Research on the Continuous Quality Improvement Mechanisms of Engineering Education Within American Colleges and Universities

Dr. Hang Zhang, Jining Normal University,China

Hang Zhang is working as a lecturer in Jining Normal University,China. She received her Bachelor's degree in English from Tianjin Foreign Studies University in 2002, and Master's degree in Higher Education from Guangxi Normal University in 2009, and PH.D in Educational Economics and Management in Beihang University in 2021. She studied as a visiting scholar in School of Education, Indiana University Bloomington,USA. Hang Zhang's academic interests include global comparative education, engineering education ,higher education administration and entrepreneurship education. She possesses rich teaching and training experiences in higher education.

Hao He

Hao He is a master's student in the Graduate School of Education, Beijing Foreign Studies University. He received his Bachelor of Engineering degree from Taiyuan University of Technology. Currently, his research interests focus on engineering education in higher education.

Dr. Ming Li, Beijing Foreign Studies University

Ming Li is an assistant professor at the Graduate School of Education, Beijing Foreign Studies University, Beijing, China. He received B.A. in Qingdao Agricultural University, M.Ed. in Shandong Normal University, and Ph.D. in Beihang University. From March 2013 to June 2013, he studied in School of Engineering Education at Purdue University as a visiting scholar. After obtaining the PhD title, he worked as a postdoctor at the Institute of Education, Tsinghua University. He is interested in higher education administration as well as engineering education. Now his research interest focuses on the quality assurance in higher education, especially quality assurance in engineering education.

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Abstract

The process of engineering education program accreditation is essentially a continuous improvement process. It requires the accredited program to establish an effective continuous improvement mechanism. This research conducts an in-depth survey and analysis on three important dimensions, i.e., theoretical exploration, procedure optimization and methodological innovation of continuous quality improvement in engineering education under the background of program accreditation by the Accreditation Board for Engineering and Technology (ABET), based on historical literature review, program self-assessment reports and expert accreditation reports submitted by colleges and universities. It finds that, under the guidance of program accreditation agencies, the philosophy of continuous quality improvement has been internalized by American colleges and universities as the core concept of the quality assurance of program education; the process of continuous quality improvement is gradually optimized, covering the definition of educational objectives for engineering program, the definition of expected educational outcome of engineering program, the confirmation of evidence that can prove educational outcome, etc.; the continuous quality improvement is confronted by technical dilemma which has caused pressures and challenges for engineering faculty to develop new methods; the concept of continuous quality improvement guides and forms positive assessment, evidence and quality cultures. This research aims to comprehensively analyze the mechanism of continuous quality improvement from multiple dimensions, and provide a reference for the quality assurance in engineering programs in other countries, especially those with a short history of program accreditation practice.

Key words: the United States; engineering education; continuous quality improvement; mechanism; ABET; Washington Accord

1. Introduction

Since the 1980s, the quality assurance movement of higher education has emerged from developed countries and swept worldwide, under the influence of the popularization of higher education, reform of higher education management system, intensification of economic globalization and talent competition, and the philosophy of Total Quality Management (hereinafter referred to as TQM). In the United States, the program accreditation system has played an important role in the quality assurance of higher education, providing a mechanism for colleges and universities to ensure quality to the society, promoting continuous quality improvement (hereinafter referred to as CQI) of the program through periodic accreditation, and helping program development to obtain various types of support. Needless to say, the Accreditation

Board for Engineering and Technology (ABET), as an important program-level quality assurance mechanism, is also playing an important role in the process of promoting the development of American engineering education, although the criticism and doubts of the accreditation system have never stopped. The process of engineering education program accreditation is essentially a continuous improvement process. It requires the accredited program to establish an effective continuous improvement mechanism.

