

AC 2007-248: THE NEED FOR A QUALITY CONTROL SYSTEM FOR COMMUNITY COLLEGE ENGINEERING EDUCATION

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The Need for a Quality Control System for Community College Engineering Education

Abstract

This paper is based on a collaborative effort between the National Academy of Engineering and the National Research Council, with support from the National Science Foundation that was initiated to improve engineering education at community colleges and improve the prospects for community college students' achievement of Bachelors Degrees in Engineering at four-year institutions.

The paper attempts to establish some basic ground rules for building a quality control assessment system and creating active partnerships between Community Colleges and the four-year Universities with an ongoing dialog. This effort is also directed at building a unified approach for attracting and retaining students in engineering and to articulate a seamless engineering curriculum for a continuum of education that will fortify engineering education for the new millennium.

Introduction

It is generally accepted that engineers are essential to both the public and private sectors in order to maintain a strong economy, and that it is in the national interest to vigorously pursue the development of a competent and diverse domestic workforce in science, engineering, and technology. If the United States is to remain competitive in a global, technology-based economy, there will need to be a concentrated effort to convince more students to prepare for careers in engineering and technology and to provide them with a high quality education.

It is estimated that 40% of engineering graduates in the U.S. attended a community college during their studies, and half of these graduates began their academic studies at a community college¹. Other studies indicate that some underrepresented groups are more likely to begin their college studies at a community college than at a four year institution. Students who study engineering at a community college represent only a very small fraction of the total community college enrollment, and like the general public, a large part of this student population seems to be unaware of the opportunities a career in engineering offers. This suggests that there may be a large reservoir of students at the community college level that could be attracted to the Engineering Profession to meet anticipated shortages and diversity goals.

Community colleges generally provide good quality, affordable, and easily accessible educational programs in a wide variety of disciplines^{2,3}. If we are to fulfill the growing need for students to receive a strong basic education in science, technology, engineering, and math, these institutions must play a larger role in the preparation of STEM graduates. However, these institutions also face serious challenges in offering comprehensive engineering programs due to the rapid evolution of Bachelor's degree programs, the availability of qualified faculty, and the ability to provide adequate resources for students and faculty. In many cases, the process of obtaining guidance, assistance, and cooperation from local and regional four-year Universities is another challenge.

Without some level of coordination between community college and bachelor's degree engineering programs, students' efforts at the community college may not contribute effectively to their continuing progress at the senior school. In order to facilitate the offering of appropriate course work and efficient transfer of credit hours between two and four year institutions, it might be helpful to have a streamlined accreditation process for community college engineering programs that would assure students as well as the universities they transfer to that the course work taken at a community college was viable. This certification would be even more important for students transferring beyond the local service area of their community college.

Although an ABET process already exists for the accreditation of engineering technology programs at two-year colleges, there is no corresponding process for general two-year engineering science programs. This situation calls for a coordinated initiative to develop fair and efficient assessment and evaluation measures that could be implemented at the community college level. Such a review process could be used to ensure uniform standards for Associate degree programs in Engineering in addition to helping colleges of engineering evaluate entering transfer students. Developing such a process would require an extended open dialog involving Community College Engineering Programs, Four-Year Engineering Colleges, ABET, and ASEE, with possible support from the National Science Foundation and other agencies. It seems that ASEE is well positioned to play the central role in this effort to develop a mechanism that would narrow the gaps between community colleges and universities on a national level.

Recent trends

The importance of this issue was underlined recently by U.S. Education Secretary Margaret Spellings in a public address to the Accreditation Forum in Washington, D.C. She called for a stronger accreditation process and an increased level of assessment of the educational outcomes produced by all colleges and universities. The challenge of international competition in both the economic and assessment arenas is pushing the American education system to adopt innovative methods to improve STEM education outcomes, while the public is demanding more information about academic programs to help them make better choices.

The fact that traditional engineering education in the U.S. needs to change can not be denied. The question is "How?" Among several solutions proposed at various forums the most common was to increase the quality of education received by students. Since community colleges have become a major provider of higher education and they are often perceived as "second class" institutions⁴, they have an obligation to uphold higher standards and develop convincing quality control procedures that will assure four-year institutions of the value of their programs. More and more states and four-year institutions are reaching out to help two year colleges improve their engineering programs, and then recruiting their students through "two + two" articulation agreements that provide a seamless student transition^{5,6}. As a result, all stakeholders benefit from high quality engineering programs at the community college level^{7,8}.

Mission of two-year engineering science programs

ABET provides guidelines to evaluate four year engineering programs that prepare engineers for various fields of engineering, and also for two-year applied science and technology programs

that prepare technicians and technologists for various industries. Why are there no corresponding guidelines for two-year engineering science programs? No other entity or agency has provided a consistent framework to help these programs gauge the success of their efforts with respect to national or industry wide standards. One possible reason is a lack of consensus on a precise role for two-year engineering science programs. That these programs are often referred to as “pre-engineering” programs demonstrates the need for a better definition and understanding of these programs. Moreover, without a clear definition it is impossible to determine the quality of a program or assess its results.

