Outcomes Assessment
OPPORTUNITY ON THE WINGS OF DANGER

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Why would 370 engineering faculty from 150 institutions and four countries travel to Terre Haute, Indiana, in April? No, ski season was over. Actually, it was to attend the first "Best Assessment Processes in Engineering Education" symposium, held on the Rose-Hulman Institute of Technology campus. Response to the symposium is indicative of the degree of interest in learning about assessment techniques that can be applied to engineering education.

It would be wonderful to report that the primary motivation for the interest in assessment is because we are all wildly interested in learning how we can implement continuous quality improvement in our educational programs. Although we *are* interested, we also need to answer to a multitude of demands on our time and resources. In reality, the changes in the accreditation requirements embodied in EC 2000[1] represent a new approach to validation of quality in engineering education and are driving the interest in outcomes assessment. Many agree that EC 2000 is the right and appropriate approach to accreditation. But it also presents several major challenges for each of us.

I have had opportunities to interact with faculty and administrators from various campuses, engineering societies, and ABET. The purpose of this article is to share my observations from the field of assessment and my experience from interacting with those who are working to align their educational processes to be consistent with both the letter and the spirit of EC 2000.

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MAJOR CHALLENGES

There are three Chinese characters that make up the English word "challenge": 1) opportunity, 2) on the wings, 3) of danger. I would like to provide what I believe to be the major challenges facing each of us as we move to outcomes assessment. These challenges will highlight both the opportunities and the dangers associated with our transition to EC 2000.

■ *Understanding Assessment and the Continuous Quality Improvement (CQI) Process*

Engineering faculty recognize the importance of the use of models in solving engineering problems. The value that a CQI model contributes is that it gives faculty a common language and a conceptual framework to guide the process.

Opportunity • There are many models that have been developed that depict the CQI process—including the "Two-Loops of EC 2000"[2] and "Assessment for Continuous Quality Improvement"[3] models. I have had engineering faculty share with me copies of CQI models they have developed that represent everything from a chemical process to an electrical circuit. The important thing is that you develop/adapt/adopt a model that is meaningful to you and your program that includes all the elements of the CQI cycle. Development of this framework will provide a common understanding of what the process entails and will guide you as you structure your activities.

Danger • There are really two dangers in development of a model. The first is that all the elements and relationships that are crucial to the CQI process are not included. The minimal elements that need to be illustrated in a model are

- The relationship between your program outcomes and your program and institutional mission
- Student learning outcome goals for your engineering program (broadly stated, not measurable, *e.g.,* communications skills)
- Involvement of constituencies, *i.e.,* where are your constituents involved and what is the nature of their involvement
- Specific performance specifications for each learning outcome (measurable, *e.g.,* demonstrated ability to use correct grammar)
- Educational practices and strategies employed to provide students with the opportunity to gain knowledge, skill, and experience to achieve the desired outcomes
- Collection of evidence (assessment) to determine whether or not the learning outcome has been met
- Evaluation of the evidence, *i.e.,* interpretation of evidence and recommendations for improvement
- Feedback loops, *i.e.,* what is the nature of feedback loops and how is assessment and evaluation information used to improve programs

The second challenge in the development of a model appropriate for your program is that you spend all your time debating the complexity and validity of the model and do not get on with it. Like the CQI processes you will develop, the model itself can be improved as you go through the cycle and learn more about the process and your institutional culture.

■ *Use of Assessment Terminology*

I call this the "Tower of Babel" effect. I recently read an article that described the importance of language and meaning in systems engineering.[4] It described the problems faced when workers with the same goal cannot communicate well enough to accomplish the task before them.

Opportunity • As in the case of scientific notation, the use of terminology in assessment is not standardized. The terms (goals, objectives, criteria, metrics, etc.) are often used differently or interchangeably. This can create confusion and alienation from the CQI process. Development of "Stepping Ahead: An Assessment Plan Development Guide"[5] was created, in part, to address this issue. But when EC 2000 was crafted, the term "objective" was used in the way that the guide uses the term "goal." It is important to note that there is no one right way to define these terms. Each engineering program/college should agree upon term definition and use terms consistently. This provides an opportunity to focus on the meaning of assessment terms and will, in the long run, clarify the process and serve the program well. Table 1 demonstrates assessment term definitions[5] with examples. It is not meant to be exhaustive of all possible combinations or examples.

