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Introduction

Why are industrial technology programs engaged in assessment? There are many answers to this question - ranging from "we're required to do this" to "we want to know if we're meeting our mission" to "we want to know how to improve what we do". After nearly two decades of dualistic debates over whether assessment should focus on accountability or improvement there is a reluctant consensus that dealing with both is an economic and political inevitability (Angelo, 1999). In this context when we say we are "doing assessment" it means we are first and foremost improving student learning and secondarily determining accountability for the quality of learning produced. Effective assessment addresses both of these issues by providing a plan that defines what will be measured, how it will be measured and most importantly, how the results will be used thus providing a very valuable tool for program improvement. Recognizing the formative and summative nature of effective assessment, many accrediting agencies have incorporated it as an integral component of the accreditation process and specify the development, integration, and documentation of an assessment plan as a required component of the self-study.

An effective assessment program will show desired program outcomes and the measures used to evidence student mastery of these outcomes. Although extensive literature exists on theories and methodologies related to formative assessment, a well defined process for the summative assessment of programmatic outcomes in NAIT accredited programs does not exist. This results in a tendency to measure everything in hope of measuring the

"right" things. It has been argued that we have far too much assessment, but the quality and the diversity of this assessment is not right (Race, 1995). The challenge for effective program assessment then becomes one of determining what to measure, when to measure and how to use the results for program improvement (Palomba and Banta, 1999). This paper introduces a program assessment model that has been effectively implemented at Southwest Missouri State University (SMSU).

Methods of Assessment

Authentic assessment is an approach to assessment which is designed to correspond as closely as possible to "real world" student experiences. In the context of industrial technology programs, "real world" student experiences are the norm and the various forms of authentic assessment are widely accepted. Amos (1998) describes the application of authentic assessment techniques to measure student attainment of industry desired competencies in a construction technology program. A few of the common means of assessment include certification exams, student or teaching portfolios, student or alumni surveys, and capstone experiences. These techniques when viewed in a broader perspective can also be used for programmatic evaluation. Table 1 lists advantages and disadvantages of various assessment methods as described by Nichols (1995).

An effective assessment program will utilize multiple measures, both direct and indirect for a given outcome. For example, the combination of surveys with a capstone experience or nationally normed test may provide a clearer assessment picture. The key

to effective assessment is the way in which the assessment method is implemented, how information is extracted, and how the information is utilized after extraction. It is better to minimize the number of competencies measured, while using multiple measures to provide a more accurate representation of the program. The assessment method chosen for the SMSU model was the senior capstone experience in conjunction with an internship and interviews of students, alumni, and employers.

Senior Capstone

The senior capstone project has been identified as a valuable element of the assessment process. This standard research component for graduate programs is now becoming more popular in undergraduate programs for the assessment of behavioral and cognitive achievement (Kenny, 2002). SMSU has recently adopted a senior capstone sequence which integrates an internship and project. The capstone course requires a solution to a real world problem which is identified in the "internship phase". In conjunction with the "project phase", a written paper and oral presentation are completed for evaluation by a jury of faculty and industry members. The capstone model was selected because of the value added to the undergraduate student's education while supplying meaningful assessment data. Students are advised that the project should demonstrate the full breadth of their education with emphasis on the specific outcomes being used for program assessment.

Students seek an industry partner during their senior year and identify a substantial but surmountable "real world" problem, then together with a faculty advisor determine the scope of work. At the conclusion of the semester, much like the traditional thesis, the students submit a final written report and make a major presentation. Desired program outcomes are integrated into the course criteria and into the evaluation rubric as part of the assessment plan. Examples of several broad, overarching outcomes used at SMSU are:

- The project must demonstrate aspects of technical and project management competence. Students must choose a project that will prepare them for their role as a technical manager.
- The project must demonstrate the ability to work in a team environment. Students typically

Table 1 Assessment Methods

Method	Advantages	Disadvantages
Standardized or Certification Exams	-Direct measure. -Easy to Administer. -Less open to subjectivity or bias. -Usually nationally normed across institutions. -Statistically valid and reliable.	-May not reflect a department's intended educational outcomes. -May be relatively expensive -May provide aggregate scores that don't allow focusing on specific outcomes. -Nationally normed group may not be appropriate for department.
Student or Teaching Portfolios	-Direct measure. -Longitudinal collection of work. -Give a very good picture of cognitive ability.	-Risk of subjective evaluation. -Evaluation of portfolios extremely difficult. -Coordination to get identical content in portfolios difficult
Student, Alumni or Employer Survey	-Indirect measure. -Measure attitudes towards major and department -Measure the long-term development of students and behavior.	-Does not measure cognitive ability -Considerable development time -Measures attitudes at a specific time that may not reflect long-term feelings.
Capstone Experience	-Direct measure. -Provides evidence related to most important outcomes. -Assesses both behavioral and cognitive performance. -Situation closely resembles situations encountered in their professional lives. -Can be used to secure industry support and involvement.	-Considerable time involvement.

work in teams of two to three students.