By looking back at history and combining the viewpoints of relevant research, the quality assurance practice of engineering education in American colleges and universities since the 1990s can be divided into three stages: the EC2000 pilot period (1995-1999), the EC2000 promotion period (2000-2007), and the EC2000 transformation period (since 2008). During each stage, colleges and universities have made new progress in quality assurance practices under the leadership of ABET, but also exposed different quality assurance problems. The main problem in the EC2000 transformation period is reflected in criterion 4, “Continuous Improvement”. With the deepening of the accreditation, especially since “Continuous Improvement” was added to the 2008-2009 accreditation criteria, colleges and universities have introduced the concept of “Continuous Improvement” into their internal quality assurance processes. The problems of quality assurance in engineering education are more prominently manifested in the aspect of “Continuous Improvement”, as well as ABET’s role in promoting engineering education reform and innovation in institutions. In order to integrate the concept of continuous improvement into the department, school or college of engineering, colleges and universities have taken active measures. This research focuses on conducting in-depth research on the continuous improvement mechanism of engineering education in American colleges and universities, hoping to provide references for the quality assurance practices of engineering education in other countries with a short history of program accreditation practice.

2. Literature Review

Since the establishment of the engineering education program accreditation system, the research on this topic has mainly included studies on accreditation organization, criterion, procedure, and effectiveness, as well as cross-national comparative studies. Since the 1990s, research on this topic has shown two distinct convergent trends: First, related studies have focused on the engineering education program accreditation systems in Europe and the United States, especially that of the United States. Second, related studies have focused on both macro and micro aspects of quality assurance in engineering education. Research on quality assurance in engineering education in colleges and universities mainly includes, but is not limited to, the following dimensions: the subject, policy, concept, model, and method of quality assurance in engineering education. Continuous quality improvement, as both a concept and a practical model of quality assurance, has attracted significant attention from both the

theoretical and practical circles of engineering education.

In terms of theoretical research, continuous quality improvement, as a sub-concept of educational quality assurance, reflects a new change in the concept of quality assurance; in terms of practical exploration, continuous quality improvement, as a policy term for program accreditation, reflects new development in quality assurance practice. For continuous quality improvement in engineering programs, relevant research mainly focuses on the methodological level. In the mid-1990s, ABET achieved a transformation in the accreditation paradigm through mechanism innovation. ABET took this reform as an opportunity to propose the accreditation criteria based on learning outcomes. EC2000 requires engineering program in each discipline to define what current graduates should do based on their program goals and learning outcomes, while also having a continuous improvement process based on program outcome assessment. In this context, there are numerous research papers on learning outcome assessment. For instance, Brannan, Dion, and Fallon explored assessment strategies for student learning outcomes, provided two specific assessment cases using program objective matrices, and explained the characteristics of this assessment method and how it meets EC2000 and promotes continuous improvement in classroom teaching [1]. Kenneth Stier and Richard Boser analyzed general program assessment methods as elements of curriculum continuous improvement that meet accreditation criteria, helping ABET accreditation faculty in the technical field develop effective assessment plans [2].

Due to the lack of comprehensive analysis of the historical background, internal logic, and basic concepts of continuous improvement in engineering education, it is difficult for people to conduct in-depth research on the micro level of continuous improvement in engineering program. How to ensure and continuously improve the quality of engineering program remains a key issue in current and future engineering education research. Therefore, the academic community urgently needs to break through the single level of methodology and comprehensively analyze the mechanism of continuous quality improvement from multiple dimensions such as theory, procedure, method, and culture.

3. Research Methods

3.1 Literature Analysis

The research intends to comprehensively collect and review the literature materials about CQI in engineering education within higher learning institutions, analyze and discuss the historical background, implementation and issues of CQI in engineering education. Specifically, the research attempts to collect policy text and regulations, summary reports, meeting materials, policy text of educational authorities and ABET official documents, and makes comparative analysis of the experience of colleges and universities.

3.2 Case Study

This research selects several well-known universities in the United States as cases. By comparing the reforms carried out by different types of American universities, it summarizes the practical experience in ensuring the quality of engineering education. The cases involve the University of Washington, Washington State University, and Worcester Polytechnic Institute. Through the case study, this research analyzes the reforms conducted by different universities at the micro level, reflects on the practical experience of American colleges and universities in ensuring the quality of engineering education, and explores beneficial implications for the quality assurance of higher engineering education in other countries.

