Abstract

ABET’s Criteria 2000 identifies 11 desired outcomes for engineering education. Engineering programs will be evaluated according to their success in producing students with the ability to: 1) apply knowledge of mathematics, science, and engineering; 2) design and conduct experiments and interpret data; 3) design a system, component, or process; 4) function on multi-disciplinary teams; 5) identify, formulate, and solve engineering problems; 6) understand their professional and ethical responsibilities; 7) communicate effectively; 8) understand the broad impact of engineering solutions; 9) recognize the need for life-long learning; 10) understand contemporary issues; and 11) use techniques, skills, and modern engineering tools.

As one of the first Chemical Engineering programs to be evaluated under Criteria 2000, the Chemical Engineering Department at the University of Arkansas developed a list of 16 possible tools that might be used to assess these outcomes. That list has been narrowed to 6 tools that are of the most practical value, both to students and the Department. Of these, the most valuable is the student portfolio.

Student portfolios are the only assessment tool that adequately address all 11 of these outcomes. Students begin their portfolios in the freshman year and update them throughout their academic career. Portfolios are checked as part of coursework requirements each year. In addition, students use their portfolio in meeting with their advisor and planning their academic and professional careers.

A standardized format is required for the portfolio, which is actually a very individual-specific document. This provides some uniformity and allows the development of an ABET Outcomes Checklist for assessing our progress in meeting Criteria 2000.

Introduction

ABET Criterion 3 (Program Outcomes and Assessment) outlines 11 desired attributes for graduate engineers that challenge engineering departments to produce graduates with both technical and professional skills. As one of the first Chemical Engineering programs to be evaluated under Criteria 2000 in 1996, the chemical engineering program at the University of Arkansas (U of A) originally developed a list of 16 documentation tools that could be used for outcome assessment.

As is noted in Table 1, this list has been subsequently narrowed to 6 tools, which ensures overlapping assessment of each outcome. Of these tools, the student portfolio is the only
assessment tool that assesses each of the Criterion 3 outcomes. Thus, it is viewed as a formidable program assessment tool. In addition, and perhaps more importantly, it serves as an invaluable planning tool for students in both assessing strengths and weaknesses in both their academic and professional careers.

Table 1. Documentation for Criterion 3 Outcomes

<table>
<thead>
<tr>
<th>Documentation</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
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<th>h</th>
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<th>j</th>
<th>k</th>
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<tbody>
<tr>
<td>Quantitative metrics, including transcripts, scores of FE, MCAT, GRE</td>
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<tr>
<td>Job Offers/Alumni Career History</td>
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<td>X</td>
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<tr>
<td>Senior Exit Interviews/Alumni Surveys</td>
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<td>X</td>
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<td>Student Portfolios</td>
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<td>X</td>
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<td>X</td>
</tr>
</tbody>
</table>

(a) apply knowledge of mathematics, science, and engineering  
(b) design and conduct experiments and interpret data  
(c) design a system, component, or process  
(d) function on multi-disciplinary teams  
(e) identify, formulate, and solve engineering problems  
(f) understand their professional and ethical responsibilities  
(g) communicate effectively  
(h) understand the broad impact of engineering solutions  
(i) recognize the need for life-long learning  
(j) understand contemporary issues  
(k) use techniques, skills, and modern engineering tools.

Portfolios have been used extensively, particularly in other disciplines, for some time. Shackelford\(^1\) describes the characteristics and content of a number of different types of student portfolios including showcase portfolios, descriptive portfolios, evaluative portfolios, and competitive portfolios. Portfolios can be used as learning tools in the classroom\(^2\)-\(^4\) or as well-designed instruments to enhance the traditional job search.\(^5\)

Portfolio use in engineering programs is less prevalent. Olds and Miller\(^6\) discuss the use of portfolios as their major instrument in chemical engineering program assessment and evaluation at the Colorado School of Mines. They present the plan for development of the portfolio as well as “lessons learned” in using the portfolio.

The purpose of this paper is to discuss the development and use of the student portfolio at the U of A both as a student planning tool and an assessment tool for ABET accreditation. The U of A portfolio concept, consisting of an academic portfolio and a smaller employment portfolio, is presented, including a presentation of the sections of each of the portfolios and their purposes.
The necessary steps in preparing, tracking, updating, and reviewing the portfolio, and the value to the student are then discussed. Finally, implementation for use as an outcome assessment tool is outlined and discussed.

**Portfolio Content**

As was noted earlier, the U of A student portfolio actually comprises two required portfolios: the academic portfolio and the employment portfolio. Every chemical engineering student is required by the Department to prepare both portfolios. Although the students are given an outline of the sections of each portfolio, the content of each of these documents is very individual-specific. The academic portfolio serves as an historical record of the academic and professional accomplishments of the student, and aids in the planning of both short-range and long-range academic and professional careers. The employment portfolio is actually a subset of the academic portfolio and serves as a document that the student can use in job interviews as an augmentation of the traditional resume.

