On Quality Assurance Mechanisms in Engineering Education: A Case Study of Purdue University

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Abstract

Quality assurance in engineering education plays an increasingly important role in cultivating engineering talents around the world. The ABET EC2000 reform, in particular, has had a range of different impacts on U.S. universities and colleges as they work to meet accreditation standards. For example, large research-oriented universities with strong quality assurance cultures may pay more attention to setting up internal quality assurance systems at multiple levels. It is necessary to explore and discuss how such universities establish their own internal quality assurance mechanisms to continuously promote quality improvement, while also meeting accreditation requirements. This paper uses Purdue University as a case study of these processes. As valuable background information, relevant global literatures on quality assurance in engineering education are first reviewed in this paper. Then, the quality assurance mechanisms in engineering education at Purdue University are then more deeply analyzed and presented based on data from interviews with ten key stakeholders involved with ABET accreditation at Purdue University. The stakeholders were interviewed using a semi-structured protocol which elicited their concrete experiences of preparing for ABET accreditation as well as their attitudes towards quality assurance in engineering education. All stakeholders were also asked to share their views about other internal quality assurance mechanisms and current efforts to assure the quality of engineering education. The interviews were systematically analyzed using qualitative coding procedures, including inductive and deductive coding. This paper finds that Purdue University, as a research-oriented university, has set up a relatively integrated internal quality assurance system of engineering education which includes at least two types of mechanisms: organizational mechanism both at the university level and the college/departmental level, evaluation mechanism of coping with ABET accreditation and evaluation mechanism of teaching and learning to facilitate daily management.

Keywords: quality assurance, engineering education, ABET, accreditation, EC2000, continuous quality improvement

1. Introduction

In the United States, ABET, Inc. has been recognized as the unique authorized accreditor of postsecondary degree-granting programs in engineering. For more than 80 years, accreditation has provided quality control for engineering education in the United States, seeking to assure that graduates of accredited programs are prepared for professional practice. By the 1980s, the accreditation criteria had become increasingly prescriptive, inhibiting development of innovative programs to reflect changing needs of practice. In 1996, the ABET Board of Directors adopted the new set of standards, called Engineering Criteria 2000 (EC2000). EC2000 shifted the basis for accreditation from input-what is taught, to output-what is learned. In 2002, ABET, Inc. commissioned the Center for the Study of Higher Education at Pennsylvania State University to undertake a three-and-a-half-year study to assess whether the implementation of the new EC2000 evaluation criteria is having the intended effects.¹
The weight of the accumulated evidence collected for Engineering Change indicates clearly that the implementation of the EC2000 accreditation criteria has had a positive, and sometimes substantial, impact on engineering programs, student experiences, and student learning. However, the main findings of the EC2000 impact study have been brought into scrutiny and consideration. Research-oriented universities like Purdue University with strong quality assurance cultures may pay more attention to setting up internal quality assurance systems at multiple levels. Since 1878 when the engineering degree was first awarded, Purdue has been ranked among universities with the most undergraduate degrees in engineering. Purdue enjoys a high prestige with excellent quality in engineering education not only in the United States but also among the international engineering education field. Its high quality in engineering education strongly depends on the external and internal quality assurance in teaching.

This study is interested in two specific aspects. First, in what extent does the quality assurance by ABET accreditation affect the engineering education at Purdue? The second aspect is to know what significant changes have been made at Purdue by ABET accreditation. Further, the principal concern of this study is with the internal educational quality control and its implementation through the process of accreditation. It is assumed that it is necessary to explore how colleges and universities in the United States fully exert their own functions and establish the internal quality assurance mechanisms in order to continuously promote quality improvement.

2. Literature Review

Higher education has globally transferred from the elite stage to the massification stage. The enrollment expansion of higher education has sparked the concern of the quality of higher education. The research on internal quality assurance of higher education gradually becomes a hot issue in the current theoretical research of higher education. Research on Internal Quality Assurance is mainly at the university level. And it mainly includes the definition, function, principle, content, method, and model, theoretical and practical foundation of quality assurance in higher education. With the rise of quality problems in higher education, research on quality of engineering education also emerged. Research on quality assurance in engineering education mainly relates to engineering education accreditation. Research topics of external quality assurance in higher engineering education are mainly inclusive of organization, criteria, process and international comparative research of accreditation system.

In the United States, since 1932 when ECPD promulgated the first engineering accreditation criteria, much research literatures have been related to accreditation criteria and accreditation implementation. Particularly since the implementation of EC2000, there are more and more research articles related to Engineering Criteria 2000 (EC2000), which are inclusive of researches on background, perspective, philosophy, philosophy of EC2000, its impact on U.S. and global engineering education, teaching reforms in colleges and universities, and the educational quality improvement initiatives under the EC2000, etc.. Research articles on teaching reform mainly focused on the reform strategies of engineering

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Footnote:

1. The Engineers’ Council for Professional Development (ECPD) was founded in 1932 as an engineering professional body dedicated to the education, accreditation, regulation and professional development of engineering professionals and students in the United States. In 1980, ECPD was renamed the Accreditation Board for Engineering and Technology (ABET) to more accurately describe its emphasis on accreditation. http://www.abet.org/about-abet/history/
teaching and curriculum from the perspective of curriculum design, students appraisal and classroom teaching evaluation under ABET accreditation, and impact of ABET upon the development of engineering disciplines and programs. A few monographs were also produced. Research on quality assurance in engineering education mainly involved internal assurance strategies based on Total Quality Management (TQM), ISO 9001. In addition, there have been some case studies in colleges and universities on how to meet the accreditation. These case studies share the practical experiences of preparing for ABET accreditation.

Since the beginning of the 1990s, the concept of “quality” began to appear frequently in the field of engineering education practice, the principles of quality assurance (Total Quality Management, Quality Function Deployment, etc.) also began to be introduced into the field of engineering education. Related researches began to inspect the concept of quality and quality assurance philosophy of engineering education. In addition, research articles tried to introduce quality assurance philosophy to the research of engineering education. Finally, there are some research articles which compared EC2000 and ISO9000.

During the mid-1990s, the new accreditation criteria (EC2000) required the program define what the graduates should be able to do, and have continuous improvement process based on program outcome. In this context, there appeared a lot of research articles related to learning outcomes assessment. Other researches focused on the assessment methods of program and course. Course is an important carrier of engineering education, and course quality is the core element of the engineering education quality. Therefore, the course assessment is an important aspect of the quality assurance in engineering education. Related researches concentrated on general course assessment, capstone design course assessment, EPICS project assessment, and also share experiences based on course assessment within institutions practice.

