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Building the Assessment and Measurement Foundation for Continuous Improvement in Engineering Programs

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Abstract

In a previous paper, a process was described to facilitate continuous monitoring of progress toward achieving predetermined programmatic milestones in an engineering program whereupon program policy, implementation procedures, and curriculum content can be modified as needed to achieve desired program outcomes associated with ABET EC-2000 criteria. The process consists of accumulating data through the use of pre-selected programmatic measurement instruments, and, periodically re-evaluating the effectiveness of these instruments, in order to build a solid database to verify the achievement of desired program outcomes. A feedback mechanism was also presented to insure that program objectives and the mission of the organization are also reviewed on a regular basis and changed if necessary.

In the intervening time, this process has been implemented, and approximately one year's data has been accumulated. Thus far the process has brought to light things which were not known or not fully appreciated before, such as certain aspects of how students learn and what they (students) want vs. what employers want them to know. Some of these findings have resulted in significant program changes. The assessment and measurement process currently in use (a) facilitates the gathering of pertinent information and distillation of it into ideas which shape the program for the future, (b) serves as a useful tool for measuring the milestones of achievement defined to produce the desired outcomes, and (c) provides a feedback mechanism for periodic assessment and continuous improvement.

This paper describes the work done in the past year in implementing and exercising this process, i.e., what worked, what failed and why. Essential factors such as faculty "buy-in," involvement of an industry advisory board, student, alumni and employer inputs, the interface with university administration, national trends in engineering education, and communications and teamwork are discussed, and the results of this faculty team project are presented.

The lessons learned and changes made in the assessment and measurement process, and the resulting modifications of the curriculum, should assist in insuring long-term continuous

improvement of the program in order to continue providing competent engineering graduates for today's fast-changing global engineering industry.

Introduction

At this time, almost all ABET-accredited engineering programs have undergone at least one visit under the EC-2000 criteria[1]. As a result, many institutions have been advised to improve the data-gathering process in such a way as to focus on gathering meaningful data to assist in the assessment process; and, to provide mechanisms for feedback and periodic re-evaluation to assure continuous program improvement.

Implementation of this new way of doing business requires that an institution not only *have* a good program, but that it *prove* that it has a good program. To do this, much diligence and careful attention to detail is demanded to document in sufficient detail the results obtained from the measurements used to assess the program. Additionally, continual re-evaluation and feedback is needed to adjust the program in such a way that positive changes are made for continuous improvement. While the new criteria require more labor to make the process work, it is satisfying to discover areas that need improvement, to make the necessary changes, and to see the results and the benefits coming from this effort. While not all things tried ultimately work, or work effectively, it is reassuring to observe the mechanism of the feedback process, and how, if it is set up properly, defects are uncovered and workable changes ultimately do, in fact, provide a degree of continuous improvement for which all programs strive. In what follows, the implementation of one specific continuous improvement model is described, and the progress achieved to date is reported.

Background

In an earlier publication[2], a process for assessment and measurement of an engineering program for compliance with ABET EC-2000 criteria was proposed. This process was developed from knowledge of constituent requirements and/or desires and program constraints, from which the mission statement of the program emanated. Once the mission statement was in place, program objectives were defined, and desired program outcomes were developed. This process is depicted in the diagram of Figure 1.

Next a set of measurement instruments was selected, and an assessment philosophy developed for the use of each instrument, after which the measurement, or data-gathering process was started. There were two classes of measurement instruments: one to obtain constituent (employer, alumni, faculty, and student) inputs for long-term program improvement, and another to assure that *all* students successfully attain, at least minimally, each of the desired program outcomes by the time they graduate. An ambitious effort was made to utilize nine measurement instruments, all feeding data back simultaneously, for program assessment.

A scheme employing a triple-feedback process was developed[3] to (1) assure correct applicability and usage of the selected measurement instruments (MIs); (2) facilitate periodic re-assessment of the desired program outcomes (DPOs); and (3) provide for long-term evaluation of the program objectives (POs). With two years of data gathering, analysis and documentation, certain things came to light which are the subject of the remainder of this paper.

Refinement of the Process: Lessons Learned

The first lesson came early when the nine original measurement instruments were re-evaluated after six months, exercising the innermost feedback loop of Figure 1. At that time it was discovered that many of the chosen instruments, while providing meaningful quantitative input for improving the program, proved to be cumbersome and inadequate for measuring specific desired outcomes. It was decided at this point to simplify the system, dropping several of the less useful instruments, e.g., the course/instructor evaluations, and to develop and utilize a comprehensive, "mini-FE" exam, administered to seniors just prior to graduation. This examination incorporates questions dealing with aspects of all the desired program outcomes, thus serving as a test of program adequacy as much as student competency. In this way the number of measurements was reduced from nine to six, and a much better, simpler and easier-to-use set of measurements is now being utilized with regularity.

The next step was to exercise the intermediate feedback loop for the purpose of examining, after the first year, the desired program outcomes to assess whether or not changes needed to be made. These periodic assessments are conducted in a faculty retreat held at the end of each semester. Designated faculty are responsible for the maintenance of certain measurements, and they report their findings at these meetings. The results are then evaluated collectively, and decisions to continue, alter or stop certain processes are made. At the present time, the six instruments (alumni surveys, senior exit interviews, mini-FE exam, student advisory committee inputs, FE exam results, and industrial advisory board evaluation of senior projects) seem to be adequate.

