A Systematic Approach to Prepare for ABET Accreditation

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A Systematic Approach to Prepare for ABET Accreditation

Abstract

Preparing for an ABET accreditation visit is a periodic process that can be facilitated using a systematic approach to conduct the Self Study and generate the report. This paper presents a multi-year approach to accreditation applied within Yale University's Chemical Engineering program to understand the accreditation policies and procedures, investigate mechanisms to record and track performance, and detail a series of continuous improvements within the program. The systematic approach includes two key components: the creation of an internal web-based system to distribute information and serve as a repository of submitted work, and a School-wide method to track the achievement of Student Outcomes using embedded assessments from all required courses within the curriculum. This systematic approach to preparing for an ABET accreditation visit has improved the program's ability to address issues and manage the assessment process.

Introduction

The preparation of the ABET Self Study can be a daunting periodic process. The coordination of all activities related to accreditation often falls to a single faculty member who not only must become an expert at all aspects of accreditation, but also must instruct fellow faculty members of their roles and responsibilities in the accreditation preparation process. It is proposed, and demonstrated by the experiences reported in this paper, that the ABET Self Study preparation process can be improved through the use of web-based information portals. These portals need not be extremely sophisticated in their design and can be easily implemented as a means to educate faculty and serve as a collection and distribution point for the many elements that are involved in conducting the Self Study.

In a similar fashion, the assessment of Student Outcomes benefits from the use of systems that effectively measure performance, involve a large number of faculty members, and use the results from a large number of the required courses in the curriculum. Here too a method is proposed, and demonstrated by the experiences reported in this paper, to efficiently measure levels of performance in achieving Student Outcomes using embedded assessments within a program's required courses.

This paper summarizes two approaches to facilitate the Self Study process. The development of a web portal to guide the accreditation preparation process is presented as a model to ease the administrative burden of educating faculty members on accreditation policies and procedures. The portal serves as a single access point to promulgate a schedule, distribute information, and serve as a repository for accreditation information. In addition, the portal serves as a mechanism for collecting and sharing draft chapters of the Self Study. As opposed to file-sharing methods,

the web portal is informational based such that a new user could use the site to learn about pertinent accreditation details.

This paper also details a system that has been developed at Yale to track the achievement of Student Outcomes within each of the program's courses. The system takes advantage of the scoring mechanism used within each course and aligns individual assignments, exams, labs and reports with specific Student Outcomes. The performance of each student in the course measures that course's contribution to achieving levels of performance for each relevant Student Outcome. Because this method is implemented in each course, the data from the individual courses is easily aggregated to provide a comprehensive assessment of the program's overall performance meeting Student Outcomes.

It is noted that both systems are simple in their construction and implementation, and as such can be easily adopted and adapted by other institutions. Because of this simplicity, the faculty workload is minimized and a greater number of faculty members are involved in the accreditation preparation process.

Background

Though the assessment and the associated feedback improvement processes are continuous, the periodic nature of accreditation necessitates the need for a system to educate and guide a large number of individuals (faculty, staff, and students) on the elements of accreditation. While the majority of ABET's policies and procedures remain unchanged between accreditation cycles, faculty members that are not directing a program's accreditation efforts often require refresher training on their role in the accreditation preparation process. A web portal that provides this basic level of information and serves as a source for transmitting and collecting accreditation documents has been developed and found to benefit the Self Study preparation process.

The local system for accreditation information and documentation is similar to that developed by other institutions, though less comprehensive in its role as a catalog of assessment efforts. For example, Christensen, Perez, Panta, and Bedarahally developed a program-level system to collect, analyze and present assessment data using a web-hosted data base for document control and sharing[1]. Their system serves as a tool for not only assisting with the Self Study process, but also as a tool for the program evaluators to use as a single access point for retrieving and viewing documentation for several programs at their university.

The embedded assessment method for outcomes achievement detailed in this paper is motivated by Felder and Brent's guidance to measure the level of attainment of outcomes through the use of outcomes indicators[2]. The need to include direct assessment methods such as "targeted assignments (assigned problems, exam questions, projects)" is advocated by Shaeiwitz and Briedis as an essential component of the assessment and improvement processes within a program[3]. These authors note the value of targeted assignments that are integrated across the curriculum as key measures of outcomes achievement. An additional benefit of such embedded

assessments based on the course's traditional assigned work is the potential inclusion of all faculty members in the assessment process.

The topic of the numerical assessment of performance criteria determined by course instructors reported by Zahorian, Summerville, Craver, and Elmore also influenced the locally developed method for assessing the attainment of Student Outcomes[4]. In describing their own web-based assessment plan, these authors advocate spreading the coverage of outcomes attainment (and assessment) across the entire curriculum, an approach used in the method presented in this paper.

The embedded assessment system presented in this paper is based on a common spreadsheet that is used in all of the program's required courses. This system was used in a previous accreditation review. Faculty members use their normal grading systems on the spreadsheet where specific assignments and exams are identified and used to demonstrate the attainment of Student Outcomes. Unsatisfactory, acceptable and exemplary levels of performance are also established by the course instructor. This information is then analyzed at the course level to determine the extent to which Student Outcomes are obtained in the course. Since all required courses use the same scoring spreadsheet, the individual course results are easily compiled to measure the program's effectiveness achieving Student Outcomes. It has been found that the system requires only a small amount of additional upfront work at the beginning of the semester to map the correlation between the coursework and the relevant outcomes. As a result, a large number of faculty members are involved in the assessment process.