- The project must demonstrate math and scientific principles. Quantitative evidence must be a substantial part of the project solution.

Evaluation of outcomes achievement is accomplished by student peers, a faculty committee, an industry partner, and advisory council members. The faculty committee also provides evaluation of the written report. For each of the listed evaluators a rubric is provided which clearly states the intended outcome and a rating scale. This data is then compiled into a comprehensive assessment matrix that is analyzed regularly. Any shortcomings are documented and addressed with appropriate programmatic changes. For example, in a recent group of graduates it was noted that cash flow analysis was a common weakness among the students. This topic was traced back into the curriculum and it was determined that inadequate coverage was being provided.

The capstone model requires extensive planning and requires the student to demonstrate that he or she is ready for graduation. Employers and program supporters are able to see first hand student and program quality, thus further strengthening the relationship between industry and education (Tooley, 1999). Because many of the employers are also advisory council members they are very comfortable in making suggestions regarding perceived shortcomings or strengths of the program. The capstone model is truly "authentic assessment" with the capacity to accurately address the dual needs of student learning and program quality.

Competency Identification
Identification of the intended educational outcomes is a very difficult and important process after the commitment is made to develop an assessment plan. The terms "competencies" and "outcomes" are often used interchangeably. The outcomes should be descriptions of cognitive, attitudinal, and behavioral attributes a student

should possess upon graduation. The assessment plan as a whole should seek to answer the following:

- Are our students learning what we think we are teaching?
- How do we know our program is meeting its objectives for student learning?
- What are the indicators that our program is effective?
- Can we find areas for improvement in our degree program?

Developing outcomes and an assessment plan that paints a clear picture of a program without becoming unwieldy can be accomplished given a department has a unified vision of their purpose. The initial faculty inclination is to attempt measurement of all course level competencies as they rightfully believe that everything taught is important to student success. Experience has shown that attempting to measure too many competencies results in an unmanageable process that is prone to failure. Angelo (1999) suggests that two to three assessment questions should be identified and answered in a given year. Some accrediting agencies have been very specific in their expectations regarding outcomes that must be addressed in the assessment process. For example, the Engineering Accreditation Commission of ABET (2002) lists the following program objectives that with minimal adaptation could find application in any technology related program:

"Engineering programs must demonstrate that their graduates have:
   (a) an ability to apply knowledge of mathematics, science, and engineering
   (b) an ability to design and conduct experiments, as well as to analyze and interpret data
   (c) an ability to design a system, component, or process to meet desired needs
   (d) an ability to function on multi-disciplinary teams
   (e) an ability to identify, formulate, and solve engineering problems
   (f) an understanding of professional and ethical responsibility

   (g) an ability to communicate effectively
   (h) the broad education necessary to understand the impact of engineering solutions in a global and societal context
   (i) a recognition of the need for, and an ability to engage in life-long learning
   (j) a knowledge of contemporary issues
   (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice."

Statements are intended as overarching concepts which should span several courses and are not individual course objectives taken from each syllabus. As such, these statements should be broad in nature, such as "graduates should demonstrate effective oral, written and graphic communication skills" and the accomplishment of statements should be ascertainable.