After two years of gathering data, the third feedback loop was recently exercised, that is, the objectives of the program were re-evaluated by all faculty in the most recent faculty retreat. It was concluded, after indepth discussion, that the stated program objectives were in fact still valid, so that no program objectives were changed.

Summary and Conclusions

The triple-feedback loop has now been exercised completely one time, and found to be a useful tool for organizing the continuous assessment and improvement program. Now that a working process has been established and tested at least once through all its facets, it appears that two principal lessons were learned: (1) it is okay to fail, i.e., if one instrument does not work, it should be modified or discarded, and something else tried, until a suitable solution is found; and (2) no engineering department can be strong and healthy without the support and active participation of an industrial advisory board, alumni, students (an active and enthusiastic student professional section such as ASME, and a diverse student advisory committee), and faculty. A team with this combination of members, all of whom understand the purpose and value of accreditation and continuous improvement, led by a department head who knows the accreditation process and the need for continuous improvement, will not fail.

Plans for Continuous Improvement

It is planned to continue the process which is presently in use, with only minor modifications, and to now work on better, more regular, and more detailed documentation of the assessment results. In approximately another two years, after two complete cycles of the triple-feedback process are complete, an overall reassessment will be conducted to ascertain whether or not any critical aspect is being omitted. In the meantime, the biggest challenge will be for faculty to maintain their commitment and dedication to making the process work. If this succeeds, then it will truly be a win-win situation for students, employers and the dedicated faculty who must carry the burden of ensuring continuous improvement in engineering education.

References

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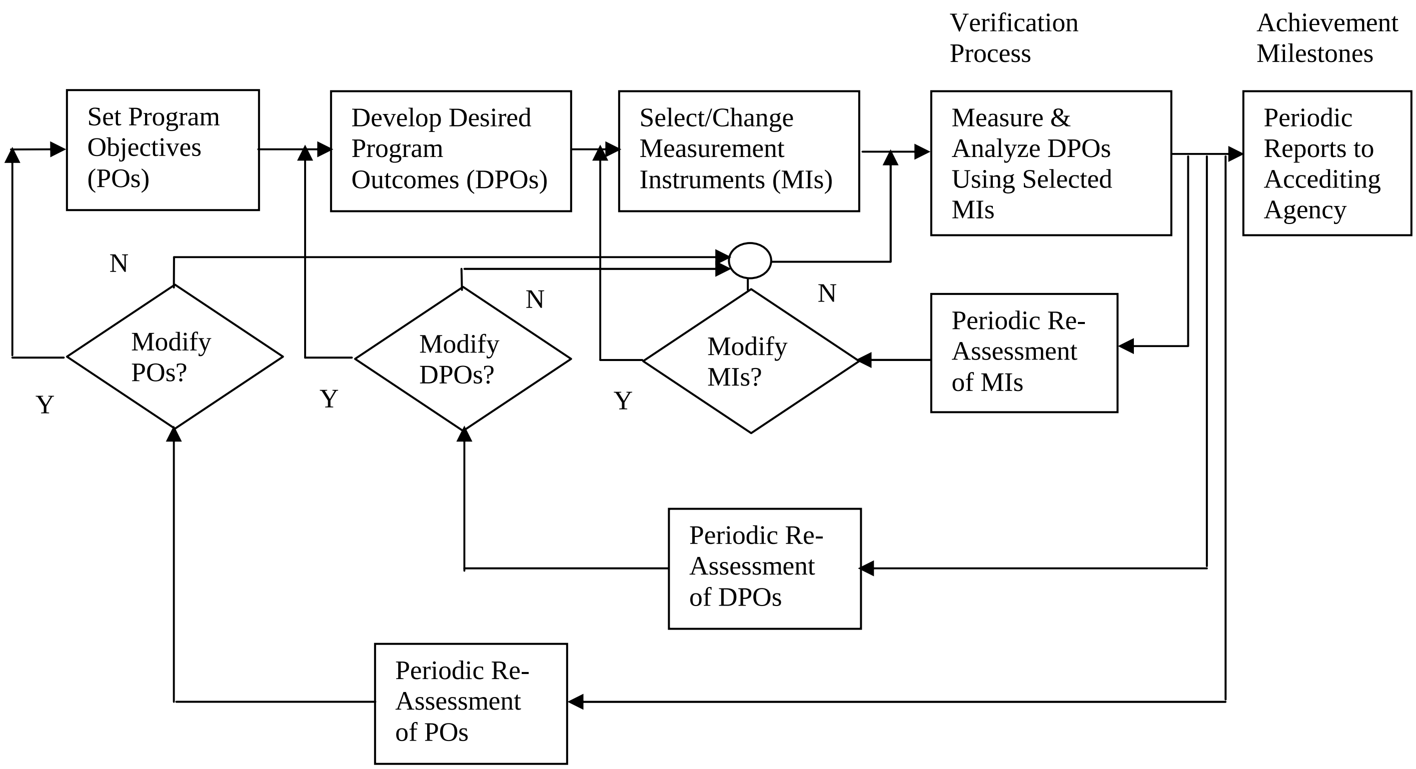

Figure 1. Process for Insuring Continuous Improvement in Verification of Desired Program Outcomes