

## Course Assessment Plan: A Tool for Integrated Curriculum Management

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### Abstract

As we enter the 21<sup>st</sup> Century in engineering education, a common desire exists to improve curriculum structure, integration and assessment. Much has been written and discussed in workshops and professional journals concerning the top-down process for assessing and/or revising a program curriculum. Institutions are finally realizing they cannot afford to rely solely upon the senior capstone design experience to be the integrator of all previous engineering experiences. Studies are beginning to show the positive effects of well-integrated curricula where assessment methods are applied consistently. What is missing in many instances is a credible link between top-down curriculum management and bottom-up course assessment. At the United States Military Academy at West Point, a widely accepted assessment model provides the framework for program management.

The Department of Civil and Mechanical Engineering at West Point has long prided itself on working hard to provide a rigorous and well-integrated undergraduate engineering program of study. Over the last five years we have developed and refined an integrating tool within the academy's assessment model called a *course assessment plan*. The course assessment plan provides that crucial link between the program curriculum and the individual courses. The plan process and content will be the major focus of this paper. To illustrate the impact of the course assessment plan in closing the assessment loop, we will discuss an example of a course change with implications at the program level that was initiated and completed through use of the plan.

### I. Introduction

While many institutions may not possess the unique mission and faculty composition of the United States Military Academy, we all share the same desire and requirement to improve our curriculum structure, integration and assessment as we move forward into the 21<sup>st</sup> Century. Accordingly, EC2000 Criteria for curricular objectives and content states the following<sup>1</sup>:

I.C.2 “(Curricular) objectives are normally met by a curriculum in which there is a progression in the course work and in which fundamental scientific and other training of the earlier years is applied in later engineering courses.”

I.C.3 “The program must not only meet the specified minimum content but must also show evidence of being an integrated experience aimed at preparing the graduate to function as an engineer.”

Much has been written and discussed in workshops and professional journals concerning the top-down process for assessing and/or revising a program curriculum. The thread for accomplishing this goal of providing a coherent and relevant engineering education is *integration*. Commonly “curricula require students to learn in unconnected pieces, separate courses whose relationship to each other and the engineering process are not explained until late in a baccalaureate education, if ever.”<sup>2</sup> However, institutions are now realizing they cannot afford to rely solely upon the senior capstone design experience to be the integrator of all previous engineering education.

Studies are beginning to show the positive effects of well-integrated curricula. Everett, Imbrie and Morgan<sup>3</sup> describe in detail their efforts to integrate engineering and non-engineering courses to improve engineering curricula. Their longitudinal study following freshman groups entering the College of Engineering at Texas A&M from 1994 through 1997 suggests that not only do student retention rates improve, but knowledge retention improves as well. This is evident in post-course exam average grades as well as a reduced number of failures associated with students participating in the integrated program. Everett et al.<sup>3</sup> further explain their process for creating the integrated curriculum in great detail.

Current professional literature is replete with articles about the bottom-up assessment process for individual courses, but several problems have come to light. Ernst points out that the “emphasis on course content and on the curriculum as a collection of courses has led to compartmentalization of the learning experience, and away from the integration of learning.”<sup>4</sup> Indeed, while assessment is often touted at the course level, many institutions don’t take full advantage of the data that is provided from the program level assessment process. Ideally, course level data would be shared within the department and across departmental boundaries.<sup>5</sup> This would enable all *stakeholders* in a course to help improve individual courses *and* the integrated program as a result of the assessment process. *Stakeholders* in a course could include the department head, professors associated with prerequisite and follow on sequence courses, lab technicians, etc. For example in a thermodynamics course, the interested parties or stakeholders could include professors associated with prerequisite and subsequent courses like engineering mathematics, physics, heat transfer and power trains as well as the technician responsible for the steam and gas turbine laboratories.

