Reflections on Outcomes Assessment and the ABET Accreditation Process

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Summary

Because of new accreditation guidelines included in Engineering Criteria 2000 (EC 2000) many of us in engineering education are in the midst of a transformation in the way we define a quality educational experience for our students. Traditionally, we have focused on measuring the quality of educational inputs (e.g. student quality, student/faculty ratio, number of books in the library, amount of research funding, size of the university endowment). Now, we must seriously consider how to move from an "inputs oriented" method of assessing quality to an "outcomes oriented" process in which we:

- clearly define our constituencies and ask for their input periodically
- describe what we want our student to know and be able to do using measurable terminology
- determine how to make the measurements
- decide what the data mean and what we should do to improve our program
- determine how to inform all constituencies about our results and decisions
- continue to work to improve the assessment process itself

Completing all these steps effectively and on a continuing basis is a daunting task for most faculty members, even though we can see the potential benefits if assessment is done correctly and efficiently.

In this paper, I will reflect on some of the lessons we've learning in nearly 2 decades of outcomes assessment work at the Colorado School of Mines. [1] As part of this discussion, I'll comment on the role of ABET and the accreditation process (including preparations for an ABET visit) in shaping outcomes assessment activities and attitudes at CSM. I'll also briefly discuss issues related to sustaining the process once ABET leaves campus and the final accreditation decision is received.

Introduction and Background

Beginning in 1998, faculty from my department at the Colorado School of Mines (CSM) spent nearly two years consulting with key internal and external stakeholders (e.g. students, faculty, employers, alumni) and using this input to draft an assessment plan which would provide

sufficiently detailed information for improving the curricular and pedagogical processes in the program. Tasks completed during this effort included[1]:

- Setting general goals and specific, measurable objectives based on the institutional mission statement and the needs of employers and other constituencies
- Determining performance criteria which describe expected levels of student performance towards meeting the goals and objectives
- Revising our curriculum and pedagogical methods to ensure that students are being given sufficient opportunities to meet the objectives
- Selecting assessment tools and evaluation methods which would indicate which objectives are being met at satisfactory levels and which are not
- Developing a process for implementing and sustaining the assessment plan including strategies for providing feedback to all important stakeholders, enhancing the educational experience for our students, and improving the assessment plan itself.

Although CSM had been involved in a state-mandated assessment program for over 15 years, the steps listed above required many months of discussion among faculty, students, and other program constituencies. We certainly did not proceed through the list in lock-step but revisited previous decisions many times before deciding upon the plan we would implement 2-3 years prior to our next ABET visit during October 2000. More details have been reported about our assessment plan and the developmental process used. [2]

Lessons Learned in Developing and Implementing an Assessment Process

Perhaps the most important lesson we've learned at CSM in nearly 15 years of assessment work at the course, program, and institutional levels is that it is extremely important to develop and use an assessment process with clearly delineated steps. Several helpful guides to developing an assessment plan exist, most notably those by Rogers and Sando [3] and the National Science Foundation [4], but we have found the process based on answering the questions summarized in Table 1 most helpful for our needs.

By answering these questions iteratively, we can be assured that we have not overlooked any important components of our assessment plan. Such a process does not dictate that a particular assessment method be used, but it does help faculty to decide which methods are most appropriate for measuring certain objectives.

We also learned early in the process that periodic and active participation of the department faculty and support from the department head are crucial. After some initial but unsuccessful attempts at departmental-level decision-making for each of the questions shown in Table 1, we created a pyramid management structure with one faculty member designated as the "assessment

[1] A glossary of terms is provides at the end of the paper.

coordinator" responsible for day-to-day monitoring of the process and a four-member assessment committee consisting of the assessment coordinator, the department head, and two faculty members responsible for assessing student work, interpreting the results, and reporting to all relevant constituencies. Major decisions about potential curricular and pedagogical changes and improvements in the assessment process itself are still discussed and decided upon by the entire department faculty. This management structure has been successful so far and seems to provide a reasonable balance between the need for actively managing the assessment process and keeping busy faculty members in the assessment loop.

Table 1
Program Assessment Matrix [5]

Goals	What are the overall goals of the program? How do they complement institutional and accreditation expectations?
Objectives	What are the program's objectives? What should our students know and be able to do?
Performance Criteria	How will we know the objectives have been met? What level of performance meets each objective?
Implementation Strategies	How will the objectives be met? What program activities (curricular and co-curricular) help our students to meet each objective?
Evaluation Methods	What assessment methods will we use to collect data? How will we interpret and evaluate the data?
Timeline	When will we measure?
Feedback	Who needs to know the results? How can we convince them the objectives were met? How can we improve our program and our assessment process?