The research perspective tends to the nature of “practice” when responding the program accreditation, however, weakens the nature of “theory” when discussing the quality of engineering education. Most researches are conducted to better answer the technical questions, which has the obvious nature of “practice”. The issue is the lack of diversity in research dimensions and perspectives. First of all, most researches focus on the program accreditation system of engineering education in the United States, and the research topics mainly relate to the accreditation philosophy, criterion, procedure, effectiveness, models and methods of quality assurance coping with program accreditation. However, the research perspectives excessively focus on the program dimension, and apparently lack the school-level dimension, college/department-level dimension, course-level dimension, which is difficult to utterly reflect the characteristics and principles of quality assurance practice.

Although there are many theoretical foundations such as Stakeholder Theory, Total Quality Management Theory, Bloom Classification Model and Cooper Learning Circulation, the theoretical interpretation is not complete when are introduced in the research topics.

3. Research Design

3.1. Research Hypothesis

The hypotheses of this study include, first, quality assurance mechanisms of engineering education consist of internal and external parts, both of which are closely connected; secondly, as for the subject of quality assurance, the internal quality assurance mechanism is more important than the external quality assurance mechanism, i.e. ABET accreditation; and thirdly, research-oriented universities like Purdue University should have established a relatively well-integrated internal quality assurance system of engineering education. Figure 1 briefly
shows the preliminary framework of the quality assurance mechanisms of engineering education which is composed of external and internal quality assurance mechanisms for engineering education. Indeed, the external quality assurance mechanisms of higher education in U.S. consist of accreditation, academic rankings, federal and state governance. As for engineering education, program accreditation is virtually the direct and main quality assurance mechanism. In order to cope with the requirements of program accreditation, the higher learning institutes are supposed to establish integrated internal quality assurance mechanisms including self-evaluation mechanism. Actually, ABET requires the programs applying for accreditation to establish self-evaluation mechanism which is part of accreditation process. Thus, the self-evaluation mechanism is part responsible for coping with program accreditation, and part servicing for the internal quality assurance. In fact, colleges and universities might establish self-evaluation mechanisms at the course, program, departmental, college or university level beyond the self-evaluation mechanism coping with accreditation. The function mechanism of accreditation appears exactly in the intersection, as figure 1 showed.

![Figure 1. Preliminary Framework of Quality Assurance Mechanisms of Engineering Education](image)

### 3.2. Research Question

The purpose of this research is tri-fold. First, the perceptions on quality assurance in engineering education at Purdue University are explored. Secondly, the mechanisms of quality assurance in engineering education at Purdue University are analyzed. Thirdly, the characteristics of the mechanisms of quality assurance in engineering education at Purdue University are studied as reference which others can follow to develop an quality assurance system within a given college or department. The research questions which guided this study are:

1. What are the attitudes and perceptions towards ABET accreditation among the key stakeholders involved in accreditation?
2. How the quality assurance mechanisms in engineering education are established and implemented at Purdue University?

### 3.3. Research Method

The research is conducted on the basis of Grounded Theory which is a systematic methodology in the social sciences involving the construction of theory through the analysis of data. As researchers review the data collected, repeated ideas, concepts or elements become apparent, and are tagged with codes, which have been extracted from the data. As more data are collected, and as data are re-reviewed, codes can be grouped into concepts, and
then into categories. These categories may become the basis for new theory. Thus, grounded theory is quite different from the traditional model of research, where the researcher chooses an existing theoretical framework, and only then collects data to show how the theory does or does not apply to the phenomenon under study. Grounded Theory is an inductive type of research which is one of the frequently used qualitative research approaches. The main research methods consist of literature analysis and interview.

3.3.1. Literature Analysis

The research intended to comprehensively collect and review the literature materials about the quality assurance in engineering education within higher learning institutions in the United States from the perspectives of Organizational Behavior, Policy Science, Management Science and Pedagogics, analyze and discuss the historical background, implementation and influence of the quality assurance in engineering education. Specifically, the research selected representative colleges and universities in the United States, collected policy text and regulations, summary report, meeting materials, policy text of educational authorities and ABET official documents.

3.3.2. Interview

The research used all possible opportunities to experience the practice of higher engineering education in the United States, extensively exchanged with ABET officials and key members of the Committee, explored the uniqueness, complexity and practical effect of the quality assurance in engineering education, so as to have a more comprehensive perceptual understanding of the quality assurance in higher engineering education. In the process of research, interviews were conducted by face-to-face interview. The interview time for each interviewee was approximately one hour. Prior to the interview, the researchers developed scientific interview outline and interview questions through repeated discussions with the advisor, which provided a good expert validity.

3.4. Data Collection

3.4.1. Design of Research Protocol

The researcher visited Purdue University as a visiting scholar between March and June, in 2013. Purdue University had taken part in accreditation in 2007, and would receive ABET reaccreditation in July. Every school of engineering at Purdue University had to start significant self study of ABET on July one, and do internal review before have all the drafts done on June one. There are totally 14 or 15 programs which were required go through the accreditation process. The researcher’s cooperative advisor whose main research was interested in engineering education history had abundant working experiences at Purdue University, and involved in ABET accreditation. The advisor provided systematical academic consultation and guidance for this research. Previous the interview, the researcher collaborated together to design scientific interview protocol and questions which attained good expert validity. In process of research, the researcher made some adjustments on interview protocol and questions to improve the effectiveness. In addition, the researcher combined literature analysis and in-depth interview to improve the reliability. In order to evaluate the protocol, methods and strategies, and to clarify the interpretations and ideas, the researcher had his advisor comment and review on the research plans, findings and conclusions as they developed. The interview protocol includes following questions:

1. External quality assurance is important at Purdue for what purposes or objectives?
Why is it important for these things?

2. What are your views on external quality assurance from ABET accreditation in general?

3. What impact has the ABET accreditation on internal quality assurance in the engineering education had within your department? Are there contradictions/tensions related to internal vs. external quality assurance?

4. What significant changes have you observed in quality assurance in engineering education since the implementation of ABET EC2000?

5. What internal quality assurance systems, processes, data management tools, etc. does your department/program use?

6. What do your departments/programs do in order to demonstrate quality or excellence beyond what is required by external quality assurance? What kind of metrics/data/evidence is collected to demonstrate this quality?