4. Research Findings

4.1Theoretical exploration of continuous quality improvement of engineering education

(1) The theory of Total Quality Management

The Total Quality Management (TQM) was proposed by Armand Vallin Feigenbaum in the early 1960s. In 1961, Feigenbaum first proposed the concept of TQM in the book “Total Quality Control”. Feigenbaum’s viewpoints on TQM have been widely accepted worldwide, and the concepts and connotations of TQM have also been further developed. However, TQM has encountered difficulties in the practice of higher education quality assurance. As we all know, higher education is a systematic and complex activity, and has the following essential characteristics that are different from industrial and commercial activities. First of all, the main “product” of higher education is educational services; secondly, the process of higher education is irreplaceable; finally, the quality standards of higher education have certain uncertainty and diversity. Higher education has an academic culture that is different from industrial and commercial culture. Therefore, higher education management cannot simply misappropriate the ideas of “process management” and “target management”. The journey of TQM in the field of Western higher education has shown that there are obvious contradictions and conflicts between the management philosophy foundation of TQM in higher education applications and higher education attributes. However, it is undeniable that TQM has a certain impact on many aspects of higher education management. Especially since the 21st century, in the quality assurance practice of higher education, TQM is still playing a role. The comprehensiveness, full-time participation, and full-process of TQM are reflected in the quality assurance practice of higher education.

Since the 1990s, the concept of “quality” has begun to appear frequently in the field of engineering education, and the theories of quality assurance have also begun to be introduced into the field of engineering education research. Some research tried to examine the concept of quality assurance in engineering education, and introduce the

relevant concepts of quality assurance into engineering education research [3]. Continuous quality improvement (hereinafter referred to as CQI) is a term developed from TQM. The application of CQI in the field of engineering education is reflected in two levels, one is program accreditation agency, and the other an institution. The CQI of institution is synchronized with the one of accreditation agency. Only the institution forms the philosophy of CQI based on self-study, can the CQI of accreditation agencies be realized. ABET pays great attention to helping engineering program to form the philosophy of CQI. With the development of accreditation pilot, people gradually recognized the function and essence of continuous improvement stipulated by the new accreditation criteria (EC2000). Brannan K P, etc., pointed out that the continuous improvement of engineering education can be described in Criteria 2 and 3 of the "Basic Level Accreditation Criteria". While the list of actions is displayed in linear fashion, the assessment process is really more of a looping process [4]. In the 1990s, ABET proposed a continuous improvement model with a "dual cycle". This improved model includes two cycles, i.e., cycles in and outside school. In 2004, Gloria Rogers further proposed a more sophisticated continuous improvement model. Although the model also includes two cycles internally and externally, it also clearly clarifies the relationship between the elements. Under the guidance of the COI philosophy, ABET finally decided to add "continuous improvement" in the accreditation criteria as an important criterion. It is clearly required that the accrediting program must prove that the action has been employed.

(2) The theory of Outcome-based Education

Currently, Outcome-Based Education (hereinafter referred to as OBE) has become the mainstream concept of education reform in many countries. In the United States, people are not satisfied with their contribution and performance in science and technology, which prompted people to reflect on the practicality of education and the importance of educational results. In this context, in 1981, American scholar Spady W. D. proposed the concept of OBE. Subsequently, OBE was attached great importance and applied at an amazing speed. The book "Outcome-Based Education: Critical Issues and Answers" written by Spady conducted in-depth research on this model [5]. OBE has realized the conversion of educational paradigm. After about 10 years of development, it has formed a theoretical system. It is still considered the correct direction to pursue excellence in education. OBE is the structural model of organizing, implementing and evaluating education based on the expected learning outcome. Chandrama Acharya pointed out that there are four main steps to implement the OBE education model: defining, realizing, assessing and using, which covers various elements of PDCA [6].

