Continuous Quality Improvement: Key to the Globalization of Engineering Education

Reynaldo B. Vea, Jose B. Cruz, Jr.

Mapua Institute of Technology, Philippines/
The Ohio State University, USA

Abstract
The Mapua Institute of Technology, the largest engineering school in the Philippines, upon a change of owners in the year 1999, defined a new vision of becoming an "international center of excellence." Many of its alumni had heretofore established successful professional engineering/architecture practice in many countries, but the school was still desirous of establishing in a definitive way its adherence to international engineering education standards as a step towards the attainment of its vision. It recognized the necessity of setting up a system of continuous quality improvement and, within this framework, to attain recognition from a widely-recognized accreditation body. Due to the affinity of the Philippine education system with that of the U.S. and the pre-eminence of American engineering education, Mapua chose the U.S. Accreditation Board for Engineering and Technology (ABET)[1], as its certifying body, and ultimately to international standards in engineering education. A major characteristic of the Continuous Quality Improvement process is adherence to an outcomes-based performance evaluation of activities that support institutional missions and program objectives. The school has reviewed the alignment of its vision, mission, program objectives, desired outcomes and syllabi and the system by which the alignment can be kept and enhanced. To achieve its new vision, Mapua is taking steps towards the global preparedness of its engineering graduates. Among Mapua's major initiatives are establishment of processes to relate outcomes to program objectives, mission, and vision, and the creation of a systematic and comprehensive student advising system. An academic advisory panel has also been created for each of its academic degree programs to establish and implement a feedback loop in that part of its curricular development activities focused on the relevance of its programs to industry and the community. In a country where the school accreditation system may be said to be mature but input-based for the most part, Mapua's efforts at establishing a CQI system and undergoing an outcomes-based certification process may be viewed as pioneering and therefore significant. In this presentation we summarize our experience in using CQI as a framework for the globalization of engineering education at Mapua.

Keywords: CQI, Globalization of Engineering Education

Globalization of engineering as part of educational objectives

The Mapua Institute of Technology states its vision thus: "*To be an international center of excellence in integrated engineering, architecture and information technology education by providing instructions that are current in content and state-of-the-art in delivery and by engaging in cutting-edge research*." It has declared itself to be "*Filipino in spirit but global in outlook*." Furthermore, among other mission components, it aims "*to bring to bear the*

world's vast store of knowledge in science, engineering and other realms on the problems of industry and community in order to make the Philippines and the world a better place."

Such statements proceed from Mapua's keen awareness that the practice of engineering has become globalized. The freedom of movement of professionals, firms and information across national boundaries is unprecedented. Still, even greater mobility is being sought by means of the mutual recognition agreements on the "substantial equivalency" of engineering degree programs across countries and the establishment of international registries of engineers.

For Mapua to remain relevant, competitive and true to its vision-mission statement, it has to produce engineers who can effectively practice their profession in such a world. It has to embrace this requirement as an educational objective of its various engineering degree programs.

The validity of this objective is underscored by recent developments in the Philippines. The country is active in the ASEAN Register of Engineers as well as in the APEC Registry of Engineers. There is a growing consciousness of the importance of the Philippines becoming a member of the Washington Accord[2]. There is also an on-going project to form a broad coalition of Philippine organizations for the promotion and development of the service sector of the economy, including the engineering services sector, for the international market.

Adoption of continuous quality improvement as a means to attain objectives

The rapidity of social and technological developments in a global, knowledge-based economy necessitates that an engineering school be nimble, persistently keyed to major changes and trends, and always self-aware of its performance vis-à-vis its educational objectives. To be otherwise is to risk being left by the wayside as an unknowing victim of inertia in a fast changing environment.

But even if the environment were less dynamic, a school, if it were to progress, has to have a way to assess itself against its objectives and to make the necessary adjustments even as it continuously evaluates the validity of the objectives themselves in a never ending upward spiral. That the current environment is very dynamic and competitive only underscores the necessity for putting in place a system for continuous quality improvement (CQI).

Continuous Quality Improvement is a simple and pragmatic systems approach to planning, implementation, operations, evaluation, re-planning, and repetition of the process in an un-ending manner, to achieve goals. The first step in such a process is a development of a set of goals and objectives, in consultation with the constituents. There should be suitable metrics for the objectives. In the context of an educational system, the principal elements are a student body, faculty, curricula, laboratories, libraries and other information resources, computational facilities, physical facilities and infrastructures, and administration. The second step is to develop a set of outcomes, involving the elements of the process, supporting the stated objectives. The third step is performance evaluation. As with objectives, there should be suitable metrics for outcomes and evaluation. Evaluations should suggest changes to improve the process. Ultimately, evaluation should determine how well the stated objectives are achieved.

Form the point of view of Mapua, therefore, adopting CQI concepts and practices is simply a matter of necessity. Or, to put it in more emphatic terms, Mapua considers CQI to be a key to its success in its engagement in the global arena.