Danger • The most significant danger is that there will be no attempt to develop a common assessment language among the key players and the process will fall apart due to confusion and frustration. Different members of the community may have strong preferences for term definition because of their experiences. Listen carefully and bring closure on this issue early in the process. There will be lots of battles to be fought during the process—this is not one of them. Agree to agree and move on. Then use the terminology consistently—and often.

■ *Development of Performance Criteria*

Development of specific, measurable performance criteria is probably the most challenging—and important—step in this process. Most of us can begin with EC 2000, Criterion 3 (the eleven desirable attributes of the engineering graduate), to develop our student outcome objectives (goals?). These are broadly stated, however, and cannot be measured. The challenge of each engineering program is to define what is meant by each of the objectives. We think we know when students demonstrate the ability to communicate effectively, but when faculty begin to spell out what they mean, they find there is not always a clear consensus. In addition, if we value "effective" communication skills, we need to tell students what characteristics should be present in order for them to

TABLE 1
Definitions of Assessment Terms

Term	*Definition*	*Other Terms Used*	*Example*
Goal	A statement describing a broad outcome; not measurable	Objective Outcome	Graduating students will be effective team members.
Objective	Statement(s) derived from the goal that define the circumstances by which it will be known if the desired change has occurred; not measurable	Goal Outcome	When engaged in a dialogue with team members, or as part of a small group project, students will perform effectively as team members.
Performance Criterion	Specific, measurable statement identifying performance required to meet the objective. The performance criteria must be confirmable through evidence. Objectives may have multiple criteria.	Outcomes Standards Specifications	1. Initiate and maintain task-oriented dialog. 2. Work for constructive conflict resolution. 3. Strive for meaningful group consensus. 4. Support other team members in the effective performance of their roles. 5. Initiate and participate in group maintenance activities

demonstrate such skills. We also need to provide students with opportunities to learn, develop, and demonstrate the skills, and give them feedback on their progress. For this to happen, we need to develop measurable performance criteria that give precision to the objective.

Opportunity • The exercise of developing measurable performance criteria will provide faculty with a shared understanding of the desired outcome. It will also promote discussion about strategies that can be implemented to give students the experiences they need to be able to demonstrate the outcome. The criteria that are developed will also shape the assessment method and enable faculty to develop assessment processes that are clearly linked to the desired outcome.

Danger • This is a component of the CQI process that is often left out. It is common for the assessment planners to move from listing objectives to choosing assessment methods. This is understandable because the development of measurable criteria is painstaking—critical, but painstaking. This is where common sense must prevail. Continuing with the "effective communications skills" example, it would be possible to develop fifteen or more very well-defined performance criteria for effective communications skill. If you look at all of your learning objectives (fifteen or more?) and each of them has ten or more performance criteria, the overall assessment task becomes overwhelming. Start with as many performance criteria as you can think of for each learning objective and prioritize them in order of importance. The final number chosen should include those criteria that are considered to be critical to the objective and still make the assessment task manageable.

■ *Use of Local Resources*

Recently, I heard an engineer say, "We engineers find it hard to believe that we can learn anything from someone who is not an engineer!" Although this was said in jest (I hope), there seems to be a reluctance to go outside engineering circles to ask for help in designing and/or implementing the CQI process as it relates to education.

Opportunity • It is important to capitalize on your local resources. Many regional accreditation agencies have moved to an outcomes-assessment-based accreditation process for the institution. The likelihood of there already being someone on your campus who is charged with the responsibility to do outcomes assessment is very great. Find them and begin a dialog about how what they are doing at the institutional level can inform and assist your program-assessment efforts. It would also be very unusual if you did not already have resources on your campus that could provide assistance in areas of educational assessment design (College of Education, Educational Psychology, etc.), data collection (Institutional Research, Registrar, Admissions, Student Affairs, etc.), and statistical analysis of social science data (Social Sciences, Business, etc.). Identifying local resources and engaging them in the planning and implementation process will provide both an economy of effort and a perspective external to the engineering program. This is bound to strengthen the overall quality of your assessment efforts.

