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How an Engineering College Uses a University's Quality Enhancement System to Generate and Manage Evidence for Multiple Accreditation and Accountability Bodies

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ABSTRACT *Colleges and universities interact with multiple constituents or quality monitoring groups that require programme-level assessment of student learning. These required assessments might be used to demonstrate accountability, programme improvement or a combination of both. These demands often challenge instructional faculty to choose between the competing interests of research in their discipline and research on student learning for assessment purposes. This article offers one approach for engineering departments that simultaneously makes student learning research more meaningful for instructional faculty while farming out to the central administration those jobs it does not have the time or resources to do effectively. An engineering programme is better able to ensure the ownership, development and integrity of and research into its own curriculum if it has a centralized university improvement system that presents unit-level quality management research to external market and accountability groups.*

Keywords: accreditation; assessment; engineering; outcomes; quality management systems

Introduction

Colleges and universities in the USA interact with multiple constituents or quality monitoring groups that require assessment of student learning. These required assessments might be used for accountability, programme improvement or a combination of both. Accountability information is provided to political bodies, such as state coordinating boards, and programme improvement information usually informs special and regional accrediting bodies, as well as specific university strategic planning priorities. In 2005–2006 the nation's political environment developed greater expectations of educators to use assessment more effectively so that it positively affects student learning, substantively improves curriculum and informs education consumers through transparency of assessment systems output.

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However, these demands often challenge instructional faculty to choose between the competing interests of research in their discipline and research on student learning for assessment purposes. Instructors should not be burdened with duplicative work commitments to meet the multiple evaluation responsibilities in higher education, such as annual student learning assessment activities, programme review, special accreditation review, state-level performance data and regional accreditation, which compares with national accreditation in many European nations. In today's higher education environment an important question is: how can instructional faculty use their time more effectively so that effort is not wasted in conducting features of assessment work that can be better done by a centralized university quality enhancement process?

By keeping many of the systematic components of assessment removed from the programme level, faculty can focus on what matters most to them, maintaining ownership and improvement of their own department's curriculum. In other words, centralizing the assessment infrastructure to (1) handle data storage, (2) provide planning resources for instructional faculty, (3) organize quality peer review processes, (4) report quality enhancement information and (5) develop communication formats for external viewers encourages localization of a department's programmatic curriculum development.

With multiple constituent groups making demands on engineering departments, centralized integration of assessment tasks has the potential to streamline the process. Described herein are excerpts from each of the quality monitoring group's evaluative requirements, with emphasis placed on their commonalities and their variances, along with the coordinated response of Colorado State University's (CSU) quality enhancement system, which is designed to generate multiple evidence patterns.

Accreditation and Accountability Agencies and Their Learning Assessment Requirements

Higher Learning Commission of the North Central Association of Colleges and Schools (HLC)

Regional accreditation in the USA plays a critical role in maintaining a university's reputation and access to many federal programmes, including financial aide. Three of the five evaluation criteria required by CSU's regional accrediting body (HLC) explicitly requires assessment of student learning.

Accreditation Board for Engineering and Technology (ABET)

Specialty accreditation for engineering in the USA is provided through (ABET). As with the HLC, student learning outcomes comprise a major portion of engineering accreditation (ABET Engineering Criteria, 2000). Eleven student outcomes are required, as described in Table 1. The special accreditation process is more prescriptive than the regional bodies, which are more interested in the process of how outcomes are designed, assessed and lead to quality improvements.

Institutional Programme Review and State Regulation

The university uses programme review to engage programmes in evaluative inquiry that generates programme improvements and develops evidence for informing state programme quality requirements and university strategic planning metrics. Information on

TABLE 1. ABET programme outcomes

(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.

student learning performances and feedback is attained from departments' annual learning assessment plans These plans outline a programme's prioritized student learning outcomes, its methods of measuring student learning other than use of course grades and data collection for demonstrating the strengths and weaknesses of students' learning. Course-embedded assessments, externally developed standardized tests, student programme exit surveys and alumni surveys generate data on student learning effectiveness at the programme level. Groups of engineering instructors within a department use common review criteria to evaluate sets of student papers or student design projects or student oral presentations to determine learning levels at an aggregated level. Instructors' course grades are not part of this process.

Commonalities and Variances of Requirements

Some of the commonalities of all three levels of quality monitoring include: (1) use of systematic processes of continuous improvement; (2) demonstration of feedback loops whereby instructors improve the curriculum based on deficiencies revealed by their research on student learning quality; (3) use of direct assessments, such as programme instructors' evaluation of senior design projects, rather than indirect student surveys, to demonstrate student learning performance; (4) faculty instructors' engagement in the assessment process.

Some of the variances include: (1) CSU's regional accrediting body requires evidence showing that students are prepared to function in a diverse, global environment, whereas ABET does not; (2) the regional body requires evidence showing that assessment results of student learning are available to constituents, including students, while ABET does not; (3) the regional body and programme review require evidence showing that planning and evaluation processes demonstrate a capacity to improve quality, whereas ABET does not.

