ChE assessment

ISSUES IN DEVELOPING AND IMPLEMENTING AN ASSESSMENT PLAN

In ChE Departments

JAMES A. NEWELL, HEIDI L. NEWELL,
THOMAS C. OWENS,* JOHN J. ERJAVEC,* RASHID A. HASAN,* STEVEN P.K. STERNBERG*
Rowan University • Glassboro, NJ 08028-1701

Initially, the assessment requirements imposed by the new ABET Engineering Criteria 2000[1] appear daunting. Even the terminology is confusing. Compounding the challenge is the fact that engineering faculty typically lack experience in conducting outcomes assessment. Several authors have made analogies between the outcomes process of assessment and chemical process control loops.[2,3] Although these may be useful analogies for defining the purpose, they do not provide specific ideas on how to approach such a large and ill-defined problem as program assessment. No matter how hard we try, we cannot use Laplace transforms and transfer functions to make our problems go away. Instead, we must recognize that we will have to face these new challenges head-on.

The University of North Dakota was slated to be a pilot program for reaccreditation review under EC 2000 in the fall of 1997. Unfortunately, the massive flooding of the nearby Red River of the North in the spring of 1997 caused the accreditation visit to be postponed for one year. Although the flood was devastating to the city, the university, and faculty homes, it did save us from going up for accreditation prematurely. We were not ready! Like many programs that had been reviewed under the previous system, we did not realize how much lead time an organized and documentable assessment plan would require.

We had spent time rewriting mission statements and asking ourselves how we could determine if our students were really learning. Like most programs do, we saved everything: tests, final exams, lab reports, homework assignments, journal entries, etc. But we had no real plan as to what we should do with them. With the extra time afforded us by the flood, we began a series of discussions, planning sessions, and activities that helped us, finally, to address the pivotal issues. We were able to involve our constituencies by including students directly in the writing and planning and by meeting with our industrial advisory board. In the fall of 1998, the chemical engineering program at the University of North Dakota was visited under EC 2000. This site visit was the culmination of a two-year-long process (which really should have been longer) of preparing and implementing an assessment plan.

We wanted to write a paper that provided practical sugges-

James Newell *is Associate Professor of Chemical Engineering at Rowan University. He serves as a Director of the Chemical Engineering Division of ASEE and has received the Dow Outstanding New Faculty Award. His areas of interest include high-performance polymers, integrating communications across the curriculum, and undergraduate research.*
Heidi Newell *is currently the assessment/accreditation consultant for the College of Engineering at Rowan University. She previously served as assessment consultant for the University of North Dakota. She holds a PhD in Educational Leadership from the University of North Dakota, an MS in Industrial and Organizational Psychology from Clemson, and a BA in Sociology from Bloomsburg University.*
Tom Owens *has been Chairman of the Chemical Engineering Department at the University of North Dakota since 1975 (with two brief interruptions to serve as acting Dean). He holds a PhD from Iowa State and is actively involved in self-paced learning, distance learning, and technical communications.*
John Erjavec *is Associate Professor of Chemical Engineering at the University of North Dakota. He holds a PhD from Princeton University and specializes in experimental design and statistical analysis of experimental data. He is actively involved with the Energy and Environmental Research Center.*
Rashid Hasan *is Professor of Chemical Engineering at the University of North Dakota, where he has been since 1979. Originally from Bangladesh, he holds a PhD in chemical engineering from the University of Waterloo, and his research focuses on multiphase flow modeling.*
Steven P.K. Sternberg *is Assistant Professor of Chemical Engineering at the University of North Dakota. His PhD is from Purdue and his research focuses on flow through porous media and the use of native plants to remove metal contaminants from water. He is actively involved with novel teaching techniques and undergraduate research.*

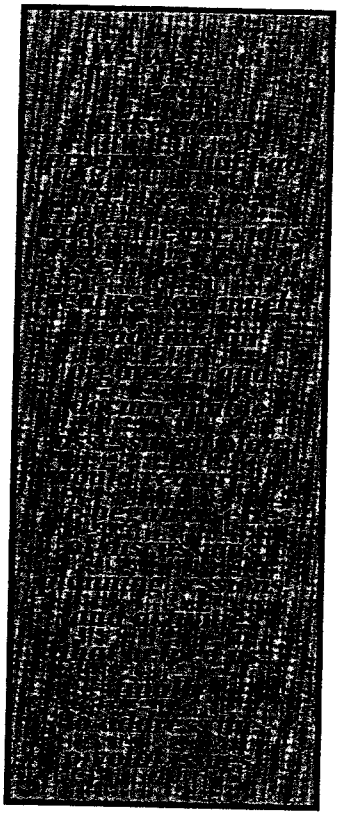
* *Address: University of North Dakota, Grand Forks, ND 58202*

tions for reassessment that may not appear in a manual. The remainder of this paper is devoted to providing answers to questions that we struggled with and to providing advice for other departments.

