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## **AC 2012-5261: DEVELOPMENT AND IMPLEMENTATION OF MULTI-LEVEL OUTCOMES ASSESSMENT PLAN FOR A CONSTRUCTION DEGREE PROGRAM**

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# Development and Implementation of Multi-Level Outcomes Assessment Plan for a Construction Degree Program

## Abstract

Assessment of learning outcomes for academic programs is an essential part of quality control and quality assurance. This process becomes rather intensive for professional degree programs because of the specific discipline requirements combined with institutional approaches and industry expectations. Accreditation agencies, at national, regional, and discipline levels, define outcomes assessment as a required component in their evaluations and most higher education programs have a version of these processes in place. This paper describes a seven-element outcomes assessment plan for a construction science and management program. The plan has a comprehensive list of components including academic, industry and student reviews. The first two elements of the plan are academic review items which consist of program level assessment and assessment of learning objectives for individual construction courses. The information from these reviews are then combined with information received from the industry representatives. Detailed feedback are collected through survey instruments from the companies that hire full-time employees or interns from the program. In addition, the program's Industry Advisory Council annually reviews the content and delivery of the construction courses through their Curriculum Committee. The student review elements include student evaluation of individual courses, specially designed exit surveys for graduating seniors, and alumni surveys for the graduates five and ten year into their careers. The paper also includes discussion about the challenges of defining a common terminology for the different assessment elements and creating the data collection system using technology.

## Introduction

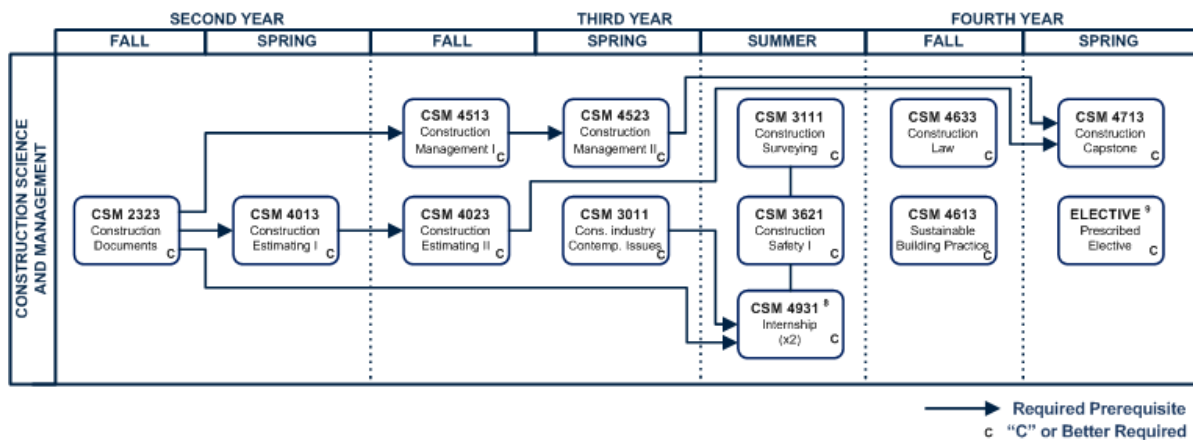
Assessment of learning outcomes for academic programs is an essential part of quality control and quality assurance. This process becomes rather intensive for professional degree programs because of the specific discipline requirements combined with institutional approaches and industry expectations. Accreditation agencies, at national, regional, and discipline levels, define outcomes assessment as an important component in their evaluations.

The Accreditation Board for Engineering and Technology (ABET)<sup>1</sup> for engineering and technology programs, and the American Council for Construction Education (ACCE)<sup>2</sup> for construction programs place a large emphasis on the outcomes assessment and define a version in their respective accreditation requirements. ABET provides a large collection of documents and resources at their website<sup>3</sup> which includes very practical information about the fundamentals of assessment<sup>4</sup> and challenges in development and implementation<sup>5</sup>. ACCE spearheads the outcomes assessment discussion specifically for construction programs<sup>6</sup> and enables detailed discussions on this subject at their annual meetings<sup>7,8,9,10</sup>. It is important to note that ABET uses a learning outcomes based approach for the accreditation of the engineering and technology programs while ACCE still employs a prescriptive contact hour approach for several topical content areas.

This paper describes a seven-element outcomes assessment plan for a construction science and management program. The plan has a comprehensive list of components including academic, industry and student reviews. The paper also includes discussion about the challenges of defining a common terminology for the different assessment elements and creating the data collection system using technology.