A summary of the content of each of the portfolios is shown in Table 2. The academic portfolio is initially prepared as a component of CHEG 1212, Chemical Engineering Laboratory I, a freshman-level laboratory course that mainly emphasizes basic measurements and oral and written communication. The academic portfolio is prepared in a three-ring binder and contains ten sections along with supporting material (certificates, clippings, letters, photos, etc.) for each section.

<table>
<thead>
<tr>
<th>Academic Portfolio</th>
<th>Employment Portfolio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mission Statement</td>
<td>Executive Summary</td>
</tr>
<tr>
<td>Resume</td>
<td>Table of Contents</td>
</tr>
<tr>
<td>Educational Objectives</td>
<td>Mission Statement</td>
</tr>
<tr>
<td>Educational Experience</td>
<td>Resume</td>
</tr>
<tr>
<td>Transcript</td>
<td>Career-Point Analysis, including education, work experience, and skills</td>
</tr>
<tr>
<td>Course work summary</td>
<td>Five-Year Plan, including life-long learning plan, job search, and early career</td>
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<tr>
<td>Professional Employment Narrative</td>
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<tr>
<td>Other Employment Narrative</td>
<td></td>
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<tr>
<td>Extracurricular Activities</td>
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<tr>
<td>Honors and Awards</td>
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</tbody>
</table>

The first section of the academic portfolio is the mission statement, a brief statement of purpose, beliefs, and lifelong goals. Students are given sample mission statements, and are encouraged to review techniques for preparing mission statements, such as those outlined by Steven Covey7 or available online at ivillage.com. Mission statements change with time, and students are encouraged to keep all drafts of their mission statements in their portfolios. The next section is the resume. Students are given instruction in the preparation of a single-page resume and the common pitfalls to avoid in resume preparation. The resume, of course, will change with time, with some thing dropping off and others appearing. Again, students are encouraged to keep all
of the revisions of their resumes in the portfolio.

The third section is the education objective, which includes both near-term and long-term objectives. This section seeks to explore why the student chose chemical engineering as a field of study, why they chose the U of A, and the goals for their education at the U of A. Long-term objectives include a discussion of life and career after graduation and life-long learning goals. The fourth section contains educational experiences, including a discussion of their particular high school experience and other educational experiences such as foreign travel, attendance at special schools, etc. In this section the students are asked to critically evaluate their high school experience as preparation for study at the university.

Following a current transcript, the next section contains a coursework summary. This summary includes a narrative on each course taken in the curriculum, and briefly describes why the course was taken, the value of each course to the student, and a description of any special projects or assignments required in the class. Up to one page may be written for each class.

The professional employment experience narrative follows, in which the student describes and discusses professional employment and programs, why they chose the particular activity, and what they learned. A similar narrative is prepared for other employment experiences that are non-professional, but still have significant value in personal development.

Extracurricular activities, both inside and outside the university, are discussed, including a description of the activity, the student’s role, and the value of the activity. Finally, honors and awards are presented and discussed.

The employment portfolio is a subset of the academic portfolio. It is initially prepared in CHEG 3221, Professional Practice Seminar, a sophomore-level course aimed at organizational and technical communication issues and professional development. The employment portfolio is also a collection of narrative and supporting materials. In addition to a career-oriented mission statement and a resume, the employment portfolio contains a career-point analysis and a five-year plan. The career-point analysis highlights and augments the resume, giving narrative and supporting data in educational experience, work experience, and a variety of skills. The five-year plan contains an educational plan, both prior to and after graduation, the plan for the student’s job search, and plans for the early career. As was noted earlier, the employment portfolio can be taken to the job interviews as an impressive supplement to the resume.

The portfolio preparation process begins with presentations by the instructor on required portfolio content, the preparation of mission statements, and resume construction. After allowing students a few weeks of preparation time, each student is interviewed to see what he has accumulated and if he has any questions on portfolio content. The resume is also reviewed, and a general review of academic and professional progress is performed. It is at this meeting that plans for the future are discussed. Final portfolio preparation occurs after this meeting.
Although students see value in the portfolios during or soon after preparation, by nature they will not continue to update the portfolios unless updating is required. A schedule for initial preparation and review of the portfolios is shown in Table 3. As is noted, each of the portfolios are updated, reviewed, and graded once per year throughout the student’s academic program. Currently two departmental faculty members are handling the portfolio preparation and review process.