Danger • There is a real danger that engineering faculty and administrators will adopt the attitude that no one outside of engineering can possibly understand the complexity and demanding curricula that embody the engineering discipline. It is important to remember that what you are looking for here are "worker" bees, not the queen. There are others outside of engineering who can help you think through the design of your assessment plan, ask the right questions, and collect and analyze the data. It is the primary purpose of the engineering faculty and administrators to give the plan substance, evaluate the results, make recommendations based on the evaluation, and implement the improvement. All the other steps can be done in consultation with others.

■ *Hiring An "Expert" To Do It For You*

There are many resources available to you from within higher education. People who are knowledgeable and experienced in assessment and evaluation processes are available to support you in your efforts.

Opportunity • A critical element in satisfying the requirements set forth in EC 2000 is to educate yourself in the assessment and CQI processes as they relate to educational programs. Having "experts" provide professional development activities for faculty is a good way to get the process started with a common language and understanding. If you have no local resources, seeking consultation from outside the college could be very beneficial.

Danger • There is a temptation to hire someone with expertise in assessment to do assessment for you (or, "to" you). Although having someone on the staff to assist in the process would be advantageous, there is a danger that others would expect him or her to develop and implement the plan. The appropriate role of an assessment specialist on the staff would be to guide the process and work with faculty to develop and validate *their* assessment plan. Determining responsibility for collection and analysis of data should be done in consultation with engineering faculty and administration. Evaluation of assessment results is more appropriately done by the faculty. Faculty should then recommend changes for improvement in the engineering program based on their evaluation of the assessment results.

■ *Student Involvement*

We must never forget that all of this is about improving the quality of student outcomes. It is designed to prepare

students for careers and lifelong learning. As the focus of this effort, we need to find ways to involve students in the assessment of their own learning outcomes.

Opportunity • As learning objectives are moved from the abstract to the concrete through development of specific, measurable performance criteria, students will have opportunities to assess their own skills in ways that are meaningful to them. For example, the use of peer assessment when students are asked to give oral reports will not only provide opportunities for them to assess each other, but will also reinforce the characteristics that are important for oral communication to the student who is making the assessment. The feedback being given to students making the reports will help them know where they need to make improvements. This can be done within the context of an engineering class.

Danger • The process of assessment for continuous quality improvement is designed to help us improve our engineering programs. We cannot forget that we can only improve our programs if we improve the educational outcomes for *individual* students. There is a danger that they will be left out of the process. Statistics are the impersonal representation of a collection of personal experiences of individual students. Let us accept the challenge of getting them involved in the assessment of themselves and their peers. Who knows? This act alone may be the most significant improvement in our programs and have the greatest impact on student outcomes.

It is time to take advantage of the lessons learned from those who have been engaged in outcomes assessment in different contexts and apply them to engineering education. . . . we can take advantage of the opportunities provided by the new approach to accreditation to assess our programs as a whole.

The dangers in doing so can be avoided if we are willing to learn from others who have been there.

■ *"One Size Fits All" Mentality*

The assessment process is like the engineering design process in many ways. One of the most significant ways is that it is a process that is ambiguous—there is no *one* right answer. Some answers are better than others, and some answers are definitely wrong.

Opportunity • Although CQI models can provide a good starting point, development of an assessment plan should reflect the uniqueness of your institution, your student body, and your program. The move to outcomes assessment requires conversations about who you are and what outcomes you want for your students—not someone else's students, institution, or program. These conversations should contribute to shared definitions and understandings that will enhance the overall educational experience for students and faculty alike.

Danger • Because of the sense of urgency that we all feel to get moving on the development of our assessment plans and data collection, there is a danger that we will try to impose someone else's framework or methods to our own program. There is a real risk in this approach because of the lack of personal buy-in from the people who are going to be responsible for implementation, evaluation, recommendations, and improvements—your faculty. Again, reviewing the work of others is very positive. There will also be things that you will be able to adapt/adopt for use on your campus, but those decisions need to be made *after* you have developed a clear understanding of your learning outcomes objectives and performance criteria for your program. Not until you reach these understandings will you be able to determine what methods will best fit your program.