## Program and Curriculum Structure

Established in 2008, the Construction Science and Management Program at the University of Texas at San Antonio is a young professional degree program which was designed to meet the ACCE accreditation standards. The program is housed in the College of Architecture which includes a common first year for all majors in the college (with pre-major designations) followed by a “gateway application” into the professional degree programs. Students start enrolling into the discipline specific courses in their second year. The outcomes assessment plan detailed in this paper focuses on eleven specific construction courses which are under the program’s direct control. Figure 1 shows the required construction courses, and their suggested sequence and prerequisite relationships.



**Figure 1.** Required Construction Science and Management Courses

As illustrated in Figure 1, the program requires an internship as a part of the degree while providing an opportunity for a single elective class. The required construction courses include:

- CSM 2323 Construction Documents (plan reading, specifications, installations)
- CSM 3011 Construction Industry Contemporary Issues
- CSM 3111 Construction Surveying
- CSM 3621 Construction Safety I
- CSM 4013 Construction Estimating I
- CSM 4023 Construction Estimating II
- CSM 4513 Construction Management I
- CSM 4523 Construction Management II (Planning and Scheduling)
- CSM 4613 Sustainable Building Practice
- CSM 4633 Construction Law
- CSM 4713 Construction Capstone

## Multi-Level Outcomes Assessment Plan

The outcomes assessment plan for the construction program consist of seven independent elements categorized under three review groups. The first two elements of the plan are academic review items which consist of program level assessment and assessment of learning objectives for individual construction courses. The information from these reviews are then combined with information received from the industry representatives. Detailed feedback are collected through survey instruments form the companies that hire full-time employees or interns from the program. In addition, the program's Industry Advisory Council annually reviews the content and delivery of the construction courses through their Curriculum Committee. The student review elements include student evaluation of individual courses, specially designed exit surveys for graduating seniors, and alumni surveys for the graduates five and ten year into their careers.

The information collected from these review elements are combined in a collective assessment report every year. The program's annual faculty retreat creates the opportunity for a faculty wide discussion which is scheduled as an all-day meeting. At the end of the combined review and assessment discussion, benchmarks are established for all review categories to measure progress. This meeting also includes defining the target's for the next year and an action plan to accomplish the new targets. It is important to note that all review elements are in an annual review cycle. The only exception to this cycle is the career surveys which are collected from alumni five and ten year into their careers. Figure 2 illustrates the multi-level outcomes assessment plan for the Construction Science and Management Program.

One of the major challenges in developing a multi-level plan is to define a common terminology that will enable coordination among the different review elements. In 1998, Hauck outlined a detailed taxonomy of learning outcomes for construction higher education <sup>11</sup>. This effort used American Institute of Constructors' Certified Professional Constructor (CPC) exam content descriptions and ACCE accreditation topical categories as the main sources. Hauck proposed a list with over 200 skills, categorized under 42 sub headings and 11 headings. As noted in his research, the list included various overlaps and may present difficulties in relating to specific course content.

The multi-level outcomes assessment presented in this paper uses a simplified approach to include the following categories:

- Construction Body of Knowledge
  - Quantity Take –Off and Estimating
  - Planning and Scheduling
  - Industry Methods and Practice
- Professional Ethics
- Written and oral Communications

This simplified list provides the opportunity to collect and compile the information in a manageable scale while providing a global view. The learning outcomes assessment of individual courses provide a detailed review with 64 individual objectives which are then processed under the same simplified list. The 64 individual objectives address all required ACCE accreditation topical categories.

