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Engineering Change: A Study of the Impact of EC2000*

J. FREDERICKS VOLKWEIN, LISA R. LATTUCA, PATRICK T. TERENZINI, LINDA C. STRAUSS and JAVZAN SUKHBAATAR
Center for the Study of Higher Education, Pennsylvania State University, University Park, PA 16802–3203, USA. E-mail: volkwein@psu.edu

This paper summarizes the research design, sampling plan, and instrument development for the Engineering Change (EC) Project, a three-year research activity that examines the impact of ABET's EC2000 on engineering education. The project assumes that, if EC2000 has been effective, evidence of change in ABET-accredited programs will be linked to changes in engineering student outcomes. The primary focus of the EC Project, thus, is on student learning. Compared to engineers prepared under previous guidelines, engineers educated in EC2000 accredited programs should exhibit higher levels of achievement in the 11 learning outcomes identified in the accreditation standards, Criterion 3, a–k. The EC Project includes a secondary focus on curricular modifications and instructional practices, on institutional policies and reorganization, and on faculty cultures and attitudes that may, in turn, have affected student learning. Thus, the following evaluation questions guide the EC Project: What impact, if any, has EC2000 had on student learning outcomes in ABET-accredited programs and institutions? What impact, if any, did EC2000 have on organizational and educational policies and practices that may have led to improved student learning outcomes? To address these research questions, we developed a project evaluation plan that contains the following elements: conceptual framework, research design, sampling strategy, and instrument development.

INTRODUCTION

IN THE EARLY 1990s, the Accreditation Board of Engineering Education (ABET) and its Accreditation Process Review Committee (APRC) examined existing accreditation criteria and processes and presented proposals for change. As Prados, Peterson and Aberle pointed out, the primary reason for this reform was the mismatch of industry needs and the skill sets of the engineering graduates [1]. In addition, it was widely perceived by the engineering education community that ABET's rigid accreditation criteria was a barrier to innovation [2, 3].

Comprised of engineering academics and industrial leaders, and the members of the ABET Board of Directors and Commissions, the APRC was quite instrumental not only in identifying needed changes in accreditation, but also in preparing and facilitating consensus-building workshops. The problems included excessively long and detailed accreditation criteria and a complicated and user-unfriendly accreditation process. ABET's leadership believed that, to meet these challenges, engineering education must undergo a paradigm shift. Prados noted that the paradigm shift required a movement away from assessing engineering programs on the basis of resources, curricular requirements, faculty credentials, and seat time. Instead, new standards were needed to emphasize clear educational objectives, industry collaboration, outcomes assessment, and continuous improvement [2, 3].

By 1994, jointly with the NSF and industry, ABET conducted three workshops devoted to each of the following issues: accreditation criteria, participation, and process [3, 4]. A synthesis workshop in 1995 resulted in revised guidelines for program criteria and a strategy for program evaluator training. Based on these workshop recommendations, ABET developed the new accreditation criteria EC2000, which includes both common criteria for all engineering programs and program-specific criteria for 23 different engineering sub-disciplines [5].

This new educational paradigm for engineering education maintains the technical (i.e. mathematical and scientific) knowledge base of the field, but also stresses the development of communication, teamwork, and group problem-solving skills. Engineering curricula and instruction must now integrate subject matter so that students will see relationships among those subject areas from the beginning of their undergraduate programs. Integration will be aided by design experiences that will focus student attention on issues of cost, timeliness, social and environmental concerns, health, safety, and other real-world issues.

To successfully develop students with these kinds of knowledge, skills, and dispositions, engineering education requires new forms of teaching

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and learning. Team-based projects will replace lectures. Case studies will develop students' abilities to integrate design, development, manufacturing and marketing. The fundamentals of engineering will be introduced in the context of application rather than as isolated technical concepts and principles. In addition to relying on multidisciplinary and multicultural teams, courses and programs will incorporate non-engineering students and real-world examples from industry. Instructional teams will be multidisciplinary and include practitioners as well as academics. Finally, internships and cooperative education opportunities will supplement coursework and engage students in active learning in the field.

Thus, ABET accreditation during the late 1990s shifted away from a bureaucratic checklist approach that emphasized meeting standards for curricula, resources, faculty, and facilities toward a focus on student educational outcomes. New standards, now known as EC2000, were written to reflect this shift in emphasis, and they stimulated significant restructuring of curriculum requirements, instructional practices, and assessment activities in engineering education. Evidence of learning outcomes, like those articulated in Criterion 3, now serves as a central focus of program self-study documents under EC2000 [5].