The fact that the method relies on the normal grading system requires no additional faculty time to administer this system at the course level. For faculty that are familiar with the methodology, approximately one hour of time is required to map the course's assignments to specific Student Outcomes and to make this notation in the course spreadsheet. For faculty that are not familiar with the ABET accreditation preparation process, approximately three hours of time are needed to explain the accreditation process, Student Outcomes and the role of the spreadsheet as a tool to assess performance.

The Yale School of Engineering & Applied Science designed and implemented this spreadsheet analysis system to aggregate the data from individual courses into a composite view of the program's ability to achieve Student Outcomes. This last feature required no additional effort by the faculty or administrators – an aspect of the methodology that was very well received.

The current system provides insight into the attainment of Student Outcomes at the course level and at the program level. The system does not measure the level of attainment of Student Outcome for individual students. The data to measure individual performance is contained within the database that is used in the present system, but there are no plans to use the collected information for the assessment of individual students.

Systematic Approach for Accreditation Information Sharing

The web portal to coordinate the Yale's Self Study process is illustrated in Figure 1. In addition to publicizing the accreditation preparation timeline, the portal also serves as a tool to relay accreditation training information (such as instructional handouts on aspects of the accreditation preparation process) and to post reference material related to accreditation (such as ABET policies and procedures and previous versions of a program's Self Study). In this application this single web portal serves three programs, noting the majority of the information for each program is common. Though not displayed in Figure 1, the site also serves as an archival record of draft chapters of the Self Study.

This web-based portal differs in purpose from other file-sharing methods commonly used to coordinate team based work such as Google Docs, Dropbox, Box, or other multi-user file sharing systems in that this site also serves as an instructional tool to guide faculty members through the accreditation preparation process. As such, information is presented in an accessible method that can be easily shared by including links to the site in email announcements.

In Figure 1, for instance, the text that reads "ABET Schedule 2013-2014" is a hyperlink to a pdf document (Figure A-1 in Appendix A) that can be shared directly. The hyperlink format is favored in lieu of a set of instructions to point to the same schedule within a filing system. Also, since the posting of information and the embedded files are under the control of a single coordinator, issues associated with documentation version control are mitigated.

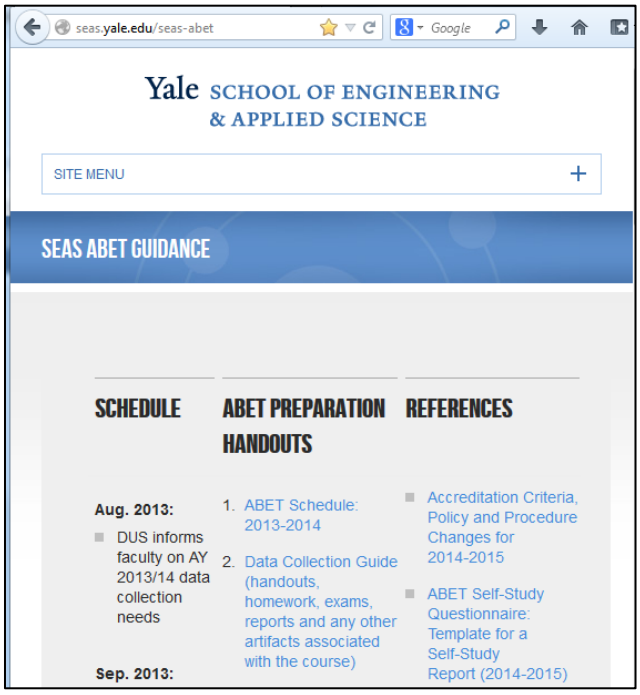


Figure 1 Web portal to guide the Self Study process

The section of the portal labeled "ABET Preparation Handouts" is used to share documents that are primarily used for faculty instruction. Figure A-2 in Appendix A illustrates the typical information that is distributed at the beginning of the semester to guide the collection of course information for the Self Study. Figure A-3 in Appendix A is an example of a handout prepared to assist faculty with setting up the Student Outcomes Assessment Spreadsheet that is the subject of the next section.

These archived handouts have proven to be very helpful in instruction sessions for faculty members who were leading program accreditation efforts. The material was readily available during the training sessions and could be referenced and shared by the program leads when instructing faculty members within their own programs. Having all of the information displayed in a single location established the site as the primary information source, thereby saving time of the faculty and staff who were involved in the preparation of the Self Study.

The "References" section of the web portal cataloged a collection of information pertinent to the preparation of the Self Study. In addition to serving as a single access point for the official ABET documents (which are distributed on a number of different pages on ABET's own web site), this section included previous versions of the Self Study, Draft Responses from ABET and ABET's Final Statement for all programs. Here too, having all information available at a single location benefitted all programs as the information could be accessed and shared. This section of the web portal also served as the archival site for each chapter of each program's Self Study thereby serving as a reference to the program and School leads who directed the Self Study effort.

