Closing the Loop: Assessing, Evaluating, and Improving a TC2K Quality Program

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Introduction

This paper describes an ongoing process: the integration of the new ABET accreditation criteria for engineering technology (TC2K) into the School of Science, Engineering, and Technology at the Pennsylvania State University at Harrisburg. Currently three technology programs – Electrical Engineering, Mechanical Engineering, and Structural Design and Construction Engineering – are implementing outcomes based assessment processes that will lead to an atmosphere of continuous improvement and quality education. This paper documents the deliberate planning and the subsequent execution of a comprehensive plan designed to successfully link established program outcomes, classroom instruction, assessment and evaluation processes, and process improvement initiatives. Building on course assessment as a foundational linchpin, the methodology effectively integrates input from alumni, employers, industry advisory panels, faculty, and students. Iterative techniques incorporate multiple reviews during the education process and subsequently provide timely opportunities for implementing education initiatives and creating a positive, conducive environment to accommodate continuous improvement.

This paper addresses specific, deliberate actions taken by the School of Science, Engineering, and Technology to establish and sustain a comprehensive program of assessment and evaluation consistent with an academic environment of continuous improvement that demonstrates compliance with the technology Criteria 2000 (TC2K). The primary objective and ultimate end-state for this plan was to affect a transition to a student-focused academic environment of excellence. This plan encompassed specific actions considered essential for establishing an academic format of continuous improvement envisioned by the TC2K executed in four phases as depicted in Figure 1. Phases include (1) Awareness Training For Senior Key Personnel, (2) Internal Organizational Assessment and Outcome/Objective Development, (3) Team Building For Process Control And TC2K Implementation, and (4) An Action Phase Designed To Perpetuate the Program. To date, the first phase has essentially been accomplished and phases 2, 3, and 4 are being implemented with a certain degree of overlap as the iterative nature of the plan provides an avenue for continuously improving the implementation process. This paper reports the current status of the plan, citing specific examples on outcome development, assessment, and evaluation and on tracking process improvement initiatives.
Phase I – Training For Senior Key Personnel

This phase created an acute sensitivity in the senior faculty from the targeted programs as well as the other faculty within the school. Initially, this took the form of “training the trainer” sessions for senior faculty achieved by sending selected faculty representatives from each program to a number of formal seminars. These seminars were hosted by credible organizations dedicated to supporting institutional efforts for TC2K implementation including the Technology Accreditation Committee (TAC) from ABET and the Teaching and Learning Consortium from the Pennsylvania State University. The seminars typically lasted several days and featured both large lecture-type instruction and small group interactive sessions. The seminars proved highly effective in presenting the overall concepts encompassed by TC2K. However, the value of the seminars was found not in the theoretical discussions of continuous improvement but rather in the “hands on” training that served to equip the faculty with tools to implement the tenets of the TC2K. Seminar participants examined and simulated various methodologies for developing appropriate program objectives and outcomes, matched a wide variety of assessment techniques to hypothetical venues, and practiced iterative response cycles by performing outcome evaluations followed by hypothesizing specific actions to correct identified weaknesses while simultaneously reinforcing and sustaining strengths.

Participants during this phase of the plan developed an appreciation for the potential benefits possible through an application of the principles of continuous process improvement. Faculty from each of the three targeted programs returned to their campus with a clear vision of the intent behind ABET’s shift to the new criteria and a keen...
perception of the potential gain of a program dedicated to continuous improvement. The awareness phase proved to be a catalyst for action as awareness sponsored collective efforts for a preliminary organizational assessment and naturally transitioned the School toward Phase II.

**Phase II – Internal Organizational Assessment and Outcome/Objective Development**

The seminars\(^1,\,2,\,3\) noted earlier aided in creating a vision of the program’s ultimate destination, but TC2K implementation required the faculty to assess their current condition as a school and as academic programs. The organizational assessment initially targeted school personnel to inventory their prevailing attitudes toward the TC2K program shift. A series of informational briefings and presentations were conducted to collectively educate the collective faculty and staff from the school as well as the three programs individually. By design, each presentation evolved into an active dialogue where both the abstract concepts and the practical implementation issues were addressed. This proved to be an effective venue to assess the relative values, beliefs, opinions, and perceptions of the faculty and prepared the programs for a more formal internal audit. Input from the faculty was clearly mixed from excitement and enthusiasm to skepticism and resentment.