In the 1990s, ABET penetrated the philosophy of OBE into the formulation and implementation of engineering education accreditation criteria. ABET realized the transformation of accreditation paradigm through mechanism innovation, and proposed the Engineering Criteria 2000. EC2000 requires the accrediting program to

define what the current graduates should do according to program objectives. At the same time, EC2000 had a continuous improvement process based on learning outcome assessment. Although the theoretical community is still controversial about whether OBE can be called “theory”, the application of OBE has already shown an irresistible trend. Under the influence of OBE, the principle of outcome-based assessment is deeply rooted in the hearts of the people, and the reform of engineering education continues to deepen. In the study of the quality assurance in engineering education, many researches on assessment principles and methods have also emerged. The combination of practice and research of quality assurance in engineering education is presented.

4.2 Procedure optimization of the continuous quality improvement of engineering education

(1) Rational exploration of continuous quality improvement procedures

Continuous improvement is the core element of the quality assurance in engineering education. It is specifically reflected in criteria 2, 3 and 4 of EC2000. However, EC2000 does not clearly propose continuous improvement procedures for reference. To this end, the theoretical community of engineering education has conducted continuous exploration of the topic, trying to summarize and refine the continuous improvement models. Mary Besterfield-SACRE and Larry J. Shuman were supported by NSF to conduct a study [7]. They have developed a theoretical framework that helps to better understand educational outcome based on Bloom’s Taxonomy. Through this framework, each educational outcome is refined into a series of attributes, and engineering faculty can integrate educational outcome into engineering program through these attributes. Sarapin M I proposed the five-stage program assessment model [8]. Strong S, etc., proposed the eight-stage program assessment model [9]. According to the continuous improvement models proposed in the theoretical community of engineering education, it is not difficult to find that these models are mainly based on two logics. The first logic is the theoretical sublimation based on the theory of Bloom’s Taxonomy, and Taylor’s educational evaluation, while the second logic is a summary of experience based on the exploration of engineering education practice.

(2) Practical exploration of continuous quality improvement procedures

Many colleges and universities combine the characteristics of institution and background of program development to integrate the COI into the quality assurance, and explore continuous improvement model. For example, the chemical engineering program at Washington State University has developed a continuous improvement model which mainly includes three stages. The first stage is to collect data by employing 8 different methods to collect data. The second stage is to hold an evaluation meeting. The program assessment of chemistry engineering is a cycle process, the core of which is evaluation meeting. The core topic of the meeting is to

evaluate the learning outcome information obtained through different tools. The meeting will also cause other issues to be discussed for the next evaluation meeting. The third stage is to hold committee meeting. At the meeting of the consulting committee, the majority of stakeholders (faculty, alumni, industry, scholars, and students) handled macro issues on evaluation activities. These issues include program mission and goals, outcome reforms, future development direction, curriculum reform, and planning of the School of Chemical Engineering [10]. Taking the Electrical and Computer Engineering (ECE) program at Worcester Polytechnic Institute (WPI) as an example, the continuous improvement of this program mainly includes the following procedures[11]: defining the educational objectives of the engineering program, defining the expected outcome of engineering program, identifying evidence that can prove educational outcome, determining the assessment methods for obtaining evidence, identifying feedback channels for continuous improvement, taking improvement actions based on the evaluation results.

4.3 Methodological innovation of the continuous quality improvement of engineering education

(1) Reality dilemma of continuous quality improvement methods

The accreditation criteria of EC2000 clearly put forward requirements for continuous quality improvement, but did not provide specific assessment methods and technologies. Engineering faculty are always confused by the complexity and uncertainty of quality improvement. Therefore, EC2000 is no longer the lowest-level criteria of educational quality, because it not only requires that the program meet the minimum quality standard of ABET, but also a process of continuous improvement. Faculty within the program are naturally the primary assessors, and need to learn and master comprehensive and scientific assessment technologies and methods. EC2000 requires faculty to obtain evidence of students' learning through various ways and employ various methods. However, in order to find the most sufficient evidence to prove that students meet the learning outcome criteria stipulated in EC2000, it still causes some pressure and challenges to engineering faculty. It can be seen that how to provide sufficient evidence on the basis of the use of assessment methods is still an important issue facing engineering program and faculty.