7. What are your views on your department’s/program’s methods of internal quality assurance?

8. What policies and principles frame the quality assurance system of your department? How are policies of internal quality assurance made? Bottom-up or top-down? Are there contradictions/tensions related to internal quality assurance between the department/program, college, and/or university?

3.4.2. Selection of Interviewee

Table 1. Introduction of participants

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>GENDER</th>
<th>POSITION OR RANK</th>
<th>ACCREDITATION EXPERIENCE</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Female</td>
<td>Director of Strategic Planning and Assessment</td>
<td>Former</td>
</tr>
<tr>
<td>2</td>
<td>Female</td>
<td>Director of Assessment for the Office of the Provost</td>
<td>Former</td>
</tr>
<tr>
<td>3</td>
<td>Male</td>
<td>Associate Professor of Electrical and Computer Engineering/Undergraduate Coordinator</td>
<td>Former</td>
</tr>
<tr>
<td>4</td>
<td>Male</td>
<td>Associate Head and Professor of Aeronautics and Astronautics/ABET Coordinator</td>
<td>Former</td>
</tr>
<tr>
<td>5</td>
<td>Male</td>
<td>Associate Dean of Engineering for Undergraduate Education/Professor of Chemical Engineering</td>
<td>Former</td>
</tr>
<tr>
<td>6</td>
<td>Female</td>
<td>Associate Professor of College of Engineering Education</td>
<td>Former</td>
</tr>
<tr>
<td>7</td>
<td>Male</td>
<td>Director of Engineering Education Undergraduate Degree Programs</td>
<td>Former</td>
</tr>
<tr>
<td>8</td>
<td>Male</td>
<td>Professor Agricultural &amp; Biological Engineering</td>
<td>Former</td>
</tr>
<tr>
<td>9</td>
<td>Female</td>
<td>Associate Professor of College of Engineering Education</td>
<td>Former</td>
</tr>
<tr>
<td>10</td>
<td>Male</td>
<td>Associate Professor of College of Engineering Education</td>
<td>Former</td>
</tr>
</tbody>
</table>
According to the relevance of professionals with this study, and the current situation of engineering education at Purdue University, the researcher chose the interviewees at Purdue University with the guidance of his advisor. The researcher finally took interview with ten key stakeholders mainly consisted of engineering faculty and administrative staff who were involved with ABET accreditation at Purdue University (Table 1). The researcher assumed that individuals who were involved in both educational process and accreditation were able to assess the effectiveness and efficiency of quality assurance in engineering education. Thus, interviewees all have following characteristics: participating in and affected by accreditation; teaching or administering in accredited program; maintaining responsibility for assessing learning outcomes.

The stakeholders were interviewed using a semi-structured protocol which elicited their concrete experiences of preparing for ABET accreditation, as well as their attitudes towards quality assurance in engineering education. As the interview went forward, research issues became continuously more and more complex. In order to improve the particularity and effectiveness of the interview, the researcher adjusted the interview outline and questions.

### 3.4.3. Collection of Qualitative Data

The interviews followed a face-to-face model. The mediate interview time is about one hour (Table 2). In order to take an in-depth analysis of interview data, this study transfers all recording transcription into text, and finally forms English text after repeatedly proofreading. The researcher tries to code the interview data in order to ensure the validity of study. Close to the beginning of the interview, the researcher designs the scientific interview outline and the interview questions. In addition, this study uses the multivariate (triangle) test in order to achieve objectiveness and rigorousness, hence enhancing the credibility of the qualitative study. At the same time, this study combines integrated literature review with in-depth interview, compares the conclusion with views widely accepted by academy of engineering education.

### 3.5. Data Analysis

#### 3.5.1. Introduction of Analysis Tool

<table>
<thead>
<tr>
<th>NAME</th>
<th>INTERVIEW TIME</th>
<th>INTERVIEW DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mary Brown</td>
<td>00:59:43</td>
<td>04/24/2013</td>
</tr>
<tr>
<td>Jennifer Smith</td>
<td>00:44:59</td>
<td>04/15/2013</td>
</tr>
<tr>
<td>John Varner</td>
<td>01:02:13</td>
<td>05/01/2013</td>
</tr>
<tr>
<td>Frank Miller</td>
<td>00:59:00</td>
<td>05/07/2013</td>
</tr>
<tr>
<td>Jack Moore</td>
<td>01:00:51</td>
<td>05/08/2013</td>
</tr>
<tr>
<td>Nancy Reiner</td>
<td>00:53:47</td>
<td>05/31/2013</td>
</tr>
<tr>
<td>James Taylor</td>
<td>00:46:08</td>
<td>04/09/2013</td>
</tr>
<tr>
<td>Wales Reed</td>
<td>01:18:33</td>
<td>06/05/2013</td>
</tr>
<tr>
<td>Lucy Vacant</td>
<td>01:00:30</td>
<td>06/08/2013</td>
</tr>
<tr>
<td>Thomas Robinson</td>
<td>01:15:40</td>
<td>06/11/2013</td>
</tr>
</tbody>
</table>

Note: The names are all pseudonyms.
This study chooses NVIVO 11.0 as data processing tool. NVIVO 11.0 is professional analysis software of qualitative data, and can make in-depth qualitative analysis on the video, audio clips, interviews, documents, photos, media content, and so on.\textsuperscript{28} It can help the researcher extract valuable views from the data by encoding, classification, induction and analysis of research content, and record the thinking process for subsequent analysis. This study mainly uses the function of data encoding, data analysis and statistics of NVIVO 11.0, which can analyze the overlapping of different views during the interview process based on the theme coding and hierarchical coding of the interview data, and further classify the same or similar views to extract valuable information for the research.

3.5.2. Application of Analysis Tool

In the process of data analysis, the researcher first input the transcript of Word formatted text into NVIVO 11.0(Figure 2), and made data encoding as for the research question and the interviewees’ views. In the process of coding, the research was based on the data analysis process of Ground Theory, and strictly adopted multiple coding process which consisted open coding, axial coding and selective coding.