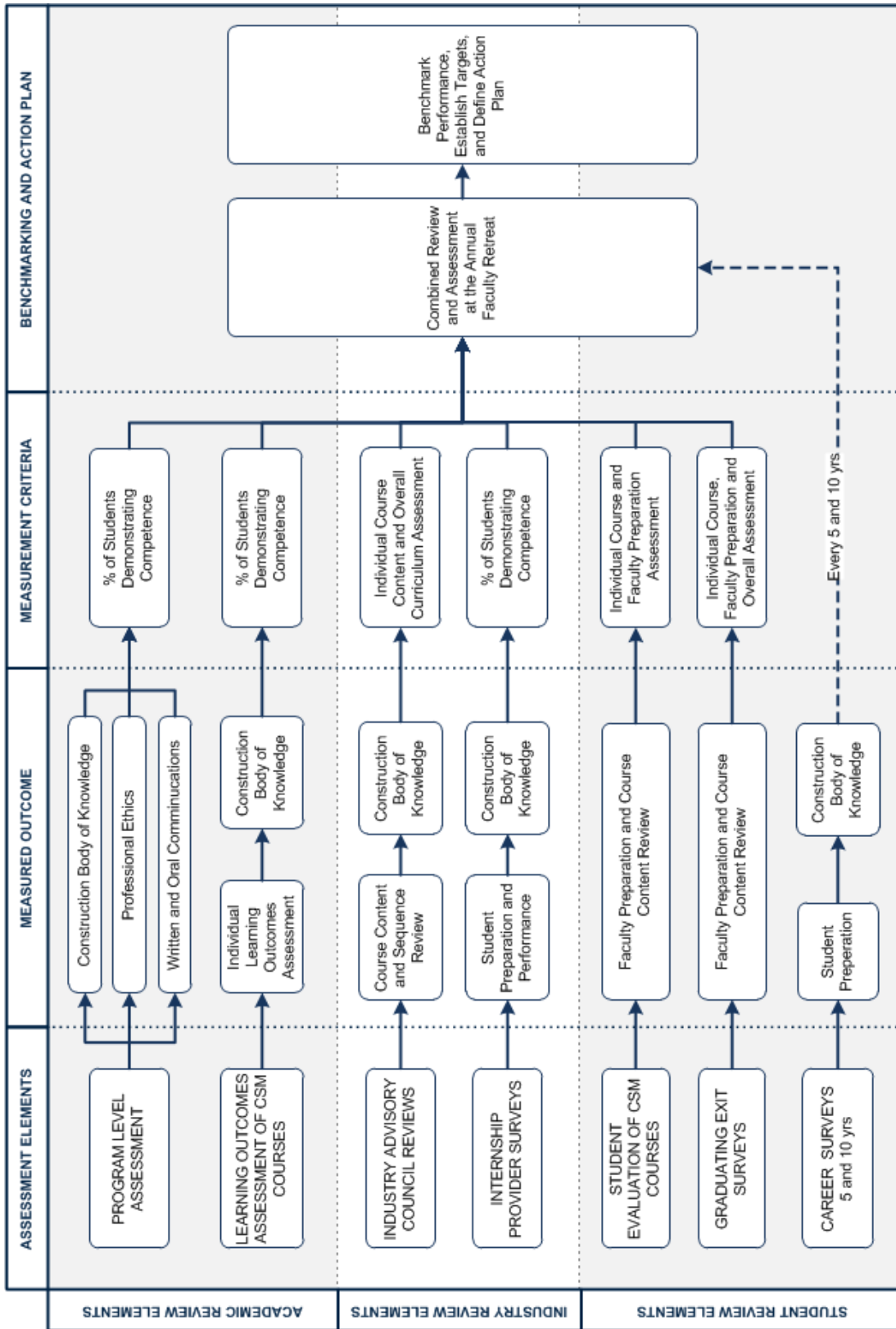


Figure 2. Multi-Level Outcomes Assessment plan

## Program Level Assessment Plan

The first academic review item is program level assessment completed in an annual cycle. Table 1 illustrates the goals, learning outcomes, assessment methods, measurement metrics and performance criteria for each of the assessment categories as defined in our simplified approach. The measurement metrics use a four level performance criteria where acceptable level is defined as 95% of the students demonstrating competence at level three or higher.