The organizational assessment searched for objective measures that would initially establish the relative strengths and weaknesses of the programs. The ABET criteria furnished an initial framework for the assessment but the generic nature of the criteria made interpretation and direct application difficult. Programs immediately began to personalize the TC2K “a-k” outcomes\(^4\) in light of specific program goals and academic characteristics. Consequently, although the TC2K ABET criteria provided an initial backdrop for this early preliminary program assessment, the final result was that each program independently began the creative process of developing their own unique program goals, objectives, and outcomes. The Structural Design and Construction Engineering Program actually chose to develop their program outcomes independently of the TC2K “a-k” outcomes.\(^4\) Their initial efforts proved insightful but not fully complete when subsequent comparisons were made to the applicable TC2K criteria. Nevertheless, the two lists ultimately merged and became a fairly comprehensive list of program outcomes. Additionally, this same program also chose to restructure their outcomes in accordance with B. S. Bloom’s taxonomy of education objectives that defines six major categories of the cognitive domain. This was an effective drill for the faculty within the program since it produced a set of outcomes that they could not only more readily relate to, but also one that clearly bore their “stamp of ownership.”

With program outcomes in hand, Phase 2 of the plan continues with the programs auditing their curriculum in order to cross reference the program outcomes with course learning objectives. The resulting matrix has provided a number of intriguing insights with some outcomes covered in most if not all of the courses; these outcomes became “threads of continuity” within the programs. Other outcomes, however, were found in a smaller number of courses and, in a very few cases, in only one or two courses. In
planning assessment activities later, this will certainly become a critical point of
discussion due to the limited opportunity to formally develop and assess student mastery,
evaluate their performance, and apply any corrective measures in time to ensure student
proficiency prior to graduation. Ultimately, this audit may lead in some instances to
changes within courses and perhaps in curriculum to ensure adequate coverage,
assessment, and evaluation of each outcome.

**Phase III – Team Building for Process Control and TC2K Implementation**

Due to relatively small size of the programs, this phase primarily occurred at the
School level. This phase prompted the creation of an internal action committee to
coordinate efforts across the program lines. Principle areas of focus included aiding
programs in energizing their industry advisory committees and in identifying additional
program constituents that might provide input in terms of perceived educational needs
and expectations. Identifying constituents generally included alumni, employees,
industry representatives, other special interest groups depending on the specific program,
and the faculty and staff themselves. The industry advisory committees for the programs
were already viable and playing an active role in developing outcomes, objectives,
surveys, and curriculum development. During this phase, the school director appointed
the author as a special TC2K coordinator to monitor and assist in implementation of the
new TC2K criteria. Each program further identified a representative to serve on a
committee chaired by Dr. Cottrell. This committee worked across program boundaries to
share lessons learned and to promote success. The TC2K coordinator answered directly
to the School Director on matters pertaining to TC2K but worked directly with program
chairmen as needed. The programs involved in this process were each relatively small,
so the “team” infrastructure within the programs was kept to minimum. Meetings were
scheduled routinely to discuss planning, organizing, staffing, and other related issues of
common interest.

**Phase IV – The Action Phase to Perpetuate the Program**

Final implementation is being achieved during an action phase and by design,
continues in a perpetual, iterative state of dynamic, fluid execution of TC2K within the
programs. Figure 2 provides a visual representation of the methodology employed by the
Structural Design and Construction Engineering Technology Program to make
continuous improvement a reality. The methodology builds on University, School, and
Program missions and goals which are themselves iterative in nature to reflect assessment
and input from appropriate staff, faculty, and other constituents. The Program Goals and
Mission have a direct link to Program assessment and evaluation activities. By
definition, this phase is characterized by ongoing training and support coupled with a
constant drive to sense and address the recurring needs of the faculty as they work
collectively to implement TC2K. The goal is for the programs to ultimately progress to a
point where iterative cycles of continuous improvement would commence characterized
by an appropriate level of assessment, evaluation, and response actions that are planned
and executed to correct deficiencies or reinforce success. The actions represent the
significant cornerstones required to support Phase IV of this plan.
Figure 2. The Continuous Improvement Methodology
Building on course assessment as a foundational linchpin, the methodology presented effectively integrates input from constituents – alumni, employers, industry advisory panels, faculty, and students. It envisions annual cycles in course assessment, exit interviews with graduating seniors, input from institutional agencies and hierarchies, and collective course assessment and review. Other annual faculty inputs originate from professional development activities, interaction with industry practitioners, and involvement with professional organizations. Tri-annual surveys capture assessment data from alumni, employers, and industry representatives critical for assessment of program objectives as well as outcomes. At the program level, comprehensive evaluation of assessment data supports strategic plans to reinforce success and to foster improvement as needed. Specific process improvement initiatives are developed and implemented at both the course and program level as appropriate.