As the process was developed and piloted, we learned (sometimes in painful ways) several important lessons at each step. These included:

Creating program goals and objectives

- Time spent developing goals and objectives is well worth the effort later in process. Too often faculty want to jump immediately to data collection (usually with surveys) before deciding what they wish to measure.
- The discussion of goals and objectives can serve as a valuable faculty development tool as faculty work towards consensus on the goals of the program. It is surprising how often faculty who believe that they have common goals find that they do not. The opposite discovery is also made with some frequency.

- Fewer goals and objectives are better since each objective must be assessed. Resist the temptation to develop large numbers of goals.

Setting performance criteria

- Calibration is important – decide upon a realistic level of performance for students.
- Setting performance expectations can become a high-stakes, political process because this is the step at which value judgments enter the discussion. However, the discussions involved can lead to very valuable consensus building among the faculty.

Aligning the Curriculum with Program Goals and Objectives

- The curriculum may not completely cover all relevant program objectives and a discussion about how to fill in the gaps is a worthy program-level activity.
- Some faculty members tend to overstate the number of program objectives addressed in their courses. An honest appraisal of the contribution of each course to program goals and objectives must be conducted.
- Co-curricular activities (e.g. participation in student professional societies, internships, study abroad programs) are important facets of a student's educational experience but are harder to assess and include in the assessment process.
- Faculty should realize that covering a topic in multiple courses is not a fault in a program, but rather that many skills require extensive practice in order to achieve proficiency.

Selecting assessment methods

- Multiple methods need to be selected to assess as many of the objectives as possible. This is known as "triangulation." Over-reliance on one method can be misleading.
- Rely on sampling techniques particularly if the program has many students; not every student must be assessed.
- Faculty should participate in the discussion to determine what student work or other data will constitute evidence that objectives are being achieved.
- Developing and calibrating scoring rubrics is a time-intensive activity that must be completed to ensure data validity and reliability. Rubrics must be specifically designed for the objectives and performance criteria included in the assessment plan. Once they have been developed, however, rubrics make the task of evaluating student work relatively easy.
- The choice of methods can be improved each time student work is assessed. If something doesn't work, it should be discarded, and not everything will work.

Implementing the process and providing feedback to constituencies

- Don't measure an objective if you don't want to know the results; be sure to use the assessment data to make program improvements when necessary. If others don't see changes resulting from your assessment activities, they are likely to lose interest quickly.
- Make sure all relevant data are reported to stakeholders and used to improve the program.
- Develop an assessment phase-in plan; not all the objectives have to be measured at the same time.
- Develop a long-range plan to measure objectives periodically but not necessarily every semester or academic year.
- Try to avoid overburdening faculty and other stakeholders with too much data. A few, well-chosen pieces of information may be much more effective than a "data dump."

Using assessment data to make program improvements

- Be sure to use assessment results to guide program improvements and try to avoid intermingling these results with the ever-present anecdotal comments from faculty members.
- Understand that proposing program changes based on assessment data will meet with resistance from some faculty; try to focus the discussion on program improvement rather than changes in individual courses "owned" by faculty.
- Don't try to "fix" everything at once. Focus on making the most dramatic changes first. Solid examples of ways in which assessment leads to improvements in the curriculum and student outcomes will help convince skeptics that the effort is worthwhile.

Overall

- Avoid the temptation to start collecting assessment data before developing clear goals, objectives, and an assessment process. Before decisions are made about which materials to collect and assess, be sure to answer questions about what is being assessed, how the data will be analyzed, when materials will be collected, and who will receive the results.
- Try to avoid the potentially endless discussion of what ABET means by various terms such as "outcome"; as a campus, select terms and definitions which the faculty are comfortable with and apply them consistently across programs.
- Be sure to promote stakeholder buy-in by involving as many constituencies as possible in the assessment development and implementation process.

- Include as many of the faculty as feasible in the process. If one lone faculty or staff member is assigned the assessment task, the plan will almost assuredly fail. Develop a management structure that balances day-to-day assessment activities with periodic input from the program faculty.
- Look for campus resources to help faculty get started with assessment and provide faculty development opportunities. Most schools have some level of assessment expertise on campus—do not be afraid to search for help in training engineering faculty to become good assessors.
- Remember that the quality of results is more important than quantity. Assessment does not have to measure every learning objective in every course in the curriculum. Collect and interpret results that will be of the most value to improving the learning and teaching process and use sampling techniques to collect a snapshot of student achievement.
- Find ways to reward the efforts that faculty put into assessment. Rewards may be monetary, but they can also include release time, publication possibilities, recognition during annual faculty evaluations, and support for attending assessment-related conferences.