CSU's quality enhancement process centrally directs programme assessment planning to develop evidence that can fulfil the multiple quality monitoring standards when there are variances among agencies and to satisfy the highest level of rigour for those standards that are common among agencies so that one evidence pattern suits all. An example matrix that CSU uses to coordinate production of evidence patterns is shown in Table 2.

The PRISM Model and its Quality Enhancing Operations

CSU has developed a Plan for Researching Improvement and Supporting Mission (PRISM), a campus-wide continuous improvement process that uses an interactive web-based reporting database to support its multiple quality enhancement efforts. The university's peer review committee conducts regular and scheduled quality reviews of programmes' assessment plans, providing feedback on how to improve the definition of learning research goals or outcomes, how to strengthen planned measurements, such as using more concise learning rubrics, and how to more clearly present data that shows student performance on course assignments.

These online conversations among programme instructors and review committee members about assessment planning are accessible to the university community and accrediting bodies. The university's enhancement system also encourages programmes to upload files holding assessment instruments, such as learning rubrics, student projects, internship forms and student satisfaction surveys so that they are accessible by the university community. The online conversations, learning research instruments and best practices that peer reviewers identify are evidence patterns that accrediting or regulatory bodies seek as proof of instructors' engagement in learning research and resource sharing. They demonstrate the institution's capacity to sustain its continuous improvement during the years to come.

Information sharing is a key strategy for encouraging quality enhancements in programme planning and evaluation. Engineering educators view and use the PRISM learning research resources to avoid having to re-invent the wheel. The best of 169 academic programmes is at their disposal. For example, when engineering programmes are deciding how to assess the communication outcomes for their students, outcome rubrics developed by speech and composition instructors can be easily found on the PRISM web site. In a broader sense, CSU instructors can also view the best practices in assessment underway at two other universities that are using the PRISM system. Each of the three institutions benefit from the synergies that develop from the multiple peer review activities, resource development and information sharing, including the programme improvements developed.

ABET requires that programmes provide a schematic drawing of their assessment process with a time line that reflects systematic processes. CSU provides this with a concept model illustrating the institution's eleven part comprehensive system and a time line revealing an annual process cycle. Figure 1 describes the comprehensive design, while Figure 2 defines a focused role for faculty that drives the knowledge generation needed for CSU's continuous improvement process. CSU's planning process uses the annual, short-term, localized learning research of an engineering programme to support the longer term strategic planning efforts that emerge from programme review and ABET and regional accreditation. The model emphasizes how departmental instructors and the central administration both benefit from this systematic collaboration.

Compliance with standards is a characteristic of quality. Operating from an internally developed evaluation rubric defining a set of quality standards, a centralized university peer review committee external to the college of engineering makes sure that engineering sustains well-developed planning standards that apply to the most demanding evaluative criteria expected by the multiple review entities. For example, while ABET requires some direct learning assessment, the CSU committee asks that nearly all learning outcomes use direct assessment. In addition, the CSU process requires student learning at the graduate level, not an ABET requirement, but a regional accrediting standard. Furthermore, university evaluation standards require programmes develop diagnostic plans that identify strengths and weaknesses in programme performance, an outcome of all ABET evaluation teams.

Systematic peer review sustains programme compliance to standards. For example, ABET now requires engineering educators to provide summaries of their assessment