![Figure 2. Capture of NVIVO 11.0 Working Preliminarily with Inputting Sources](image)

**Open Coding**

First of all, it uses the method of open coding to determine the related topics from the interviewees’ views. Open coding in Grounded Theory is the analytic process by which concepts to the observed data and phenomenon are attached during qualitative data analysis. It is one of the procedures for working with text as characterized by Strauss (1987), Strauss and Corbin (1990). Open coding aims at developing substantial codes describing, naming or classifying the phenomenon under consideration. Open coding is achieved by segmenting data into meaningful expressions and describing them in single words or short sequence of words. Further, relevant annotations and concepts are then attached to these expressions.\textsuperscript{29} According to the preliminary analysis of interview materials, the researcher obtained a total of 49 codes as following by the function of free node, “measure of data collection”, “time of data collection”, “pressure on faculty”, “design of learning objectives”, “assessment of...
Secondly, it uses the method of axial coding to review the data with code and concept. Axial coding is the disaggregation of core themes during qualitative data analysis. Axial coding in Grounded Theory is the process of relating codes (categories and concepts) to each other, via a combination of inductive and deductive thinking. The basic framework of generic relationships is understood, according to Strauss and Corbin who propose the use of a coding paradigm, \(^{30-31}\) to include categories related to (1) the phenomenon under study, (2) the conditions related to that phenomenon (context conditions, intervening -structural- conditions or causal conditions), (3) the actions and interactional strategies directed at managing or handling the phenomenon and (4) the consequences of the actions/interactions related to the phenomenon. In the process of open coding, more and more similar views appear. The free nodes are transferred into a tree node under which related views are classified. In the axial coding process, the researcher related the open codes with similar themes or concepts together. For instance, “time of data collection”, “measure of data collection”, “focus on
learning outcomes”, “focus on professional skills”, “design of learning objectives” and “assessment of program” were all categorized into a tree node-“assessment”. “Teaching technology”, “teaching method”, “teaching culture”, “learning method”, “teaching philosophy” were all categorized into a tree node-teaching and learning.

Selective Coding

Finally, it uses the method of selective coding to categorize the core concept. Selective coding in Grounded Theory is the choosing of one category as the core concept, around which the other categories from the axial coding phase are grouped for the purpose of explaining the phenomena which has been observed. For instance, “teaching and learning”, “policy”, “organization”, “faculty”, “curriculum”, “culture”, “assessment” were all categorized into the core concept-impact of program accreditation. At last, the researcher categorizes three core concepts, “issues of quality assurance mechanism”, “internal quality assurance mechanism”, “external quality assurance”. As the increase of views and further understanding of researcher to interview data, the tree node and data classification are constantly adjusted. The analysis framework is finally established after the completion of all data coding.

4. Research Findings

4.1. External Quality Assurance Mechanism

4.1.1. Strengths of Program Accreditation

In the United States, the development of professional accreditation of engineering education has been continuously implemented for 80 years. ABET has been committed to optimize and implement the accreditation process which is regarded as the most efficient and innovative method of quality assurance in higher education. By 2013, 3278 programs of 671 colleges and universities in the United States have been accredited, which clearly illustrates that “despite the changes and new trends in education, institutions, faculty, and students in the United States see ABET accreditation as the gold standard in technical education accreditation, much as they did 80 years ago.” Meanwhile, ABET aimed to be more responsive to the needs of an increasingly complex and globally diverse set of constituents throughout the world. ABET began to offer accreditation services outside the United States in 2007, in response to a growing demand from international institutions. Within five years, 324 academic programs at 64 institutions in 23 other nations have achieved ABET accreditation. Interviewees universally approve the role and legitimacy of ABET in quality assurance.

Requirements of Various Stakeholders

In the United States, the state government has regulation which demands that only graduates from ABET-accredited programs have the certification to become qualified professional engineers. Thus, the majority of colleges and universities are actively involved in accreditation even if applying for ABET accreditation is voluntary. As the Director of Engineering Education and responsible for undergraduate degree programs, Mr. Taylor argued,

“External quality assurance is very important at Purdue. This is informed by the State. State says that you must graduate from ABET-accredited programs to become a license professional engineer. Now, most engineers in USA are not professional engineers, but people who work with the government. And lots of my graduates are going to consult and eventually work with the government. So, that is why it is important to be given accreditation from ABET. That is a legal reason
because of the legal requires.”

Except for the state government, requirements still came from the industry, parents and students, as Mr. Varner argued,

“No, it is voluntary. We don’t have to do it. But there is a pressure from, you know, industry. They want to have accredited graduates from the ABET-accredited programs. There is pressure from the parents, because they want their students be graduated from the programs. For a long wire, MIT did not take accreditation, because their reputation, you know they are always the typical No.1. But even this is the pressure from the industry, probably from the parents, students who want their degree accredited. I think ABET helps bring together different opinions across academic units, or what engineering education should be provided. You will look at the ABET criteria, they all make sense.”

Requirements of Continuous Improvement

When asked “External quality assurance is important at Purdue for what purposes or objectives? Why it is important for these things?” respondents all identify the importance and legality of ABET in promoting the quality assurance in engineering education within colleges and universities. The interviewees all recognized the importance of program accreditation by articulating “it is a reasonably good job which particularly takes our graduate criteria,” “it is important process which is reasonable for university like Purdue to go back to check with the university to make sure the thing that they should be doing,” “ABET accreditation is very important that they want to assure that program that the students being taught the appropriate things of program,” as Mr. Reed argued,

“As for the strengths, it does have motivated the exams, curriculum improved properly. That is important. That is beneficial. It motivated to look at the kind of feedback if you get from alumni to students and the faculties, to put together, to make appropriate changes. That is the beneficial part. That gets exited, not so beneficial system tremendous amount of work. I think when you document everything that actually works. You could not do improvement without documentation and review.”

4.1.2. Impact of Program Accreditation

Are post-EC2000 engineering graduates any better prepared to enter the profession than were their pre-EC2000 counterparts a decade ago? What impact, if any, has EC2000 had on student learning outcomes in ABET-accredited programs and institutions? What impact, if any, has EC2000 had on organizational and educational policies and practices that may have led to improved student learning outcomes? To answer these questions, the Penn State research team examined educational practices in engineering programs and assessed student performance pre- and post-implementation of EC2000. The conceptual model guiding the study (Figure 4) summarizes the logic of the study’s design.

Figure 4 assumes that, if implementation of the EC2000 evaluation criteria is having the desired effect, several changes in engineering programs would be evident:

Engineering programs would make changes to align their curricula and instructional practices with the 11 learning outcomes specified by EC2000 (Criterion 3.a-k).

Alterations in the faculty culture would be evident as faculty members engaged at a higher rate than before EC2000 in activities such as outcomes assessment and curriculum revision.

Faculty and program administrators would adjust program practices and policies
Regarding faculty hiring, salary merit increases, tenure, and promotion criteria to give greater recognition to the kinds of teaching and learning required by EC2000.