Translating the program objective into desired outcomes

Program objectives relate to the expectation of Mapua students in the period after graduation. One of these objectives is that they are able to practice engineering effectively in a global arena. Program outcomes refer to the abilities already acquired by the students at the time of graduation. The achievement of program outcomes indicates that the students are equipped to achieve the program objectives.

Mapua translated the program objective of having its graduates be effective in global engineering practice into a set of program outcomes. To wit, at the time of graduation it is expected that Mapua students shall have:

1. Technical proficiency substantially equivalent to global standards;
2. Familiarity with international engineering standards;
3. Ability to work in teams;
4. Proficiency in English as the international language;
5. Good level of communications skills, oral and written; and
6. Familiarity with western and eastern cultures.

Mapua developed metrics to assess how well it is doing in achieving its objectives through the outcomes. It has made changes in the Institute to continuously improve the quality of engineering education.

ABET substantial equivalence as a means for implementing CQI

Mapua's decision to voluntarily subject itself to the process of ABET Substantial Equivalency Certification [3] was clinched by ABET's espousal of CQI starting in the year 2000 when it adopted an outcomes-based Criteria 2000[1,4]. Initially, Mapua was simply looking for concrete and well-established international engineering education standards it could comply with, as it laid the foundations for CQI. The fact that the Philippine educational system is akin to that of the U.S. made the choice of ABET a little easier. The realization of outcomes 1 & 2 therefore is partly tied-up to Mapua's relationship with ABET. Previous to Engineering Criteria 2000, accreditation by ABET was input-based. In [4], Prados et al describe initial findings on the impact of this drastic change in the nature of the ABET accreditation.

The ABET criteria for engineering accreditation are outcomes-based, and its accreditation process makes use of continuous quality improvement principles. ABET accredits engineering programs in the United States but not outside the U.S. However, it designates and recognizes programs outside the U.S. as "Substantially Equivalent" to those in the U.S. It does this recognition in two ways. One way is through the Washington Accord[2], a Mutual Recognition Agreement signed in 1989, Under the Washington Accord, signatory countries perform their own accreditation and accredited programs are recognized as substantially

equivalent to those under ABET. For those countries that are not signatories to the Washington Accord, programs may be evaluated directly by ABET to designate them as "Substantially Equivalent" [3]. The Philippines is not a signatory to the Washington Accord, and so Mapua is in the process of being evaluated by ABET directly. The ABET criteria for substantial equivalence essentially apply the CQI process to engineering education.

The necessity of multi-disciplinary approaches to solving today's problems leads to the desired outcome of students having the ability to work in teams. Mapua is fostering this through its multi-disciplinary undergraduate and graduate projects and research. The school is also expanding its academic offerings into the areas of biotechnology, health sciences, business and social sciences so that as an institution it is able to encourage the deeper interplay of various realms of knowledge.

That a Mapua graduate will also be technically proficient to an international level and be knowledgeable about international standards also makes it possible for him to work in international teams. Knowledge of English, good communication skills and familiarity with various cultures are also essential to the ability to function in global teams or just to be able to engage in global practice of the profession.

Mapua experience in CQI

CQI requires an outcomes-based evaluation of a school's activities. As an initial step Mapua had to define desired program outcomes based on its institutional vision, mission and program objectives as discussed above. The alignment of all these, including course syllabi to achieve the desired outcomes, had to be reviewed and established. At one level the contribution of each course to each of the desired outcomes had to be assessed The revision of course syllabi to tighten up alignment had indeed been a major undertaking.

Furthermore systems by which the alignment can be kept and enhanced had to be devised. Among the major systems introduced are a comprehensive and systematic student advising system and a system whereby industry and the community can offer feedback on the relevance of Mapua's curricular programs.

Student Advising

Just like other schools, Mapua has had a system for academic and personal advising of its students for a long time. All faculty members had been mandated to schedule a fixed number of consultation hours per week and students come in for academic advising on a voluntary basis. Personal advising had been done basically on a voluntary basis through the guidance and counseling office, although results of tests administered by the office may require students to come in for counseling.

The institution of CQI has deepened the appreciation of the need for and has further clarified the requirements of a student advising system. With the definition of program outcomes, all school systems, including student advising, have been given a clearer rationale. All systems must support the attainment of program outcomes. In the case of the student advising system, individual attention to students has been more clearly related to institutional objectives.

On the substrate of curricular content which is keyed to program outcomes, the student advising system must assist students perform better academically. If this is achieved then the attainment of program outcomes is better secured. The student advising system must come with a monitoring system and an evaluation system as feedback, which is an essential part of CQI. The performance of the system must be measured against the attainment of program outcomes. In this case the metric would basically be the academic performance of the students.