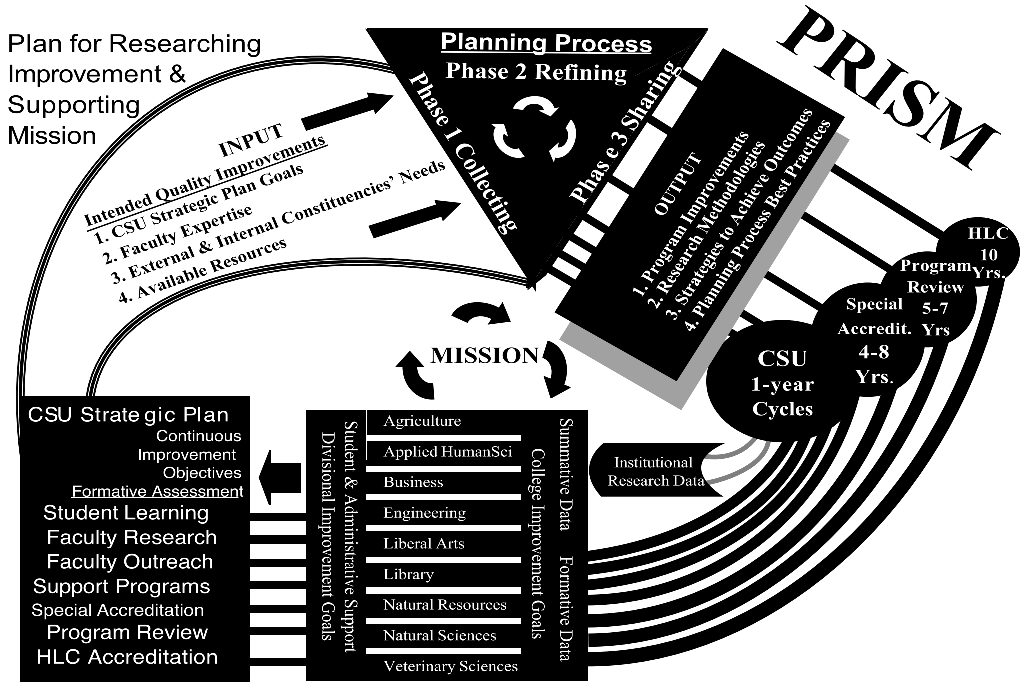

FIGURE 1. Concept model for a quality enhancement system

results, not data dumps—long presentations of research results that lack explanatory discussions. The peer review committee annually reminds out of compliance programmes to provide these summaries and informs them on ways to improve their data presentations.

When engineering instructors need assistance in developing learning research or researching into the impact of their outreach services, they can call upon resources or expert staff centrally, without maintaining this expertise within their own department. For example, if instructors need a comparative assessment model to research the comparability of student learning on distance education courses and on-campus courses, the university's PRISM site provides online results of a grant project that produced this information.

In addition, PRISM uses an online database to track and monitor engineering programme assessment activity levels, ensuring that they all produce assessment results that lead to improvements according to a consistent time line: a characteristic of a systematic process. The comprehensiveness of the system is also a motivating factor in developing an improvement culture. Monitoring helps all colleges remain on similar process tracks. Why should engineering faculty devote valuable research time to learning assessment if the non-engineering instructors in other colleges on campus are not doing it? This structural stimulation of culture development further reinforces the quality enhancing capacity of this comprehensive system.

An annual university-wide assessment report presents assessment profiles for engineering departments and indicates if a unit is not generating improvements or if its learning research is weak or superficial. Departments can use the reporting resource to compare their assessment activity levels and research effectiveness to other university departments, another feature of quality enhancement provided by the central system.

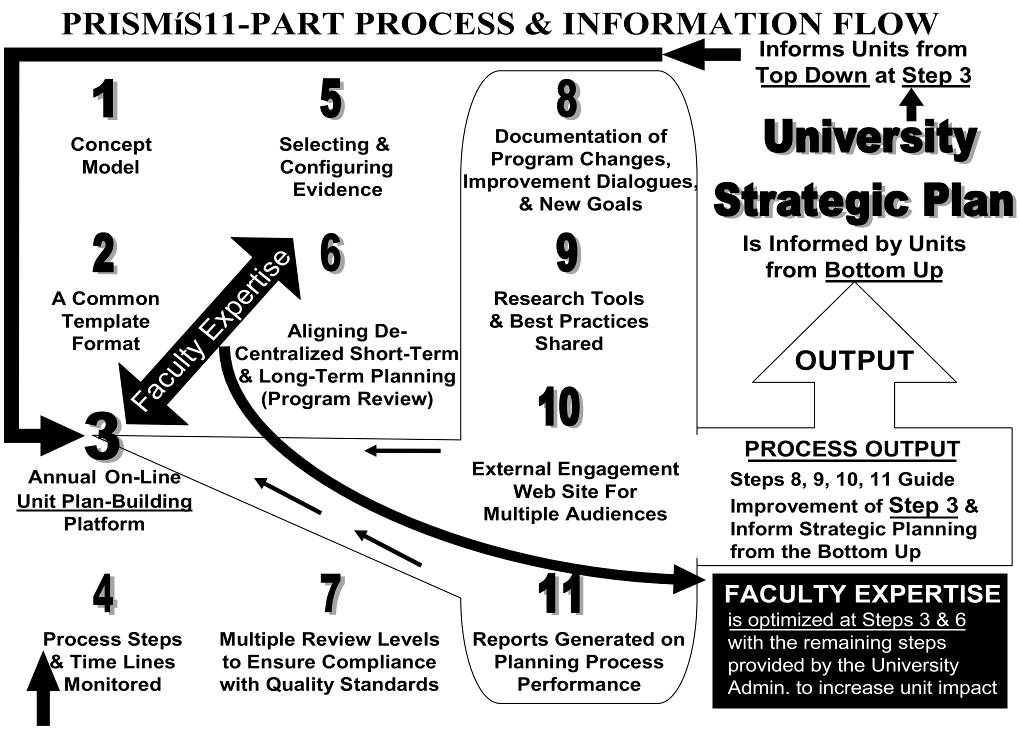

FIGURE 2. Process description of the CSU quality enhancement system

Sharing learning research or assessment information with parents, students, faculty, administrators and external review entities is a centralized university service that releases engineering educators from this obligation. They can refer students to the site to view the programme's student learning outcomes that are being researched or refer employers to the site to view student internship performance results. This presentation web site becomes a pattern of evidence that satisfies accreditation site teams in their role of ensuring university engagement with constituents and satisfies the state legislature in its role of providing university performance information to education consumers.