Has EC2000 improved the quality and skills of engineering graduates? ABET has concluded that, in the spirit of continuous quality improvement that it encourages in engineering schools, it must ascertain the impact of its new criteria on institutions and on student learning, and then use these findings to enhance its own understandings and processes. The study described in this paper is designed to fulfill this need. Our project is 'Engineering Change: A Study of the Impact EC2000'. We use the abbreviated title, 'EC Project', to refer to this study throughout this paper.

EVALUATION FRAMEWORK AND PLAN

This paper summarizes the research design, sampling plan, and instrument development for the Engineering Change (EC) Project, a three-year research activity that examines whether engineers educated in programs responding to ABET's EC2000 accreditation criteria and processes are better prepared than graduates of pre-EC2000 programs. Thus, the following evaluation questions guide the EC Project:

- What impact, if any, has EC2000 had on student learning outcomes in ABET-accredited programs and institutions?
- What impact, if any, did EC2000 have on organizational and educational policies and practices that may have led to improved student learning outcomes?

To address these research questions, we developed a project evaluation plan containing the following elements: Conceptual framework, research design, sampling strategy, and instrument development. These are supported by a review of the engineering and higher education literature to identify relevant research, instruments, and measures.

Conceptual framework

The framework for this study assumes that, if EC2000 has been effective, evidence of change in ABET-accredited programs will be linked to changes both in engineering programs and in student outcomes. The conceptual framework for this project (shown in Fig. 1) posits that the altered EC2000 accreditation standards influence curricular modifications, instructional practices, assessment initiatives, institutional policies and reorganization, faculty development activity and related faculty values. These changes in engineering education influence student learning outcomes. Thus, the EC2000 processes and criteria, and the organizational changes that result from their use, will impact student learning outcomes, which in turn will influence employer assessments of students' preparation. Finally, this framework posits that, in the presence of effective continuous improvement practices (CQI), information about student learning outcomes and employer satisfaction provides the basis for further improvements in curriculum and instruction, as well as educational and organizational policies and practices.

The assumptions that are embedded in our conceptual framework are generally supported by the research literature. Several studies have already documented industry and EC2000 impact on faculty and curricula [6–10]. Moreover, some institutions have developed educational goals and objectives and measurable learning outcomes, and have begun the process of assessing student outcomes against those goals and objectives [11–21]. Moreover, quality assurance, quality control, and improvement provide a natural foundation for good practice in every engineering field [22–26].

Thus, we have designed an evaluation that focuses primarily, but not exclusively, on the connections between EC2000 and student learning outcomes. The new accreditation standards may influence student outcomes only indirectly. Accurate attribution requires that we also ascertain the impact of EC2000 on the forces that may have a more direct impact on students, such as curriculum and instruction, administrative policy and practice, and faculty attitudes toward teaching, learning, and assessment (which we refer to as faculty culture). Compared to engineers prepared under previous guidelines, engineers educated in EC2000 accredited programs should exhibit higher levels of achievement in the 11 learning outcomes identified in the accreditation standards, Criterion 3, a–k. However, before we can confidently conclude that any changes are a result of EC2000, we must also examine other potential sources of influence (such as changes in student quality, industry pressures,

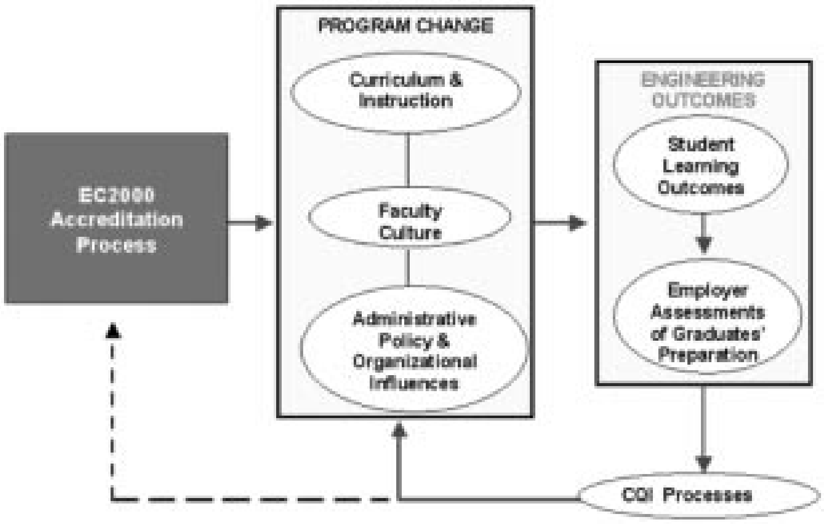

Fig. 1. Conceptual framework.

market demand, or faculty and institutional actions unrelated to EC2000). However, if we find that changes in programs and institutions inspired by EC2000 standards accompany improvements in student learning outcomes (as reported by graduating seniors, alumni, employers, and faculty), we will have persuasive evidence that these improvements are a consequence of EC2000 rather than the result of other factors.