Even with a well defined mission and clear educational objectives for two-year engineering science programs, the ongoing advances in technical and scientific knowledge make it an impossible task to cram everything desired into any two year curriculum, pre or post. Knowledge alone does little to motivate and prepare students to become true engineers, regardless of the specific field. This is an area where the two-year colleges could have a tremendous impact with a clearly defined mission. At this level, they could be shaping broader habits of mind to prepare students to think like engineers without forcing them to select a specialty at the beginning of their academic studies. This would be similar to other professions like medicine, architecture, or law. The two-year engineering science programs should introduce students to engineering principles and analysis, the engineering design process, and the variety of engineering disciplines while covering the basic math, physics, and core curriculum.

With their capability to employ master’s level professional engineers with extensive industry experience, community college programs can help bring real life engineering scenarios to students earlier in their studies through a variety of introductory courses. These might include projects involving mechanical and electrical components as well as material science and environmental engineering concepts that would help students learn how different fields of engineering relate to and depend on each other. This would yield a better overall understanding of the engineering profession and enable students to make more educated choices regarding the field of engineering that is most suitable for their personality and career goals. This is an important stage when students are probably beginning to experience a tension between their skills and abilities and the demands of engineering education. At this point, a well-designed program could help spark or maintain their interest in engineering and build a strong foundation for future engineering education and lifelong learning.

Advantages of a quality control system for engineering science programs at two-year institutions

Since no standard accreditation process is currently in place for two-year engineering science programs, a quality control system should be developed to assist two-year institutions and engineering colleges in evaluating these programs. Such a system, having criteria similar to those established by ABET for four-year programs⁹ as guidelines would have multiple advantages.

1. It would provide a structured framework for assessment, evaluation, and continuous improvement of the program. This is especially important with the multitude of programs offered by various community colleges and within community college districts. Objective

standards would serve both transferring and receiving institutions when making comparisons among collaborating or between competing programs.

2. It would help students and their families choose the most effective programs that would be transferable to four-year institutions and prepare them for lifelong learning. Particularly for families with first generation students, choosing the most appropriate college program is a difficult and confusing task. With a quality control system in place, more information will be available with which to make an informed choice.
3. It would help four-year institutions to screen applicants and transfer course credits earned at different community colleges, whether the institutions are within or beyond their immediate service area. Four-year institutions often have to evaluate and compare hundreds of applications in order to select the best candidates. A quality control system would simplify the process of determining appropriate credit hours for transfer from two-year institutions. The system could also help eliminate the so-called “easy A” programs that try to attract students by lowering standards in order to help them earn good grades without much effort.
4. It would facilitate an ongoing dialog between two-year colleges and four-year institutions that could strengthen and expand articulation agreements. Since receiving institutions are in a privileged position to evaluate the performance of graduates of two-year programs, a quality control system will foster increased communication between institutions, resulting in improved coordination of two and four year programs.

Since no agency or organization currently provides accreditation specifically for two-year engineering science programs, each program is advised to conduct its own internal evaluation and complete a self-study questionnaire developed in accordance with ABET accreditation procedures. Representatives from ASEE and ABET could provide assistance in developing the questionnaire. After completion of the questionnaire, a committee of volunteers representing the stakeholders in the program’s success can be selected. Among those who have a vested interest in program outcomes would be representatives from the district or civil entity supervising the college where the program is offered, four-year institutions and engineering employers from the surrounding area, and program alumni. The committee would validate the questionnaire for their region and then certify that the program provides the graduates with what they need to know or be able to do to succeed as engineering graduates or as junior level engineering students at a four-year institution. This certification process would be repeated periodically, with review of available data and identification of desirable innovations.

Implementation of a quality control system for two-year engineering science programs will require the active support of many individuals and entities. Faculty will need to understand why a quality control system is needed, how is going to be accomplished, and what their role in the enterprise will be. The college administration has an extremely important role in the process by providing full support throughout the transition and incorporating results into institutional self-studies. Four-year institutions participating in this initiative have an equally important role to provide guidance and by offering advice in establishing performance objectives and learning outcomes aligned with their educational objectives. By working together all stakeholders in the program will contribute to its success and help further strengthen education of engineering graduates.

Summary and Conclusions

In recognition of the need to produce a larger and more diverse pool of engineering graduates, the National Academy of Engineering has started a national effort to more effectively utilize community colleges as a viable pathway for students to obtain Bachelor's degrees in Engineering. Both promises and pitfalls associated with this initiative have been identified in the NAE Report and other published papers^{10, 11}. This paper has focused on the adaptation of a traditional element of four-year engineering program assessment in order to overcome some of the obstacles. A streamlined accreditation process developed for two-year college engineering programs offers a mechanism to help achieve the goals of this national effort. With a well established mission, a strong quality control system in place, dedicated and enthusiastic faculty, administrative support, and the educational advantages that two-year institutions offer¹², it would be easy to envision a reversal in the recent trends of declining engineering enrollment and retention across the nation.

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