**Table 1.** Program Level Assessment Plan

<b>CSM PROGRAM ASSESSMENT PLAN</b>			
<b>GOAL</b>	<b>LEARNING OUTCOME AND ASSESSMENT METHOD</b>	<b>METRIC (LEVELS OF PERFORMANCE)</b>	<b>CRITERIA</b>
<p><b>CONSTRUCTION BODY OF KNOWLEDGE:</b></p> <p>Ability to demonstrate fundamental quantity take-off and estimating skills, planning and scheduling skills, and industry methods and practice.</p>	<p>Assessment of student work for quantity take-off and estimating in CSM 4013</p> <p>Assessment of student work for planning and scheduling in CSM 4523</p> <p>Assessment of student work for industry methods and practice in CSM 4523</p>	<p>(1) did not demonstrate awareness/understanding,</p> <p>(2) basic understanding of concepts,</p> <p>(3) ability to produce or demonstrate basic take-off and estimate/plan and schedule/industry practice skills,</p> <p>(4) ability to produce or demonstrate comprehensive and accurate take-off and estimate/plan and schedule/industry practices.</p>	<p>95% of students will demonstrate competence at level (3) or higher</p>
<p><b>PROFESSIONAL ETHICS:</b></p> <p>Ability to demonstrate understanding of ethical principles and applicable industry and professional codes.</p>	<p>Assessment of student work in CSM 3011 and CSM 4713</p>	<p>(1) did not demonstrate awareness,</p> <p>(2) basic understanding of concepts,</p> <p>(3) ability to demonstrate basic understanding of ethical principles and codes</p> <p>(4) ability to demonstrate comprehensive understanding of ethical principles and analysis using codes.</p>	<p>95% of students will demonstrate competence at level (3) or higher</p>
<p><b>WRITTEN AND ORAL COMMUNICATIONS:</b></p> <p>Ability to demonstrate written and oral communication skills.</p>	<p>Assessment of student work in CSM 4513 (written), CSM 4713 (written and oral), and CSM 4931 (written and oral)</p>	<p>(1) did not demonstrate awareness,</p> <p>(2) basic understanding of concepts,</p> <p>(3) ability to demonstrate basic written/oral proposal presentation skills,</p> <p>(4) ability to demonstrate comprehensive written/oral proposal presentation skills.</p>	<p>95% of students will demonstrate competence at level (3) or higher</p>

Review of each category is accomplished through the assessment of student work from selected courses (multiple courses for some categories) and includes assessment of homework assignments, class projects, and examinations. This program level assessment plan is also used as a part of the university’s regional accreditation efforts. It is important to note that, based on the observed performance level, each category requires an action plan to complete the assessment cycle.

### Assessment of Learning Objectives for Individual Courses

The second element of the academic review is the assessment of learning objectives for individual construction courses. As illustrated in Figure 1, eleven construction courses are subjected to this review that include a total of 64 individual learning objectives. These objectives are identified by the construction faculty as a group taking accreditation requirements, industry expectations, and academic requirements into consideration. These objectives are noted in each course syllabus and explained to the students in the first class meeting of every semester.

The faculty members who are assigned to construction courses identify corresponding exam question(s), homework assignment(s), and/or class project(s) for each learning objective. Similar to the program level assessment, student work is assessed at the end of the semester for level of performance. These results are then grouped under the simplified assessment categories.

Table 1 presents the results of the course specific learning outcomes assessment for the CSM 4013 Construction Estimating I course. In this example, there are four learning objectives and each objective is identified with four final exam questions illustrating the student’s level of performance. The average competence percentages are categorized under “Construction Body of Knowledge - Quantity Take-Off and Estimating” for the combined review.

**Table 1.** Course Specific Learning Outcomes Assessment for Construction Estimating I

<b>COURSE SPECIFIC LEARNING OUTCOMES ASSESSMENT</b>					
<b>CSM 4013 – Construction Estimating I</b>					
<b>LEARNING OUTCOMES</b>	<b>STUDENT PERFORMANCE</b> <b>(% of Students Demonstrating Competence)</b>				
	<b>Q1</b>	<b>Q2</b>	<b>Q3</b>	<b>Q4</b>	<b>Average</b>
<b>1 - Interpret Construction Documents and Specifications</b>	58%	42%	100%	85%	<b>71%</b>
<b>2 - Be Familiar with Units of Measure in English &amp; Metric Systems</b>	100%	85%	85%	70%	<b>85%</b>
<b>3 - Be Familiar with Fundamentals of Quantity Survey &amp; Labor/Production Rates</b>	58%	70%	100%	85%	<b>78%</b>
<b>4 - Be Familiar with Construction Procedures Relating to Quantity Surveys, Estimating, Scheduling, &amp; Bidding in CSI Format</b>	85%	70%	100%	100%	<b>89%</b>

## Industry Reviews

Industry reviews include surveys of internship providers and curriculum reviews through the Program’s Industry Advisory Council. The Council’s “Curriculum Committee” review the content of the construction courses, and their sequencing at their annual membership meeting. The committee traditionally invite faculty members and students into their discussions to shape their review comments. For example, in the last curriculum committee meeting, the review noted the need for Building Information Modeling (BIM) content to be included in estimating and scheduling classes as well as a specialized BIM class focusing on system management. These recommendations were discussed in the combined assessment meeting and included in the action plan for implementation.