Research design and sample selection

The research design recognizes:

1. the need for both pre-EC2000 and post-EC2000 evidence from multiple sources;
2. the variable circumstances of individual programs that adopt EC2000, and stand for review by ABET, at different points in time between 1996 and 2006;
3. the need to control for, or otherwise account for, the fact that some programs participated in an NSF engineering coalition during the 1990s and others did not; and
4. the need for representative sampling from a range of engineering disciplines, a range of institution types, and a range of program sizes.

To answer the research questions with confidence, we must look both backward and forward through ABET accreditation cycles to examine institutional functioning and student outcomes before and after EC2000. The normal six-year ABET review cycle spreads out the impact of EC2000, with some engineering programs being reviewed under the new standards sooner than others. For the purposes of our research design, we grouped engineering programs into the four categories shown in Table 1. These four groups will enable us to determine if programs with longer histories of EC2000 accreditation produce more qualified graduates (based on the 11 competencies specified in Criterion 3, as well as on other evidence of student learning).

The four groups of engineering programs are as follows:

- *Pilot phase of EC 2000*. In 1996 and 1997, five institutions served as pilots for the new EC2000 accreditation standards and procedures. Programs at these institutions underwent their second EC2000 accreditations in 2002 and 2003.
- *Early EC2000*. The early EC2000 group of institutions shown in Table 1 chose to be reviewed under the new EC2000 criteria in years when use of the new criteria was still optional. There are 106 institutions in this group; they underwent EC2000 reviews in the years 1998, 1999, and 2000. These institutions were presumably most confident of their ability to meet the new accreditation standards, or at least were willing to give them a try.
- *Deferred EC2000*. The deferred EC2000 institutions had the option of review under the new EC2000 criteria in 1998, 1999, or 2000, but instead chose to be reviewed under the 'old' ABET accreditation standards. These institutions presumably felt least able to respond to the EC2000 criteria, or for some other reason wished to wait until 2004–2006.
- *Required EC2000*. These are those institutions that are scheduled for an accreditation review in a year in which they are required to use the EC2000 criteria (2001, 2002, or 2003).

Because the EC2000 study targets engineering disciplines, the unit of analysis is the engineering program. In consultation with ABET, we targeted seven engineering disciplines for the study: aerospace, chemical, civil, computer, electrical, industrial and mechanical engineering. This array of disciplines provides the opportunity to study (1) those disciplines that produce the vast majority of engineering graduates in any one year (chemical, civil, electrical, and mechanical), and (2) disciplines with strong ties to particular industry sectors (aerospace, computer, industrial).

Table 1. Four groups of EC2000 institutions by accreditation cycle

Program Groups	N	Pre-EC2000 Accreditation	Most Recent Accreditation	Next EC2000
Pilot Institutions/Programs	5	1990, 1991	1996, 1997	2002, 2003
Early EC2000	106	1992–1994	1998–2000	2004–2006
Deferred EC2000	88	1992–1994	1998–2000	2004–2006
Required EC2000	129	1994–1996	2001–2003	2007–2009

While the program is the unit of analysis, these programs are embedded within institutions, so the sampling plan grouped together all the eligible institutions with engineering programs. In order for its programs to be considered in the population for study, each institution had to meet two criteria: (1) it had to offer a program in at least one of the seven targeted engineering disciplines, and (2) each target program must have been accredited by ABET since 1990 (in order to have pre-EC2000 graduates in the mid-1990s, as well as post-EC2000 graduates in 2004). Using these criteria, we identified 244 institutions as the population from which our program sample is drawn.

Sampling strategy

With the assistance of the Penn State Survey Research Center, we decided on a disproportionate stratified random sample with a $7 \times 3 \times 2$ design. This sampling strategy is random, because each institution has an equal chance of its programs being selected, and it is stratified, because we have three selection strata. The first stratum consists of the seven targeted disciplines. The second stratum covers the three EC2000 review statuses (early: 1998–2000; required: 2001–2003; and deferred: 2004–2006). The third selection stratum consists of the programs and institutions that did and did not participate in the various NSF engineering coalitions during the 1990s.

The sample is 'disproportionate', because we made several adjustments to round out the sample. First, we added four EC2000 pilot institutions (first reviewed in 1996 and 1997 under the draft guidelines). Next, we added three Historically Black Colleges and Universities in order to ensure their representation in the study. Finally, we oversampled some of the smaller disciplines (such as aerospace and industrial), to ensure that there are enough faculty, students, and alumni in each of the cells to conduct reliable statistical analyses. For example, in our 7×3 sampling matrix, 14 of the 21 faculty cells exceed 100, and 19 of the 21 student cells exceed 100. In fact, 15 of the 21 student cells exceed 200.