Maintenance of the online database and resources is also done centrally. Instructors are not expected to resolve day-to-day problems that emerge or to develop technology upgrades to the system for continuous improvement. In addition, the ongoing peer review serves as a continuous workshop for improving assessment practices, reducing department work on faculty development in this area, which is another regional accrediting requirement.

Linking programme planning to the institutional mission and strategic priorities is a common quality standard among the evaluative entities in the USA. The university holds a higher quality standard for integrated planning than do the special or regional accrediting bodies. In fact, CSU's programme review guidelines require programmes to use their annual PRISM formative assessment information as part of their programme review self-study data presentation. For sharing of long-term planning, the PRISM system provides access for instructional faculty to view all programme review action plans and departmental self-study reports. Many annual assessment plans directly relate to the longer cycle goals of action plans, researching progress continuously on instruction, discipline-based research and community outreach. Engineering educators use their annual assessment process to generate information for their university programme review and ABET evaluations. In other words, work done once is used many times through the information dynamics of a centralized assessment infrastructure.

PRISM's Contextual Position Within Higher Education Quality Management Practices

While other online interactive continuous improvement systems may be operational in the USA, it is unknown if any approach the comprehensiveness of PRISM, integrating annual planning, programme review and strategic planning, while reaching 169 academic programmes in eight colleges. Georgia Institute of Technology's Online Assessment Tracking System (OATS) has similar annual online assessment planning features that consider compliance with ABET and its regional accrediting body; however, its focus is on annual assessment planning, tracking and reporting and does not incorporate many of the 11 operating components of PRISM.

On the evaluative side, the concept of using comprehensive quality management systems on university campuses is encouraged by some regional accreditation bodies. The Academic Quality Improvement Programme (AQIP) model developed by the Higher Learning Commission serves as an alternative to the standard compliance model for quality assurance. Additionally, the US National Institute of Standards and Technology administers the Malcolm Baldrige National Quality Award, which recognizes higher education institutions that use these kinds of quality enhancing systems to generate and report improvements in education.

PRISM borrows from several quality management concepts, but it does so selectively. Considering John Heywood's defining characteristics of total quality management (TQM), the PRISM process does not include quality assurance measures, quality audits, value-added performance levels or quality assessment by external consultants. To some extent PRISM does use quality controls with respect to its internal peer review process, which expects programmes to use university planning and evaluation standards to guide their process activity. Heywood (2000) Seymour (1993) and Lewis (Lewis & Smith, 1994) translated Deming's quality principles to the higher education environment. While PRISM grasps the two principles of continuous improvement and teamwork, it does not emphasize other Deming principles, such as customer satisfaction, fear reduction or leadership. PRISM does place an emphasis on measuring process, which is one of the four conceptual accents of TQM that Bogue identified: for example, 'An accent on process analysis and performance measurement' (Bogue & Hall, 2003, p. 168).

From the literature on organizational learning the four characteristics provided by Preskill and Torres best match PRISM's components: (1) evaluative inquiry is integrated into the organization's work processes and is preformed primarily by organization members, not handed to external consultants; (2) evaluative inquiry for organizational learning and change is ongoing, not episodic; (3) it strongly relies on the democratic processes of asking questions and exploring values and assumptions through dialogue and reflection; (4) evaluative inquiry contributes to a culture of inquiry and occurs within an infrastructure that values continuous improvement and learning (Preskill & Torres, 1999). Agreeing with Tierney (1999), PRISM focuses on process measures that are determined internally, not for external audiences, as a way to nurture curiosity and self-interest among instructors at the department level. Organizational productivity develops from formative evaluations using 'constant analysis, continual reassessment and constancy of purpose' (Tierney, 1999).

Further supporting a process-oriented approach to student learning assessment is Sessa and London's (2006, p. 211) discussion on the evolutionary aspects of organizational learning. When programmes evaluate the effectiveness of an instructional improvement they 'should focus on what elements of the process work well, not just whether the intervention overall achieved the intended goal'.

PRISM also falls into the knowledge management paradigm described by Petrides and Nguyen (2006). Their illustration of a data–information–knowledge–action cycle resembles the dynamics of PRISM, whereby its planning processes collect data, the instructors evaluate them for information purposes, a knowledge reservoir develops in the department, resulting in shared learning, and action is taken in the form of improvements based on knowledge.

However, despite the emphasis on quality management in the business world, respected observers, such as ex-Harvard University president Derek Bok, have noted little progress among higher education institutions in moving systematically toward adopting comprehensive improvement systems for educational quality. Bok (2006, p. 316) recently wrote:

> Most successful organisations today, regardless of the work they do, are trying hard to become effective 'learning organisations' that engage in an ongoing process of improvement by constantly evaluating their performance, identifying problems, trying various remedies, measuring their success, discarding those that do not work, and incorporating those that do. In theory, universities should be leaders in such efforts, since they have pioneered developing methods for evaluating other institutions in the society. In fact, however, they leave a lot to be desired when it comes to working systematically to improve their own performance.

