Planning for Curriculum Renewal and Accreditation Under ABET Engineering Criteria 2000

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Abstract

This paper presents a set of integrated methodologies for the enhancement of engineering academic programs and for preparation for accreditation review under ABET Engineering Criteria 2000. The Curriculum Renewal Methodology builds on a base of strategic planning, and provides alternative approaches for analysis of the content of existing curricula and the development of new curricula. The Accreditation Preparation Methodology builds upon the selection of program objectives for an engineering program and moves through selection of outcomes, outcome indicators and criteria, and the development of systematic processes for program assessment and improvement. The development of these methodologies was sponsored by the NSF funded SUCCEED Engineering Coalition. This paper describes software and reference guides that have been prepared to facilitate use of the methodologies, notes linkages between the two methodologies, and reports on applications of the methodologies at universities within the SUCCEED coalition.

I. Introduction

For many years, curriculum revision and preparation for accreditation review have been two closely linked activities for the typical engineering faculty member. Two to four years before the end of an institution's Accreditation Board for Engineering and Technology (ABET) accreditation cycle, program faculty would gather to determine what changes they wanted to make and have in place before the next ABET evaluation visit team came to campus. Motivations for curriculum change ranged from fear, *e.g.*, "we must change course sequence 'X' in order to conform to the current ABET Criteria;" to envy, *e.g.*, "all of Preeminent University's engineering students take 'Y' and our students don't;" to dominance, *e.g.*, "Professor Chaired wants to add course 'Z' to the curriculum and that's what we are going to do--period." Clearly, accreditation preparation drove this type of curriculum revision, but not necessarily in the right direction and, at least arguably, not for the right reasons.

With ABET Engineering Criteria 2000, the nature of engineering accreditation has changed significantly. ABET maintains its central role of "assuring that graduates of an accredited program are prepared adequately to enter and continue the practice of engineering."[1] But now, through Criteria 2000, ABET requires:

[1] Engineering Accreditation Commission, Accreditation Board for Engineering and Technology, Inc., *Engineering Criteria 2000*, Second Edition, 1997.

> "a system of ongoing evaluation that demonstrates achievement of these [program] objectives and uses the results to improve the effectiveness of the program," and
>
> "Each program must have an assessment process with documented results. Evidence must be given that the results are applied to the further development and improvement of the program." [2]

In this paper we present a methodology for curriculum revision, specifically a process designed to promote innovation and renewal, which applies the concepts of continuous improvement to curriculum change efforts. The methodology does not develop a universal engineering curriculum, but rather it provides program administrators and faculty with systematic means of assessing and continuously improving their curriculum. This process for making changes is a natural complement to the Criteria 2000 requirements for systematic review of program objectives and the adoption of an assessment process to insure further program development and improvement.

In the pages that follow, overviews will be presented for both the Curriculum Renewal Methodology and the Accreditation Preparation Methodology. Each overview includes a description of software and/or reference guides that have been developed to facilitate methodology use. Next, links in the application of the two methodologies will be explored. Finally, the paper closes with a discussion of the use of these methodologies by engineering programs within the National Science Foundation funded Southeastern University and College Coalition for Engineering Education (SUCCEED).

II. Curriculum Renewal Methodology

The curriculum renewal methodology has been developed to enhance efforts by a program faculty to analyze and understand an existing curriculum, to measure and assess input from a variety of informed sources, and to design an improved curriculum in response to the inputs received. Using this methodology, the new curriculum will be aligned with the strategic directions of the academic unit which offers the program.

The methodology for curriculum renewal is a five-stage process: Stage 1 - Preparation, Stage 2 - Strategic Planning, Stage 3 - Analyze Existing Curriculum, Stage 4 - Design New Curriculum, and Stage 5 - Implement New Curriculum (see Figure 1 below). Continuous curriculum improvement is attained with planned, periodic recycling through Stage 2 to Stage 5 addressing the curriculum as a whole, and by formal techniques for improving course conduct (how a course is taught) and course content (what is taught in a course).

A. Stage 1 - Preparation

This stage is the key component of the Curriculum Renewal Methodology. The steps in this stage include: leadership commitment and gaining faculty support, creating a Curriculum

[2] *Ibid.*

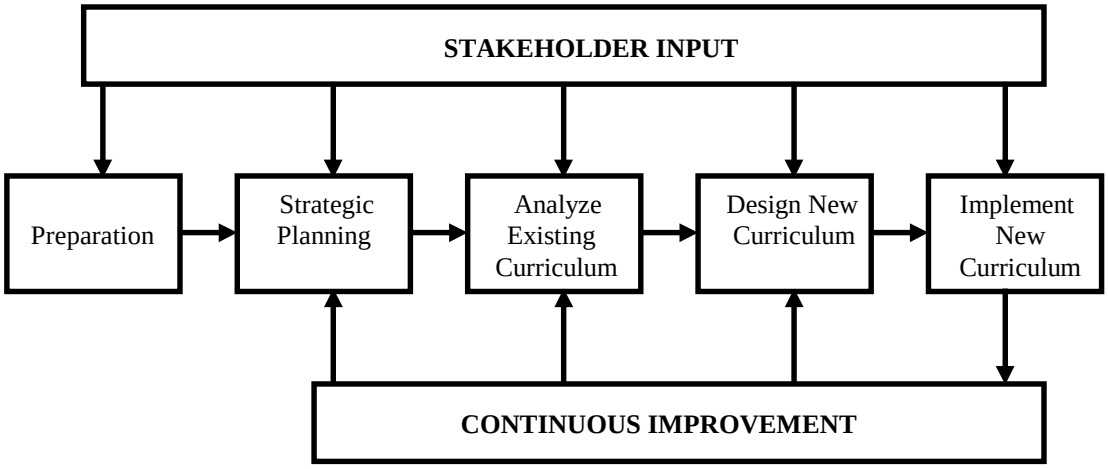

Figure 1: Graphical Display of Stages in the Curriculum Renewal Methodology

Design Team, benchmarking, identifying a curriculum structure, and identifying and gathering input from other stakeholders. Completing these steps will help to insure that the renewal process runs smoothly and efficiently through time.