The end result is a sample of almost 200 programs at 40 institutions. The programs at the institutions are remarkably similar to those in the defined population. Both the number of undergraduate degrees awarded by a discipline and the number of faculty in each discipline are within three percentage points of the population totals. The percentage of private institutions in the sample is greater than the number in the population; however, the percentage of undergraduate degrees awarded by public and private institutions aligns with the population from which the sample is drawn. Finally, the profile of small, medium, and large programs in the sample roughly matches the actual program size profiles in each of the seven disciplines.

Sources of evidence

The study relies on a multi-method approach, employing both qualitative and quantitative techniques, to answer the evaluation questions we have posed. The value of a multi-method approach has been noted by many researchers, like Kahn, Colbeck, Rogers, Pascarella, and Terenzini [21, 27, 28, 29]. Each of the data sources we have identified provides information about the impact of EC2000 from a different perspective. Each data methodology and data source also has particular strengths and weaknesses. An evaluation plan that relies too heavily on a single source of evidence, such as one population of participants, or a single method of data collection, such as a survey, may be biased, due to measurement errors associated with the data source or collection procedure. To compensate for the weaknesses of individual methods and data sources, we have designed an evaluation plan that utilizes multiple data sources and methodologies in order to yield more reliable and valid assessments than less diverse approaches can provide. Figure 2 summarizes the overall research design and sources of evidence.

The EC Project identifies seven sources of evidence and develops appropriate data collection strategies and instruments for each. As noted above, the programs in the seven engineering disciplines are the units of analysis and we grouped them into four categories: pilot, early, required, and deferred (later in the EC2000 review process). Within each of these groups, we will collect and compare the pre-EC2000 and post-EC2000 evidence. First, we are assembling existing data and then we will collect new data.

Existing data

As noted in Fig. 2, there are three types of existing data: Fundamentals of Engineering examination scores, national and professional society databases, and self-study documents.

1. *Fundamentals of Engineering examination scores*. We will analyze FE exam results for

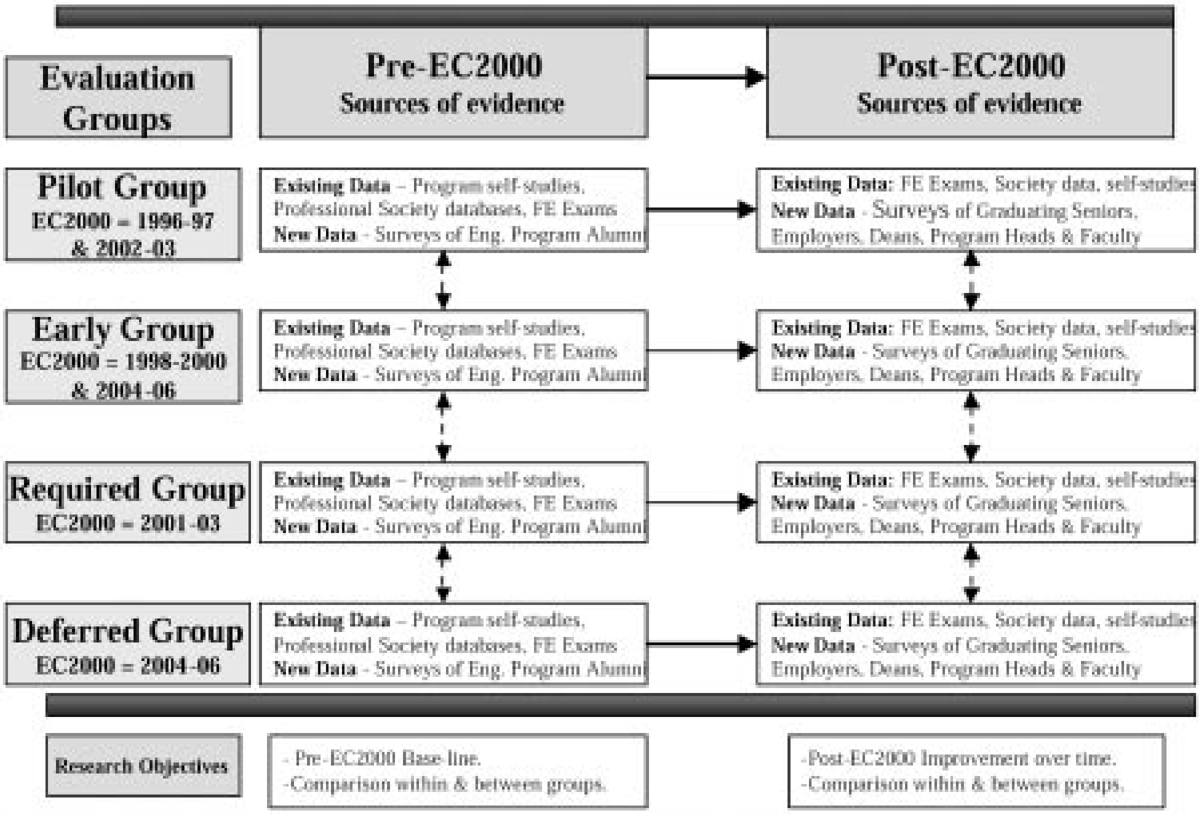

Fig. 2. Research design for the EC2000 Project.