Assessment methods must be applied consistently semester to semester and should be part of an integrated program of assessment and feedback to affect positive change or maintain superior performance.<sup>5</sup> What is often missing is a credible link between top-down curriculum management and bottom-up course assessment. At the United States Military Academy at West Point, a widely accepted assessment model provides the framework for program management. The Department of Civil and Mechanical Engineering at West Point has long prided itself on working hard to provide a rigorous and well-integrated undergraduate engineering program of study. By reputation, we have achieved that end as we consistently rank near the top of undergraduate engineering programs nationwide.<sup>6</sup> Over the course of the last five years, we have developed and refined an integrating tool within the academy's assessment model called a *course assessment plan*. The course assessment plan provides that crucial link between the program curriculum and the individual courses.

## II. USMA Description

The United States Military Academy at West Point is the oldest engineering institution in the nation, having taught engineering science and design to students of military art since 1802. The Academy's overarching general educational goal is "To enable its graduates to anticipate and to respond effectively to the uncertainties of a changing technological, social, political and economic world."<sup>7</sup> Of the nine specific program goals, three address engineering goals specifically:

- Think and act creatively.
- Understand and apply the mathematical, physical and computer sciences to reason scientifically, solve quantitative problems and use technology.
- Use the engineering thought process by which mathematical and scientific facts and principles are applied to serve the needs of society.

Since this applies to all students regardless of academic major, even non-engineering students supplement their general education or core requirements with a five-course engineering sequence capped with at least one design course.

To support these program level goals, the Department of Civil and Mechanical Engineering strives to maintain its status as a national leader in undergraduate engineering education by focusing on:

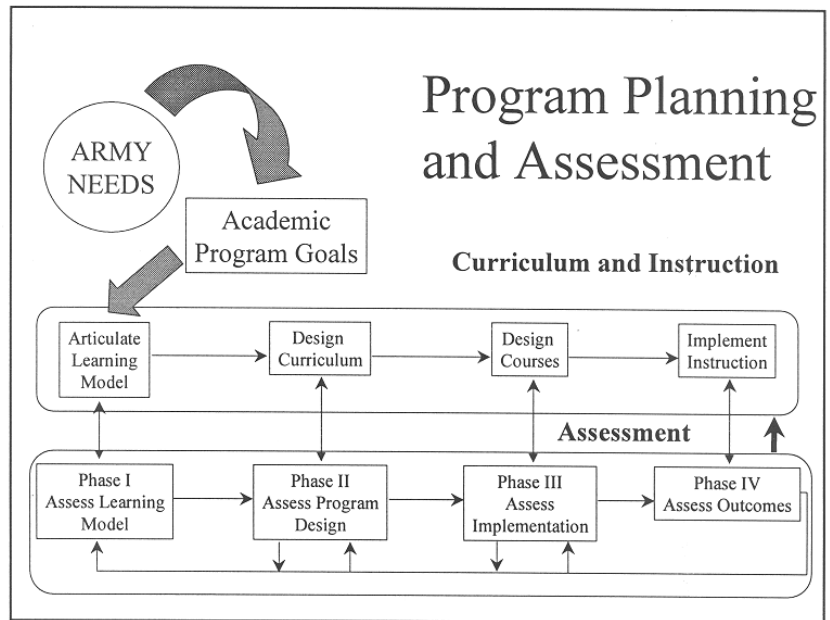
- Design/Problem Solving, Interdisciplinary effort, Teamwork, & Hands-On challenges
- Teacher Professional Development

- Research & Scholarship in Teaching & Learning
- Technology used to Enhance and Motivate Learning

Because we are a military institution, we have a unique faculty makeup that consists of 78% military and 22% civilian. Of that portion of the faculty that is active-duty military, 85% are only here for a 3-year tour after graduate school. With this high turnover level, we long ago had to solve the problem of maintaining an integrated curriculum while providing continuity in the face of continuous change in faculty. The course assessment plan and process assists us with creating a mechanism for course continuity.

### III. Program Planning and Assessment Process

The United States Military Academy (USMA) Program Planning and Assessment Model is shown in Figure 1.<sup>8</sup> The model clearly indicates that the design of the academic program goals is motivated by current and future Army needs. Phase I (referring to Figure 1) occurs at the academy level and involves the articulation of the academy's learning model. This learning model is not static but instead dynamically connected in the assessment process through the implementation of frequent academy program reviews.



