Involving Industry in the Assessment Process: Preliminary Findings

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Abstract *- Industry is an important partner and stakeholder in engineering education. Input and feedback from various stakeholders, such as industry, has become an important ingredient for effective assessment and continuous improvement programs. Universities are challenged to find ways to solicit and integrate industrial input throughout the assessment process, from planning to the evaluation of results. The NSF sponsored Coalitions for Engineering Education (Academy, Ecsel, Foundation, Gateway, Greenfield, SUCCEED, and Synthesis) have engaged industry both at the coalition and institutional level. This paper will describe the preliminary results from 15 of the coalition schools, which is part of a larger study of the levels of industry and faculty involvement in planning and implementing assessment in coalition schools.*

I. Introduction

The assessment of student learning outcomes has emerged as a primary focus for higher education institutions in today's competitive environment. As a result, input and feedback from various stakeholders is becoming a crucial ingredient for effective assessment and continuous improvement programs. Involving stakeholders in the assessment process is critical for several reasons. First, it insures that what is being assessed is valued by the campus community and its larger community, i.e., employers, boards of regents, trustees, graduate schools, state legislatures, and parents [1, 2]. Second, stakeholder participation strengthens accountability by creating a shared understanding of the language of assessment, assessment results, and interpretation of those results [3, 4]. And last, it addresses the particular needs of engineering colleges and programs who have been mandated by their accreditation board (ABET) to incorporate industry into their assessment and continuous improvement efforts [5].

This mandate is yet another task for engineering faculty and administrators to address on top of the ever-growing challenges they face in developing, implementing, and evaluating new curricula. It comes with few, if any recommendations for how best to integrate industry into the assessment process. In an attempt to fill this void, we will examine the practices of engineering colleges and schools. This study attempts to answer these questions: What is the status of engineering colleges and programs in developing processes for integrating industry into their assessment programs? In what ways do campuses solicit and integrate industrial input in the assessment process? Evaluation experts recommend integrating stakeholders in all aspects of the process, from its planning to the evaluation of final results [6, 7]. How then is industry, arguably one of the most important partners and stakeholders in engineering education, being integrated into the process? The answers to these questions are critical. Only by effective academy-industry integration will faculty develop curricula and assess learning outcomes related to the needs of industry, faculty, and students.

The purpose of this paper is to identify, describe, and examine practices for involving industry in assessment processes implemented by institutions, supported by the NSF Engineering Education Coalitions Program (Ecsel, Foundation, Gateway, SUCCEED, and Synthesis). Approximately sixty coalition schools were selected for their cross-the-board emphasis on assessment and program evaluation. For this paper we have examined a sub sample of these schools. We felt that the added emphasis placed on assessment by these schools would provide a data-rich sample for educators to learn and expand upon. The various coalitions have engaged industry both at the coalition and institutional level. Exemplars of how individual campuses and faculty have partnered with industry to support the development and implementation of comprehensive assessment programs will be discussed.

II. The Study

The goal of this research is to identify best practices engaged in by the colleges and universities who are participating in educational reform efforts, partially supported by the NSF Engineering Education Coalitions program. Our preliminary sample (N = 15) represents the entire spectrum of engineering colleges from large, public research institutions to small, private teaching institutions.

In order to identify and gauge the involvement of industry for each individual college or university, a campus representative was interviewed by telephone. The position of interview respondents varied from assessment coordinators to associate deans. To date, 15 interviews have been conducted.

We asked campus representatives to describe how industry stakeholders were involved in planning for assessment. Assessment planning and processes were categorized into the following areas: defining student learning outcomes and program objectives, selection and development of assessment tools and processes, and the use of assessment results. We also asked interviewees to describe industry's role in assessing/evaluating student performance (in and outside of the classroom), evaluating academic programs and curriculum, and finally evaluating the assessment program it-

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self. Within this framework, we identified four types of industry participants: industrial advisory boards, employers, industrial recruiters and Co-op supervisors. Because there were so few responses regarding employers and recruiters, we collapsed them into the "industrial advisors" category. The level of involvement was measured by estimating the number of meetings industrial representatives, faculty, and administrators attended to work on assessment. This measure, while a somewhat crude measure – it cannot for example tell us about correspondence outside the meeting or the quality of their participation, - does tell us something about commitment. For example, industrial representatives who attend a meeting once a month are far more involved than those who attend one meeting a year.

For the campuses we interviewed, engineering administrators, usually the associate dean responsible for overseeing ABET-related activities, most often direct the assessment process. Faculty are also intimately involved in planning for assessment and collecting data. However, their involvement is typically limited to assessment activities within their own academic department. Most campuses have a faculty and administrative team to direct the ABET process (assessment and collection of data regarding the ABET student learning outcomes are activities usually seen as synonymous at these campuses). Since the ABET self-study process focuses on the individual programs it fosters a highly de-centralized approach. As a result, these teams are frequently the only means to link the activities of individual departments with college-wide activities.

III. Industry's Role in Assessment Planning Activities

In order to ascertain how industry is involved in assessment activities at these campuses, we asked respondents to describe involvement in the following assessment activities: 1) Defining student learning outcomes; 2) Defining program objectives; 3) Selecting and developing assessment tools; 4) Using assessment results for academic decisions; 5) Assessing student abilities in the classroom; 6) Assessing student performance outside the classroom; 7) Evaluating academic programs and curricula; and 8) Evaluating the assessment program.