Implementation at the Programme Level: Perspective of an engineering faculty member

A significant time commitment is necessary to get instructional faculty and departments ready to implement an assessment programme as comprehensive as PRISM. At first it appears complex and, in the words of instructors, unnecessary. As pointed out by Knight (2000), faculty life is becoming more intensified as workloads increase, while assessment of student learning remains low on the rewards scale. He also pointed out that instructors are not always the best people to implement assessment programmes.

Therefore, several developments must occur at a university before instructors will embrace and engage with the assessment process. First, engineering educators must be convinced that it is valuable. Instructors place a high value on student learning and effective curriculum design based on systematic evidence, so the use of assessment data to improve student learning should bring action to this value. Second, as mentioned by Knight, the demands on educators' time is immense. A quality enhancement system that can automate procedures and provide resources that facilitate the development of assessment plans will be helpful in getting educators engaged in research on student learning Third, academic culture includes regular peer review of their work. If this same type of review is used for assessment its credibility will be strengthened. Finally, instructors are suspicious of new activities that appear to be passing fads, disappearing as soon as the current administration changes. Therefore, the goal of the Higher Learning Commission to have improvement in student learning be continuous and become part of the university culture is critical. Instructional faculty will not fully embrace assessment until they know that it will always be valued. Recent revision of the university programme review guidelines to incorporate annual learning research gives the process greater validity and sustainability.

The PRISM model is one approach to addressing the above issues. To see how the model works at the programme level and facilitates instructors' involvement, an example assessment plan for CSU's engineering science programme is presented. The College of Engineering at CSU comprises five departments that award seven undergraduate degrees. Each degree programme develops an assessment plan to research student learning. During the autumn 2004 semester enrolment included 1515 undergraduate students and 579 graduate students.

Example Implementation

The sequence of events for assessment using PRISM for the engineering science programme is based on the academic year. Each autumn semester starts with a revised assessment plan and a report of the previous year's data results. After a department has submitted the revised plan, a university-wide peer review subcommittee (the university's director of assessment, one member from the engineering college and one from another college) evaluates it and provides comments to the department. Then the departments must respond to those comments and revise the plan as necessary. At this stage the plan is accepted for implementation. During each semester data is collected according to the plan guidelines and stored in the online database. The peer review committee also reviews the programme's presentation of data results and resulting programme improvements, again providing comments. Departments respond to these committee comments as well and make the requested adjustments to data collection or data presentation. This process is then repeated each year.

Initial implementation of the PRISM system required each engineering programme to develop at least three learning outcomes for use in the university-wide database. Engineering departments decided to use student learning outcomes related to those specified by ABET. For the engineering science programme, student outcome 1 in the PRISM model addresses ABET outcome (c), an ability to design a system, component or process to meet the desired needs. The PRISM system requires a statement of the outcome to be assessed. For engineering science the outcome chosen was a restatement of the ABET outcome to demonstrate its close relationship with the ABET process. Unfortunately, a simple restating of the ABET outcome does not meet ABET guidelines nor CSU quality standards for outcome definition as it does not, for example, provide the more detailed measurable learning characteristics. Therefore, the programme added a second statement to elaborate what the students should learn and to better communicate to students what the programme's learning expectations are. Details of these elaborations can be found in Figure 3.

The next planning component after the outcome states the strategy used to accomplish this educational outcome. One indicator of programme improvement will be modifications made in the curricular or pedagogical strategies used to affect student learning outcomes. This feature enables the programme to show the evolution of curricular strategies and the assessment results that supported their development.

Next, the assessment method is defined. For this outcome final student design reports are evaluated by either faculty or alumni reviewers who are not associated with course design. This allows a low stakes assessment (Knight, 2000). Having the review performed by individuals outside the grading hierarchy provides greater independence and a programme level perspective of learning outcomes and curricular intent.

The final component required in PRISM is the expected performance level for measuring the programme's expectations of student learning performance. This is a critical step where

Outcome 1
Student Learning/Development

Description & Methodology

Outcome
All engineering seniors will have an ability to design a system, component, or process to meet desired needs. (ABET 3c)

Students are expected to show proficiency in critical design methodology and process elements, including: problem definition, scope, analysis, risk assessment, creativity, synthesising alternatives, iteration, regulations, codes, safety, sustainability, and multiple objectives and various perspectives.

Process Used to Develop the Outcome Performance (Strategy)
The engineering science curricula include a series of courses that focus on design projects. This starts with the first year courses and culminated in a two course senior design sequence. The senior design experiences are structured to be fairly comprehensive, and require teams of students to work together to complete the design assignments.

Assessment Method(s)
All engineering students are required to participate in a capstone design project that synthesises their engineering knowledge. The projects are documented through a series of reports including, project proposals, oral presentations, and final project reports. Faculty members serve as mentors for these projects. The design project work will be evaluated by engineers separate from the design mentors -typically the Engineering Science Faculty Committee and/or external advisory board members. Due to the small number of students in this program, all senior reports will be collected. Each of these reports will be evaluated for matching of the design solutions with the design requirements. Additionally, the reports will be evaluated for the demonstration of the elements of design identified in the above outcome description. The results of these reviews will be made available to the department faculty, and external advisory boards for comment. Note: These reports are generated during the spring semester so results will be available after the Spring 2005 semester.