Systematic Approach for Student Outcomes Assessment

This section details the spreadsheet-based method to assess the attainment of Student Outcomes within a program. This approach measures the attention each outcome receives within each course and for the program as a whole and it establishes the levels of performance obtained for each outcome for each course and for the program as a whole. The summative results of these measurements at the program level are displayed in Figure 2. Similar analysis is also provided at the course level that documents the contributions of each individual course to the attainment of Student Outcomes.

The program level analysis results from data collected from each course within the curriculum. A common spreadsheet, displayed in Appendix B, is used in each of the program's required courses and serves as the starting point for the assessment system. The course instructor uses this spreadsheet to:

1. record individual performance for all students for each assigned course exercise
2. assign a "weighting factor" to each exercise to indicate that specific assignment's value as an outcome indicator

3. assign a fractional component of each Student Outcome that is associated with each graded exercise, and
4. establish the unsatisfactory, acceptable and exemplary "Levels of Performance" attainment of Student Outcomes.

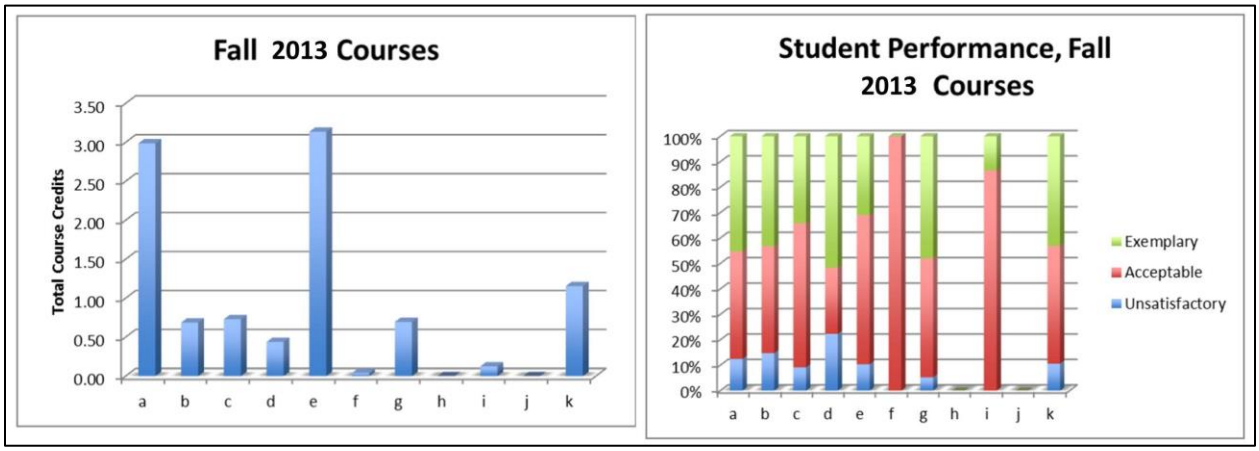


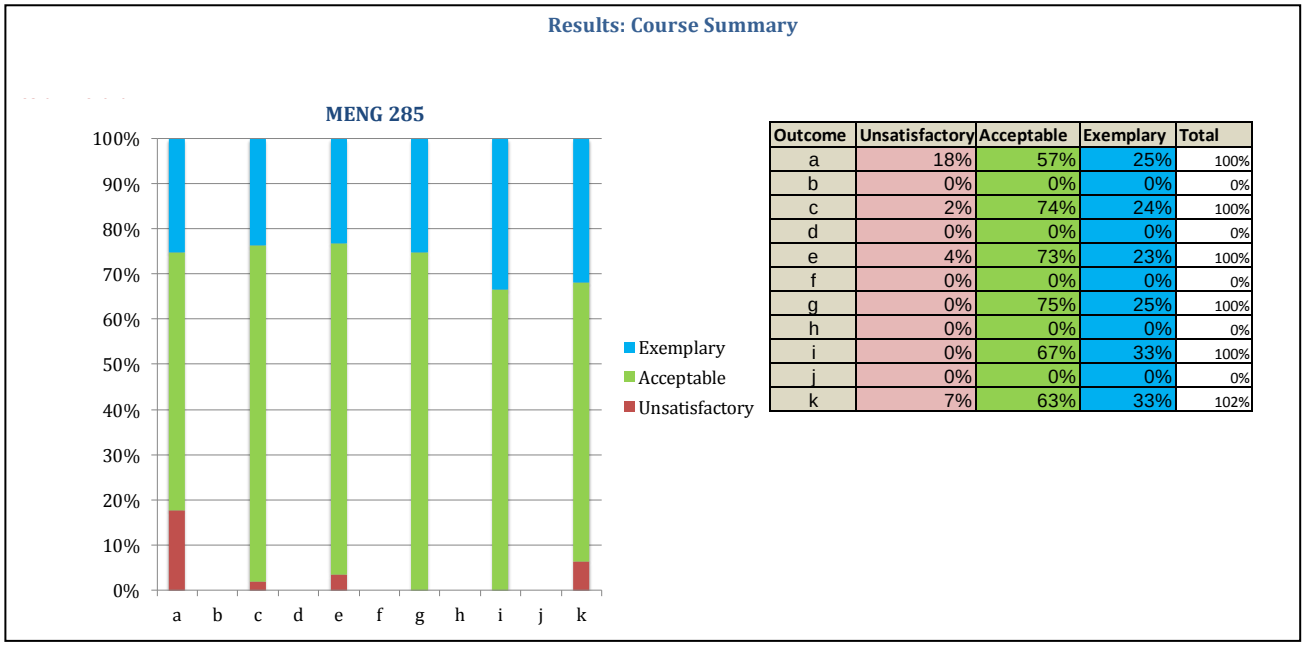
Figure 2. Program level analysis of outcomes coverage and levels of performance achieved