Leadership commitment and faculty support, or buy-in, are prerequisites to successful application of the Curriculum Renewal Methodology. Unless the program director (typically the academic unit chair), is committed to curriculum renewal, the faculty will have no reason to support it. The program director must demonstrate commitment to the curriculum renewal by his or her continuing allocations of needed time and financial resources. In addition, the program director must secure support for curriculum renewal from at least a majority (and/or the key members) of the faculty if renewal is to succeed.

Application of the methodology is guided by a Curriculum Design Team (CDT) whose members perform the steps of the renewal effort as representatives of the entire faculty. The CDT should include faculty members in the educational program who are willing to devote time and effort to the curriculum renewal process and who represent the professional interests of the faculty in the academic unit as a whole. The CDT may also include other program stakeholders, such as: alumni, employers, visiting committee members, and students. Ideally, approximately five faculty members will serve as permanent members of the CDT. However, the entire faculty should participate in curriculum deliberations throughout the process. Use of focus groups and/or ad hoc committees can help to ensure ongoing faculty participation.

Benchmarking is the process of comparing oneself to the best in the field. The CDT can benchmark their curriculum by comparing it with recognized leading programs in their academic discipline. The results of benchmarking show the faculty where their program stands at the beginning of a curriculum renewal cycle in terms of performance gaps and opportunities for enhancement. The benchmarking effort will also help to demonstrate at the end of a renewal cycle how far the faculty have come in achieving desired curriculum changes.

The next step of Stage 1 is to specifically identify a general hierarchical structure on which to base study of the educational program. A hierarchical structure fosters faculty discussion and agreement at high levels and avoids turf battles over perceived ownership of individual courses. Establishing such a structure makes analyzing the existing curriculum more efficient.

During the preparation stage the program faculty should consider when and how other stakeholders can be brought into the curriculum renewal process. Stakeholder input is critical to the successful development of an enhanced curriculum and this input should be utilized throughout the stages of the renewal methodology. Information gathered at the beginning of a renewal cycle by means of surveys of key stakeholders can be very useful as the process unfolds.

B. Stage 2 - Strategic Planning

The strategic plan for the academic unit, if available, should be used in setting the review criteria for the curriculum renewal process. A strategic plan involves establishing long-term goals, adopting courses of action, and allocating the necessary resources to help accomplish the goals. If an academic unit has not developed a strategic plan, it should do so early in the curriculum renewal process. This will enable the subsequent stages in the renewal methodology to proceed efficiently and to help the CDT develop program objectives which contribute directly to achievement of the goals of the academic unit.

Curriculum renewal goals are changes that must be made in the academic curriculum to contribute to the academic unit's strategic goals. The curriculum renewal goals may include: desired subject area competencies, specific laboratory or classroom experiences, and/or the integration of selected curriculum elements.

Performance measures are established to evaluate candidate curriculum revisions. Objectives are the threshold values of these measures that any proposed curriculum revision must satisfy. Milestones are the dates by which a proposed curriculum revision must achieve the established objectives. The choices of performance measures made by the CDT must reflect ABET general and program-specific evaluation criteria. In addition, the choices of values that the CDT makes for specific performance measures, objectives and milestones are constrained by the resources available for curriculum changes and for ongoing operation of the revised curriculum. Constraints that may slow or prevent implementing curriculum changes must be identified. Common constraints may include, but are not limited to: time, money, and the number of individuals who are willing to participate in the curriculum renewal effort.

Input from stakeholders plays an important role in this stage. If stakeholder expectations were not assessed in the preparation stage, they must be assessed here. After the first cycle of curriculum renewal, stakeholder expectations must be reassessed on each pass through Stage 2 and directed specifically toward curriculum renewal. The CDT must ask for stakeholder input in terms of the selected performance measures, or recast the input information they receive in terms of these measures.

C. Stage 3 - Analyze Existing Curriculum

To compare a proposed curriculum and the existing curriculum, the existing curriculum must be documented and its content made clear. Two methods of curriculum analysis are provided in the Curriculum Renewal Methodology. Both take a structured, hierarchical view of the curriculum.

The **Knowledge/Skills Method** is built on the premise that engineering graduates should possess certain skills and that these skills are developed throughout the curriculum from knowledge acquired in the study of the curriculum. Skills are divided into four broad categories: Engineering Design Skills, Engineering Control Skills, Problem Solving Skills, and Organizational Skills. Knowledge is similarly divided into three broad categories: Fundamental Knowledge, Core Knowledge, and Main Knowledge. The Fundamental Knowledge and Core Knowledge categories include elements of knowledge that are common to all engineering disciplines. Main Knowledge consists of those knowledge elements which define a particular engineering discipline. This method of curriculum analysis results in a calculation of the average concentration for each subject area, displayed in a knowledge/skills matrix. A parallel calculation giving average knowledge and skill contents for each course is also used to evaluate how a given course contributes to the current curriculum requirements. Graphical illustrations are useful here because they can display the intricacy and complexity of a curriculum in a concise, easy-to-understand manner. Features of the subject areas and time-phasing of curriculum allocations among the knowledge and skill areas can be illustrated graphically.