QUESTIONS

How do we get started?

Schedule a relaxed meeting that does not occur during normal school hours or take place in your usual, more stressful surroundings. Use this meeting to discuss the steps and develop a timeline. Much of the accreditation and assessment preparation is sequential. Therefore, you will create your timeline for activities by noting your ultimate deadline for submitting your self-study to ABET (*e.g.*, June 1st prior to your accreditation visit) and working your way backward to the present. The major phases are



- *Selecting and writing about: vision, mission, goals, objectives, outcomes, indicators, practices, assessment methods, and assessment criteria*
- *Discussing and writing the self-study report*
- *Designing, pilot testing, and administering your assessment tools or collecting other data for assessment purposes*
- *Collecting materials for the various appendices to the self-study report*
- *Analyzing collected data*
- *Making changes to the educational experience based on your findings*
- *Assessing your improvements*

We cannot provide a timeline for you since all programs are different. Remember that you will need at least one complete cycle before your accreditation visit, so you must be done planning at least one year before the visit.

Should we get help?

Yes. Although assessment is worth it, it does add to already overburdened faculty workloads. Therefore, we hired an accreditation/assessment consultant who kept us on pace and helped translate the assessment-speak into ideas that we could understand. The consultant should not make decisions for you, but rather should serve as a facilitator in your efforts. One of the coauthors of this paper holds a PhD in higher education administration and had several years of assessment experience, so finding a consultant was easy for us. But almost all universities have a potential consultant in place. Some university personnel have been doing assessment for years. If you cannot afford (or do not prefer) an external consultant, try talking to individuals within your institutional research department or your college of education who may be able to recommend cost-effective assistance. Remember, a consultant should be just that—a consultant. He or she can help you greatly, but he or she cannot plan or do the assessment for you.

What do all these terms mean?

We recommend that early in the process you develop a set of common terms and definitions so that each of you will know what everyone else is talking about. Regrettably, there is no consensus in the assessment community. The important thing is that you all use the same terms and define them for the evaluators. We used the following definitions:

Vision statements outline your mission of the future.

Mission statements outline the purpose of your program.

Goals are the lofty aims. Things such as "We want our graduates to be effective communicators" are goals. You may wish to include university and college goals with your program goals.

Objectives are more specific. Perhaps things such as "When giving an oral presentation, our students will a) provide an introduction appropriate for a given audience, b) speak clearly, c) present facts in a logical manner d) support their arguments with facts and data, and e) clearly summarize key points.

Outcomes tell us what specific result(s) will occur, such as "Students will write effective documents."

Indicators are the specific items to which a "yes" or "no" answer to the outcomes questions can be applied, such as "Is the document formatted correctly?"

Practices are opportunities in your educational experience for student learning, such as a class or an activity.

Assessment Methods are the actual tools or other data-collection techniques you use to assess student learning, such as portfolios, alumni surveys, the Fundamentals of Engineering Exam, etc.

Assessment Criteria are the stated levels of performance for each assessment method that will be used to guide decisions and set priorities for improvement. You will want to develop those ideas that are unique to your program and highlight your strengths in addition to ideas required by outside bodies.

How can we make sure all of us are addressing criteria that we need to address?

Use various matrices to give you visual pictures of how your outcomes map to your curriculum and also to your assessment methods. Two sample matrices are shown in Tables 1 and 2. You should try to make sure there are at least three "hits" for every item in the rows and columns for each matrix. On the other hand, if there are too many "hits" in a row or column, you may be able to eliminate some in favor of addressing other desired areas.

How much data should we accumulate?

If you save every exam and homework assignment, you will be buried with so much data that you will be unable to figure out what is meaningful. By planning carefully in mapping instruments to your objectives, you can reduce the data collection considerably. Remember, assessment is not just "do it once and forget about it." Sampling is the key concept in data collection. In general, you should gather the least amount of data that will give you the most information. In other words, some assessment methods may require input from all sources, other may only require strategically selected samples. Whenever possible, use or modify existing data collection opportunities to reduce the burden of data collection. For example, your university might already be collecting information you need. You will want to do a project cost analysis (*i.e.,* in terms of materials and time) in conjunction with data collection and, in reality, this may impact how much data you can feasibly collect.

How do we keep track of things?