pre-EC2000 and post-EC2000 graduates to see if there are changes in the particular student outcomes measured by these exams. While the FE exam does not assess many of the learning outcomes identified in EC2000, and while many programs do not require the exam and many students do not take it, the exam nevertheless provides a direct measure of student knowledge of basic engineering concepts and principles.

2. *National and professional society datasets*. This is a source of information not only about institutional and program characteristics, but also about practicing engineers and their employers.
3. *Self-study documents*. We have examined a sample of self-study documents to review assessment strategies, to collect outcomes instruments, and to consider the impact of EC2000 on administrative policy and organizational structures, curricular and pedagogical practices, and faculty culture.

New data

As noted in Fig. 2, there are many sources of new data that will provide additional evidence for evaluating the impact of the new accreditation standards: graduating seniors, pre-EC2000 alumni, employers, faculty, program heads and deans.

1. *Graduating seniors*. We are designing and pilot testing an outcomes survey instrument that is central to the study and will be administered to several thousand 2003/4 seniors. For the 183 programs being sampled, we will ask their graduating seniors to self-report on the extent to which they believe they have achieved each of the 11 learning outcomes established in Criterion 3 of the new standards and to provide us with a description of their educational experiences in engineering programs.
2. *Alumni/ae*. We believe that the best source of pre-EC2000 information will come from engineering alumni who graduated before 1995. For the 183 programs being sampled, we are designing and pilot testing an outcomes survey instrument that will be administered to all their 1993/94 graduates. Thus several thousand alumni will be asked to reflect back and assess the extent to which they graduated with the abilities and skills that are articulated in Criterion 3 of the new accreditation standards.
3. *Employers of engineering graduates*. We will ask employers to assess the skills and abilities of recent engineering graduates and tell us whether they have perceived changes in engineering graduates' capacities since the implementation of EC2000. Can they compare the performance of pre-EC2000 graduates and post-EC2000 graduates on the 11 Criterion 3 competencies? This sample of several hundred employers will represent those who commonly hire graduates of the focal engineering disciplines at the same

sample of institutions and programs developed for the student/alumni surveys.

4. *Faculty*. For the same 183 programs being sampled, we will ask all full-time faculty with at least three years of experience to respond to an instrument that is being designed and pilot tested. The survey instrument seeks to assess the preparation of current seniors on the a–k outcomes and to compare this to the preparation of pre-EC2000 graduates. Faculty will also be asked to report on the impact of EC2000 on curricular innovation, instructional practices, faculty culture, and the use of CQI processes.
5. *Deans and program heads*. Program heads will report on the impact of EC2000 on academic policy and practice, curricular restructuring, and the use of assessment databases and CQI processes. The deans and program heads will be asked about institutional policies, priorities and resources, as well as about faculty culture and CQI. In both program head and faculty surveys, we will explore the extent to which curricular and pedagogical practices, such as those that ABET promotes (i.e. team and collaborative projects, multidisciplinary approaches to teaching and learning, problem- and case-based learning, and integration of real-world problems and concerns into the curriculum), have been instituted.

Table 2 shows that each data source contributes differently to the components of the study. Each component benefits from multiple sources of evidence. In all cases, data collection procedures are being designed to permit analysis across the seven engineering disciplines.

Instrument design and development

The EC Project team is developing a set of instruments that will gather information from graduating seniors, alumni, employers, deans, program heads, and faculty. As noted above, each of these populations and instruments has its particular role in the evidence collection process. However, the ultimate test of EC2000 is its effect on student learning outcomes, so the assessment of a–k outcomes among students and alumni is the central component of the EC Project. Engineering faculty and employers will offer other perspectives on the impact of EC2000, and these can be used to corroborate the information from students and from the FE exam results. Due to the centrality of the student and alumni surveys, this section of the paper summarizes the design and development of these instruments. These will gather information in three primary areas:

1. *Pre-college characteristics*. Examples of these are gender, race/ethnicity, degree aspirations, high-school achievement (such as grades and admissions test scores), parents' education. Because these variables may account for differences in student learning outcomes during their educational careers, our analyses will use these variables to control differences among students in different engineering programs and schools at the time they entered their programs. The use of these controls will enable us to make better assessments of programmatic effects on student outcomes.
2. *Educational experiences*. These will include the major field, types of courses taken, instructional methods experienced, nature and frequency of formal and informal contact with faculty members, internships, full/part-time study, employment on/off-campus. Information on these sorts of variables will permit assessment of: (1) the nature of the educational experience to which graduating seniors have been exposed (which will permit some evaluation of the extent to which students' programs are consistent with the expectations implied in EC2000); and (2) the extent of the relative contributions of each experience (or area of experience) to student outcomes.
3. *Learning outcomes*. The outcome areas covered in the instruments will be primarily (but not exclusively) the 11 outcomes specified in Criterion 3 of EC2000:
   a) An ability to apply knowledge of mathematics, science, and engineering
   b) An ability to design and conduct experiments, as well as to analyze and interpret data
   c) An ability to design a system, component, or process to meet desired needs

Table 2. Components of the evaluation model and sources of data

	Professional Society and National Database	FE Exams	Self-Study Docs	Faculty Survey	Program Chairs and Deans	Senior Survey	Alumni Survey	Employer Survey
Student Outcomes		X	X	X	X	X	X	X
Institutional & Program Characteristics	X		X		X			
Administration Policy & Organization Influences				X	X			
Curriculum & Instruction			X	X	X	X	X	
Faculty Culture				X	X			
CQI Processes			X		X			
EC2000 Accreditation Process			X	X	X			

d) An ability to function on multi-disciplinary teams
e) An ability to identify, formulate, and solve engineering problems
f) An understanding of professional and ethical responsibility
g) An ability to communicate effectively
h) The broad education necessary to understand the impact of engineering solutions in a global and societal context
i) A recognition of the need for, and an ability to engage in life-long learning
j) A knowledge of contemporary issues
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

To enhance their psychometric reliability, we aim to construct instruments containing scales of three to six items in each outcome area. Because developing objective tests of student learning and skills can be extremely time-consuming and costly, the measures we are developing rely on student self-reports. The evidence from the social science literature indicates that student self-reports have only moderately positive correlations with objective measures when used to gauge the learning or skill of an individual [29], but, when aggregated to compare the performance of groups, the reliability of self-reported learning and growth is quite high and is generally considered to be a valid measure of real differences in learning between groups [30–34].

Figure 3 shows the steps in our instrument development process. Early in the project, we undertook a scan of the engineering and higher education literature to identify relevant research, instruments, and measures. Concentrating on those assessments relevant to measuring a–k outcomes, we assembled over a hundred different articles, conference papers and self-study documents that describe strategies, methods, and instruments. For each of the learning outcomes in Criterion 3, we assembled all the available survey items. This generated a list of over 300 alternative self-report items, 20–40 for each of the 11 outcomes. As a group, we engaged in a period of item reducing, combining, rewording, trashing, and editing. This cut the list of items by about 60%. Next, we involved a small group of stalwart Penn State engineers to evaluate the usefulness of the items, give us wonderful suggestions for further revising the wording, and pare the list down to a handful of items that in their judgement fairly measure each of the 11 outcomes. We went back and forth several times until we were mutually satisfied with the results.

We engaged in a similar process for each of the 11 outcomes and are now preparing a pilot test of about 50 self-reported outcomes items. To give a concrete example, Table 3 shows the references and 30 items that we found for measuring Criterion 3e, 'An ability to identify, formulate, and solve engineering problems.' After the process of item reduction, editing, and interaction with engineering faculty, we narrowed the items for pilot testing down to the following three. On a scale, students will be asked to rate their own ability to:

E1 Define key engineering problems
E2 Formulate a range of solutions to an engineering problem
E3 Evaluate and select from among potential solutions to an engineering problem

Pre-EC2000 alumni will be asked to think back to the point of their own graduation and similarly rate themselves.

Data collection

While the instruments are under development, we will be actively working with the institutions in our study to minimize the impact on their