Based on this information, the contributions to each relevant Student Outcome from the course's targeted indicators are computed. Figure 2 illustrates the aggregate data from a single course that is obtained using this system. The graph clearly indicates the course's contribution to each Student Outcome and the levels of performance for each outcome. For the presented example, the course only addressed Student Outcomes a, c, e, g, i, and k. The level of attention each outcome area receives in the course, measured by the weighted value of the targeted assignments/exams correlated with each outcome, is calculated on the spreadsheet.

The results from all of the required courses in a program (as summarized in Figure 3) are then combined to produce the program's overall attainment of Student Outcomes (as illustrated in Figure 2). The process of combining the individual course data into a single attainment result for an entire program is an automated process. Individual courses are selected from a menu of all courses, with the contribution to the program then determined from that set of selected courses. While the levels of performance within a specific course are established by the faculty member, those levels can be adjusted during the analysis to establish a uniform evaluation level across a program.

The use of coursework such as assignments, projects, reports and exams, whether in whole or in part, as formative assessment tools (i.e., assessment conducted during a course) is a well-recognized standard practice. Using this same collection of student work as a subset of measurable indices that are correlated with specific outcomes is a valid assessment approach since specific assignments can be structured to target a particular Student Outcome. For example, a standard experiment to investigate a reaction process could be altered to include a

design component where the students need to determine the sensors to record the system's variables. In this case, the scored "lab report" becomes an artifact that correlates with ABET's Student Outcome-b (design of a component) as well as Student Outcome-k (use of modern engineering tools).



Outcome	Unsatisfactory	Acceptable	Exemplary	Total
a	18%	57%	25%	100%
b	0%	0%	0%	0%
c	2%	74%	24%	100%
d	0%	0%	0%	0%
e	4%	73%	23%	100%
f	0%	0%	0%	0%
g	0%	75%	25%	100%
h	0%	0%	0%	0%
i	0%	67%	33%	100%
j	0%	0%	0%	0%
k	7%	63%	33%	102%

Figure 3. Assessment results: Performance Levels for each Student Outcome in a single course

It is important to emphasize that this method does not simply use student grades for assignments to assess student outcomes within assessment areas, but rather the system relies on a carefully developed "course assessment matrix"[2] that identifies key items of coursework as being relevant to specific Student Outcomes. An example of this mapping (taken from the example in Appendix B) is illustrated in Figure 4. In the presented matrix, all homework assignments are aligned with an outcome, though that need not be true for all courses. The fractional component of each assignment to the relevant outcomes is also recorded in this matrix.

	HW1	HW2	HW3	HW4	HW5	HW6	HW7	HW8	HW9	HW10	HW11	FINAL EXAM	
ABET Outcome													Percent of Course
a					0.5		0.5				0.75		12.1%
b													0.0%
c		0.5				0.5		0.5	0.5			0.2	19.7%
d													0.0%
e				0.5			0.5					0.4	15.2%
f													0.0%
g									0.5			0.2	7.6%
h													0.0%
i						0.5							3.4%
j													0.0%
k	1	0.5	1	0.5	0.5			0.5		1	0.25	0.2	42.1%
(should sum to 1)	1	1	1	1	1	1	1	1	1	1	1	1	100%

Figure 4. Map of coursework to relevant Student Outcomes

To highlight the performance by individual students, the spreadsheet also identifies the levels of performance within each assignment, as illustrated in Figure 5. The thresholds for the Levels of Performance are determined by the course instructor. This presentation of the data, which is analogous to the program perspective of the Levels of Performance achieved for each Student Outcome (Figure 2), is important since it highlights the distribution of students in each performance category. Simply relying on a class average for an embedded assessment measure tends to mask areas of poor (or superior) student performance.

	Descriptive Title of HW [100]	Descriptive Title of HW [100]	Descriptive Title of HW [100]	Descriptive Title of HW [100]	Descriptive Title of HW [100]	Descriptive Title of HW [100]	Descriptive Title of HW [100]	Descriptive Title of HW [150]	Descriptive Title of HW [100]	Descriptive Title of HW [100]	Descriptive Title of HW [100]	FINAL EXAM [300]
Unsatisfactory	0	0	0	0	4	0	2	1	0	2	1	0
Acceptable	7	8	6	8	6	8	9	10	9	6	6	9
Exemplary	5	4	6	4	2	4	1	1	3	4	5	3

Figure 5. Levels of performance (for assignments associated with Student Outcomes) determined using the Student Outcomes Assessment Spreadsheet

ABET Accreditation Use and Improvements

It is suggested that the presented spreadsheet-based method to assess the attainment of Student Outcomes can be augmented with other outcomes assessment methods, including direct and indirect methods, to provide a comprehensive measure of the program's ability to meet Student Outcomes. Included in the portfolio of potential assessment tools are:

- results from the Fundamentals of Engineering Exam (direct assessment)
- faculty review of the Student Outcomes attained during capstone design course (direct assessment)
- survey of capstone design students on attainment of Student Outcomes (indirect assessment)
- design portfolio and/or student resume review (indirect assessment)
- exit interviews of graduating students (indirect assessment)
- survey of Departmental External Advisory Board (indirect assessment)
- alumni survey on their attainment of Student Outcomes at graduation (an approach that benefits from having additional time/experiences to reflect upon when evaluating their undergraduate education) (indirect assessment)

While it would not be expected that each indicator provides the same result with respect to measuring the attainment of Student Outcomes, comparing data from a variety of methods helps substantiate the findings and highlights Student Outcome outliers that deserve attention.

