Continuous Improvement in Engineering Technology Programs

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Abstract

Continuous improvement in engineering technology programs is an increasingly popular topic. The Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (TAC of ABET) has developed new TAC of ABET Engineering Technology Criteria 2000 (ET2K) which are being implemented. Accredited engineering technology programs will soon be required to have plans for "continuous improvement" and evidence that the results are applied for ongoing program improvement. Plans for continuous improvement are a part of the current criteria, but the emphasis of continuous improvement is increasing. Current programs may be weak in outcomes assessment and the feedback element under the new criteria.

The new TAC of ABET criteria are less specific and thus more flexible. This will allow more diversity among engineering technology programs. Controls must be in place to ensure that program changes are truly improvements and that academic programs are not continuously disrupted by many poorly planned changes. Changes developed with good intentions may yield unforeseen deleterious effects. Programs having identical or similar titles may serve different student populations, different employers and have somewhat different objectives. Thus, attributes that are good for one program may not be suitable for another. On the other hand, some anchor components are expected in all similarly named programs to insure that program names connote meaning to students, parents, employers, faculties and other stakeholders.

There are many ideas concerning the elements needed for continuous improvement, and there is confusion about what constitutes continuous improvement. Sometimes continuous improvement seems to be confused with continuously changing programs and attempting to incorporate every recommendation tabled. Perspective is easily lost in selecting program improvements and adapting them for implementation while ensuring that those selected enhance the synergy of the overall academic program. This paper discusses continuous improvement in the context of Total Quality Management (TQM) and offers ideas for implementing the continuous improvement process into engineering technology programs. It outlines possible continuous improvement program methods, tools and procedures. It discusses the documentation that might be produced in an academic continuous improvement program. Further, it discusses linking feedback from outcomes assessment to the continuous improvement process.

Total Quality Management (TQM)

Belatedly business managers in the US began to notice the Japanese economic miracle as it slowly arose as a phoenix after World War II. The Japanese began to compete aggressively with American industry. Of course, America did not suffered destruction of its industry and infrastructure during World War II. As the economic threat from Japan became apparent, American businessmen started to research the basis of the Japanese economic miracle. Surprisingly, the economic miracle was closely tied to two Americans who had been shunned by corporate America. They were Drs. W. Edwards Deming and Joseph M. Juran. Not only did the Japanese achieve productivity and quality levels comparable to those in America, but also they surpassed them in many industries. This caused American managers to investigate the methods used by the successful Japanese. After getting off to a slow start in the US, TQM has over the last couple of decades become embraced as the most popular basis for doing business in organizations. It has matured and the concepts encompassing and defining TQM have become universally accepted. Its philosophy rests on continuously improving the organization. A philosophy and guiding principles underlie its precepts. It represents a disciplined approach using management techniques and technical tools to achieve sustained continuous improvement of an organization.

The TAC of ABET criteria do not make a direct reference to TQM. The wordings used in the criteria, however, indicate concepts consistent with TQM. Certainly, continuous improvement is a concept associated with TQM.

Achieving Continuous Improvement

One important component of continuous improvement is to benchmark performance parameters of one's organization against comparable organizations. The best performing organizations are identified with terms such as World Class and Best in Class. Benchmarking is a valuable tool, but alone it is not enough. Time compression of functional processes has pervaded most organizations operating in our contemporary economy. By merely following other organizations through benchmarking with the accompanying time lag from learning of the initiatives of others until implementation, a follower organization will never be the leader. The market leaders are at the forefront in developing the best business methods, and they are inevitably more successful than the followers. Every organization, however, can profit from not working in a vacuum but instead by selecting good ideas from all sources.

Other methods of promoting continuous improvement include insuring that true past improvements are not lost, incorporating lessons learned from past improvement efforts into future improvement activities, anticipating future needs, using innovation to develop instruction breakthroughs and eliminating less meaningful instruction.

Continuous Improvement Requirements of TAC of ABET [1]

Currently TAC of ABET criteria expect engineering technology programs to have plans for continuous improvement. Visiting evaluation teams are expected to look for "evidence which demonstrates implementation of continuous improvement processes and procedures for each program." Evaluators look for evidence that assessment data are being used to improve the program, but the criteria do not directly address this. Evaluators also look for written plans for continuous improvement and evidence that the continuous improvement plan has been implemented. The new criteria called Engineering Technology Criteria 2000 (ET2K) are being phased in over the next couple of years. The criteria include a phrase specifically requiring "evidence that the results [of continuous improvement] are applied to further development and improvement of the program."

Selecting Improvements

It is difficult for anyone to be opposed to improvement. The problem is in selecting limited achievable improvements and implementing them. It is also important not to confuse improvement with changes to the academic program. Changes are not necessarily improvements. Changes, which are improvements, must be planned to improve the synergy of the academic program as a whole to improve student education.