Expected Performance Level
The goal is for ninety percent of the design objectives to be met by both the proposed and final design solutions in student senior design projects.

Additionally, it is expected that the design projects will demonstration a majority of the design elements listed in the outcome above. It is unrealistic to expect every project to cover every design element but a majority of these items need to be present. Each project will be ranked on a scale of High, medium, and low for the demonstration of these design elements: problem definition, scope, analysis, risk assessment, creativity, synthesising alternatives, iteration, regulations, codes, safety, sustainability, and multiple objectives and various perspectives. If any element is consistently ranked low across the projects, curricular modifications will be implemented.

Comment 1 Feb 17, 2005 12:42 PM	Outcome: Define the learning characteristics of effective design so that students can recognise the learning they are to develop. This will also provide the programme with multiple aspects to measure for determining strengths and weaknesses. Make the outcome more student active and measurable with statements, such as "students will demonstrate design learning characteristics A, B, C, and D in a defined learning demonstration" rather than "seniors will have an ability to design."
Response to Comment 1 Mar 29, 2005 10:41 AM	The outcome has been expanded to include typical design elements that should be part of the student learning experience.

Comment 2 Feb 17, 2005 12:49 PM	Criterion: Please expand the performance expectation (90%) to include each of the design learning characteristics that will be listed in the outcome so that reported results will indicate a range of scores showing strengths and weaknesses.
Response to Comment 2 Mar 29, 2005 10:47 AM by SILLER, THOMAS J	This has been added to the criterion in the plan
Results & Planning	
Data Summary & Evaluation	
Programme Improvements	
Symposium VII Group *Student Self Assessment* Symposium VII Individual *Student Self Assessment*	
Best Practice 2/17/2005 12:57 PM	Plan Component *Assessment Method: Student Learning* Outcome 2 Best Practice Student involvement-- results During the senior design projects, all students are required to make oral presentations. These presentations may be to the class, design teams, clients, etc. A group of faculty separate from the design mentors -typically the Engineering Science Faculty Committee, will observe these student presentations. The presentations will be graded on a rubric classifying the presentation into the categories of excellent, proficient, adequate, and inadequate. This rubric will be given to the students before the presentation. A sample of student presentations representing at least fifty percent of the number of students in the class will be collected. The results of these reviews will be made available to the students, department faculty, and external advisory boards for comment. When appropriate, external reviewers from industry will also be asked to help in the review process.
Best Practice 4/6/2005	Plan Component *Assessment Method: Student Learning* Outcome 1 Best Practice External advisory persons used All engineering students are required to participate in a capstone design project that synthesises their engineering knowledge. The projects are documented through a series of reports including, project proposals, oral presentations, and final project reports. Faculty members serve as mentors for these projects. The design project work will be evaluated by engineers separate from the design mentors -typically the Engineering Science Faculty Committee and/or external advisory board members. Due to the small number of students in this program, all senior reports will be collected. Each of these reports will be evaluated for matching of the design solutions with the design requirements. Additionally, the reports will be evaluated for the demonstration of the elements of design identified in the above outcome description. The results of these reviews will be made available to the department faculty, and external advisory boards for comment. Note: These reports are generated during the spring semester so results will be available after the Spring 2005 semester.

FIGURE 3. Engineering science programme assessment plan

the programme must define the meaning of success for each student learning outcome. Again, based on feedback from the review committee, this criterion planning component has evolved. The criterion has been modified to include performance levels for each for the components of the defined design performance. Details of this set of changes are also available in Figure 3.

Finally, the learning research results from the assessment are entered into the database, followed by a section for programme improvements generated by faculty evaluation of the data in this particular assessment component. This storage of improvements provides the information required by ABET to track the quality improvement cycle based on assessment data collection and analysis.

Successes in Implementing PRISM

The PRISM model described above has accomplished the goal of integrating the many assessment demands placed on engineering faculty. Bakos (1996) noted that the goal of programme improvement is more likely to occur when assessment is 'part of a larger set of conditions that promote change'. CSU's integrated system positions assessment in the larger context of programme improvement university wide. Details of this integration and instructor involvement are presented in Table 2. PRISM responds to multiple quality monitoring groups using common assessment instruments and requirements that do not lead to duplication of faculty effort.

Successful organizational change is also more effective when it is owned by people, not a technological system (Spencer-Matthews, 2001). Although the PRISM system depends on technology to enhance sharing and review, the real impact comes from the ability of instructors to own the assessment at the course and curriculum level. This encourages instructor buy-in to these activities. Welsh and Metcalf (2003) pointed to three best practices to get buy-in: (1) instructors are more interested in activities that are clearly motivated by the desire to improve programmes, not accountability; (2) instructors want to be personally involved; (3) instructors prefer activities that have an outcomes perspective on quality. PRISM is based on a model of tracking programme improvements that are directly related to outcomes defined by instructors. In effect, PRISM addresses each of these three best practices.