The challenge to student advising at Mapua has thus been defined under a CQI framework. In response a system which is more aggressive in stance, comprehensive in scope and systematic in operation has been devised. A triune of Academic, Personal and Peer advising has been organized. All students are engaged starting from their first year. They are engaged throughout their entire stay in the school. Advising schedules per term are worked out. Each advisee has a record folder which contains, among other things, an Academic Performance Evaluation (APE) form. Likewise there is an Advisee's Evaluation of Adviser (ERA) form and an Adviser's Evaluation of Advisee (EAR) form. The head of the system prepares an annual summary of the evaluation forms and together with the other administrators of the system identifies areas of improvement.

Academic Advisory Panels

To continuously evaluate and improve the very validity of the program objectives and outcomes and to help measure performance, Academic Advisory Panels at the level of the various schools and at the level of the Institute have been created.

At the program level, the panels consist of business, technology and community leaders. Alumni are the main resource in the selection of panel members. In semi-annual meetings the panels give feedback on the attainment of program objectives and outcomes and comments on the objectives and outcomes themselves.

The Institute level panel consists of the chairs of the program level panels and is chaired by a member of the Institute's Board of Trustees. In line with its global objectives, Mapua may appoint foreign nationals to the panel.

In order to broaden and deepen the information that serves as a basis of the panel's analysis and recommendations, duly-budgeted research support is provided by the Institute's faculty. This is a feature not seen locally in such types of linkage activities.

English and Software for Faculty

Faculty development has always been a central concern of Mapua. Since student performance, which is the direct measure of the attainment of outcomes, is directly dependent on the competency of the faculty, the importance of faculty development cannot be overstated. The alignment of vision, mission, objectives and outcomes under a CQI framework has lent faculty development initiatives more focus. Thus in addition to the general development of faculty through graduate education and research, specific expertise and competencies related to the desired program outcomes must be paid particular attention to.

For the global practice of engineering, faculty must have facility in standard applications and mathematics software. Mapua has given access to this software set and it is devising a plan for the easy ownership of laptop computers by faculty.

To improve student proficiency in English, an Institute-wide program has been adopted. Logically, the action had to start with the faculty first. This program uses simulations of standard internationally-recognized English Proficiency exams to measure individual progress and program effectiveness. This quantitative feature fits into a CQI framework very neatly.

Common-use computer labs
Mapua has installed additional common-use computer facilities with the relevant software for students and faculty to help in the attainment of program outcomes. The campus is fully networked and has the potential for access to most any technical information available in cyberspace.

Planned growth towards globalization

The academic expansion of Mapua naturally leads to a desire to attain University status. Since this could mean more substance in multidisciplinary studies and in team work then this is a move that complements globalization.

With Mapua's ABET initiative, opportunities may lead to a significant increase in the number of international students from the region enrolled at Mapua. There are several factors that could cause this change. One might be the use of English as a medium of instruction. This could attract potential students from countries where instruction is not in English. A second factor might be the use of international standards, such as ISO standards, in design courses. One major benefit of such a change in the percentage of international students would be more exposure of Mapua students to a diversity of culture, and more opportunities for students to gain experience in multi-cultural design teams. This should more sharply focus Mapua thinking and action on the attainment of global standards.

With the projected high growth in the global trade in services and with the favorable position of the Philippines in this regard, Mapua has joined the movement towards promoting and developing the engineering services sector. This should lend more importance and urgency to its educational objective of having its graduates practice successfully in the global arena.

With all these new and exciting developments, it behooves the Mapua Institute of Technology to practice CQI throughout the Institute, as a key to the success of its globalization efforts.

References

[1] http://www.abet.org
This is the web site of the Accreditation Board for Engineering and Technology.(ABET).
[2] http://washingtonaccord.org

A mutual recognition agreement known as the Washington Accord was signed in 1989. See the web site for the signatories to the agreement.

[3] http://www.abet.org/subequi.shtml

[4] John W. Prados, George D. Peterson, and Lisa R. Lattuca, "Quality Assurance of Engineering Education Through Accreditation: The Impact of Engineering Crtiteria 2000 and Its Global Influence," *Journal of Engineering Education*, Vol. 94, No. 1, January 2005.

Biographical Information

REYNALDO B. VEA
President, Mapua Institute of Technology. B.S.M.E., *magna cum laude*, University of the Philippines; S.M., Massachusetts Institute of Technology; Ph.D., University of California at Berkeley; Member, National Academy of Science and Technology (Philippines); ASEAN Engineer; APEC Engineer; Past President, Association for Engineering Education in Southeast Asia and the Pacific (AEESEAP).

JOSE B. CRUZ, Jr.
Distinguished Professor of Engineering, The Ohio State University. B.S.E.E,, *summa cum laude*, University of the Philippines; S.M., Massachusetts Institute of Technology; Ph.D., University of Illinois at Urbana-Champaign; Member, National Academy of Engineering; Corresponding Member, National Academy of Science and Technology (Philippines); Fellow, IEEE; Fellow, AAAS; Fellow ASEE.