All of those program changes would reshape students’ educational experiences inside and outside the classroom, which would in turn enhance student learning (defined as improved student performance on measures of the 11 EC2000 learning outcomes).

Employers would report improvements in the knowledge and competencies of the engineering graduates they have hired since implementation of EC2000.

![Figure 4. Conceptual Framework for Engineering Change Study](image)

Comparisons of 1994 and 2004 graduates’ self-reported learning outcomes show 2004 graduates as measurably better prepared than their counterparts in all nine learning areas assessed. However, in fact, it may be a different story for specific university like Purdue University, as Mr. Smith argued,

“Do you mean the significant change? No, minor. I think what is kept from having a huge significant impact is what we’re talking about the weakness, the amount of work, the amount of effort, a amount of people’s work. You know, when we create the document to collect all the definite information, they only look at one small bit of it. I don’t think there has been huge change at all.”

Actually, there are some changes due to ABET accreditation although it may be not significant change. Most of the changes are directly from program accreditation. According to the interviewees, the impact mainly is reflected in “assessment”, “faculty”, “culture”, “teaching and learning”, “organization” and “policy”.

**Assessment**

Assessment is of importance for program which prepares the accreditation. Thus, assessment is the most important impact of accreditation on program. One responsibility of engineering program is to pay more attention to or even make significant innovation in assessment. The impact mainly is reflected in “time of data collection”, “measure of data collection”, “focus on learning outcomes” and “continuous improvement mechanism”.

Time of data collection was frequently referred by the interviewees as a positive impact upon program. For instance, Mr. Miller argued, “we have to spend and organize months of time in collecting data, because if you do not have the data to be sent to ABET, there will have a trouble.” Mr. Smith argued, “the biggest weakness right now from the ABET accreditation is
the amount of paper’s work, you know, a lot of busy work. I think the main tension is that you are throwing one more thing at me to do, and I am already too busy. That is exactly the tension.”

Measure of data collection refers to the technical section of data collection, and consist direct and indirect measurement, or formal assessment and informal assessment which are frequently innovated by program. For instance, Mr. Miller argued, “people do not tell us how they measure things. What we are to measure specifically, I mean a-k, are very general statements. They have no meaning and tell you actually how to measure. It will be important if we select direct measures and indirect measures.” Mr. Varner argued, “we have a variety of assessment methods like exams, projects, homework assignments, survey. There is direct measure in the classroom. Now, we go back to look over all the experience through feedback on how you did generally. We ask something to employers, looking at our graduates how well they prepared.” Mr. Moore argued, “I would say the assessment will be prepared for ABET outcomes. And you can hear from very meticulous types of assessments, i.e. formal assessments and informal assessments. And this is just the type of evaluator wants to ask. But usually, the assessment piece has been done before the evaluators show up, and in the report sent to the ABET.” Mr. Varner argued, “we have created assessment plan because ABET mandates that. So, we have assessment plan that we try to monitor courses and actually the performance of students on the regular basis. Basically, we didn’t really change much how we did things. We assess learning outcomes to each of our courses, and map those to a-k, in the normal courses. I think most of departments do the similar things. But there are certainly other ways as I know. The university thinks of differently. They could just be some periodically final assessment in the product in all outcomes.”

Learning outcomes are the focus of EC2000 Criterion 3. Every program is supposed to innovate assessment methods to prove that the students achieve the learning outcomes when they graduate. For instance, Mr. Moore argued, “ I think the ABET EC2000 was a good switch from the old way we doing things. I think focusing on learning outcomes was a right way to go because at the end of the day students come to the university to learn, companies hire students who have learned or supposed to learn something.” Mr. Varner argued, “But the truth is that everything we do probably looks good. Really, the main change that we made as result of EC2000 is adding learning outcome to all the courses and assessing the courses data on individual’s learning outcomes, not just overall grade. That is significant change that ABET did.”

Continuous improvement mechanism is required by ABET. With the in-depth implementation of ABET accreditation, “Continuous Quality Improvement” (CQI) advocated by EC2000 has been deeply rooted in the hearts of the people. When asked “What policies and principles frame the quality assurance system of your department?” respondents mentioned many times and identified the concept of program accreditation, CQI. For instance, Mr. Moore argued, “the faculty will look at their courses, and will assess which is the weakness in the course, and make a judgment for the course to improve the area. And they assess on the students are learning the materials better after these changes have been made. So that is continuous improvement in the process, faculty are always assessing their courses to see if the students are learning materials. They also can find out other ways to improve the course, so the students can learn the materials better. So that is what continuous improvement is doing with the assessment data and using it to improve the course.” However, under the external pressure of accreditation, not everyone agrees with this concept although it has penetrated into people’s thought and practice, as Mr. Varner argued, “CQI is not a new idea. It is a label that people put on it. Now, they change the focus. It is true. I’m not sure it truly succeeds like that. They actually still perform, and still pretty much dictate what has to be
Faculty

Faculty has different attitudes towards program accreditation. Although it is the main responsibility of faculty to prepare for accreditation, faculty always feels pressure or even maintains resistance to program accreditation. However, program accreditation brings both pressure and benefits to faculty. For instance, Mr. Miller argued, “our faculty care about doing a good job in teaching. They do not want anybody else, faculty member or committee much like ABET to tell you how to do a good job. So there is normal resistance against doing exactly what ABET want them to do. ABET requires them to collect performance data what they are doing and what they are achieving, to collectively to modify the program to better improve the achievement. The faculty does not want to do that. That does not mean they are not interested in improving, but they are not interested in doing response to the demand from external pressure. Mr. Taylor argued, “well, I mean all the men take the responsibility, from the dean and the departments' heads-they have done with the ABET coordinator and the individual faculty. But the problem is that professors do hundreds of different things. This is one of them. And this is one that they can’t avoid, not like research paper……I think what happened is that except for when they actually know they have to do ABET assessment which is the year before the visit, people turn to do nothing with ABET assessment because it does not appears critically urgent. And if you want to get promoted, I passed it. But if you are in the system of associate professors, and you want to get promoted, then it seems much more urgent and critical, and get the papers written and to get good student evaluations.” Mr. Moore argued, “the ABET allows the professors, they give the professors the opportunity to think about, not just share much information and the students growth, but how do I do in the way that facilitates the learning.”