(2) Diversity of continuous quality improvement methods

Program accreditation requires faculty to collect evidence of students' learning through various channels and various methods. Multi-channel and multi-way data collection is undoubtedly important for program improvement. At the same time, high requirements are put on information literacy. ABET has incorporated the professional development of faculty into the accreditation system and has done a lot of work, laying a solid foundation for the effective results of the accreditation. On this basis, the engineering faculty have comprehensively employed a variety of assessment methods, not only employed conventional assessment methods, but also committed to

developing new assessment methods. In the program evaluation practice at the institution level, colleges and universities often employ the following methods when conducting program evaluation: graduation design, classroom evaluation, case research, paper and pen test, questionnaire survey, etc. However, in the program evaluation practice at the engineering education level, the assessment of program education outcome has put forward higher requirements for the use of assessment methods. Therefore, the assessment methods of engineering education are more diverse and comprehensive. Although many methods can be used to assess learning outcome, considering the persistence of assessment and the economy of resources, most colleges and universities use some conventional methods to obtain valuable information, and try to avoid the resource consumption due to the development of new tools.

In the College of Engineering (COE) at the University of Washington (UW), assessment methods employed in each engineering department/program are not the same, in order to meet the requirements of EC2000 [12]. On the other hand, engineering faculty also actively reflect on the reliability and validity of various assessment methods. In previous engineering education documents, validity and reliability were not often used. Engineering education research does not use these terms when dealing with validity and reliability. The results in education measurement can provide framework for engineering education. Engineering education literature shows that many engineering educators have also begun to pay attention to the validity and reliability of research. For example, American scholars conducted systematic research on the validity and reliability of engineering education [13]. By better understanding the validity and reliability, the engineering faculty will better cope with the evaluation of validity and reliability. In addition, engineering faculty have also begun to reflect on the effectiveness of some conventional assessment methods.

4.4 Cultural shaping of the continuous quality improvement of engineering education

(1) Outcome-based assessment culture

In early accreditation activities, ABET attached great importance to educational investment, and the accreditation criteria also paid too much attention to educational investment. The emphasis of EC2000 reform shifted from educational input to educational output, by making adjustments and modifications of accreditation criteria, clearly proposing the ability requirements of engineering graduates, and correspondingly reducing the prescribed requirements for curriculum content and class hours. ABET requires that all institutions applying for program accreditation must provide evidence to confirm that graduates have these abilities. Under the guidance of CQI, American colleges and universities have shaped the outcome-based assessment culture. With the active participation and efforts of faculty, students' learning outcome assessment has become an important measure in many American colleges and universities.

(2) Fact-based evidence culture

Under the guidance of CQI, American colleges and universities have shaped the empirical culture. Both institution and program accreditation attach great importance to the value of facts and data. They emphasize collecting and compiling data to evaluate the quality of institution or program, and gradually form a culture of evidence. With the development of the accreditation system, the connotation of this evidence culture has also been continuously expanded. It pays more attention to evidence related to teaching ability and benefit. The current evidence related to educational practice emphasizes the transparency and disclosure of accreditation information and related evidence.

(3) Excellence-oriented quality culture

Under the guidance of CQI, American colleges and universities have shaped the quality culture of pursuing excellence. With the in-depth development of ABET accreditation, the philosophy of CQI advocated by EC2000 has become popular. CQI has become the core concept of quality assurance. For most American colleges and universities, passing ABET accreditation means recognition of its reputation and educational quality. American colleges and universities, especially first-class universities, generally recognize their own quality of engineering education. This self-confidence stems from the culture and spirit of pursuing excellence, which is reflected in the excellent students and faculty, in the emphasis on reputation.