The presented method can be improved to provide finer resolution on the attainment of specific Student Outcomes. In its current form, an individual assignment or exam can be used to measure performance in more than one Student Outcome. The current use of this method assumes that the assignment score applies equally to each Student Outcome, though that may not be the case.

For example if an assignment that was correlated with two equally weighted (weighting factor = 0.5) Student Outcomes received a score of 80%, it is possible that the level of performance on one outcome may actually be exemplary and the other unsatisfactory with the reported level being noted as acceptable.

To avoid this ambiguity, documentation can be presented to substantiate the assumed uniform distribution of performance. As another alternative, future iterations of this method could include separate scores for each aligned outcome (a fact that counters the ease of using the current method where the spreadsheet serves as the single record of all scores that determine student performance in the class). Another alternative includes aligning work with only a single Student Outcome (an approach that would reduce the number of samples that are used to measure the attainment of Student Outcomes). These and other approaches will be analyzed over the next year to improve the current system.

It is noted that the presented method makes use of all required courses in a program to determine the attainment of Student Outcomes. Because the standard spreadsheet is used in each course, altering the subset of courses to review for attainment of Student Outcomes is as simple as selecting that cohort of courses as the sample set to evaluate (a process that has been automated by simply highlighting the list of courses to use as input data for the program analysis). This modality facilitates explorations of the data such as the Student Outcomes that are attained during the junior and senior years. The ability to select the list of courses to summarize can also serve as a planning tool to indicate the changes to a program if a course is removed or to forecast (with an associated degree of accuracy) changes when a new course is added to the curriculum. This analysis tool is a powerful component of the presented method.

Results

The method for sharing accreditation preparation information and assessing the achievement of Student Outcomes are effective tools to engage a larger number of faculty members in the assessment process. These methods are easy to implement as a template that can be modified for local use. The methods have been used to add a degree of efficiency to a university's assessment system when multiple programs are being reviewed.

The information portal has a dual use as a mechanism to deliver information (for training purposes) and to store information (for reference and retrieval purposes). The web portal is effective as a single access point to guide the Self Study process and as a repository for the documents needed to conduct and report on the process. Since it is a web page, the tool is very easy to use and versatile. It can serve as an information source for various levels of accreditation training whether that be by a School for all accreditation coordinators or by a department lead for the faculty members within that department.

The Student Outcomes Assessment Spreadsheet is a valuable tool for gathering direct assessment data. Because the spreadsheet is used in all of a program's required courses, the results from the individual courses can be combined to indicate the program's effectiveness achieving Student Outcomes. This tool also has two functions as it assesses performance at the course and program levels. Since the tool is the same, deficiencies identified at the program level (such as insufficient coverage of a particular outcome) can be backtracked to individual courses where changes can be made and the system improved.

References

1. K. Christensen, R. Perez, P. Panta, and P. Bedarahally, "Unifying Program-Level ABET Assessment Data Collection, Analysis, and Presentation," *41st ASEE/IEEE Frontiers in Education Conference*, 2011.
2. R.M. Felder, R. Brent, "Designing and Teaching Courses to Satisfy the ABET Engineering Criteria," *Journal of Engineering Education*, v. 92(1), 2003, pp. 7-25
3. J. Shaeiwitz, D. Briedis, "Direct Assessment Measures," *American Society for Engineering Education Annual Conference Proceedings*, 2007
4. S. Zahorian, D.H. Summerville, S. Craver, M. Elmore, "ACTS—an ABET Compliance Tracking System," *American Society for Engineering Education Annual Conference Proceedings*, 2012