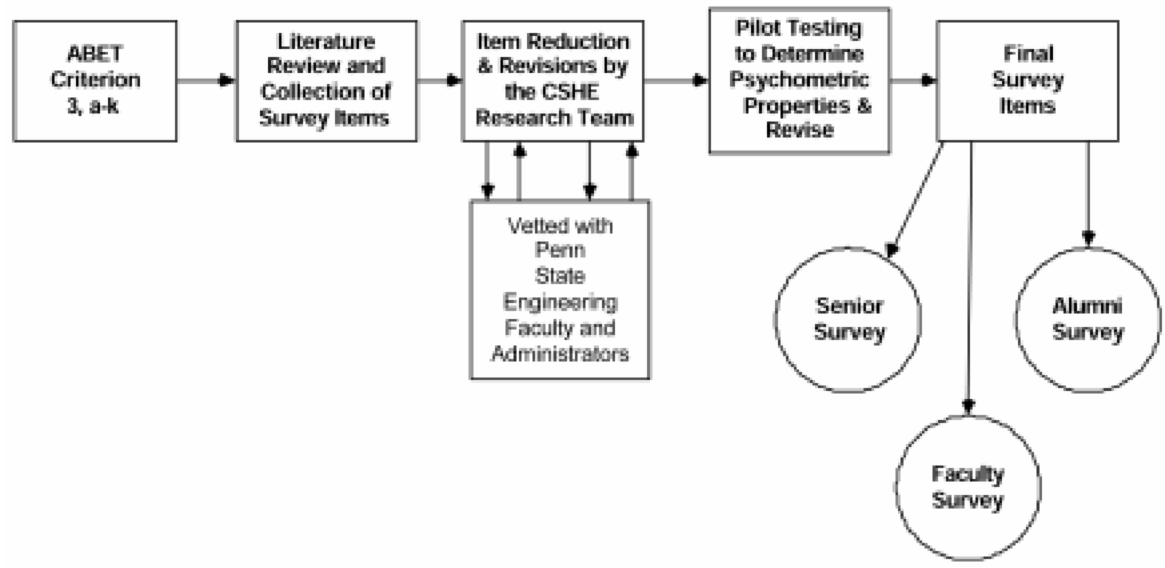

Fig. 3. Measuring outcomes a–k.

Table 3. The items and sources used to measure Criterion 3e: an ability to identify, formulate, and solve engineering problems

The students on this team were able to apply their knowledge of mathematics, science and engineering in the solution of problems and to develop designs.	Doepker [35]
This project demonstrated the ability to identify, formulate and solve engineering problems.	*Ibid*
An ability to define and solve engineering problems.	Terry, Harb, Hecker and Wilding [36]
Students will be able to identify, formulate, and solve civil engineering problems, particularly the planning, design, construction, and operation of systems, components, or processes that meet specified performance, cost, time, safety, and quality needs and objectives.	Meyer and Jacobs [8]
Ability to develop innovative approaches.	Koen [37]
Exert high levels of effort; strive to achieve goals.	*Ibid*
Effective problem-solving.	*Ibid*
Ability to formulate a range of alternative problem solutions.	Lang and McVey [38]
Ability to identify problems.	*Ibid*
Ability to choose problem solutions.	*Ibid*
Improve problem-solving and decision-making abilities	Bailey, Floersheim and Ressler [39]
Creative problem-solving.	McGourty, Sebastian and Swart [20]
Develop many potential solutions, while discouraging others from rushing to premature conclusions.	*Ibid*
Suggest new approaches and challenges to the way things are normally done.	*Ibid*
Be able to analyze and synthesize engineering problems, including the design and conduct of experiments.	DeLyser and Hamstad [18]
Be able to independently accomplish engineering tasks.	*Ibid*
The ability to think critically, and to identify, evaluate, and solve complex technical and non-technical problems.	Skvarenina [14]
Formulate descriptions of mechanical engineering problems that, when solved, satisfy a need.	Johnson [40]
Ability to formulate unstructured engineering problems.	Moreno *et al.* [41]
Analyze circuit behavior.	Ahlgren and Palladino [42]
Describe mathematically.	*Ibid*
Solve for circuit rspe.	*Ibid*
Use engineering methods to identify, formulate, and solve engineering problems.	UC Davis [43]
To what extent has your experience at this institution contributed to your knowledge, skills, and personal development in solving complex real-world problems?	National Survey of Student Engagement [44]
Problem-solving.	NJ Institute of Technology [45]
Identify, formulate, and solve technical problems.	UNC Charlotte [46]
Ability to identify and formulate open-ended engineering problems.	Colbeck Cabrera and Marine [47]
Ability to solve open-ended engineering problems.	*Ibid*

operations. We will assist them, not only by relieving programs and colleges of the data collection burden, but also by providing a modest monetary reimbursement to offset any costs associated with the study.

Because some research suggests that response rates vary between web- and paper-based data collection methods, and that some individuals still prefer pencil-and-paper surveys, we will give participants the option of choosing their preferred method of response in order to maximize our response rate. We will also provide modest monetary incentives to graduating seniors and alumni/ae participants. We plan to use a telephone survey for employers, assuming that this population is least likely to respond to a paper questionnaire.

The EC Project is collecting data on the following timeline:

Population	**Target Data Collection**
Deans, program chairs, and faculty:	Fall 2003
Seniors graduating in 2003–04:	January 2004
Pre-EC2000 graduates:	Spring 2004
Employers:	Spring 2004

In 2004/5, we will supply each program with the results of the student, faculty, employer, and alumni responses (when N is at least 10), so that these can be integrated into their ongoing assessment efforts.