The survey of the student performance during internship follows the survey structure and technology proposed by Hatipkarasulu and Smith <sup>11</sup>. The survey uses a password protected word file which can be completed and emailed to the program as an attachment and automatically processed into a database. The survey follows the simplified assessment approach and the performance review criteria is designed match the global categories. Figure 3 shows the preparation and performance section of the internship survey. Although subjective in nature, industry surveys of the students’ preparation and provides provide valuable information.

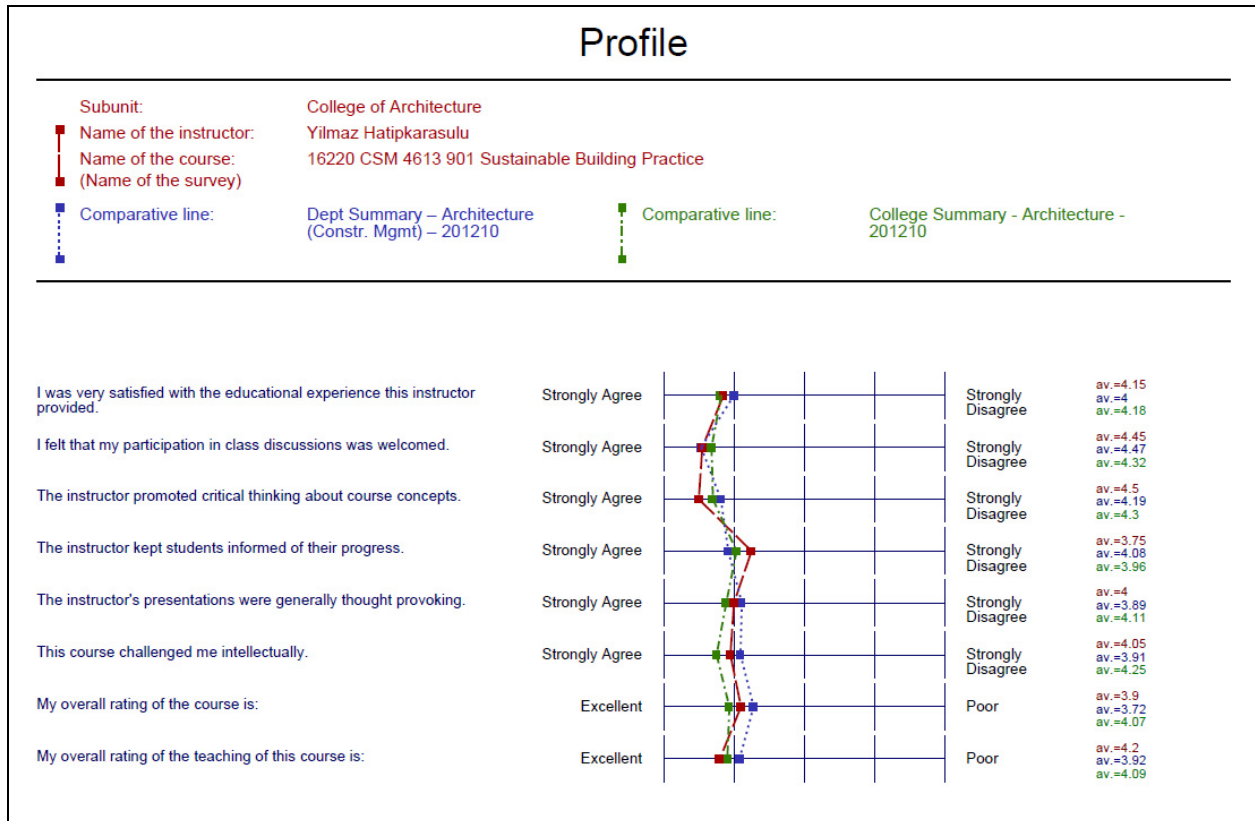
INTERN'S PREPARATION and PERFORMANCE							
1. Please list four strengths of the Intern:	a.						
	b.						
	c.						
	d.						
2. Please list four areas where you would like to see the intern improve:	a.						
	b.						
	c.						
	d.						
3. Evaluate the intern's preparation in the following areas:		VERY PREPARED (5)	(4)	SOMEWHAT PREPARED (3)	(2)	NOT PREPARED (1)	NO OPINION
	Quantity Take off / Estimating	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Planning / Scheduling	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Industry Methods and Practice	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Professional Ethics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Written Communications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Oral Communications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Overall Preparation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Comments:							

**Figure 3.** Internship Survey - Student Preparation and Performance Section



## Student Reviews

The students reviews consist of individual course evaluations, graduating exit surveys, and career surveys. Student evaluations are conducted every semester by the university and include eight standard questions. Although these questions cannot be related directly to the assessment categories, they provide valuable information for the performance of the instructor and an overall review of the course. Figure 4 shows a sample student evaluation report for Sustainable Building Practice course.