Culture

Program accreditation, as an external quality assurance mechanism, actually brings great challenge to the higher learning institute which has specific culture or environment. In order to copy with accreditation, colleges and departments have to communicate with each other for their successful experiences, all stakeholders including the dean, department head, faculty and staff have to work together to create a cooperative culture. For instance, Mrs. Reiner argued, “I think the biggest change I can see is not within our department but how for us better doing the first year engineering in the way of communicating with other departments. It is neither opportunity for us to help other engineering departments to better understand what we are doing in the first year engineering classes because they need to know what we are doing. They can do their ABET process. They need to better understand what we are doing. That is the opportunity for us to share with them for them understanding what our students learn in the class.”

Teaching and Learning

Program accreditation still brings change of teaching technology, teaching philosophy, teaching method and learning method. Amongst them, teaching philosophy may be directly impacted by accreditation. For instance, Mr. Smith argued, “the biggest impact of ABET accreditation is starting conversation about students’ learning outcomes, the conversation about what can students do. For years and years and years, the engineering education was recovered with these topics. What the students need to be able to do influenced dynamically. So it is a kind of change from what one-way communication outward to what they actually taken in the students’ classroom. We can understand and often talk, but are they absorbing
what they need to be able to do to be successful in their career? So that is a kind of change of mind from the faculty-centered to more student-centered, learning focused.’” Relatively, teaching technology, teaching method or learning method may be indirectly impacted by accreditation, as Mr. Miller argued, “there are people here who are from our classes. You give the students homework before you go to the class. They do the homework before the class, and in class they talk about it. That is called ‘flipped classroom’. However, I do not think any of the ‘flipped classroom’ always works.”

Organization

Program accreditation, to some extent, makes organizational reform, which means that the institute has to create specific positions of dealing with accreditation affairs. Additionally, special teams or strategic groups are required to be established. For instance, Mrs. Brown argued, “I think the one thing that helps is because our college is large—there are 13 schools in divisions. And all of them have a formal ABET review……But I think one of the things that help assure a kind of long term quality of approach is that their associate dean in the dean’s office be responsible for warranting about the graduate education. Appointed representatives of each discipline discuss all kinds of things throughout the year. It’s chaired by the associate dean from the graduate education. They talk about many things beyond ABET……Most of the time, the person served on that committee is also their ABET leader……served on the group called engineering leadership team which we are striving. We all meet regularly……”

Policy

There is no special policy to promote the establishment of quality assurance mechanisms at the college and department level. In addition, respondents indicate that there is no specific policy to promote the establishment of quality assurance mechanisms, as Mr. Smith argued “the policy comes from that the federal government, saying you need to do. The principle that we basically follow is about “improving students’ learning”. We do this to improve students’ learning. Where we are now, where we should go, are students learning, what we think students should learn to be successful. That is the basically guiding principle.” Respondents think that quality assurance depends on active faculty culture. Additionally, the individual effort of pursuing excellence is very important, as Mr. Taylor argued “ABET is top-down, the individual motivation for doing better job is bottom-up. Suppose I am teaching IDE301, and I develop the course, and suppose I decide to use new teaching methods. That would be driven by my desire to do better. Because as far as the ABET quality assurance concerns, I am doing well enough. I mean I give the data they want.”

4.1.3. Deficiencies of External Quality Assurance Mechanism

During the process of development, the accreditation effectiveness of ABET has been much questioned. At the end of the 20th century, as the frequency of accreditation and site visits increases, requirements for the legality of accreditation decisions increases as well. Accreditation criteria became more and more quantitative, and rarely relied on the professional judgment. In the early 1990s, ABET acted as a role of “protector” regardless of its good original intention, which gradually became a stumbling block for educational reform. Complaints from the engineering education community intensified. Both as engineer and president, President James J. Duderstadt of Michigan University and President Charles M. Vest of MIT stated jointly, engineering education must make significant changes to support the new quality-oriented environment, the rigid and multifarious accreditation criteria seriously hindered the development of engineering educational reform. These concerns received positive response of the Industry Advisory Council and the deans of the large
engineering colleges. This revolution eventually led to the EC2000 pilot reform at the end of 20th century.

However, over the last decade ABET has been in query. The respondents illustrate their views about ABET by their own participation in accreditation and educational experience. Respondents think accreditation brings a lot of work. In order to meet the demand of ABET, the school requires a large number of human resources, a lot of time, to prepare the information beyond the actual material, as argued by Mr. Smith, “The biggest weakness right now with the ABET accreditation is the amount of paper’s work, you know, a lot of busywork to do the report and report on the criteria.” Professors just respond to accreditation according to the basic request of ABET. But they do not show interest in the external pressure from ABET, which does not indicate that they have no interest in quality improvement. As an ABET coordinator, associate head and professor of Aeronautics and Astronautics, Mr. Miller argued, “Our faculty care about doing a good job in teaching. They do not want anybody else like faculty member or committee much like ABET tell you how to do a good job. So there is normal resistance against doing exactly what ABET want them to do.”

4.2. Internal Quality Assurance Mechanism

4.2.1. Transformation of Internal Quality Assurance Mechanism

EC2000 is a series of accreditation criteria jointly developed by its stakeholders through revision at the end of the 20th century in order to cope with the challenge of internal and external pressure. The criteria pay attention to learning outcomes, self evaluation and continuous improvement, rather than specific courses. In 2002, the United States launched an investigation of the impact of EC2000 on engineering education in order to evaluate the effectiveness of the new criteria. The preliminary conclusions of this study encourage people to support the continuous improvement of ABET accreditation. Through teachers’ active participation and efforts, student learning outcomes assessment as an important measure at Purdue is carried out successfully. The final purpose of assessment is to improve the teaching. The leaders of the school and college are trying to promote this progress. Effective student learning outcomes assessment programs help teachers to shift teaching model from “teacher-centered” to “student-centered”, which is an important transformation of colleges and universities. Respondents universally accept the transformation from “teacher-centered” to “student-centered”, as Mr. Smith argued,

“The biggest impact of ABET accreditation is starting conversation about student learning outcomes……So that is a kind of change of mind from the faculty-centered to more student-centered, learning focused.” “It is really a smart way to go, because now the thing you could focus on is how well you are covering your outcome.”