We will also generate comparisons, so that programs can compare their results to the larger population. If faculty, graduating seniors, alumni/ae, and employers all report improvements in student learning outcomes since the implementation of EC2000, and if improvements in the aggregate are consistent with the early, on-time, and late adopter groups, we will have persuasive evidence of the positive influence of the new accreditation standards.

The instruments, data collection and management plan and procedures, and the analytical procedures to be developed for this overall evaluation of EC2000, will serve as the eventual design of a continuing assessment system that can be implemented by ABET at such time as it is again needed. The evaluation model may also be of interest to other professional accreditation organizations that wish to examine their impact on student learning outcomes.

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J. Fredericks Volkwein, Professor and Senior Scientist, has had a four-decade career that includes university administration, teaching and research. He earned his Bachelor's degree from Pomona College and a Ph.D. from Cornell University. All his research and teaching is related, directly or indirectly, to the field of institutional research and the topic of organizational effectiveness. Dr Volkwein has produced more than 100 research reports, conference papers, journal articles, and book chapters. His recent scholarship examines the connections between outcomes assessment and accreditation. He has served as a consulting editor for three higher-education journals, and in 1995 became the editor-in-chief of the Jossey-Bass series, *New Directions for Institutional Research*. Dr Volkwein is currently co-principal investigator of the ABET-commissioned study of the impact of EC2000, as well as two other research projects within the Center.

Lisa R. Lattuca, Assistant Professor and Research Associate, received a Master's degree from Cornell University in 1986 and a Ph.D. in Higher Education from the University of Michigan in 1996. She conducts research and writes on postsecondary curricula, teaching and learning; interdisciplinary research and instruction; faculty work; and qualitative research methods. Her publications include four books: *Creating Interdisciplinarity: Interdisciplinary Research and Teaching among College and University Faculty* (2001);

Shaping the College Curriculum (1997; with co-author J. S. Stark); *College and University Curricula: Developing and Cultivating Programs of Study that Enhance Student Learning* (2002; co-edited with J. G. Haworth and C. F. Conrad); and *Qualitative Research in Higher Education* (2001; with co-editors Conrad and Haworth). Dr Lattuca is currently project director and co-principal investigator of the ABET-commissioned study of the impact of EC2000. She is also co-PI for an NSF-funded study of faculty collaborations to improve engineering education.

Patrick T. Terenzini, Professor and Senior Scientist, has over 30 years of experience in higher education as a teacher, researcher, and administrator. He holds an A.B. in English from Dartmouth College, an M.A.T. in English Education from Harvard University, and a Ph.D. in Higher Education from Syracuse University. His research interests include the impact of college on students, student retention, institutional research and planning, and the assessment of student learning outcomes. He has published over 100 articles in refereed journals and made numerous invited presentations at national scholarly and professional conferences. Terenzini is co-author (with Ernest T. Pascarella) of *How College Affects Students* (Jossey-Bass, 1991), an award-winning synthesis of twenty years of research on the impacts of the college experience on students. From 1998–2000, Terenzini (with Carol Colbeck) directed CSHE's evaluation of the Engineering Coalition of Schools for Excellence in Education and Leadership (ECSEL). Professor Terenzini is currently a co-principal investigator of an ABET-commissioned study of the impact of EC2000, as well as two other research projects in the Center.

Linda C. Strauss, Senior Project Associate, earned her M.Ed. in counseling education and her Ph.D. in Higher Education at Penn State. She has more than ten years of administrative and institutional research experience at Penn State. She has published on topics ranging from the impact of institutional and student characteristics on student outcomes to racial identity development. She has co-authored several book chapters and published in *Research in Higher Education* and the *Journal of Higher Education*. Her research interests include athletic administration, institutional research, racial identity development, and engineering accreditation. Dr Strauss serves as senior project associate for the 'Engineering Change' study of the impact of EC2000, and participates in other Center research.

Javzan Sukhbaatar is a doctoral student in the higher education program. He received a diploma (equivalent to a Bachelor's degree) in commerce from the Russian Economics Academy (Russia) and an M.B.A. from the Maastricht School of Management (Holland). Before coming to Penn State in 2001 as a Hubert H. Humphrey fellow, Javzan served as Executive Director of the Consortium of Mongolian Management Development Institutions. He has more than 20 years of administrative, teaching, and consulting experience, including having been a member and peer review expert of the National Council on Higher Education Accreditation of Mongolia. Mr Sukhbaatar currently works as a graduate research assistant for the 'Engineering Change' study of the impact of EC2000.