**Figure 4.** Sample Student Evaluation Report

The second element of the student reviews is the exit surveys collected for the graduating seniors. Similar to the industry surveys, graduating exit surveys follow the structure and technology of Hatipkarasulu and Smith<sup>11</sup>. The exit survey is designed to collect various types information and includes specific course evaluations (for importance and effectiveness) and faculty evaluations (for effectiveness). Although the information is subjective in nature, these sections provide useful data points for the combined assessment of the program. Figure 5 illustrates the course and faculty evaluation sections of the student surveys.

<b>8. Evaluate the following required courses. For each course, rate your perception as to the importance of the course as it addresses your future goals, then rate the course as to its effectiveness.</b>		<b>DID NOT TAKE</b>	<b>IMPORTANCE</b>					<b>EFFECTIVENESS</b>				
			<b>VERY (5)</b>	<b>SOMEWHAT (4)</b>	<b>(3)</b>	<b>(2)</b>	<b>NOT (1)</b>	<b>VERY (5)</b>	<b>SOMEWHAT (4)</b>	<b>(3)</b>	<b>(2)</b>	<b>NOT (1)</b>
	CSM 2323-Cons Doc	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	CSM 3011-Cont Issues	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	CSM 3111-Surveying	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	CSM 3621-Safety I	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	CSM 4013-Estimating I	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	CSM 4023-Estimating II	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	CSM 4513-CM I	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	CSM 4513-CM II	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	CSM 4613-Sust. Prac.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	CSM 4623-Safety II	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	CSM 4633-Const. Law	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	CSM 4713-Capstone	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CSM 4931-Internship	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Comments:												
<b>9. Evaluate faculty / staff based on your experience in the program.</b>  <b>Evaluate each faculty member NOT THE COURSES TAUGHT</b>		<b>VERY EFFECTIVE (5)</b>	<b>(4)</b>	<b>SOMEWHAT EFFECTIVE (3)</b>	<b>(2)</b>	<b>NOT EFFECTIVE (1)</b>	<b>DID NOT HAVE</b>					
	Dr. *****	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
	Dr. *****	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
	Ms. *****	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
	Mr. *****	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
	Dr. *****	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
Comments:												

**Figure 5.** Graduating Exit Survey – Course and Faculty Evaluation Sections

The multi-level program assessment plan also includes career surveys for the alumni 5 and 10 years into their careers. Because of the young age of the Construction Science and Management Program at the University of Texas at San Antonio, the program does not have any graduates that qualify for this survey yet. However, Bilbo<sup>12</sup> provides a compressive example of career surveys for construction managers which includes assessment of their educational preparation that can be categorized under the simplified assessment list. The survey structure and technology proposed by Hatipkarasulu and Smith<sup>12</sup> provides an applicable method for this survey as well as the other two.

## Summary and Conclusions

This paper describes a seven-element outcomes assessment plan for a construction science and management program. The plan has a comprehensive list of components including academic, industry and student reviews. These review elements are structured under a combined assessment plan that are completed in an annual cycle. The plan uses a simplified assessment category list that makes it manageable in terms of data collection, processing, and analysis. The simplified approach also enables a global review opportunity which can be used for other review functions such as the regional and professional accreditation reports.

Two important issues should be mentioned for the development of this multi-level assessment effort. The first issue is the fact that the data collection and processing requires significant time and resources. Early and detailed planning would significantly help this process, however, the support of the faculty and university administration is essential for a successful plan. The second issue is to manage the level of detail and expectations while maintaining an appropriate level of rigor and attention. It is very easy to extend the list of tasks to an unmanageable point in the process of planning.

The assessment plan illustrated in this paper provides an example of learning outcomes as a quality management tool. The plan is specifically design to function within our institution's organizational and curricular limitations. A well-structured and executed outcomes assessment plan is invaluable for any professional degree program. After all, the future professionals and leaders of the built environment depend on the quality of our work.

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