**Figure 1: USMA Program Planning and Assessment Model**

Phases II and III occur at the departmental level where programs are designed and assessed annually based on academy program requirements. The course assessment plan and process support fully the USMA vision for curriculum planning and assessment by providing the link between design and assessment in Phases II and III. The course assessment plan is discussed in more detail in the following sections of this paper. We will demonstrate through discussion and examples how we use this mechanism to both improve courses while maintaining course continuity year-to-year. The final phase included in Figure 1, Phase IV, occurs at the instructor level. Each instructor is strongly encouraged to maintain a current teaching portfolio and to perform frequent self-assessments based on academy and departmental program objectives.

#### IV. The Course Assessment Plan

Course assessment plans are written once a year for all courses taught within the Department of Civil and Mechanical Engineering. In order to prepare for the course assessment plan presentation, the *course director* begins by creating a written draft document that includes a collection of narratives, assessment data, analysis of data, and proposed course revisions. Included in Figure 2 is a sample outline for a typical course assessment plan as written in our department with attached sample data charts. The *course director's* role throughout the academic year is to teach the course as well as administer all course related requirements. For example, a fluids course director may teach three sections of a twenty-section course along with several other instructors. However, in addition to teaching, she also organizes the creation of common course wide examinations, design projects, quizzes, etc.

Course directors develop their written course assessment plan each spring as they prepare for the oral presentation to the department head and other interested individuals at various levels of curriculum management. In addition to those who manage the curriculum, all interested stakeholders are invited to attend the briefing to ensure that their interests are met. Possible attendees include those who teach courses that are linked by sequence as well as those who merely have an interest in the course topic through professional background. During the course assessment presentation, the course director briefs the highlights from the written document. The ensuing open discussions during the presentation assist the course director with any necessary final revisions to the course assessment plan document. The final document is forwarded to the department head for signature and then maintained for a period of at least five years by the course director.

The course assessment plan serves many purposes. From a course director's perspective, it is an opportunity to collect all of the previous year's assessment data into one package with narrative that attempts to quantify what the data represents. If the course director would like to change the course in the following academic year, his or her suggestions along with a supporting narrative describing resource and/or curriculum impact are included. Suggested course changes may be due to a change in curriculum; change in current technology, text or teaching techniques; or feedback via course assessment. From a departmental perspective, the course assessment plan provides an opportunity to review annually each course to ensure that it is integrated within the department supporting the current vision and maintaining its links fore and aft to sequential courses. Our department has found the course assessment plan a great means for reducing redundant material and allowing courses to truly build upon each other. In addition, the plan provides a running history of all courses within the department and assists in creating a foundation of narratives and statistics upon which to base both internal and external program reviews.

### ***Sample Course Assessment Plan Outline***

#### **1. Course Description**

- University academic course description
- Course enrollment for current year and projection for following academic year
- Course objectives
- Textbooks used in the course
- Course syllabus outlining topics and assignments
- Course standard policies

#### **2. Course Assessment**

- Narrative assessment by course director referencing qualitative statistics.
- Narrative assessment of how the course supported the current course, departmental and Academy goals.
- Narrative assessment of how the students accomplished the course goals.
- Summary of the student feedback from web-based surveys. This summary allows the course director to compare the course to other departmental courses and all USMA courses. Refer to Figure 3 for an example of this data.
- Course average grades for the last five semesters using a criterion-referenced grading system.
- Course average time data. Students are requested to complete a time survey each lesson that records the amount of time the student spent working on the course since the last lesson period. This data is tracked for the five previous semesters and an example of this data is shown in Figure 4. See reference 10 for more details on how to use this as an assessment tool.

- 3. Course Recommendations.** Any proposals for change are included in this section. All proposals for change are justified based upon the previous assessment. Justification and impact statements are included for all proposed changes.

**Figure 2: Sample outline of course assessment plan.**

## V. Outcomes

A recent change in a civil engineering course illustrates the utility of the course assessment plan and its impact at both the course and program level. The Department of Civil and Mechanical Engineering at USMA includes two different divisions along discipline lines. Both divisions conduct course-end surveys for each course taught during a given semester as well as detailed surveys of its graduating seniors. Recently, the professor associated with the civil engineering capstone design course found that the seniors were experiencing increased difficulty visualizing three-dimensional structures during the design and modeling phases of design. Upon graduation on their final program survey, these same seniors were asked to agree or disagree to the following statement: "I can create simple floor plans and framing plans using AutoCAD." The response choices to this question were on a scale of 0 to 5 ranging from strongly disagree to strongly agree, respectively. The overall response to this specific question was a 3.79 out of 5. In addition, 15% of the students surveyed registered a disagree or strongly disagree response.