4.5 Rational thinking on the continuous quality improvement of engineering education

(1) The relationship between accreditation philosophy and effectiveness

In the field of educational quality management, the “student-centered” and “outcome-based” concepts are not utterly-new. Under the external pressure of ABET accreditation, although the concept of CQI has permeated people’s minds and practical work, not everyone agrees with this concept. Some people believe that CQI is not a completely new concept, but just a label that may not be as successful as they claim. However, the requirement explicitly prescribed by EC2000 is a novelty. ABET not only requires engineering program to record what teachers teach students, but also what students actually learn. However, this paradigm and conceptual transformation is unlikely to occur without policy changes [14].

(2) The relationship between assessment form and accreditation effectiveness

Since the implementation of the EC2000 reform in ABET, there have been some changes in engineering education within colleges and universities. However, in some universities, especially conservative ones, the changes have occurred slowly, and major changes often require policy transformation. It can be seen that the scientificity of accreditation philosophy, comprehensiveness of assessment methods, and rationality of assessment procedures in the quality assurance process cannot ensure

the positive and effective reform within colleges and universities [14].

5. Research Enlightenments

5.1 Challenges of continuous quality improvement in engineering education

Currently, more and more universities have made active attempts and efforts in ensuring the internal quality. However, the focus of engineering education program accreditation is on whether institutions and programs can form a virtuous cycle mechanism, so that the materials and data obtained from quality monitoring can be continuously fed back into teaching activities through a mechanism, and the teaching quality can be in a spiral-like continuous improvement process, rather than repeating formal document collection work. The implementation of the concept and practice of continuous quality improvement varies in different colleges and universities. For universities with a relatively short history of program accreditation practice, there exists weak awareness of continuous improvement in program accreditation, mainly manifested in following three aspects [15]. One is the lack of program accreditation subjectivity. Many programs focus on preparing for evaluations as a key aspect of accreditation work, investing a lot of manpower and resource, but do not attach importance to continuous improvement work in the later stages. Secondly, there exists a lack of active participation from professional teachers. Many teachers have participated in the pre-accreditation preparation work as required, including ideological awareness and teaching behavior, but have not truly felt the importance and urgency of improvement work. Thirdly, there exists a lack of confidence in continuous improvement. Some leaders and teachers lack the courage to carry out in-depth rectification and the conscious behavior of continuous improvement, and do not have the courage to face the work pressure brought by rectification work and continuous improvement work. In the process of promoting international substantive equivalent program accreditation, how to promote the gradual establishment of effective self-improvement mechanisms is still a topic worth exploring. Continuous quality improvement is not only an important standard for program accreditation at home and abroad, but also an important aspect of quality assurance for institutions and programs. However, both institutions and programs have shortcomings in their efforts toward continuous improvement.

5.2 Inspirations from continuous quality improvement in engineering education

(1) Integrating the concept of CQI and leading the reform of engineering education

The concept of CQI is not only the goal of external program accreditation, but also the purpose of continuous improvement in engineering education. Under the guidance of the concept of CQI and outcome-based education, engineering colleges and universities urgently need to deepen curriculum and teaching reforms. Firstly, colleges and universities should prioritize the cultivation of outstanding engineering talents and proactively adapt to the needs of economic and social development; clarify the

training objectives and specifications for engineering talents; build a diversified engineering curriculum system that adapts to economic and social development; expand the professional development channels for engineering teachers, comprehensively enhance their theoretical literacy and practical teaching ability. Secondly, colleges and universities should establish subject (program) education objectives, teaching outcome objectives, curriculum objectives, and curriculum performance objectives based on the criteria prescribed by accreditation agency, and further conduct teaching design and evaluation to maintain the teaching effectiveness of program and ensure that students possess these abilities upon graduation. Thirdly, colleges and universities should focus on curriculum system reform, promote innovation in the system and mechanism of talent cultivation, and effectively solve the problems of broad talent cultivation goals, and insufficient support for students' graduation requirements in the curriculum system, especially in achieving engineering practical abilities, etc., so as to link the design of talent cultivation goals, the achievement of graduation requirements, and the construction of the curriculum system. With the development of engineering education program accreditation, for countries that will become or have already become formal signatories of the *Washington Accord*, engineering colleges and universities urgently need to closely integrate with the requirements of national strategic planning, use the core philosophy of program accreditation as guidance to organically integrate with engineering education reform practice, thereby leading in-depth and systematic engineering education reform.

