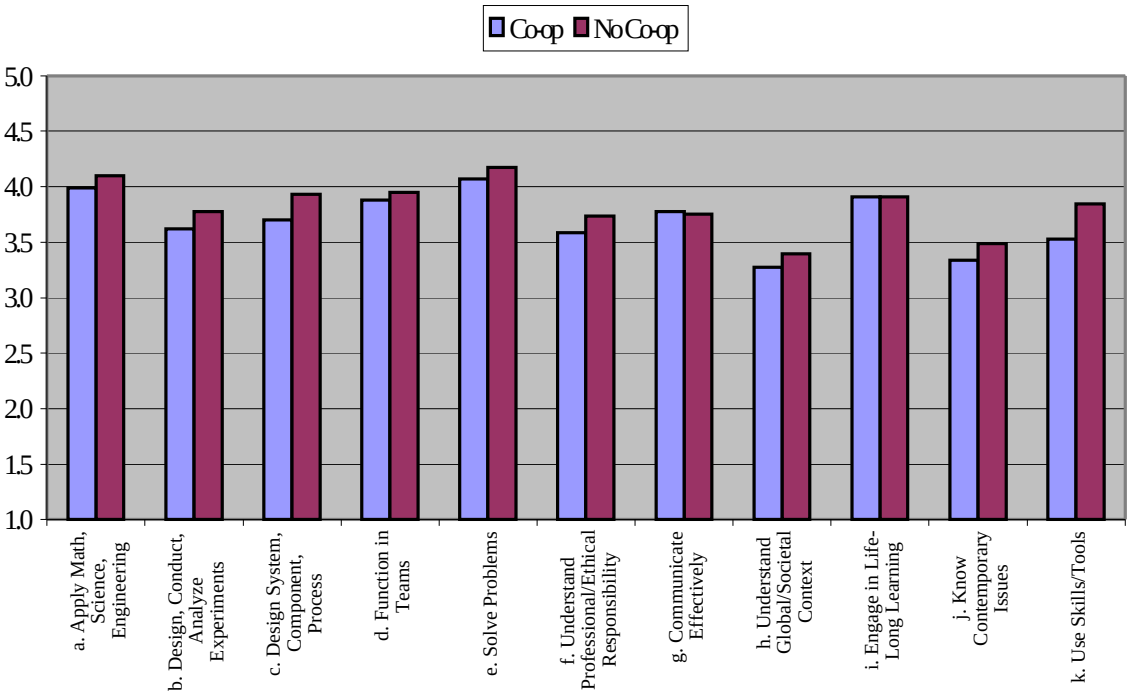

Figure 5. Ratings by graduating seniors of their professional preparation.