A second hierarchical structure called the **Augmented Syllabus Method** divides the curriculum into four parts: Foundation Materials, Defining Elements, Complementary Elements, and Integrating Experiences. This approach to curriculum analysis and renewal is described in considerable detail in Beasley, *et al*.[3] Augmented syllabus analysis documents the degree to which course-level goals are currently being accomplished. It provides detailed topical coverage, and identifies the fundamental principles included in each topic presentation. It also shows the level of accomplishment expected by the student, the prerequisite knowledge for each topic, the anticipated subsequent use of topics, and the analytical tools required. Like the Knowledge/Skills Method, the Augmented Syllabus Method lends itself to useful graphical illustration of the curriculum.

D. Stage 4 - Design New Curriculum

Developing a modern engineering curriculum requires an attempt to optimize course offerings and other elements of the curriculum within such constraints as ABET criteria, industrial advisory board recommendations, number of faculty, diversity of faculty effort and interests, number of students, and available resources. Development of the new curriculum should also be closely aligned with the academic unit strategic plan. Thus, for example, if the strategic plan for an academic unit has a goal of an improved relationships with industry, candidate

[3] Beasley, *et al*., "Curriculum Development: An Integrated Approach," *Proceedings of the 25th Annual Frontiers in Education Conference*, Atlanta, GA, November 1995.

curriculum changes might include an increased emphasis on industrial applications of the discipline.

Although the analysis of an existing curriculum must start at the course (or more detailed) level in a bottom-up fashion, the process of curriculum change should begin at the top of the subject matter hierarchy in a top-down approach. To avoid turf battles, it is crucial to delay all discussion of individual courses, credits, prerequisites and the like until the final step of the process. The faculty should initially focus on the overall structure and composition of the curriculum, and should identify fundamental principles and key concepts, and trace them throughout the curriculum.

The CDT should coordinate the process by leading initial discussions of the faculty as a whole in order to develop a consensus on basic curriculum concepts. To facilitate the design of a new curriculum, the CDT should formulate hypothetical curriculum elements to serve as "straw men" at various stages of the process and submit them for discussion and debate by the faculty as a whole.

Early discussion should be restricted to curriculum-level issues such as the determination of basic principles that should be traceable through the curriculum and an overall structure for the curriculum. Thus, the first "straw man" should be very simple, developed from a template of the curriculum structure by filling in curriculum elements. This can be accomplished by small faculty subgroups and the results compiled by the CDT. Consensus on these discussion points should be established by the faculty as a whole.

The second "straw man" should cover the approximate distribution of credit hours among the elements needed to establish a logical progression of topics throughout the curriculum. Based on this credit-hour distribution, a series of possible "mega-courses" can be established to form a concept curriculum, again avoiding the use of existing courses. The topical coverage of these mega-courses, at this point, is left for development. Their content is constrained by the structure of the curriculum and any externally imposed constraints such as those emanating from ABET. The concept curriculum assists in planning for the flow and integration of key elements and in maintaining a proper balance of the various curriculum elements. The CDT should develop measures of student and faculty time and effort required to complete each curriculum element. These time and effort measures can be used to guide the ultimate decisions on credit-hour distribution and course definition.

The final step in the curriculum development is the identification of specific courses and the topical coverage of each. This is an iterative process that is best achieved using faculty subgroups reporting back, through the CDT, to the faculty as a whole. The subgroups assigned to individual courses develop topical coverage for these courses in detail. Subgroups discuss, with the faculty as a whole, course coverage, distribution of topics, and expected mastery of topics. The results of this stage is an overall structure for the curriculum, the identification of material that is to be part of the curriculum, and the division of these materials into course-sized segments.

E. Stage 5 - Implementing New Curriculum

Once the course content features of the new curriculum have been specified, the changes that must be made to the existing curriculum to create the new curriculum are identified. When the CDT lays out the schedule for making curriculum modifications, the team must consider institutional milestones and any limitations in resources that restrict the timing of implementing curriculum changes.

F. Continuous Improvement

Once a new curriculum is in place, it should be continuously assessed and improved. This process can be institutionalized by repeating Stage 2 through Stage 5 in a planned, periodic fashion. Continuous improvement of the curriculum does not mean constant significant revamping of the curriculum. If a particular pass thorough the renewal cycle has resulted in a major "reengineering" of the curriculum, then subsequent renewal cycles are likely to focus on incremental improvement until a major change is again required.

Continuous improvement can also be applied to each course in the new curriculum. There are two purposes: One is to improve the course conduct, or how the course is delivered, and the other is to improve the course content, the specific topics covered and their levels of emphasis. These purposes are accomplished by formal techniques for securing input from students and feeding it back to the course instructor.

G. Aids to Facilitate Methodology Use

Two aids have been developed to facilitate use of the Curriculum Renewal methodology. *A Manual for Curriculum Innovation and Renewal*, currently available in draft form[4], has been prepared to describe the methodology. This manual is intended as a guide for the program director interested in rejuvenating the curriculum and as a resource for engineering faculty involved in the curriculum renewal process. The manual presents a step-by-step approach to applying the methodology, including user-tested and proven tools and techniques, along with case studies. A software package called SUCCESS[5] is also available to assist users of the methodology. SUCCESS provides templates that a CDT can use for data entry with either the Knowledge/Skills Method or the Augmented Syllabus Method of curriculum analysis. The software generates graphical displays to assist the CDT and program faculty in evaluating the current curriculum and candidate new curricula. An example of one of the SUCCESS displays of curriculum analysis is shown below in Figure 2.