Table 3. Portfolio Update and Review

<table>
<thead>
<tr>
<th>Course</th>
<th>Academic Portfolio</th>
<th>Employment Portfolio</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEG 1212 Lab I (freshman)</td>
<td>prepare</td>
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</tr>
<tr>
<td>CHEG 3221 Professional Practice Sem. (sophomore)</td>
<td>check</td>
<td>prepare</td>
</tr>
<tr>
<td>CHEG 3232 Lab 2 (junior)</td>
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<td>check</td>
</tr>
<tr>
<td>CHEG 4413 Lab 3 (senior)</td>
<td>check</td>
<td>check</td>
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</tbody>
</table>

Value to Students

The primary reason for requiring students to prepare portfolios is that they obtain a powerful planning tool for both their academic and professional careers. Weaknesses in professional activity are identified at a time when the students are able to do something about it. As an example, the student and his advisor might note that the student has not had any professional employment and that a summer job or involvement in an REU (NSF Research Experience for Undergraduates) program might be helpful in filling the void. Portfolio preparation causes students to think more about academic progress and planning, as well as what they would like to do as a career. The employment portfolio also gives an advantage in employment interviews. One senior engineering student impressed an interviewer so much with her portfolio that she was offered a job on the spot. Other interviewers have actually called the Department to express their positive responses to the portfolios our students presented.

ABET Value and Use

The portfolio has value to the outcome and assessment program: 1) as a documentation tool for assessing all 11 outcomes and 2) as a tool for setting program content, particularly with technical and humanistic/science electives. Student narratives about their experiences in these courses can help the Department determine if they are of value to our students. For example, student dissatisfaction with the Technical Communication service course, as well as the indication it was producing minimal results, led the Department to implement its own emphasis in teaching technical writing and presentation skills, integrating them into the laboratory and design classes.

To assist in grading portfolios and identifying program outcomes, a record sheet was developed. Figure 1 shows a sample of this sheet. This sheet is kept by the advisor and updated each year.
### Assessment Level

<table>
<thead>
<tr>
<th>Outcome A</th>
<th>Lab 1/Date:</th>
<th>Seminar/Date:</th>
<th>Lab 2/Date:</th>
<th>Design 1/Date:</th>
</tr>
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<tbody>
<tr>
<td>Class project</td>
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<tr>
<td>Prof. employment</td>
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<td>Outcome B</td>
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<tr>
<td>Class project</td>
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<tr>
<td>Outcome C</td>
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<tr>
<td>Class project</td>
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<tr>
<td>Prof. employment</td>
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<td>Outcome D</td>
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<tr>
<td>Class Project</td>
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<td>Employment</td>
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<tr>
<td>Extracurricular</td>
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<td>Outcome E</td>
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<td>Engr courses</td>
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<td>Professional emp.</td>
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<td>Outcome F</td>
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<tr>
<td>Lab, seminar</td>
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<tr>
<td>employment</td>
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<tr>
<td>Outcome G</td>
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<td></td>
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<tr>
<td>Lab, seminar</td>
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<tr>
<td>Class present.</td>
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<tr>
<td>Job experience</td>
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<tr>
<td>Outcome H</td>
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<tr>
<td>Mission statement</td>
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<tr>
<td>Objectives</td>
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<td>Objectives</td>
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<tr>
<td>Outcome J</td>
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<td>Elective courses</td>
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<td>Extracurricular</td>
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<td>Outcome K</td>
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<tr>
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<tr>
<td>Design project</td>
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**Figure 1. Sample Outcomes Assessment Sheet**
when the portfolio is reviewed. Notes are made on the sheet during the assessment. A second page may be used to indicate activities that are particularly noteworthy or deserve special attention, so that the activity can be found readily in the student’s portfolio and documented at a later date. Assessments for each student are made each year.

As a tool for assessing ABET outcomes, the portfolio is unmatched by any other instruments. Although participation in design classes, professional employment, or extracurricular activities may indicate satisfaction of ABET criteria, the portfolio demonstrates how that is achieved. For example, the ability to apply knowledge of mathematics, science, and engineering (Outcome A) and the ability to design and conduct experiments, as well as to analyze and interpret data (Outcome B) may be demonstrated by enrollment in laboratory or design classes and in professional employment. However, the portfolio provides in-depth discussion of these projects, as well as significant applicable projects in others classes in some class projects activities.

In addition, the discussion of professional employment experience and inclusion of supplemental materials, such as reviews by employers, project assignments, and final presentation materials give ABET reviewers a far greater understanding of the actual value of these experiences and the ways in which the outcomes criteria are met. While it is recognized that the portfolio may not always be the only, or even the best, tool for assessing a given outcome, it does provide substantial information to supplement the other selected assessment tools.

The portfolio can also be use as a tool for setting program content. Good and bad class projects will be noted for faculty use in modifying the curriculum as needed. Also, good and bad elective courses can be noted for faculty attention. This information can be used both in advising and in setting acceptable electives.

Conclusions

The academic and professional portfolios are effective tools for students to use in planning and very useful for the Department to use in assessing program outcomes. Review of the portfolio opens dialog between students and faculty on academic progress and professional development. They also serve as ABET assessment tools and for opening faculty dialog about course content. While it is recognized that the portfolio is not always the best tool of assessing a given outcome, it does provide substantial information that may supplement the application of other techniques. And in many instances, the portfolio gives faculty the best possible look at program outcomes.

Bibliography


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