Appendix A: Examples of Information Located on the Accreditation Web Portal

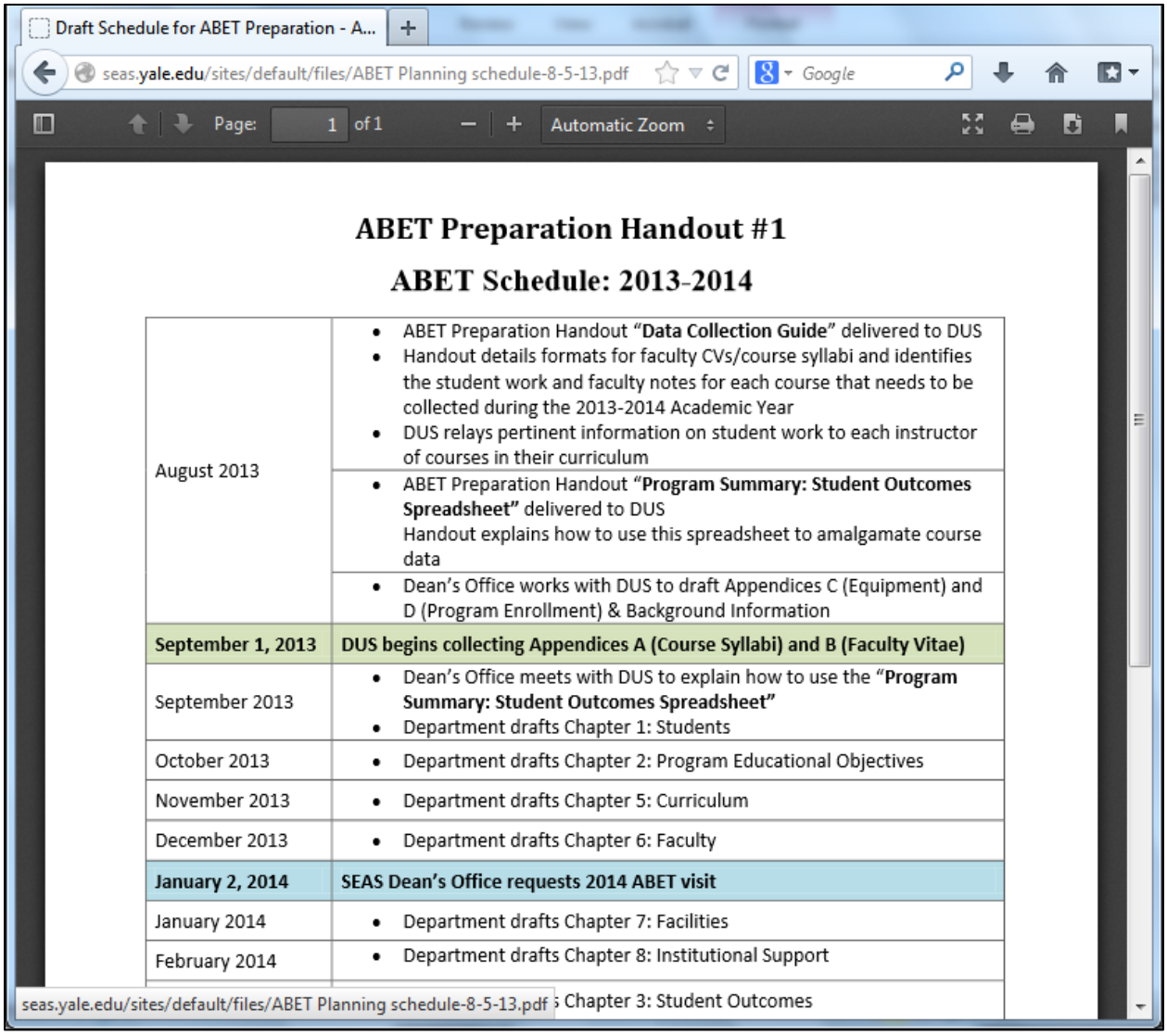


Figure A-1. Accreditation Schedule posted on the web portal

Appendix A: Examples of Information Located on the Accreditation Web Portal

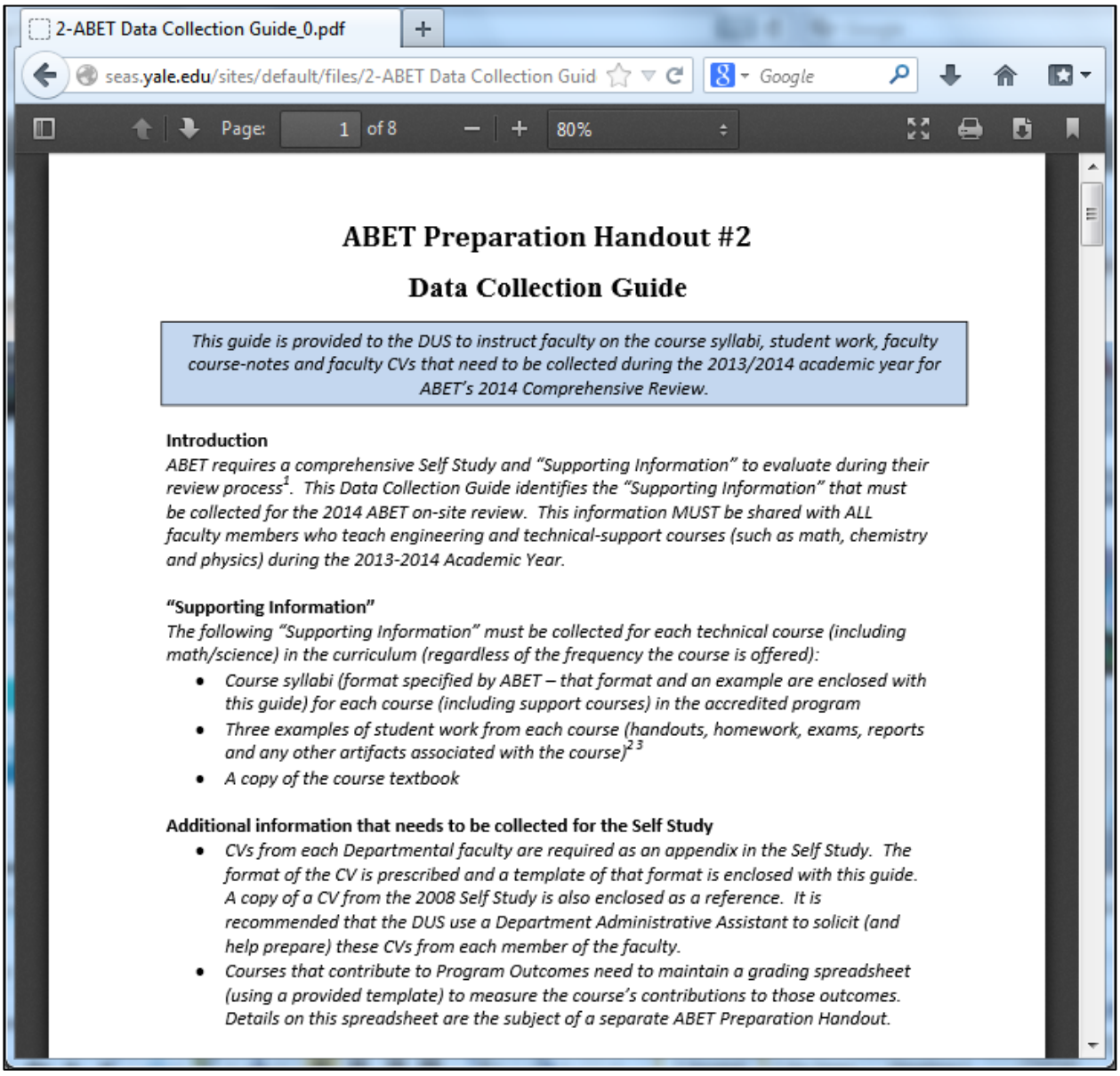