[4] Contact Dr. D. Jack Elzinga at the Department of Industrial & Systems Engineering , University of Florida, P.O. Box 116595, Gainesville, FL 32611, or phone 352-392-3087, or email elzinga@ise.ufl.edu; and check the World Wide Web site www.succeed.vt.edu

[5] SUCCESS can be viewed at www.iq-interactive.com/succeed. Contact Dr. Donald Beasley at the Department of Mechanical Engineering, 233 Fluor Daniel Building, Clemson University, Clemson, SC 29631, or phone 864-656-5622, or email don.beasley@ces.clemson.edu.

Curriculum Structure

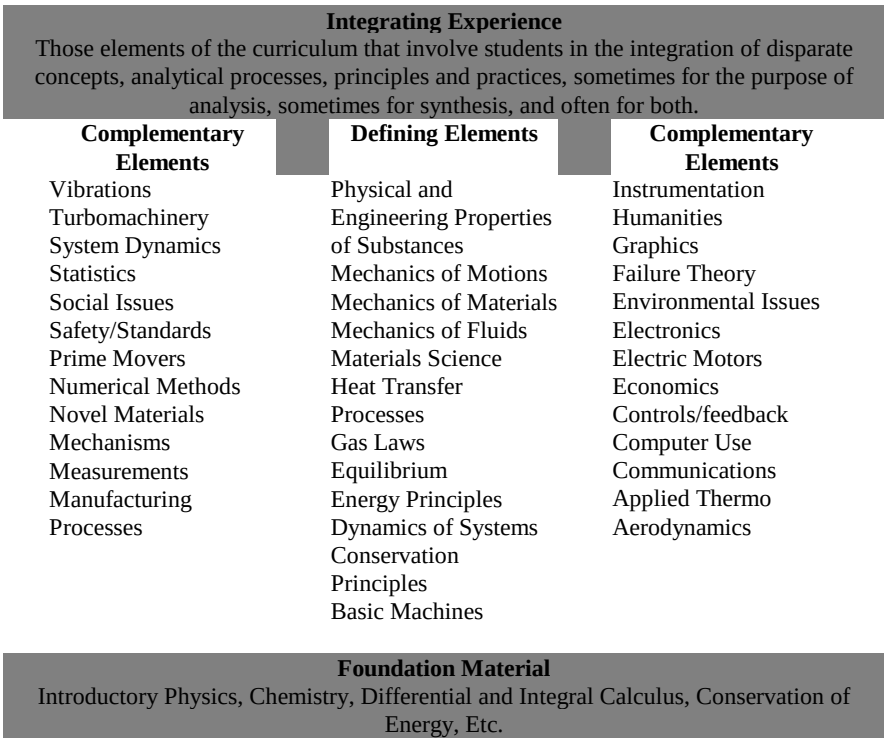

Figure 2: An Example Straw Man (Curriculum Structure)

III. Accreditation Preparation Methodology

Now the focus of attention shifts from curriculum renewal to preparation for accreditation evaluation under Criteria 2000. In the recent past, a typical engineering unit would devote approximately one year to efforts related to preparing for a general accreditation review under the existing ABET Criteria for Accrediting Programs in Engineering in the United States. With significant work and some luck, these accreditation-related efforts would not have to be repeated again for six years. For the foreseeable future, preparation for a first accreditation visit under the requirements of Criteria 2000 is likely to take three or four years. Moreover, maintaining accreditation under Criteria 2000 will require careful oversight of processes for evaluation, assessment, and improvement that must continue to operate through time.

The Accreditation Preparation Methodology presented here specifies a series of steps that the members of a program faculty, or set of program faculties within the engineering division of a university, can follow to help them prepare for their first general accreditation review under ABET Engineering Criteria 2000. For engineering units with programs scheduled for general accreditation review in the 1998-99, the 1999-2000, or the 2000-01 review cycle, the engineering unit administrators can elect to use Criteria 2000 as the evaluation criteria. The new criteria must be used for all general accreditation reviews in 2001-02 and the years which follow.

Criteria 2000 encourage innovation and emphasize outcomes assessment. These criteria require the faculty of each engineering program to develop educational objectives and subsequently to design curricula which are consistent with the program's institutional mission and the needs of the program's constituencies. Moreover, program faculty must demonstrate that outcomes that are important to the mission of their institutions and the objectives of their programs are being used to further develop and improve their programs.

The Accreditation Preparation Methodology includes six stages: Stage 1 - Adopt Program Objectives; Stage 2 - Adopt Program Outcomes, Outcome Indicators, and Criteria; Stage 3 - Adopt Ongoing Processes for Review, Assessment, and Continuous Improvement; Stage 4 - Insure Adequacy of Professional Component; Stage 5 - Document Previous Evaluation and Assessment Efforts; and Stage 6 - Conduct Cycles of Accreditation-Related Activities. A chart illustrating precedence relationships among these six stages is shown in Figure 3 below.