Instituted in Fall, 2002, course assessment cycles include assessment, evaluation, and planning process improvements for the next teaching iteration. Assessment of course learning objectives directly feeds program outcome assessment and provides routine system checks and timely input for correction and enhancement. Course instructors are responsible for implementing and tracking the effectiveness of specific process improvement initiatives in moving the course to a higher level of support of the program objectives and outcomes. As a baseline requirement for generating assessment data, standardized survey templates have been developed and implemented throughout the programs for collecting both professor as well as student perceptions of their individual mastery of course learning objectives. This data is correlated directly with the program outcomes providing a direct link program assessment and evaluation activities. It is critical to note that not all outcomes are assessed by every course, but rather only those supported directly by specific course learning objectives. Professors develop individual course assessment plans identifying appropriate techniques for each outcome for each course. Assessment practices are not limited to survey data, however, but may also include the following:

- Written or Oral Exams
- Individual or Group Exercises, Home Work or Projects
- Performance Appraisals
- Simulations
- Targeted Written Surveys and Questionnaires
- Exit Surveys and Interviews
- Focus Group Discussions
- External Examination by Another Member of the Staff and Faculty
- Behavioral Observations

At the program level, program chairmen in consultation with their respective staff and faculty will complete a comprehensive assessment of the program based on faculty course assessments as well as other assessment measures appropriate for gathering
information germane to the effectiveness of the Program in achieving objectives and outcomes. Program Chairmen schedule and conduct routine surveys, consultations, and focus groups and interviews with constituencies from outside the college such as alumni, employers, and industry representatives to solicit input concerning the development and appropriateness of program objectives and outcomes and the relative quality of graduates from the program. Program evaluation follows and faculty develop strategies to implement and track specific process improvement initiatives to ensure that the program responds to assessed strengths and areas of improvement. Part of the process also affords for a deliberate review of the Program outcomes and objectives to ensure that they continue to express the vision articulated by the mission and goals of the institution. A written report is currently scheduled to be published every three years defining the state of the program and mapping a strategic plan for fostering continuous improvement in the educational process.

**Conclusion**

TC2K implementation must be an ongoing process to embody continuous improvement. This paper reports the current efforts by the staff and faculty at Pennsylvania State University at Harrisburg to integrate the new ABET accreditation criteria for engineering technology (TC2K) into the School of Science, Engineering, and Technology. This multi-year process has involved deliberate planning and execution of a comprehensive plan designed to successfully link established program outcomes, classroom instruction, assessment and evaluation processes, and process improvement initiatives. Building on course assessment as a foundational linchpin, the methodology effectively integrates input from alumni, employers, industry advisory panels, faculty, and students. Iterative techniques incorporate multiple reviews during the education process and subsequently provide timely opportunities for implementing education initiatives and creating a positive, conducive environment to accommodate continuous improvement.

**Bibliography:**

1. ABET Faculty Workshop for Program Improvement (January, 2002), sponsored by ABET Education and Information Services. The workshop prepared faculty participants for outcomes-based accreditation based on deliberate development of program goals, objective, and outcomes that collectively provide a framework for continuous assessment and improvement in education. Work based on application of Engineering Criteria 2000 and Technology Criteria 2000 (TC2K).

2. ABET TC2K Program Evaluator Training (June, 2002), sponsored by ABET Education and Information Services during the 2002 American Society for Engineering Education Annual Conference & Exposition.


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