The Role of ABET in Outcomes Assessment

Obviously the introduction of student outcomes and assessment requirements to the accreditation process [6] has catalyzed the recent interest in assessment activities in engineering programs around the United States and my institution was no different. Although, we have been doing assessment for over 15 years as part of a state-mandated program, EC 2000 was the driver to fully design and implement an effective assessment plan which provided useful results for program improvement. Even though we should always conduct the sorts of assessment activities called for in EC 2000 whether ABET exists or not, the reality is that accreditation will remain a major player in maintaining faculty motivation and interest in the process. Thus, ABET will continue to play a crucial role (perhaps more than ever before) in promoting quality improvements in engineering education.

As promised, ABET has not only refocused our attention to achieving and assessing the quality of student learning, but ABET reviewers are also becoming a partner in the continuous process of improving our students' learning. Rather than a dreaded visit from a compliance officer once every six years to "count beans" and search for program weaknesses, an ABET review can now become an effective way to achieve meaningful dialogue among program constituencies and the ABET reviewer. We engaged in many useful discussions prior to, during, and after our official 2-day visit and were able to address minor issues prior to final accreditation actions. For example, our visitor noted that our students were not being introduced adequately to health and safety issues in process design and the course was immediately modified to include a significant amount of HAZOP work on the final design project. The assessment program was also revised to measure students' ability to identify and correct hazardous operations issues during the design of

a new process or modification of an existing process. Overall, the process of self-study followed by the ABET site visit is a much more useful and meaningful exercise that it has been in the past, and a true partnership with ABET is now possible.

In addition to complying with ABET guidelines, I believe the implementation of our assessment process has directly improved the educational experience of our students. Every required chemical engineering undergraduate course now has published learning objectives that our faculty have agreed to use in their course syllabi. Our curriculum has undergone several recent changes including addition of two new thermodynamics laboratory courses (based on perceived weaknesses in data analysis in the unit operations laboratory course) and embedded writing instruction and practice in four selected junior-level and senior-level courses (based on assessment data which suggested the need to continue communications instruction throughout the curriculum). The impact of these courses is now being closely monitored using our assessment process.

Now that our review is over and our accreditation has been continued, the challenge is to maintain the faculty's interest in and commitment to continued assessment work during the six-year review cycle. In the past, ABET and accreditation issues could be forgotten until planning started for the next visit, but now we must continue to assess student outcomes on a regular basis, report results to our constituencies, and improve both our educational program and the assessment process itself. Our challenge will be to maintain some semblance of the energy and interest shown by the faculty in the year prior to our last accreditation visit.

Glossary of Assessment Terms

Assessment – collecting and analyzing data on student academic performance [3]

Course learning objective – detailed statement that describes a specific unit of knowledge or skill that a student should be able to demonstrate in a course

Evaluation – interpreting assessment data to draw conclusions about how well program goals and objectives are being met [3]

Feedback – providing stakeholders and other interested parties with the results of the assessment and evaluation process

Goal – broad statement of desired program outcomes [3]; referred to as an "educational objective" by ABET

Method – process or instrument used to collect assessment data

Objective – detailed statement that describes under what circumstances it will be known that the goal has been achieved [3]; referred to as an "outcome" by ABET

Performance criteria – statement that defines the level of performance required to meet an objective [3]

Reliability – repeatability of measurements with a specific assessment method

Rubric – scoring guide that provides descriptions of student work of varying quality

Stakeholders – individuals or groups who have an interest in the quality of an educational program

Validity – the accuracy with which a method measures what it is supposed to measure

Triangulation – using more than one method to assess a program objective

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Biographical Information

RONALD L. MILLER is Professor of Chemical Engineering and Petroleum Refining at the Colorado School of Mines where he has taught chemical engineering and interdisciplinary courses and conducted research in educational methods for over seventeen years. He has received three university-wide teaching awards and has held a Jenni teaching fellowship at CSM. His paper entitled "Using Portfolios to Assess a ChE Program" (co-authored with Barbara Olds) won the Corcoran Award from the chemical engineering division of ASEE for best paper published in *Chemical Engineering Education* during 1999. His paper entitled "Connections: A Longitudinal Study of an Integrated Freshman Program" (co-authored with Barbara Olds) won the award for best paper in the Educational and Research Methods Division of ASEE during the 2001 annual conference.

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