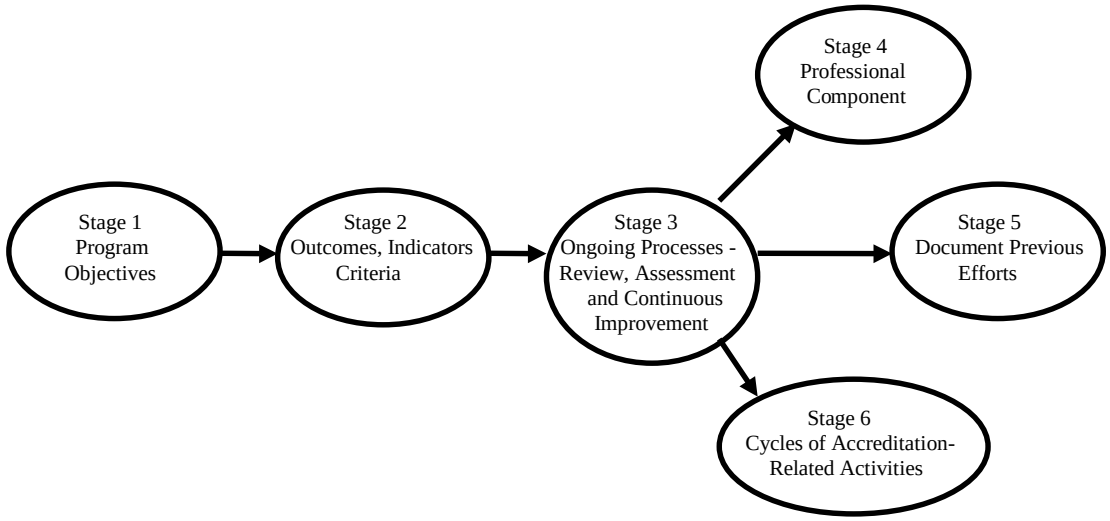

Figure 3: Precedence Relationships Among Stages of the Accreditation Preparation Methodology

A. Stage 1 - Adopt Program Objectives

The cornerstone in the accreditation preparation process is the set of Program Educational Objectives. ABET Engineering Criteria 2000 require that an engineering program have in place a set of educational objectives selected by the program's faculty, which are consistent with the mission of the institution, with the needs of the program's various constituencies, and with Criteria 2000. Each objective is a statement which describes one facet of what the faculty of the program hope to achieve with their educational program. Structurally, the set of program educational objectives may include two types of objectives: (1) objectives for which there is a documented relationship to the institutional mission and/or to any special needs of the program's constituents, and (2) educational objectives consistent with ABET 2000 Criteria [general Criteria 1 to 7, and discipline-specific Criterion 8]. These educational objectives must be published in such a manner that they are readily available for review by program stakeholders and interested members of the general public.

As a program faculty begins to prepare for accreditation, they are likely to find themselves without a formally adopted set of educational objectives which conform to ABET Criteria 2000 requirements. Fortunately, an initial set of educational objectives might be drawn from material that the program has published in the institution's general catalog description of its curricula, or from the narrative in the program's last ABET Volume II Self-Study Questionnaire for Review of Engineering Programs section titled Program Objectives. A review of the information in these sources can help the faculty to formulate a first set of program educational objectives. The important point to remember here is that the faculty does not have to come up with a "perfect" set of educational objectives at this time. In Stage 3 of the methodology, the faculty will set up an ongoing process for review and revision of these educational objectives with the requirement that stakeholder inputs concerning the appropriateness of the objectives be periodically collected and evaluated.

B. Stage 2 - Adopt Program Outcomes, Outcome Indicators, and Criteria

A program outcome is a statement which describes one element of what the faculty of a program intend for program graduates to know, to think, or to be able to do when these graduates have completed all of the program's requirements. ABET Criteria 2000 require that outcomes important to the mission of the institution and the objectives of the program, including the 11 outcomes listed in Criterion 3, be measured. An outcome indicator is the [qualitative or quantitative] assessment device chosen by the faculty to measure the degree to which one or more program outcomes have been achieved. Typical outcome indicators include tests, questionnaires, and focus-group protocols. A criterion is the value of an outcome indicator [such as a test score or questionnaire response] which the program faculty have agreed to use to represent accomplishment of one or more program objectives.

The Accreditation Preparation Methodology employs a very simple two step group process suggested by James Nichols in the book, *The Departmental Guide and Record Book for Student Outcomes Assessment and Institutional Effectiveness*,[6] to choose program outcomes. In Step 1, all faculty members are asked to consider the program educational objectives, and the mission of the institution and needs of program constituents, and then identify candidate program outcomes. These candidate program outcomes are placed on a "long list." In Step 2, the curriculum or assessment committee [if the program has such a committee], or the faculty as a whole, selects a "short list" of program outcomes for the "long list" of candidate outcomes. A voting process such as the nominal group technique can be used to make this selection.

The program's curriculum or assessment committee should make the choices of outcome indicators for each program outcome, with these choices confirmed by formal adoption by the program faculty. Outcome indicators may be quantitative or qualitative. Typical outcome indicators may also be classified by the aspect of learning that they focus on, such as attitude, behavioral change, and performance. Outcome indicators may be developed and used by a

[6] James Nichols, *The Departmental Guide and Record Book for Student Outcomes Assessment and Institutional Effectiveness*, Agathon Press, New York, 1995, pp. 17-31.

single program or set of programs at one institution, or they may be prepared by commercial sources for national distribution.[7]

Similarly, the choices of criterion value for each outcome indicator should be made by a program's curriculum or assessment committee and formally adopted by the faculty. Nichols[8] suggests that criteria be set at values that will be reasonable challenges for both students and faculty.