Most programs are under pressure to minimize the number of credit hours required for a baccalaureate degree. Funding agencies generally attempt to limit the credit hours required for degree programs. Thus, improvements that add courses to an academic program must generally be offset with a like reduction somewhere else within the program curriculum. That is, when student credit hour requirements are increased in one part of the curriculum, they must be decreased an equal amount in another. Academic institutions of higher learning often have general education requirements for all majors fixing a portion of the curriculum.

Ideas for changes in the curriculum can arise from many sources. These include faculty, accreditation agencies, industrial advisory boards, employers, students, parents, etc. They are all stakeholders in the program. There are indeed many forces at work influencing program curricula. There are a few anchors components that help define the names attached to most programs. First, the rules of the accreditation agency must be followed to have a marketable accredited program. Another is of course from the industries employing the graduates. These industries may be local, regional or national. In fact, the makeup of the program may affect the geographic demand for the graduates of a program. A program may fill a niche, which leads to recruiting of its graduates by employers served by the niche. To some extent a niche is developed to accommodate the needs of selected employers, but also employers tend to recruit graduates of programs having niches that satisfy their needs. Lastly, an anchor component suggested by the author is selected subject areas as covered both in depth and breadth by the Fundamentals of Engineering (FE) examination produced by the National Council of Examiners for Engineering and Surveying (NCEES) [2]. The author believes that this is an overlooked but potentially powerful source of quick outcomes feedback.

The Problem with Computer Usage

One area that is especially prone to problems is computer usage. Everyone agrees that the graduate of an engineering technology program should be computer literate. But there is considerable disagreement on the exact set of skills that the engineering technology graduate should possess. Some are beginning to question the need for a programming language in the curriculum. There is now a tremendous amount of specialized software available, but the popularity of some software has a short life. So will the skills learned in using particular software have lasting value for the student? The proliferation of software is sure to continue. Instructors may be encouraged to implement new software in their instruction as an indicator of their own instructional prowess by the criteria used to evaluate the performance of faculty members. It is prudent to question the extensive use of proprietary software at the expense of education in the fundamentals of engineering technology subjects.

Employers represented on industrial advisory committees will recommend that the software they use in their companies be incorporated into the curriculum. But, what percentage of the graduates can actually expect to use that software upon graduation? It is likely to be relatively small when carefully analyzed.

Every engineering technology graduate should know how to use word processing, spreadsheet and presentation software. The clear leaders with the advent of the Microsoft Windows operating system for PCs are Microsoft Word, Excel and PowerPoint, respectively. Further, the graduate should be able to use a popular CAD software package for producing engineering drawings.

PDCA Cycle [3]

The Plan-Do-Check-Act (PDCA) cycle is a simple and effective improvement technique of TQM. The PDCA cycle is broken down into four simple steps:

1. Plan exactly what is to be done.
2. Do or carry out the plan.
3. Check or study if the implementation of the plan achieved the desired results.
4. Act appropriately based on the results depending on whether they were positive or negative.

Based on the knowledge gleaned from the results, further improve the plan and repeat the cycle. This feedback aspect of the cycle is very important. This feedback receives emphasis, through outcomes assessment requirements addressed in the new TAC of ABET ET2K criteria, that was lacking in the earlier criteria.

Feedback through Outcomes Assessment [2]

Feedback through outcomes assessment is the most important step, and it is often never addressed in a meaningful way. It is the C part of the PDCA cycle involving checking or studying to insure that the plan achieves the desired results. The new TAC of ABET

ET2K criteria require that engineering technology programs demonstrate achievements by "student outcomes assessments." Further, the criteria state that the evidence may include "nationally-normed subject content examinations." The author believes this offers the best way to quantitatively measure results. The NCEES FE examination most closely meets the "nationally-normed subject content examinations" mentioned in the new ET2K criteria. Other suggested outcomes assessment tools have obvious detracting elements. Student portfolios and employer questionnaires are very difficult to objectively compare and evaluate.

Some states do not allow engineering technology majors to take the FE examination. Most states, however, allow engineering technology majors within twelve months of completion of degree requirements to take the FE examination as long as they are enrolled in an ABET-accredited program. Further, a university program can obtain the FE examination results for its students in each subject area as a quantitative measure of the performance of its students in each subject area.

Conclusion

There is much more to TQM than the continuous improvement process with feedback described in this paper. The PDCA cycle is actually a simple adaptation of the more comprehensive problem-solving (scientific) method [3]. There are a number of widely accepted TQM tools and techniques that are well documented in the literature. Different tools and techniques may be chosen for different situations. Important aspects of TQM involve identifying opportunities (or problems) and prioritizing them using a Pareto analysis for instance. An excellent background in TQM can be obtained from Reference 3 of this paper. There is little that a program needs to document to describe the mechanics of its continuous improvement process other than to say that TQM principles will be used. The mission of the program, however, should be documented to guide the use of TQM principles and keep the program on track in selecting improvement initiatives. The mission should clearly identify program anchor components. It is important, however, to document the steps and activities used in applying appropriate TQM tools and techniques to achieve specific improvements supporting the mission of the academic program. That is, the goals of each improvement initiative should complement the mission of the program.

Bibliography

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