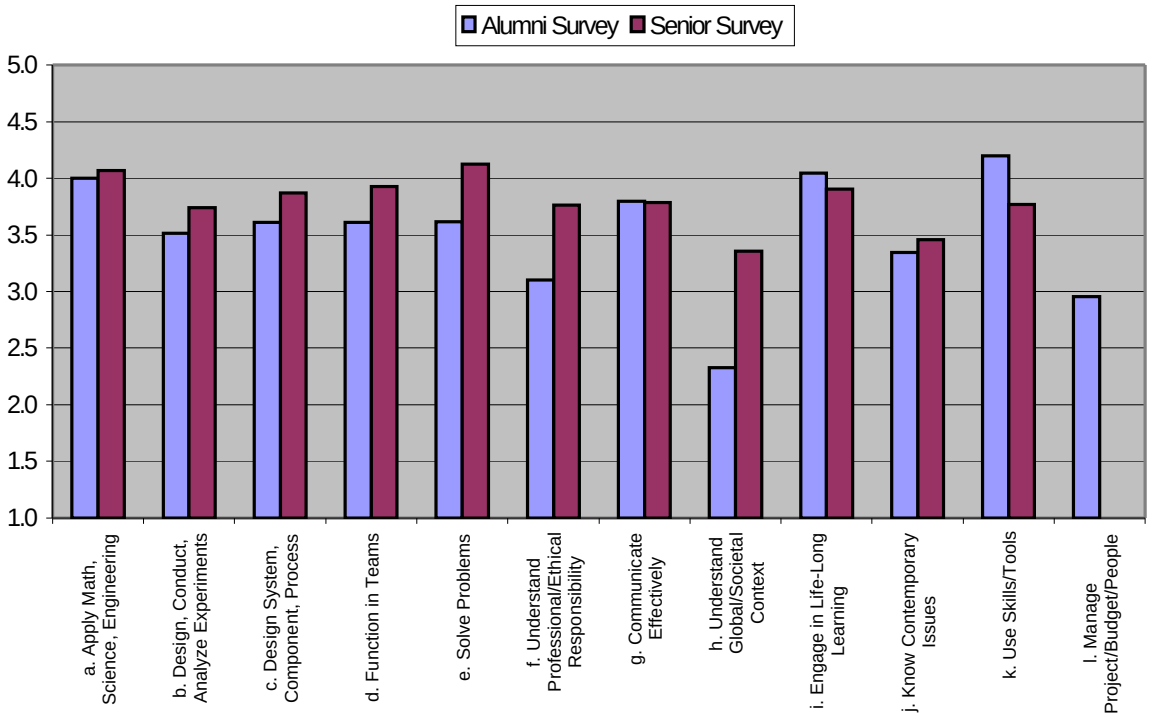

Figure 6. Ratings by graduating seniors of their professional preparation as compared to the perceptions of alumni, reflecting on their educational experiences several years after graduation.

Another factor that influences the data, and how the results are interpreted and might be acted upon, is the importance respondents assign to various outcomes. Figure 7 shows the alumni ratings of the a-k outcomes (and an additional outcome "l" corresponding to managing projects, budgets and people) plotted against their perception of the importance of these in their professional work and careers. The 45-degree line represents the case where the level of perceived preparedness is closely matched by the presumed importance of that ability or knowledge. Being "over-prepared" is not necessarily unfavorable, of course, unless it comes at the expense of being under-prepared in something else that is deemed very important. The College would not, for instance, wish to do anything that would risk the high levels of preparedness that have always been reported by our alumni with respect to their ability to apply mathematics and science to solve problems (a) or their ability to design, analyze and conduct experiments (b). The data would suggest, however, that more attention be given to developing students' understanding of professional and ethical responsibilities and managerial skills which fall into the high-importance but lower-preparedness quadrant of the chart.

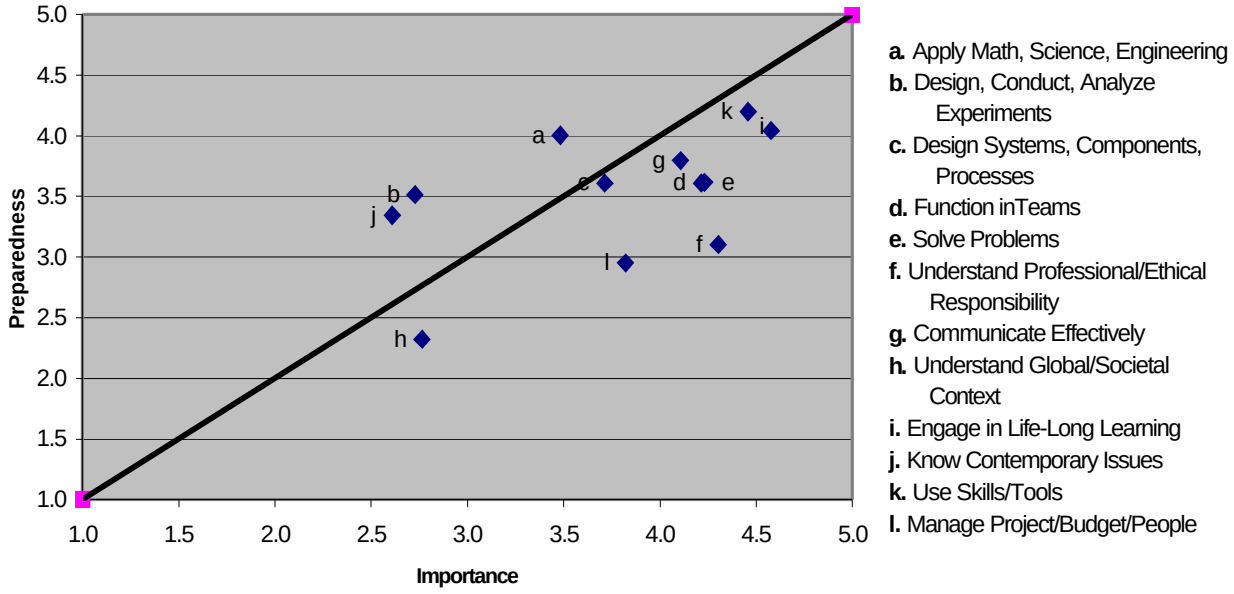

Figure 7. Ratings by alumni of their educational preparedness in various professional areas, contrasted with their perceptions of the corresponding importance of these areas.