C. Stage 3 - Adopt Ongoing Processes for Review, Assessment, and Continuous Improvement

There are two key processes that must be established in preparing for accreditation under Criteria 2000. The first process requirement is for a procedure to review and evaluate the appropriateness of the set of program educational objectives. The second process requirement is for a procedure to measure program outcomes, assess program performance, and use assessment results to further develop and improve the program.

Criterion 2 requires that a process be put into place to insure that institution mission, needs of program constituents, Criteria 2000 requirements, and findings from ongoing program assessment are periodically reviewed. Information gathered from the review of these four sources must be used through time to refine the program educational objectives. Figure 4 below shows relationships among the required elements in this process.

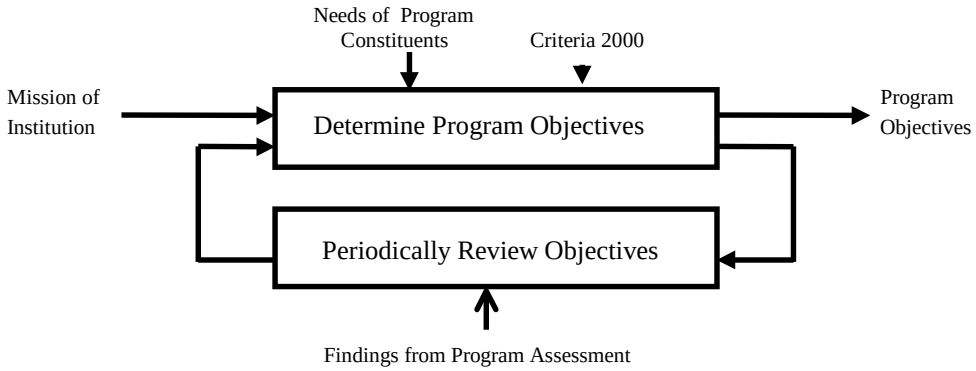

Figure 4: Process for Review of Program Educational Objectives

Criterion 3 requires that a related process be put in place to measure program outcomes that reflect program educational objectives. Criterion 3 also requires that findings from outcomes assessment be used to enhance the program. Figure 5 below shows relationships among the required elements in this second process.

The program educational objectives process and the program outcomes and assessment process must generate information the faculty can use to make informed choices concerning the adequacy of program educational objectives and the performance of the program in

[7] *Ibid*, pp. 32-52.
[8] *Op. Cit*., pp. 21-22.

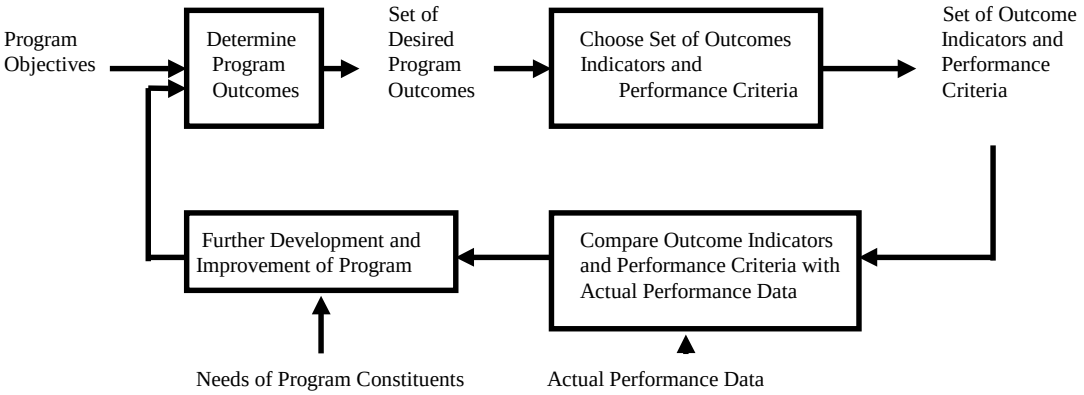

Figure 5: Process for Determining Program Outcomes and Conducting Outcomes Assessment

relation to selected outcomes. The faculty can then use this information to develop and improve the program using the curriculum renewal methodology. Moreover, the processes must be designed to produce documentation like committee and faculty meeting minutes which provides a record of program performance in terms of outcome indicator values, assessment efforts, and continuous improvement accomplishments. Nevertheless, the processes be operated across time with periodically changing program leadership and faculty member involvement. Hence, the processes should be self-documenting, and they must be relatively easy to administer and use.

Fortunately, when two or more engineering programs at the same institution are preparing for accreditation under Criteria 2000, there can be significant sharing of accreditation-related evaluation and assessment efforts among the programs. This sharing can help to reduce the burden of Criteria 2000 compliance on individual program faculties, and the shared efforts can help the engineering unit administrator in managing/monitoring accreditation activities within his/her unit. Two types of sharing are suggested: periodic discussion of accreditation-related topics among departments, and use of common processes and/or instruments to gather stakeholder information.

An ABET program coordinator should be appointed for each accredited engineering program. Periodically, these individuals should meet to discuss the progress of their program faculties in preparing for accreditation review. Items for discussion should include evaluation and assessment procedures under development; program outcomes, outcome measures, and indicators under consideration; how to be successful in making program changes within the bounds of institutional bureaucracy, and interactions with stakeholders-especially representatives of key employers of program graduates. These discussions provide opportunities for internal benchmarking of best local practices. The information sharing can also reduce the number of false starts in process development and measure selection, and help the faculties to feel more confident in the appropriateness of their accreditation-related actions.

As they work together, the ABET program coordinators will likely find assessment-related activities that they can do in parallel with the assistance and financial support of the institution.