First, set up a data warehouse. You might want to include the following electronic folders for each program: self-study, syllabi, curriculum vita, tables, policies, references, (assess-

TABLE 1
List of Assessment Methods Mapped to Objectives

A = knowledge of math, science, and engineering
B = design and conduct experiments; analyze and interpret data
C = design a system, process, or component
D = multidisciplinary teams
E = identify, formulate, and solve engineering problems
F = ethics
G = communicate effectively
H = broad education to see societal impact
I = lifelong learning
J = knowledge of contemporary issues
K = use modern tools
L = working knowledge of chemistry
M = working knowledge of ChE principles
N = department-specific objective
O = department-specific objective

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Senior Design Reports															
Senior Design Orals															
Unit Ops Lab Reports															
Clinic Reports															
Clinic Presentations															
FE Exam															
Portfolios															
E-Portfolios															
Alumni Surveys															
Employer/Recruit Surveys															
Exit Interviews															
Peer Reviews															

TABLE 2
List of Practices Mapped to Educational Objectives

A = knowledge of math, science, and engineering
B = design and conduct experiments; analyze and interpret data
C = design a system, process, or component
D = multidisciplinary teams
E = identify, formulate, and solve engineering problems
F = ethics
G = communicate effectively
H = broad education to see societal impact
I = lifelong learning
J = knowledge of contemporary issues
K = use modern tools
L = working knowledge of chemistry
M = working knowledge of ChE principles
N = department-specific objective
O = department-specific objective

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
ChE Courses															
Senior Design															
Unit Ops Lab															
Internships															
Oral Presentations															
General Eds															
Chemistry															
AIChE, SWE, etc.															

ment) tools, data, and reports. Second, set up a data storage system for paper copies. Third, develop a timeline for the fall, spring, and summer semesters, with suggestions of what should occur early in the semester, in the middle, or at its end. Obviously, assessment activities should be distributed in such a way that allows for moderate activity throughout each semester instead of periods with too much or too little collection. Finally, make each faculty member responsible for at least one assessment activity. This way, all instruments will be used without any one faculty member being overburdened. Each coordinator should maintain a set of written responsibilities as a reference to facilitate administering tools.

How do we plan improvements?

There must be a formalized system in place. We recommend having a retreat during the summer each year, which we called the "assessment marathon." Over two days, we discussed all aspects of our program, including the data from each tool, in turn. We identified strengths as well as areas for improvement and made decisions affecting our curriculum and policies. These discussions were wonderfully productive, and we left with a better feel for the program as a whole.

How involved should we be with other departments?

We were not nearly as involved with the other departments in the college as we should have been. Although we shared information, an alumni survey was the only common instrument used. A significant aspect of the assessment process is discussions about improvement, and all departments can benefit from each other's experiences. Most university-level information is useful in assessing the general educational experiences that are likely to be common across the programs. It is important, however, to remember that accreditation occurs at the departmental level, so each department is ultimately responsible for itself.

Why won't anyone provide specific answers instead of just general advice?

Outcomes assessment is a highly personal activity. The whole point of moving away from bean counting and into outcomes was to enable programs to set their own goals, defend their importance, and prove that they are being achieved. Even a reviewer of an early draft of this paper asked "What should we collect—finals exams but not homework, materials from every student or every tenth student? There are no single answers to these kinds of questions. A program that graduates 15 students a year will keep different information than one that graduates 100 or more. If final exams are one of five assessment instruments you are using to demonstrate that you have achieved an objective, you may not need homework as well. You own the process and must make your own decisions. Below is one education objective, as an example—but your department may have very different ideas.

Goal—Develop students who communicate their ideas effectively in various formats to both technical and non-technical audiences.

Objective • The Chemical Engineering Program at Rowan University will produce graduates who demonstrate effective oral and written communication skills (ABET-G).

Outcome A • Students in the Chemical Engineering Program will write effective documents, including memos, e-mails, business letters, technical reports, operations manuals, and descriptions of systems, processes, or components.

Indicators:

1. *Written at the appropriate level for the intended reader*
2. *Presents correct technical information*
3. *Contains few, if any, typographical or grammatical errors*
4. *Formatted correctly*
5. *Contains an introduction that interests and orients a reader*
6. *Contains a body that is relevant and covers important points*
7. *Contains a conclusion with summary and recommendations, when appropriate*

Practices:

1. *Chemical engineering courses*
2. *Unit operations lab*
3. *Internships*
4. *Senior plant design*

Assessment Instruments

1. *Senior plant design reports*
2. *Portfolios*
3. *Alumni surveys*
4. *Recruiter/employer surveys*
5. *Exit interviews*
6. *Peer reviews*

SUMMARY

The process of developing a workable assessment plan that is useful in preparing for accreditation under EC 2000 is long and filled with challenges. Departments must begin to analyze their program goals early and recognize the size of the task they face. Through progressive discussions and a systematic approach to planning, the task can be accomplished. Key points to remember include: identify your goals first, involve students and other constituents, minimize the data that you are required to collect and analyze, have multiple indicators for each objective (ideally involving multiple sources), and get started yesterday!

REFERENCES

1. ABET Engineering Criteria 2000
2. Felder, R., *Chem. Eng. Ed.*, **32**(2), 126 (1998)
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