Assessment Implementation
Each program must have an assessment process with documented results. Historically, assessment has been formative and designed to provide feedback to students while they are in the process of learning. Program assessment is summative in nature and designed to determine what has been learned or achieved as a result of instruction (Angelo, 1999). Evidence must also be given that the results are applied to the further development and improvement of the program. The assessment process must demonstrate that the outcomes important to the mission of the institution and the objectives of the program are being measured. The implementation of program assessment is based on the aggregation of student accomplishments using programmatic outcomes as the basis for analysis. Evidence that may be used includes, but is not limited to the following: student portfolios, including capstone senior projects; nationally-normed subject content examinations; alumni surveys that document professional accomplishments and career development activi-

ties; employer surveys; and placement data of graduates. Since the outcomes are based on the performance of program graduates, that is "Graduates of this program will …", the appropriate timing for the assessment is immediately prior to or following graduation. The use of a capstone senior course is an effective means of implementing the assessment process in that collection of data is limited to those students who will most likely be program graduates. A failure of the aggregate student population to accomplish the broadly defined outcomes is a reflection of programmatic deficiencies, not necessarily the student. The selection of overarching outcomes that integrate the objectives of multiple courses minimizes the potential for assessment apprehension within the faculty that might be caused by a negative reflection on individual faculty. Successful implementation of an assessment plan requires that the purposes of the plan be made clear to all stakeholders, including students and faculty and that ownership of the plan rest squarely with those responsible for its implementation, the faculty.

Utilizing Results

Assessment is a means as well as an end. Assessment information must be utilized for continuous improvement of student learning and the quality of the learning produced (Frye, 2002). Accrediting agencies require evidence that the result of assessment efforts is used for improvement. Generally, if a given area is under control it should continue to be monitored and assessment efforts should then be redirected to identifying another area for evaluation.

When assessment results indicate improvement is needed two options are available: One, change the outcome or assessment measure to improve results or lower the bar. This is a legitimate strategy if after analysis it has been determined that a criteria has been set at an unreasonable level that could not be reached within a realistic time frame. The second option would be to use assessment data to make incremental improvements to the program. Program improvements may be a change in what

is taught or how something is taught. Changing what is taught may be as simple as a change in prerequisites or course order or the change may be as extensive as rebuilding a program to align with industrial needs or bodies of knowledge. Changing how something is taught may involve adopting a new teaching methodology that encourages student learning. Encouraging active participation on the part of students, increasing laboratories, or adopting software simulation will often improve outcomes performance. As was the case at SMSU a change in outcomes, assessment procedure, and teaching methodology was warranted in conjunction with major programmatic changes.

Outcomes Assessment Process Model

Palomba and Banta (1999) have explained the word "assessment" as the "process that focuses on student learning; a process that involves reviewing and reflecting on practice as academics have always done, but in a more planned and careful way." Key to this process is the design and implementation of a thoughtful approach to assessment planning, the design and implementation of data collection approaches, and the examination, sharing and acting on of assessment findings. The following eight step process model has been successfully implemented at the university level, department level and

program level (Weber State University, 2000). It was also used to develop the Industrial Management (IDM) assessment program at SMSU. This model utilizes a faculty driven approach, thereby assuring faculty buy-in to the ensuing implementation.

Step 1. Agree on the mission of the program. Factors to be considered in this step include: program location and affiliation, program constituents, philosophy of the program, special or unique features of the program and anticipated results. As a result of this activity, the following mission statement was generated: "***To prepare technically oriented professionals to provide leadership in construction and manufacturing enterprises through nationally accredited undergraduate industrial management/technology programs.***" This statement was considerably shorter than the previous mission statement and more easily retained by faculty and students.

Step 2. Identify the program outcomes. Using graduation as the measurement point, what should the best students know, think, do, and believe (knowledge, cognitive, psychomotor skills, attitudes, values)? A simple approach is to ask faculty to list two or three things they would like to ensure that students learn well before graduating, and then look for common goals across the list. Given the desired

Table 2. Measurement of Outcomes

INTENDED OUTCOME	ASSESSMENT CRITERIA
7. Graduates will demonstrate technical competency in discipline specific activities.	7a. IDM program graduates will be required to complete successfully (as judged by faculty/industry jury) a major project demonstrating technical competency in discipline specific activities (Capstone).
	7b. Seventy-five percent of the graduates will "agree" or "strongly agree" with the statement "I feel very comfortable with my technical competency in discipline specific activities" on the Graduating Student Questionnaire

outcomes, it is then necessary to identify the level of expected accomplishment for each outcome. It becomes a good opportunity for a detailed curriculum review which can be accomplished in the next step.

Step 3. Articulate the outcomes and the curriculum. Using a matrix showing outcomes on one axis and courses on the other axis, map out the specific courses, course requirements and learning activities that support the program outcomes. This is also a good time to evaluate what co- or extra-curricular experiences support the outcomes. Typical findings from this activity will promote coordination between faculty while providing clear evidence of gaps or redundancies within the curriculum. It also provides a means of mentoring faculty. During this activity it was discovered that a particular faculty member felt obligated to teach every outcome in every course. The visual nature of the mapping exercise made this readily apparent and the faculty member eventually succumbed to peer pressure and established more realistic goals.