Examples include alumni surveys administered and summarized by the institution's Office of Assessment, telephone/fax surveys of key employers conducted by one or more students funded by the engineering unit administrator, and focus group sessions with key program constituents facilitated by the institution's specialist(s) in survey research.

D. Stage 4 - Insure Adequacy of the Professional Component

While the Accreditation Preparation Methodology focuses on Criteria 2000's requirements for each engineering program to have in place processes for evaluation and continuous improvement, it is important to note the critical role that Criteria 2000's Criterion 4: Professional Component plays in the conduct of an engineering program, and in the successful review and evaluation of the program. Criterion 4 requires that the engineering faculty assure that the program curriculum devotes adequate attention and time to each component [subject areas of the curriculum], consistent with the objectives of the program and institution. Program graduates must be prepared for engineering practice through the curriculum culminating in a major design experience. There are three subject area components in this criterion: one year of college level mathematics and basic sciences, one and one-half years of engineering topics, and a general education component that complements the technical content of the curriculum.

This stage of accreditation preparation is most consistent with previous faculty experience in assembling ABET Self -Study documents and preparing for the visit of the ABET evaluation visit team. The faculty must document that they have developed and teach a curriculum which has a combination of course work in mathematics and science, engineering science and engineering design, as well as general education which is appropriate to the discipline, and consistent with program and institutional objectives. Typical documentation might include minutes of curriculum committee and faculty meetings where curriculum development and refinement have been discussed, course syllabi, course files, and student portfolios.

E. Stage 5 - Document Previous Evaluation and Assessment Efforts

Looking back through time, the faculty are almost certain to find that they discussed their perceptions of how their students were performing and /or considered inputs from one or more stakeholder groups, like alumni or employers of graduates, each time they decided to change their program curricula. However, the gathering and evaluating of performance data and stakeholder inputs were likely done on an *ad hoc* basis and almost certainly not carefully documented. Once the faculty have formally adopted the program educational objectives evaluation process and the program outcomes and assessment process, and as time is available to the faculty members charged with this obligation, recent [within the last two to five years] faculty efforts in curriculum development and improvement should be recorded in the formats selected for the two processes.

This recording of historical effort is important for two reasons. First, the documentation effort will provide a trail of activity that the faculty can use as they consider the current status of their program, what changes they have made in the recent past, and what could be expected to be successful in terms of future curriculum changes. Second, the effort will help to provide

evidence to outside parties such as ABET program evaluators of the faculty's commitment to their curriculum and its ongoing enhancement.

F. Stage 6 - Conduct Ongoing Cycles of Accreditation-Related Activity

By the time an engineering program has completed Stage 4 of the Accreditation Preparation Methodology, all of the structural and process machinery required by ABET Criteria 2000 is in place. However, Criterion 2(d) requires that the system of ongoing evaluation "demonstrates achievement of these [educational] objectives and uses the results to improve the effectiveness the program," and Criterion 3 requires that the "assessment process must demonstrate that the outcomes important to the mission of the institution and the objectives of the program are being measured."[9] A logical question to ask is just how much evidence is required to demonstrate compliance with these elements of Criteria 2000?

A March 1997 letter from the Chair and Vice-Chair of the Engineering Accreditation Commission to the administrator of each engineering unit scheduled for general ABET accreditation review in the 1998-99 cycle[10] gives an answer to that question. The letter presented a list of five levels of status of implementation of Criteria 2000 assessment and process requirements. The administrators were advised that if their institutions were not at least performing at Level 3, defined as

Level 3: A systematic approach is in place, including assessment/improvement cycles, with some evidence of integration. All major elements of the criteria are included. Constituencies are clearly involved. Documentable outcomes in all areas are evident. Positive trends in many major areas are becoming apparent, and some evidence shows that results are being influenced by the approach.

they should not request evaluation under Criteria 2000.

In response to the question posed about how much evidence is required, the key words in the Commission letter are "…including assessment/improvement cycles,…" It is logical to assume that several cycles of assessment/improvement will be needed to make a strong case. Of course, the work that the program faculty perform in Stage 5 of the methodology, Document Previous Evaluation and Assessment Efforts, will help to demonstrate concern for program quality and ongoing improvement efforts. But full cycles of systematically conducted assessment/improvement, documented outcomes, and positive trends are specified.

The Accreditation Preparation Methodology suggests the schedule of ongoing accreditation-related activities such as the example shown in Table 1 below. Once accreditation preparation start-up activities are complete, this example schedule alternates activities every two years.

[9] *Op. Cit., Engineering Criteria 2000*.

[10] Letter from Richard Seagrave and Dayne Aldridge, Engineering Accreditation Commission, Accreditation Board for Engineering and Technology, Baltimore, MD, March, 1997.

Table 1
Example Schedule of On-Going Accreditation-Related Activities

Year A	Year B
Fall Semester	Fall Semester
* Review constituent inputs[(1)] and performance data[(2)]	* Review constituent inputs and performance data
* Review current Program Educational Objectives and consider possible changes	* Review current Program Outcomes, Outcome Indicators, and Criteria and consider possible changes
* Evaluate candidate program changes and plan for implementation of selected changes	* Review progress in implementing selected changes
Spring Semester	Spring Semester
* Conduct mid-career alumni focus group session	* Conduct employer focus group session
* Prepare summary report on program assessment and improvement efforts	* Prepare summary report on program assessment and improvement efforts
Summer Terms	Summer Terms
* Provide inputs for college-wide phone/FAX survey of employers and university-wide survey of recent graduates	* Provide inputs for college-wide phone/FAX survey of employers and university-wide survey of recent graduates

(1) Constituent inputs: program faculty selected alumni and employer inputs, which might include survey responses and focus group session comments; and any other stakeholder inputs gathered by the faculty.
(2) Performance data: actual values achieved for the set of outcome indicators selected by the faculty, which might include Fundamentals of Engineering Examination and Graduate Record Examination scores, student grades in selected course work, and portfolio analyses.