Another important advantage of this integrative approach is its annual process. When accreditation reviews are scheduled at 6–10 year intervals programmes tend to decrease their assessment activity until the review approaches, when a sudden increase in assessment activity reoccurs. The CSU system is based on a regular ongoing cycle resulting in more effective and meaningful assessment (Bailey *et al*., 2002).

Since the recent implementation of PRISM at CSU several success benchmarks can be identified. For example, the PRISM process has achieved portability, with it being used by the University of Nebraska at Lincoln, CSU Pueblo and the Great Plains Interactive Distance Education Alliance, a consortium of midwestern state universities. PRISM's internal annual process reports show that for the 2003–2004 archived year 2517 instructor dialogues occurred, 768 learning outcomes were defined and researched, 534 student demonstrations of learning were evaluated and 352 programme improvements were implemented. Process indicators have been developed, and they demonstrate each department's planning and evaluation activity levels, for example the range and depth of learning research. A parallel evaluation process for programme review was developed to strengthen system sustainability, which is often threatened after accreditation reviews are over. Finally, the content of

TABLE 2. Matrix aligning criteria for accreditation, accountability and programme review with corresponding evidence patterns

HLC criteria: Higher Learning Commission criteria & examples of evidence	ABET criteria: Accreditation Board for Engineering Technology criteria and guidelines for reviewers	CSU Programme Review criteria: Institution-specific State accountability Market forces	PRISM evidence: central university production of evidence types & patterns	Faculty effort for engineering
9) Examples of evidence Assessment includes multiple direct and indirect measures of learning. 3a	Criterion 1 Institution must evaluate student performance … Guidelines: assessment process uses direct assessment measures that provide 'convincing' evidence	Requirement to summarize annual assessment outcomes development whereby the PRISM system requires that two-thirds of outcomes use direct assessment	PRISM: characteristics of planning report, demonstrations of learning classification shows types of direct assessment and volume by department plus the frequency of direct measurement by departments LIVE LINKS FOR REVIEW SITE TEAMS	Programme must maintain an annual assessment plan
10) Assessment results of student learning are available to appropriate constituencies, including students. 3a		State CCHE: state should provide meaningful and user-friendly information on the quality of undergraduate education to consumers about each institution that will drive market decisions by parents, students, and employer	Web site: 'Planning for Improvement and Change' Student, parent, and employer access to outcomes, demonstrations of learning, and improvements	None
11) Faculty are involved in defining the learning outcomes and their evaluation. 3a	Criterion 5: faculty Faculty … must demonstrate sufficient authority to develop and implement processes for the evaluation, assessment, and continuing improvement of the programme and outcomes Guidelines: encourages faculty participation in the evaluation and improvement of outcomes —faculty non-involvement in the assessment process or decision-making is generally unacceptable	Unit summary of planning activity: requires description of the department's planning processes with emphasis on how effectively faculty participation is realized (impact and correlation measures that relate individual faculty goals to each programme objective), and other characteristics the department identifies	PRISM archive of plans showin g dialogues between peer review faculty and programme faculty PRISM archive of plans showing cover page— administration and responsibility of who does assessment PRISM planning characteristics report: number of comments and responses shows volume of faculty dialogue Programme review data on participation	Programme must maintain an annual assessment plan

assessment plans—student learning demonstrations, results and improvements—is readily available and transparent to faculty, students and employers.

PRISM's design attempts to reduce the negative impact of higher education's structural impediments that frustrate organizational learning and systematic improvement. It counters the frequent administrative turnover in departments with planning and critical dialogues that are stored and accessible to preserve community memory. The annual time lines, the constant monitoring and the regular peer review and reporting reduce the impact of the episodic nature of accreditation and programme review, which robs departments of consistent evaluative expertise. Its decentralized flexibility of content design favours the entrepreneurial and innovative aspects of academic departments. Still, problems with complete usage persist and some faculty resistance to the systematic process endures.

Challenges and Barriers to Implementation

One difficulty associated with the above process is the development or articulation of the learning outcome (Knight, 2000). To provide evidence that satisfied both the HLC and ABET standards all of the engineering programmes chose to use ABET criteria 'c' (an ability to design a system, component or process to meet desired needs) without any modification. Engineering educators mistakenly assumed that this general statement kept the connection between the HLC and ABET requirements explicit. However, the more difficult task, as highlighted by Knight, is the articulation of clear, unambiguous, criteria statements that define the outcome in concrete terms. The first round of university committee peer review identified the engineering planning weakness by asking for more clearly stated student learning outcomes and a better description of the programme improvement decision-making processes. Although the PRISM system explicitly tracks the use of assessment data in a quality improvement cycle, and Table 3 shows the modifications made by engineering science, these types of modifications have not been fully implemented for all engineering programmes.