Each of these observations agree with increasing anecdotal evidence from across engineering disciplines that newly minted engineers are having difficulty with three dimensional visualization and modeling. This situation had a direct negative impact on two of the outcome objectives for our civil engineering program:

- Develop graduates who can apply the engineering thought process to design components and systems.
- Develop graduates who can use modern engineering tools to solve problems.

Therefore, the deficiency in visualization skills of graduating seniors was recognized as a potential shortcoming within the program. Armed with the capstone design professor's assessment and the graduating seniors' survey feedback, the course director and other stakeholders in a course which precedes the capstone course, CE491 - *Advanced Structural Design*, discussed appropriate means for addressing the three dimensional visualization issue during the course assessment briefing for CE491. The course director proposed, and all concurred, to increase the instruction of three dimensional visualization and modeling in this course by expanding the topic's coverage.<sup>9</sup> Having now completed the loop from assessment to analysis/discussion and then action, the course director will re-evaluate the impact of this decision through targeted questions and a critical look at the performance of the following year's group of graduates in the area of three dimensional visualization and modeling. He will discuss these results during his next course assessment briefing.

USMA's course assessment plan and process is also crucial in our interdisciplinary, team taught courses. For example, ME471/EE471 - *Dynamic Modeling and Control*, is a course that is typically taught by a team of two instructors, one each from the electrical and mechanical engineering departments. The course assessment plan each year is

created by the course director in close cooperation with the other instructor. The course assessment plan is presented at one meeting with representatives from both departments present. This allows each department to gain a clear understanding of course details such as prerequisites, objectives, laboratories, design projects, training aids, etc.

Besides the benefits that the course assessment plan provides for course continuity, information sharing and inter-disciplinary course coordination, the final document also serves as a foundation for the ABET reaccreditation visit preparation. The periodic ABET review of our department is greatly facilitated by the existence of these documents for each course. As discussed in this paper, the final course assessment document clearly shows how the course has evolved since the last ABET visit. In addition, the original motivation for course modifications is discussed within the course assessment plan and, when measurable, the resulting data associated with the changes is included.

## VI. Summary

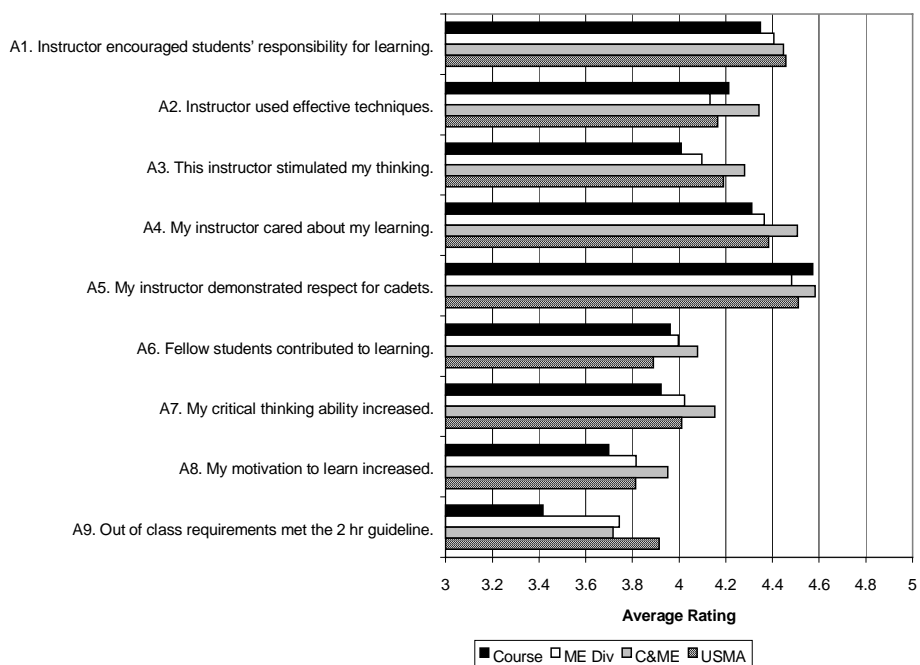
The course assessment plan can serve as the missing credible link between course assessment and program curriculum management. In this paper we discuss the components of the course assessment plan as well as the realized outcomes of the process, which include:

- course continuity
- information gathering and sharing
- inter-disciplinary course coordination
- foundation for ABET reaccreditation visit preparation.

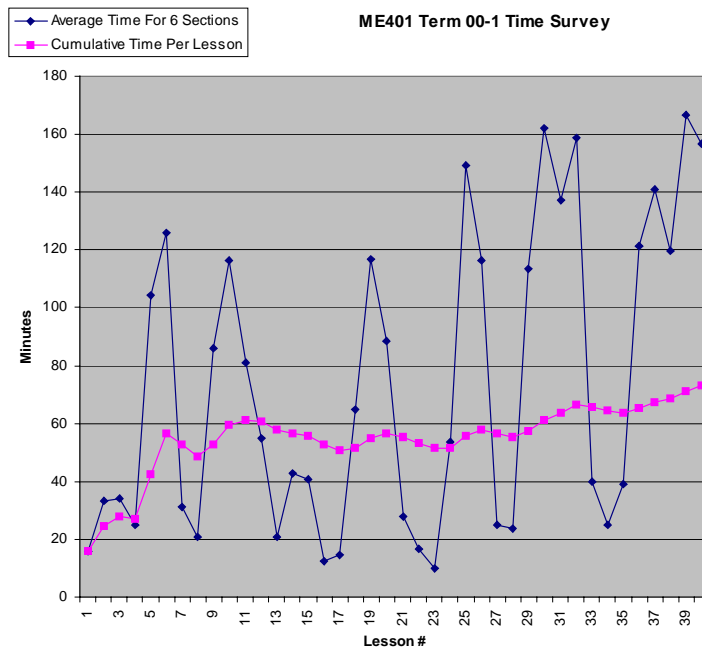
Although developed and used here at the United States Military Academy, this is by no means a process or document suited solely for our unique environment. In civilian universities, many departments may already utilize various components of this process. However, few have adopted the detailed methodology presented here. We have found that the benefits associated with this process and document far surpass the overhead and effort required to produce the final course assessment document. Since both military and civilian institutions fall under the purview of the same engineering accreditation process, the course assessment plan and process has the potential to benefit many diverse engineering programs.



Course Feedback 00-1 USMA Questions



**Figure 3: Sample student feedback based upon a 1-5 scale (5 is best) that allows course director to evaluate course as compared to other courses in the department and at the entire university. We should note that the sample size here is very high with the entire population of students submitting responses that are evaluated at each level within the Academy. For this particular chart, there were 20,000 responses by 4000 cadets at the USMA level, 1500 responses at the department level, 840 responses at the division level and 103 responses from students taking the course.**



**Figure 4: Sample time survey data for one course shows that while there are expected periodic spikes of work effort based upon assignment due dates, the average over 40 lessons was about 72 minutes of outside preparation by each student for every lesson. The sample size here was a course-wide sampling based upon each of 103 students indicating on a daily basis how much work they did outside of the classroom for each lesson.**

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<sup>7</sup> USMA Office of the Dean, *Educating Army Leaders for the 21<sup>st</sup> Century*, US Military Academy. West Point: DOIM, 1998.

<sup>8</sup> Forsythe, George and Bruce Keith. "Curriculum Design and Academic Assessment: The Engineering Thought Process." *Best Assessment Processes in Engineering Education: A Working Symposium*. Rose-Hulman Institute of Technology. Indiana: 1998.

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<sup>10</sup> Ressler, S.J. and T.A. Lenox, "The Time Survey: A Course Development Tool That Works!," *Proceedings of the 1996 Annual Conference of the American Society for Engineering Education* (Educational Research and Methods Division), Washington, D.C., June 1996.

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