Step 4. Brainstorm, evaluate and select appropriate measures of student learning for each outcome. This step should include both direct and indirect measures. Direct measures look at samples of students' work and may include written exams (standardized or locally-developed), oral exams,

embedded questions in exams/assignments which assess global outcomes, portfolio analysis, papers, writing samples, simulated activities, case-studies, capstone projects, videotapes of students' skills, inside or outside examiners, and internship experiences. Indirect measures record opinions of the students or those who work with them and may include exit interviews, participant observation, focus groups, satisfaction surveys, and reported job performance. Guidelines for selecting appropriate measures include increase reliability by using at least two measures (both direct and indirect) for each outcome; ensure validity by collecting trend data; enhance credibility by providing comparative data; and use institutional data whenever possible, to avoid duplication of effort. An example of outcomes with assessment criteria is shown in Table 2.

Step 5. Develop an assessment plan for collecting the data. The key elements of an effective assessment plan include Intended Outcomes, Assessment Method and Criteria, Schedule, and Responsibility. Prioritize the outcomes and select a manageable number to evaluate. Beware of the tendency to focus on outcomes because they are easily measured rather than those that are important to the faculty. Set a time-line and milestones for collecting data on each outcome and identify who is responsible for collecting data on each outcome. This is a dynamic

process and different outcomes can be evaluated in each cycle.

Step 6. Collect and analyze data which document student achievement of these outcomes. As a faculty driven process, the ultimate responsibility lies with the faculty for data collection and analysis. A well run administrative unit can provide valuable assistance in this area by maintaining historical records and documentation of the process in a usable format. An example of data collection is shown in the "results" column of Table 3.

Step 7. Use data to improve curriculum and program processes to improve student learning. This is the most important step in the process. Accrediting agencies that were at one time simply asking for evidence of an assessment process are now increasingly asking for evidence that the process is effectively implemented and that results are being used to improve program quality. An example is shown in the "use of results" column of Table 3.

Step 8. Communicate results of outcomes assessment process. The value of an effective assessment program goes beyond that of accreditation there are also political and economic considerations. Because programs have a significant role in the local community, we want to know how the community benefits from our graduates and university-sponsored activities. What

Table 3. Measurement of Outcomes

ASSESSMENT CRITERIA	RESULTS	USE of RESULTS
4a. Seventy five percent of the graduates of the baccalaureate program will "agree" or "strongly agree" with the statement " I am satisfied with my education" on the Graduating Student Questionnaire.	4a. Sixty three percent of the 2001-2002 graduates responded "agree" or "strongly agree"	4a. Follow up analysis determined that the unsatisfied students were in programs that had been deleted. Further monitoring of students in active programs is necessary.
4b. Eighty percent of the courses taught by department faculty will be evaluated.	4b. One hundred percent of the courses taught by department faculty were evaluated.	4b. No action required
4c. The department average for course evaluations will be 4.0	4c. The department average for course evaluations was 3.84	4c. Low performing faculty identified and counseled accordingly

changes does the program bring about in the community or industry it serves? How do our graduates impact the communities in which they live; how do programs aid others? The thoughtful design and implementation of an assessment model may address as well as answer these questions.

Conclusion

Whatever the motivation, assessment is the right thing to do — for our students, our faculty, our constituent industries, members of our accrediting agencies, and other interested parties. Although means and extrinsic ends are important, to be successful, assessment must be built on the premise that learning does matter most. Most faculty and administrators have come to accept that assessment is a vital part of the institutions culture. Unfortunately, due to previous assessment experiences gone awry, the term assessment often strikes discord with administrators and faculty. The key to effective assessment is simplicity. Start with the things that your faculty see as valuable then devise activities that will mesh assessment with their values. Choose a limited number of outcomes, build time into the process for effective data gathering, analysis and reflection, utilize the results for continuous

improvement, and resist the temptation to grow the assessment effort beyond what is possible within the available resources. A simple yet effective assessment plan includes both direct and indirect measures of desired outcomes. A capstone experience in combination with internships and surveys provides the basis for a robust and manageable assessment plan that will result in program improvement, meet accreditation guidelines, and maintain faculty ownership and involvement without overwhelming the faculty.

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