Initially one difficulty faced by engineering was shifting from the previous use of indirect measures of student learning to the requirement to make direct measures. This shift, supported by both the HLC and ABET, has not been fully embraced by the College of Engineering. The College of Engineering also lacked support from its previous dean, who considered research on student learning to be a waste of time and a threat to the instructional faculty's creativity. During a large committee meeting that included the university assessment director and college department heads the dean expressed the view that assessment never leads to real programme improvement and stifles innovation. This made it more difficult to garner the support of the department heads in implementing the new assessment programme. Subsequent leadership has been supportive of the efforts.

The PRISM model also requires assessment of graduate programmes and the research activities of the department. Both of these have traditionally not been so directly and explicitly monitored. Engineering educators' resistance to these components of PRISM has been substantial. The quality control of graduate and research programmes has been more closely guarded from external observation. Although peer review committee members consistently remind the department to improve its planning research for these areas, time will tell how well departments integrate into this feature of the centralized assessment process.

In addition to these specific implementation difficulties, there has been resistance on the part of engineering programmes to fully embrace the continuous improvement requirements of the new ABET standards. Shifting from an input-focused approach, i.e. students and curriculum, to an outcomes-focused approach has been difficult. Engineering educators must first accept this new philosophy of quality improvement being demanded by accrediting agencies and external constituents before they will fully accept a system as comprehensive as PRISM. The value of quality enhancement systems can only be realized when engineering educators embrace continuous quality improvement as a natural component of the education enterprise.

Fortunately, recent research is beginning to show the value of these types of quality improvement systems to the improvement of engineering education (Prados *et al.*, 2005). Similar issues are also now developing in Europe as engineering education organizations are attempting to develop information handling systems for quality improvement that allow access to data by external reviewers and recognize the differences between national educational approaches (Gola, 2005) A working group, the E4 Working Group on 'Quality Assurance in Engineering Education on a National and European Scale', is working to define an acceptable system for engineering education. This group has already identified four key components: (1) requirements and objectives, (2) teaching and learning, (3) learning resources and (4) monitoring, analysis and review. Clearly, the move towards continuous quality improvement is an international endeavour.

Summary and Conclusions

Assessment of student learning is a critical component of successful educational programmes. Developing and maintaining assessment programmes can require significant effort. While the centralized PRISM model eases the demands placed on engineering educators to respond to both ABET accreditation and other accreditation and programme review demands, it also places more decentralized responsibility on the faculty—to learn about themselves and act on what they learn (Wergin, 2003). Recent changes in regional and ABET accreditation standards place more emphasis on outcomes instead of inputs and on stronger evaluative review of engineering departments' assessment processes and systems for continuous programme improvement.

This article offers one approach for engineering departments that simultaneously makes student learning research more meaningful for instructors while farming out to the central administration those jobs it does not have time to do, for example maintaining databases, organizing regular external reviews, developing online multiple information interfaces for accrediting bodies and external constituents, forming structural and visible evidence of continuous improvement, keeping up with the ever-changing accrediting and accountability standards, generating annual reports on assessment and programme improvement output and organizing quality performance research so that it automatically feeds into the long cycle programme review process. An engineering programme is better able to ensure the ownership, development, research, and integrity of its own curriculum if it has a centralized university improvement system that presents unit level quality enhancement research to external market and accountability groups.

Why should the central administration be so generous? The learning research and improvement information that the engineering faculty produce becomes an asset to the university. The university needs to show its state coordinating board and regional accrediting body that it is doing quality learning research and implementing meaningful improvements based on the research. This cannot be completed without some dedication by the instructional faculty. In another way, too, this information is an asset to the university. The best practices that the engineering educators generate pull up the other colleges and their programmes as they seek better ways to do learning research and improve instruction. Centralizing features of quality enhancement does not abdicate faculty responsibility to satisfy external quality monitoring criteria. Instead, it actually raises the integrity of the programme improvement content, which is a central component of external review entities.

By using a university sponsored, web-based system, along with a required university-wide review committee, the assessment process has become more transparent to a larger group of constituents. Now the programmes can receive feedback on the collected data from a larger group of observers. The increased feedback will lead to more frequent and sustained programme improvements. Potential employers can view engineering assessment planning information online and learn how well students are performing, how much the programmes care about learning via their research, how meaningful the internships or design projects are with respect to workplace needs and if people like themselves are being used in the assessment process.

Many of the difficulties of operating a comprehensive improvement process, especially the conflict that can develop over shared responsibilities, is reduced by the federal structure of PRISM. The administration stays out of departments' business of defining academic quality, of investigating external academic environments, of setting performance levels and determining assessment planning. On the other hand, departments then accept the administration's handling of their data, respond positively to university peer review feedback, follow the prescribed time lines and use a common planning and evaluation process. Conflict is further reduced because the central system's performance measures focus on organizational process indicators, not unit outcome or value-added expectations. Rather than quality assurance, the centralized annual reporting demonstrates how well academic departments practice learning research, how much they learn and self-reflect and how actively they are improving or enhancing quality. The assumption is that good processes will generate good outcomes.

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