Figure A-2. Faculty Data Collection Handout posted on the web portal

Appendix A: Examples of Information Located on the Accreditation Web Portal

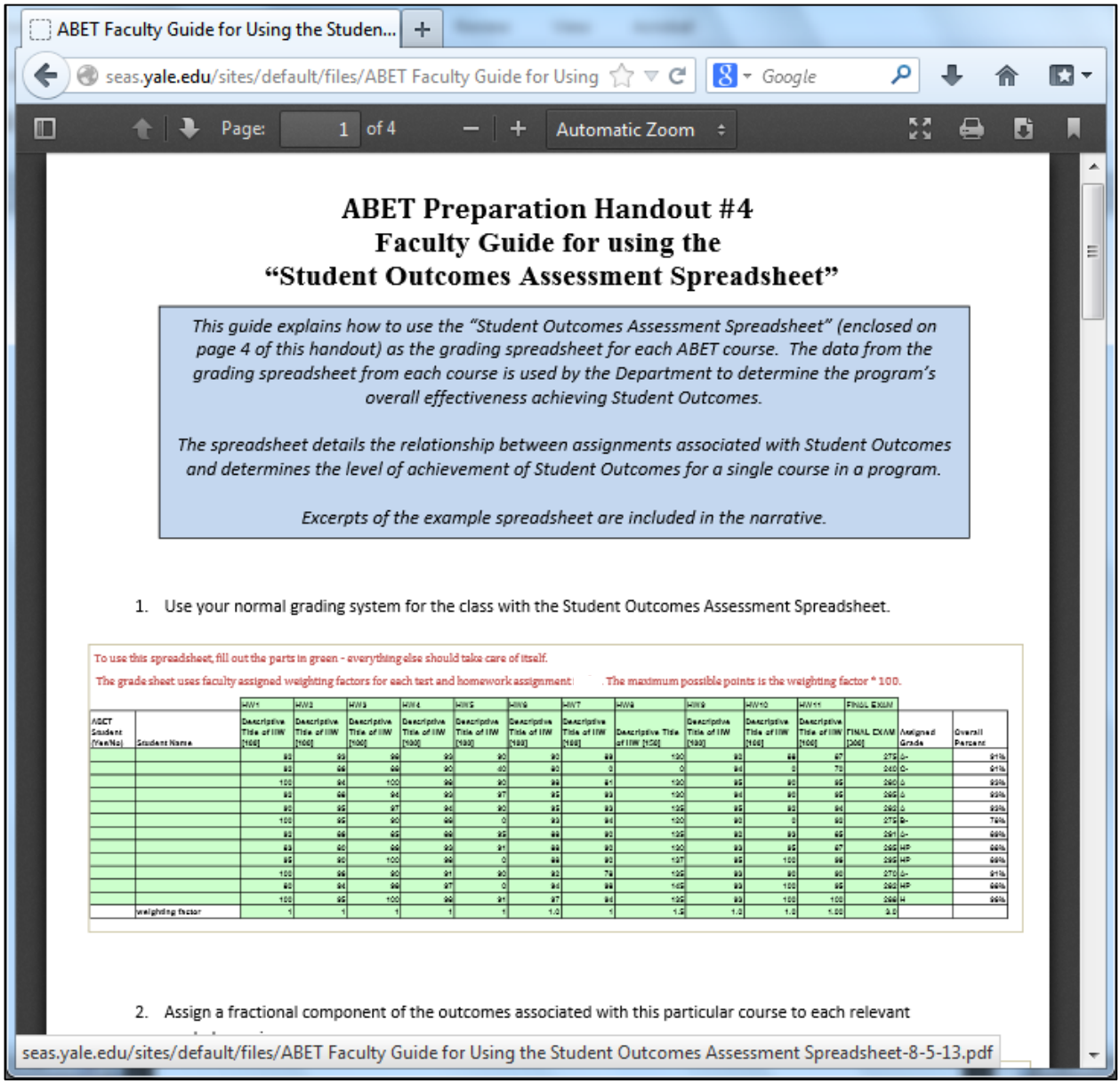


Figure A-3. Faculty Outcomes Assessment Handout posted on the web portal

Appendix B: "The Yale Method" for Assessing Student Outcomes Spreadsheet for Recording Course Level Input