WILL EC 2000 SURVIVE?

The long-term impact of EC 2000 will depend on several factors. As I have talked to engineering faculty from around the country, I have found mixed emotions about whether or not the changes will bring about real, significant improvement in the way engineering education is delivered and the quality of learning outcomes for students. I believe there are four elements critical to the successful transition to EC 2000.

1. Faculty must believe that EC 2000 will promote student learning and not be adverse to their own academic agenda.

Many faculty agree that EC 2000 is the "right" thing to do. They are in general agreement that the previous criteria were too restrictive and irrelevant to the changing nature of the engineering profession. But EC 2000 represents a radical, untested departure from what was a familiar and "comfortable" process—although unpleasant. The new approach to accreditation will take time and energy before any "payoff" will be seen. Even where EC 2000 is embraced, faculty want to know what they will have to give up in order to comply with the requirements. Unless they can see the long-term, beneficial results of their efforts, it will be difficult to get their buy-in.

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Opportunity on the Wings of Danger

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2. Administrators will need to expend resources to meet the requirements and have confidence that the resources expended will have sufficient benefit to the overall program.

Many engineering programs are already hampered by the demands for limited resources—money, equipment, space, time. etc. Deans and department heads need to make decisions about how to balance limited resources. The need to develop a culture of assessment for continuous quality improvement processes does not come without costs. If the move to EC 2000 is not see as having a defensible cost/benefit ratio in relation to other critical needs, there will be resistance to support the effort at a level that will be sufficient for success.

3. There needs to be an attitude of trust and cooperation among faculty and between faculty and administrative staff.

In the mind of a faculty member, there is a thin line between evaluating the program and evaluating "me." Administrators need to be trusted not to use program-assessment information to evaluate individual faculty members. The issue of evaluating a faculty member must be done outside the context of program evaluation to maintain faculty confidence in the process. In addition, faculty need to be trusted to use the assessment information to enhance student learning.

4. EC 2000 evaluators must understand assessment and CQI and know adequate processes when they see them.

There are at least three things that can happen when the EC 2000 evaluators come to your campus. **1)** They will be well versed in EC 2000 and have a clear understanding of the requirements, limitations, and possibilities for developing and implementing CQI and assessment processes in engineering education. As a result, they will be able to assist you in evaluating your program and make recommendations for improving your educational processes based on sound assessment information. **2)** They will not have a very good understanding of the requirements, limitations, and possibilities for developing and implementing CQI and assessments processes in engineering education. As a result, they will not be able to assist you in improving your processes, and because you have done your homework, you will end up educating them. **3)** They will not have a very good understanding of the requirements, limitations, and possibilities for developing and implementing CQI and assessment processes in engineering education—but they do not know it. As a result, they will apply inappropriate standards to the processes you have developed.

Scenarios 2 and 3 are outcomes that will erode the good that EC 2000 can bring to engineering education. Of course, the horror stories will travel much faster (and be more exaggerated) than the success stories.

The good news is that the Engineering Accreditation Commission is working very hard at providing training sessions for all EC 2000 evaluators. During this process, they are involving evaluators in discussion of the elements of assessment planning and CQI processes. Information about the availability of training sessions can be found on the ABET web site.[6]

CONCLUSION

While there are many dangers that lie ahead for engineering programs that are implementing outcomes assessment, there are none that cannot be overcome by careful preparation and planning. The industry and education representatives of ABET's Engineering Accreditation Commission (EAC) are taking the lead by providing programs to better inform evaluators and engineering faculty of the core concepts and processes embedded in EC 2000. It is important to remember that few of us have more to lose if EC 2000 fails than those who have had the courage to step forward to develop, propose, and champion the new accreditation criteria—the EAC. This activity has been in response to the deafening outcry of engineering faculty to do away with the rigid, "bean-counting" criteria that previously existed.

It is time to take advantage of the lessons learned from those who have been engaged in outcomes assessment in different contexts and apply them to engineering education. Faculty are already doing outcomes assessment in the classroom, and we can take advantage of the opportunities provided by the new approach to accreditation to assess our programs as a whole. The dangers in doing so can be avoided if we are willing to learn from others who have been there.

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