As of EC2000 reform, there are some changes of quality assurance in engineering education within colleges and universities, but there is no significant change. When asked “since the implementation of EC2000, what major changes do you think about quality assurance in engineering education is?” respondents generally believe that ABET EC2000 reform does not trigger a very significant change. If any, it is very small, as Mr.Varner argued,

“Nothing specifically came out directly from the result of ABET. We take the way that ABET is happy with. But you know the truth. Everything we do probably looks good. We have ‘flash classroom’ for the first year engineering students. It has studio, labs. Things are better going on. Really, the main change that we made as result of EC2000 was adding learning outcome to all the courses
and assessing the courses data on individual’s learning outcomes, not just overall
grade. That is significant change what ABET did.”

4.2.2. Perception on Quality Assurance in Engineering Education

Quality perceptions are basic views of subject about quality as well as judgment on the
realization degree of quality. Quality perceptions on quality assurance in engineering
education refer to views and judgment of engineering education quality, which embodies on
the evaluation and judgment of engineering education quality. As for Purdue, ABET
accreditation in only a kind of quality assurance at minimum level, as Mr. Taylor argued,

“ABET originally was set up to ensure the minimum level quality were met.
What ABET has done, to a very large stance, is a good thing. They have made sure
for every engineering program across the country is looking at important thing, at
least to some extent.”

As a top research university, Purdue makes more efforts in order to demonstrate quality or
excellence beyond what is required by external quality assurance, as Mr. Smith argued,

“Some other things that we measure in report are things like ‘professional
licensure’-the number of students successfully gets that “professional licensure”,
what kinds of jobs they get, and the average salary. Purdue engineers turn to get
better more managerial types of jobs than just simple civil engineer like other
schools. (As for) the type of jobs, we look at the number of our alumni as
president or vice president in different companies. So we promote the quality of
our alumni when they leave Purdue. We look at wealthy students now here, or the
number of them required for all students. We have a lot of other opportunities for
them to demonstrate things like EPICS\(^1\). Students participate in EPICS. We look
at the number of students that have found a job after graduation, going into the
graduate school, what their GRE score were. So there is no one single measure we
used for all our students. Every year, department makes annual report to their
college, each dean of the college organizes it, and they send the report to my
provost office. So we can pull out the stories whatever from all aggregated.”

As for Purdue’s quality of engineering education, respondents universally approve that
Purdue has an excellent quality, as Mr. Reed believed,

“Purdue gets good students. Students of engineering are good, are qualified. I
think it gets good students, but partly I think the reputation. It has a lot of demands
to get engineering education a lot of people. So, Purdue’s engineering is a good
school. I think it helps to attract the students, and it maintains good high quality
students.”

4.2.3. Organizational Mechanisms of Quality Assurance at the University Level

By the interview with stakeholders, the preliminary core finding is that it might have
integrated or harmonious quality assurance mechanisms at Purdue. Purdue always
emphasizes the importance of teaching quality, and has formed a relatively integrated quality

\(^1\)Engineering Projects in Community Service (EPICS) is a service-learning design program in which teams
of students partner with local and global community organizations to address human, community, and
environmental needs. EPICS was founded at Purdue University in Fall 1995.
https://engineering.purdue.edu/EPICS
assurance system in higher education, particularly in engineering education. The system includes following basic mechanisms, organization mechanisms of supporting effective teaching, evaluation mechanisms of teaching and learning. There are some specific mechanism characteristics under the context of Purdue University whose innovative approaches are able to provide references for other colleges and universities, especially those who lack evaluation culture.

Currently, Purdue is responsible for the management of quality assurance through Center for Instructional Excellence (CIE), Teaching Academy, and Office of the Provost.

**Center for Instructional Excellence**

The Center for Instructional Excellence (CIE) is the primary resource on campus for teaching and learning support services, and CIE has had a major impact on teaching and learning since its creation in 1998. CIE provides opportunities for faculty development through workshops, seminars, and teaching consultation. CIE also provides faculty with a number of support services, including a proctor pool to assist with test administration; instructional data processing (scoring bubble sheets); consultation with academic units and individual instructors on specific classroom teaching improvements; and an online resource with teaching topics and tips, ranging from cooperative and collaborative learning techniques to large class teaching and learning styles. CIE plays a proactive role and provides stewardship for the scholarship of teaching and learning through its affiliate membership in the Carnegie Academy for the Scholarship of Teaching and Learning.

**Teaching Academy**

The Teaching Academy is a group of master teachers brought together through a competitive nomination process to create a collective voice for teaching and learning on campus. The academy's mission is to provide leadership and resources to enhance the quality of undergraduate, graduate, and outreach teaching and learning. Academy fellows lead a seminar series, Conversations about Teaching, on important educational issues, and the academy regularly invites prominent teaching and teaching assessment scholars to present seminars on campus. The academy's faculty mentoring network connects fellows with junior faculty members to support their development as scholarly teachers, and the competitive travel grant program provides financial support for travel to professional conferences focused on teaching and learning. Faculty, professional teaching staff, and graduate teaching assistants are eligible for membership in the academy.

**Office of the Provost**

The goal of our office is to help provide the highest quality learning and research environments possible and to encourage engagement with various communities across the State of Indiana, throughout the country, and around the world. One of the important functions of the Office of the Provost is Academic Program Assessment. For instance, in the 2011-2012 academic year, the Office of the Provost in coordination with the Office of the Vice President for Research (OVPR) and the Office of Institutional Research (OIR) planned an Academic Program Assessment (APA) over the course of the 2011-2012 academic year.

**4.2.4. Organizational Mechanisms at the College/Departmental Level**

While the ABET has been added to the breadth of most engineering curricula, they fail to
emphasize key skills such as leadership, innovation, entrepreneurship, and managing change. In 2004, after the release of the NAE publication “The Engineer of 2020: Visions of Engineering in the New Century”, Purdue’s Engineer of 2020 initiative came into implementation. How to adapt an engineering program to meet the changing needs of 21st century graduates? Purdue’s first step was to engage faculty and other constituents (alumni, employers, students, etc.) in an extended discussion about the target attributes we need to develop in our students. After two years of discussions and at times heated debate, Purdue’s Engineer of 2020 Target Attributes was approved by our faculty. The 20 target attributes are listed below under the headings of abilities, knowledge areas, and qualities (Figure 5). 