YALE SCHOOL OF ENGINEERING AND APPLIED SCIENCE

MECHANICAL ENGINEERING ABET OUTCOME REVIEW

This spread sheet template tracks achievement of the ABET Student Outcomes.
To use this spreadsheet, fill out the parts in green - everything else should take care of itself.

ABET Student Outcomes:
(a) apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) design a system, component, or process to meet desired goals
(d) an ability to function on a multi-disciplinary team
(e) identify, formulate, and solve engineering problems
(f) understand professional and ethical responsibility
(g) communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context
(i) recognize the need for life-long learning
(j) a knowledge of contemporary issues
(k) use modem engineering tools necessary for engineering practice

Course Number:	MENG-123
Course Name:	

To use this spreadsheet, fill out the parts in green - everything else should take care of itself.

The grade sheet uses faculty assigned weighting factors for each test and homework assignment. The maximum possible points is the weighting factor * 100.

		HW1	HW2	HW3	HW4	HW5	HW6	HW7	HW8	HW9	HW10	HW11	FINAL EXAM		
ABET Student (Yes/No)	**Student Name**	**Descriptive Title of HW [100]**	**Descriptive Title of HW [100]**	**Descriptive Title of HW [100]**	**Descriptive Title of HW [100]**	**Descriptive Title of HW [100]**	**Descriptive Title of HW [100]**	**Descriptive Title of HW [100]**	**Descriptive Title of HW [150]**	**Descriptive Title of HW [100]**	**Descriptive Title of HW [100]**	**Descriptive Title of HW [100]**	**FINAL EXAM [300]**	**Assigned Grade**	**Overall Percent**
		92	93	98	93	90	90	89	130	92	88	87	275		91%
		92	86	88	90	40	80	0	0	94	0	70	240		61%
		100	94	100	98	90	98	81	130	95	90	95	280		93%
		92	88	94	93	97	95	93	130	94	90	95	285		93%
		90	95	97	94	90	95	93	134	95	92	94	282		93%
		100	95	90	86	0	93	94	120	90	0	92	275		78%
		92	86	85	88	95	88	90	135	92	93	85	261		89%
		83	80	86	93	91	88	90	130	93	95	87	265		88%
		95	90	100	98	0	88	90	137	95	100	96	295		89%
		100	96	90	91	90	92	78	135	93	90	90	270		91%
		80	94	98	97	0	94	98	145	93	100	95	282		88%
		100	95	100	98	91	97	94	135	93	100	100	288		96%
	weighting factor	1	1	1	1	1	1.0	1	1.5	1.0	1.0	1.00	3.0		

Please assign a fraction of a-k to each assignment. Since there are weekly assignments, it is not necessary to break things down to the level of individual problems. If there were only a midterm and a final, that might be appropriate.
Please scroll right to view the table in its entirety.

	HW1	HW2	HW3	HW4	HW5	HW6	HW7	HW8	HW9	HW10	HW11	FINAL EXAM	
ABET Outcome													**Percent of Course**
a					0.5		0.5				0.75		12.1%
b													0.0%
c		0.5				0.5		0.5	0.5			0.2	19.7%
d													0.0%
e				0.5			0.5					0.4	15.2%
f													0.0%
g									0.5			0.2	7.6%
h													0.0%
i						0.5							3.4%
j													0.0%
k	1	0.5	1	0.5	0.5			0.5		1	0.25	0.2	42.1%
(should sum to 1)	1	1	1	1	1	1	1	1	1	1	1	1	100%

This last column shows how much of the a-k goes into the course grade. This will be useful information for evaluating our program.

Please enter performance cutoff percentages below. These are the numbers that determine the cutoff between Unsatisfactory, Acceptable, and Exemplary.

Cutoff Percentages	
80	Unsatisfactory
95	Exemplary

Breakdown of Student Performance by Assignment

*Each column should add up to the number of students in the course.

	Descriptive Title of HW [100]	**Descriptive Title of HW [100]**	**Descriptive Title of HW [100]**	**Descriptive Title of HW [100]**	**Descriptive Title of HW [100]**	**Descriptive Title of HW [100]**	**Descriptive Title of HW [100]**	**Descriptive Title of HW [150]**	**Descriptive Title of HW [100]**	**Descriptive Title of HW [100]**	**Descriptive Title of HW [100]**	**FINAL EXAM [300]**
Unsatisfactory	0	0	0	0	4	0	2	1	0	2	1	0
Acceptable	7	8	6	8	6	8	9	10	9	6	6	9
Exemplary	5	4	6	4	2	4	1	1	3	4	5	3

Figure B-1. The Common Spreadsheet used to collect data for measuring the attainment of Student Outcomes