IV. Conclusions

The reformulated instrument and process for surveying graduating seniors exhibits promise as an effective and efficient tool for assessing exiting students' perceptions of their educational experiences and future plans. Its principal attribute is the ability to satisfy the objectives and needs of various parties in collecting information, while eliminating redundant data gathering. Implementation on the web takes advantage of the capability to adapt some of the queries automatically to the particular department and to eliminate the need for entry of other characteristics or identifiers that can be easily linked to each respondent record from the student

information data banks. The response rates to the survey have been very good, with just the encouragement provided by an e-mailed request from the Dean's office, underscoring the importance of students' participation and feedback. A web-based version of the alumni survey has been developed and is expected to provide a convenient option for responding by that population as well.

The results from the co-op evaluations and surveys of seniors and alumni have begun to provide a more comprehensive portrait of students' experiences and perceptions. Although the analyses are very preliminary, the results point to skill and knowledge areas in which students and alumni consistently feel they are well prepared and others in which their education was not as effective. The latter tend to be those outcomes associated with less technical proficiencies and knowledge domains. Further, co-op students generally report a significant positive contribution of their work experience to their engineering education. They consistently rate their levels of preparedness marginally lower in the exit survey than students without this formal work experience, which may be due to the exposure they have gained to the expectations of the work environment. This pattern is continued in the alumni survey results, wherein former students who have several years of post-graduate experience assign lower rankings for preparedness, as a result of their education, in most areas of expertise compared to their just-graduating counterparts. However, since the graduating seniors and alumni are not the same cohort of students, they are reflecting on different educational experiences as well. Changes in the curriculum that were implemented in the three to four years between their respective dates of graduation could (and hopefully do) account for some of the improved rankings assigned by seniors as compared to the alumni respondents. The real goal of these assessment efforts is, of course, to measure whether curricular reform efforts are effective and where further improvements are needed.

In the near future, it will be possible to compare the results from the various surveys for the same cohort of students, essentially tracking the perceptions of their educational experience through the various stages of their academic and early professional careers. While their perceptions may change as influenced by their professional advancement and the perceived importance attributed to various elements of their education, at least the actual curriculum and other educational characteristics on which a given cohort is reflecting will be a constant. This should be helpful in sorting out the impact of efforts to improve the curriculum and enhance students' learning. Future goals also include the refinement of the analyses to insure statistical reliability and significance. New data-mining technology is constantly advancing the capability to identify trends and patterns, especially in terms of the typical course selections that are made by students among the general education electives, course options in the majors, co-curricular offerings such as co-op and study abroad, and supplemental programs such as the new Engineering Leadership Development minor. Overlaying these patterns with the survey response profiles to identify key correlations will facilitate informed decisions on what and how to effect positive educational change.

Bibliography

1. URL: **http://www.abet.org.criteria.html**, "Criteria for Accrediting Engineering Programs," Accreditation Board for Engineering and Technology, Inc., (2001)
2. John Wise, Sang Ha Lee, Thomas A. Litzinger, Rose M. Marra and Betsy Palmer, "Measuring Cognitive Growth in Engineering Undergraduates: A Longitudinal Study," Proceedings of 2001 ASEE Conference and Exposition.

Acknowledgement
The authors are indebted to Art Jones of the Engineering Center for Electronic Design, Communication and Computing for his technical expertise and contributions in implementing the web-based version of the Senior Exit survey.

ANITA M. TODD
Anita Todd is the Director of the Engineering Cooperative Education and Information Sciences and Technology Internship Program at Penn State. She holds a BS in Mechanical Engineering from Penn State. Anita sits on the board of the Cooperative Education Division of ASEE and is very active in local, regional and national co-op and internship organizations.

KIMBERLY A. BARRON
Kim Barron is a junior pursuing her B.S. degree in Industrial Engineering at Penn State, as well as minors in Business/Liberal Arts and Entrepreneurship. She is an active participant in the College, working for the Dean's Office and serving as the undergraduate representative on the College of Engineering Diversity Task Force. She is a member of the Envisioneers, a student organization sponsored by the Leonhard Center, which seeks to stimulate change and improvement in engineering education.

ROBERT N. PANGBORN
Rob Pangborn is Professor of Engineering Mechanics and Associate Dean for Undergraduate Studies in the College of Engineering at Penn State. He holds B.S. and B.A. degrees in Civil Engineering and Business Administration, and earned his M.S. and Ph.D. degrees in Mechanics and Materials Science at Rutgers University. He chaired the Special Committee on General Education at Penn State and has led a number of interdisciplinary initiatives focused on curricular change and integration. He teaches and conducts research in engineering mechanics and materials.