As the needs of industry change, Purdue needs to adapt curricula to encourage these attributes in graduates so they’ll be positioned for success in today’s economy. Strategies for fostering change are four-fold: a. Engineer of 2020 workshop Purdue will organize and sponsor an annual Engineer of 2020 workshop focused on three key attributes, using material and international experts to guide our discussion. The chosen attributes will be rotated on an annual basis. b. Engineer of 2020 seed grant program Purdue will coordinate, evaluate, and administer an annual Engineer of 2020 seed grant program. Proposals will be evaluated on a competitive basis based on the potential importance and relevancy to the related target attributes. c. Travel funds to strategic workshops and conferences Purdue will provide funding for faculty and/or staff on a select basis to attend strategic conferences and workshops relevant to the target attributes. Awardees will be expected to provide a summary report of lessons learned. d. Sharing of best practices Purdue will facilitate the sharing of best practices among the schools in the College and promote cross-disciplinary curriculum innovation related to the target attributes.
4.2.5. Evaluation Mechanisms of Quality Assurance

**Evaluation Mechanisms of Teaching**

At Purdue, teaching quality evaluation has become an important quality assurance mechanism both at the university and college levels. The University Senate Document prescribes that there should be a university-wide teaching evaluation initiative to improve teaching through the development and use of teaching evaluations drawn from multiple sources.

*Course evaluation.* Student course evaluation will be obtained in a confidence and in a uniform manner.

*Peer evaluation.* Course materials may be examined by peers and, where applicable, by departmental promotions committees as part of the promotions process. The product of teaching scholarship, texts, pedagogical papers, multimedia presentations, presentations at meetings, grants for instructional improvement etc., will be evaluated for impact both within and beyond Purdue. External referees can be used for these evaluations.

*Self evaluation.* Faculty should reflect on, and have an opportunity to document, their own contributions to teaching, including their formative efforts to improve teaching.

**Evaluation Mechanisms of Learning**

Purdue’s basic framework for assessment is constructed upon four key components, and guide faculty in completing the assessment loop by asking what they want their students to learn; how they will help their students to learn; how they will know if and why their students have, or have not learned; and how they will use assessment information to improve their students’ learning.

Assessment Component #1: Define Learning Outcomes

While Purdue has no common core curriculum at the University level, core competencies were outlined in the *1995 Campus Assessment Plan* and in the *2001–2007 Strategic Plan*. These core competencies for Purdue students are:

- **Critical Thinking:** the ability to read and think critically;
- **Communication:** the ability to communicate, both orally and in writing, with clarity and precision;
- **Methods of Inquiry:** competency in quantitative and scientific reasoning;
- **Global Awareness:** awareness of the cultural, social, political, and economic forces, and the technologies that shape our world;
- **Content Knowledge:** depth of understanding of both the essential content and principal modes of inquiry in their areas of specialization;
- **Ethics:** familiarity with ethical issues facing their chosen fields;
- **Information Literacy:** competency in information literacy; and
- **Lifelong Learning:** ability to demonstrate that they are prepared for a lifetime of continual learning.

The responsibility for establishing and assessing learning outcomes within, and beyond the parameters of the core competencies rests with the faculty. Seven of Purdue’s ten colleges/schools (Agriculture, Consumer and Family Sciences, Education, Engineering, Liberal Arts, Science, and Technology) have defined learning outcomes.

Assessment Component #2: Facilitate Learning

Research for undergraduate students was a focus area of the *2001–2007 Strategic Plan*. The
impact of the greater focus on undergraduate research opportunities is evidenced by the fact that in 2007, 45 percent, and in 2008, 51 percent of the seniors who completed the Graduating Students Learning Outcomes Survey (GSLOS) indicated that they had participated in research activities. Examples of these research opportunities include the Discovery Park Undergraduate Research Internship, which involves students in interdisciplinary research projects; the Center for Authentic Science Practice in Education, an innovative effort aimed at providing undergraduate science students with earlier exposure to research experiences; and the Summer Undergraduate Research Fellowship program for students in science, technology, and engineering.

Assessment Component #3: Assess Learning
The assessment of student learning occurs both at the institutional and program levels. Assessment methods at the institutional level include surveys such as the Cooperative Institutional Research Program, GSLOS, and the National Survey of Student Engagement. Academic programs employ a wide variety of methods to assess student learning.

Assessment Component #4: Improve Learning
A review process is crucial for ensuring that student learning is monitored on an ongoing basis and that assessment evidence is used for continuous improvement of student learning. Most academic programs have some or all of the following elements in their review process to ensure that the assessment loop is closed. Assessment evidence is analyzed and translated into findings, and desired changes are implemented to improve student learning. New evidence is then gathered to assess changes and to continuously monitor learning. Responsibilities for the review process are shared by key stakeholders and effective mechanisms are in place for implementing the process.

5. Conclusions

According to the current situation of quality assurance system of higher engineering education in the United States, both external quality assurance from ABET and internal quality assurance at the level of universities, are expecting change and paradigm transformation. Engineering practice has proved that starting in the 1990s the American engineering education accreditation reform is significant. However, from the perspective of longitudinal development, the impact upon the quality improvement of engineering education is limited.

This paper finds that there exists the issue at even the research-oriented universities like Purdue University. Programs must assess student performance as part of their accreditation process. The assessment process includes collecting and analyzing the data to support a conclusion. It is essential to demonstrate objectives and outcomes for the program are being measured and accomplished. Programs often struggle with deciding what data to collect and ensuring the data is measurable. At Purdue University, programs are certain of the best methods or tools to evaluate the level of achievement of expected outcomes for graduates. Sometimes, the methods seem diversified. Many programs have sailed successfully through previous ABET visits, but they find the new process of outcomes-based accreditation somewhat overwhelming and do not know how to proceed. In other words, the concept of “continuous quality improvement” has not been well implemented in the practice of quality assurance. Therefore, there are not systematic and integrated quality assurance mechanisms referring to ABET accreditation. Moreover, it may be proper for us to regard it as a routine self-evaluation mechanisms of coping with ABET accreditation. As many respondents
demonstrated, the ABET accreditation represents only a minimum standard, and faculty have various approaches coping with it. Compared the external quality assurance mechanism like ABET accreditation, it is more important for the university to establish an integrated internal quality assurance system and mechanisms in a long term.

As a research-oriented university, Purdue University has set up a relatively well-integrated internal quality assurance system of engineering education which includes at least two types of mechanisms: organization mechanism of supporting effective teaching, evaluation mechanism of teaching and learning. However, the case of Purdue University represents only one university among many different colleges and universities, it is important for researchers to further explore how quality assurance mechanisms are established in various types of higher learning institutes, both in the U.S. and abroad. Additionally, this paper proposes a basic procedure for gathering data from other relevant stakeholders, including students, faculty, parents and employers, which is valuable and can impact other universities who are interested in improving their internal quality in preparation for ABET.

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