G. Aids to Facilitate Methodology Use

Two types of aids have been developed to facilitate use of the Accreditation Preparation Methodology. The documents "A Presentation for Engineering Program Faculty" and an ABET Criteria 2000 Program Planning Guide for Engineering Programs at Clemson University" were prepared to assist the faculty at Clemson University in their accreditation preparation efforts.[11] These documents describe Criteria 2000 requirements and the steps of the Accreditation Preparation Methodology. The "ABET 2000 Planning Guide for Outcomes Assessment," prepared by the SUCCEED Outcomes Assessment Coalition Focus Team, is a notebook which presents example educational objectives, assessment tools and methods to measure the achievement of those objectives, and processes for using the assessment results to improve the curriculum. The notebook also displays survey instruments used at several SUCCEED Coalition institutions. This notebook is accessible electronically on the World Wide Web.[12]

IV. Linkages between the Curriculum Renewal Methodology and the Accreditation Preparation Methodology

The faculty of an engineering program can use the Curriculum Renewal Methodology and the Accreditation Preparation Methodology together in a cycle of continuous program or

[11] For copies of these materials contact Dr. Michael Leonard at the Department of Industrial Engineering, 110 Freeman Hall, Clemson University, Clemson, SC 29634, or phone 864-656-0291, or email mike.leonard@ces.clemson.edu.
[12] The Web address is http://www.succeed.vt.edu/products/outcomes/.

curriculum improvement. Both methodologies can be applied to either engineering educational programs or to the collection of academic curricula offered by engineering programs. Neither methodology requires the use of the other, but the two methodologies fit together with relatively seamless interfaces.

The stages of the Accreditation Preparation Methodology refer to programs because Criteria 2000 state accreditation requirements in terms of engineering educational programs. Clearly, however, the steps used in systematic evaluation, assessment, and improvement of the educational program can be applied more narrowly to the program curriculum. In the same manner, the Curriculum Renewal Methodology speaks to the use of strategic planning and use of tools for quality enhancement to renew a curriculum. Of course, both strategic planning and quality enhancement tools can be more broadly applied to the educational program.

The Accreditation Preparation Methodology leads program faculty through the steps of creating a process to evaluate program objectives and a process to assess and continuous improve the educational program. This preparation methodology does not specify how the faculty might analyze the stakeholder data that they collect, how they might develop and evaluate candidate actions, nor how they might implement the changes that they agree to make, as does the Curriculum Renewal Methodology. On the other hand, the Curriculum Renewal Methodology leads the faculty through steps designed to continuously improve the curriculum. However, the renewal methodology does not specify what processes the faculty should use to insure that its educational objectives remain appropriate through time, or in what ways the performance of program graduates should be measured and improved, as does the Accreditation Preparation Methodology.

What one methodology leaves for the user to do by developing his/her own steps, the other methodology defines in very specific detail. Of course, neither of these methodologies is required for successful accreditation preparation or for meaningful curriculum renewal. A faculty is always free to develop its own processes and to use the steps it needs to develop these processes. Nevertheless, the two methodologies presented in this paper represent an integrated tool kit for the resource constrained engineering program faculty who must insure that their program is accredited, is as good as those offered by peer institutions, and is getting better through time.

V. Applications of the Curriculum Renewal Methodology and the Accreditation Preparation Methodology

The faculties of eight programs on five SUCCEED campuses have been formally involved in developing and/or using the Curriculum Renewal Methodology. Participating faculties have developed a variety of instruments for collection of stakeholder inputs from alumni and employers of program graduates. They have also refined and tested the Knowledge/Skills and Augmented Syllabus methods for analysis of curriculum content.

As mentioned previously, the renewal methodology is designed in such a way that a faculty can elect to use parts or all of its stages. To illustrate this point, the ways that the eight program faculties have used the Curriculum Renewal Methodology are shown below in Table 2.

Table 2
Use of the Curriculum Renewal Methodology

	IE Clemson	ME Clemson	ChE NC A&T	EE NC State	CE U of Florida	ISE U of Florida	ME VPI & SU
Gathered Stakeholder Inputs	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Identified Strategic Objectives	**X**	**X**			**X**	**X**	
Conducted Curriculum Review	**X**	**X**			**X**	**X**	
Completed Curriculum Revision	**X**	**X**			**X**	**X**	

Currently, the Accreditation Preparation Methodology is being used by the faculties of the seven baccalaureate engineering programs at Clemson University. Stages 1 through 5 of the preparation process should be completed in all of the Clemson engineering programs by June 1998. In the Fall 1998 semester, the seven program faculties expect to begin cycles of on-going accreditation related activities like those shown in Table 1. By Fall 1998, one or two other SUCCEED campus engineering units are expected to begin to use some or all of the stages of the Accreditation Preparation Methodology.

VI. Conclusions

This paper presents a set of two methodologies that an engineering program faculty can use to help it discharge the key responsibilities of curriculum renewal and accreditation preparation. The Curriculum Renewal Methodology and the Accreditation Preparation Methodology have compatible objectives and structures, and they have been developed and tested by faculties of a variety of engineering disciplines on several campuses.

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