(2) Shaping an empirical culture and pursuing excellence in quality improvement

The program accreditation of engineering education has become an internationally recognized quality assurance system for engineering education. For the quality assurance in engineering education in American universities, some of the initial challenges and pressures may be influenced by technical factors, but they are not limited by simple technical difficulties, and also involve more important issues such as ethics, culture, and fairness. In the process of vigorously promoting program accreditation of engineering education, clear requirements have also been put forward for the evidence-support capability. The transformation of outcome-based accreditation paradigm will be constrained and hindered to some extent by the previous one overemphasis of the input and process. Many colleges and universities are still struggling to adapt to this transformation, mainly manifested in the singularity of methods for assessing learning outcomes and the solidification or standardization of thinking in writing self-study report. The purpose of conducting program accreditation is not only to give a conclusion of "passing" or "not passing", but also to assess the pulse of engineering education and provide guidance for improving the quality of engineering education. Therefore, for countries that will become or have already become formal signatories of the *Washington Accord*, relevant accreditation agency should play a leading role as accreditation bodies, regularly conduct accreditation training, and promote and popularize typical experiences. Engineering

colleges and universities urgently need to focus on shaping a quality culture, allowing it to gradually evolve into their own habits and even beliefs. They should take the opportunity of participating in program accreditation to truly shape and strengthen empirical culture.

6. Conclusions

The quality assurance led by program accreditation institutions and the overall trend of the quality assurance led by colleges and universities have become an important mechanism for improving the quality improvement of higher education in the United States. Engineering education of American colleges and universities explores the theory and practice of continuous quality improvement of program education, which can provide a reference for the quality assurance in program education in other countries with a short history of program accreditation practice.

Under the guidance of program accreditation agencies, the philosophy of CQI has been gradually internalized by more and more American colleges and universities. The process of continuous quality improvement is gradually optimized, covering the definition of educational objectives of engineering program, the definition of expected educational outcome of engineering program, the confirmation of evidence that can prove educational outcome, etc. The continuous quality improvement is confronted by technical dilemmas which have caused pressures and challenges for engineering faculty to develop new methods; the concept of continuous quality improvement guides and forms positive assessment, evidence and quality cultures. Rationally speaking, the continuous quality improvement of engineering education in American colleges and universities has to deal with the relationship between accreditation philosophy and effectiveness, and the relationship between assessment form and accreditation effectiveness.

Although more and more universities globally have made active attempts and efforts in ensuring the internal quality, for universities with a relatively short history of program accreditation practice, there exists weak awareness of continuous improvement in program accreditation, mainly manifested in the following three aspects, i.e., the lack of program accreditation subjectivity, the lack of active participation from professional teachers, and the lack of confidence in continuous improvement. With the development of engineering education program accreditation, for countries that will become or have already become formal signatories of the *Washington Accord*, colleges and universities urgently need to closely integrate the requirements of national strategic planning, make full use of the engineering education program accreditation mechanism, and guide the core philosophy of program accreditation to lead systematic engineering education reform.

The main contribution of this research is an attempt to analyze the practice of American colleges and universities implementing CQI in engineering program from

four dimensions: philosophy, procedure, method, and culture, with a particular focus on the main progress and issues since the EC2000 reform. Due to the limited materials and data available, this research did not incorporate data and practical cases over the past decade. In the future, the research team will continue to pay attention to the program accreditation of engineering education in the United States, and moderately expand and integrate a global comparative perspective.

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