For each assessment activity, interviewees discussed which industrial representatives are involved and to what degree. Opened-questions were structured to solicit detailed information about the process of involvement as well as the benefits and challenges of industrial participation.

A. Defining Student Learning Outcomes

Learning outcomes specify what knowledge and skills a student must demonstrate in order for an academic program or course to meet its educational objectives. The process of defining student learning outcomes, program goals, and course objectives drives the entire assessment process [7,8]. Without clearly defined student learning outcomes, assessment activities will be of little value. Learning outcomes, just as program goals and objectives, should reflect the values of the department's stakeholders. Therefore, it is important to involve the critical stakeholders in this process.

Table 1 Stakeholder Involvement in Defining Student Learning Outcomes (N = 15)

Stakeholder	# of schools	Level of Involvement* min.	moderate	intense
Engineering faculty	15		9	6
Administrators (Deans, dept. chairs, program heads)	14	1	11	2
Industrial advisors **	11	4	6	2
Co-op supervisors				

*Minimal: attends a meeting 1 – 2 times/year, Moderate: attends a meeting 1 – 2 times/term, Intense: attends a meeting 6 – 8 times/year

** This category includes employers and industry recruiters.

As the preliminary results in Table 1 show, the majority of stakeholders involved in developing learning outcomes are engineering administrators and faculty. Industrial advisors play a moderate role. As previously mentioned, faculty usually take the lead in defining student learning outcomes. Definitions are often written by a small sub-committee of faculty that forwards its work to the larger faculty for approval. Industrial boards are also usually left out of the generative part of the definition stage. (There are exceptions such as Arizona State as described below.) Like the larger faculty, they are frequently asked only to react to a set of definitions. While these processes may be expedient in the short run, they do not encourage collaboration within or among the two groups.

In the long run, the two groups may develop a different set of priorities within the same set of learning outcomes. For example, academics may place a high value on technical writing, while industry may expect graduates to place more emphasis on oral presentations and public speaking. Thus each party has a different perspective on what communication skills graduates should possess. Collaboration between faculty and industry for assessment planning purposes is critical to avoiding such divergent perspectives of what is of value for our graduates. Several of our sample campuses have developed processes to encourage collaboration – these practices are briefly described below.

Selected Practices

Arizona State University's College of Engineering and Applied Sciences uses their industrial advisory board to help define student learning outcomes. Starting with the question: "What knowledge and skills do we want our graduates to demonstrate?" the board works through a detailed, affinity process to arrive at prioritized learning outcome statements. These statements subsequently are incorporated into various assessment processes. Iowa State University involved their college advisory board by inviting them to participate with faculty in a day long workshop to identify and put in priority learning outcomes valued by industry and the campus. The output of this workshop will be forward to departmental assessment committees.

Cooper Union actively uses their College-Level industrial advisory board to discuss and define student learning outcomes. Each meeting focuses on one or two learning outcomes such as communication and leadership skills. Industrial representatives are asked to describe skills and behaviors of successful practicing engineers. The resulting descriptions are incorporated in various assessment processes. NJIT and Cal Poly have both departmental and College-level industrial advisory boards. All boards interact with staff and faculty frequently throughout the year. Each department shares their academic plans with their local advisory members. The plans describe the major educational objectives, the strategies to achieve these objectives, the intended student learning outcomes, and assessment of said outcomes. Departmental advisory boards review these plans in detail, and provide input on the plan's major elements. At NJIT, all departmental advisory board members are surveyed as to the importance of certain student learning outcomes. This annual survey provides faculty with feedback as to required competence in both technical and professional areas.

B. Defining Program Objectives

Defining an academic program's objectives is often done in conjunction with defining student learning outcomes. Here, faculty take the leadership role, which is consistent with faculty governance of the curriculum. Table 2 Shows that faculty and administrators are moderately to intensely involved in defining program objectives. Five of the schools described how industrial advisory groups play a more limited role in defining program outcomes. As with student learning outcomes, most industrial participation is limited to one-time meetings where objectives are presented for input and feedback.

Table 2 Stakeholder Involvement in Defining Program Objectives

Stakeholder	# of schools	Level of Involvement min	moderate	intense
Engineering faculty	13	1	3	9
Administrators (Deans, dept. chairs, program heads)	8	1	5	2
Industrial advisors	6	3	2	1
Co-op supervisors				

Selected Practices

Several institutions have adopted an assessment planning process initially developed by the Gateway Coalition [9, 10]. The Gateway planning process is structured so that small teams of departmental faculty discuss and identify five major program objectives that the department plans to accomplish to support the Institution's and department's mission and accreditation criteria. Once the program objectives have been defined, participating faculty list specific strategies/actions required to accomplish these objectives. For each strategy stated, faculty identify and define what the program and student learning outcomes will be based on the stated action. These program outcomes will identify what student, department, or institutional changes are anticipated if the objectives are met. Finally, faculty review each objective, related strategies, and outcome(s), and list potential assessment methods that can be used to effectively measure whether or not the department has met its objectives. Additionally, the faculty identify how the assessment data will be used for future academic decisions.

Five schools are integrating their industrial advisory boards into the structured planning process described above. For example, NJIT has actively involved industrial partners, sending draft versions of their plans throughout the definitional process.

C. Selecting and Developing Assessment Tools

The results of our survey so far, beg a very important question: who is selecting and/or developing assessment tools? According to our results, only about a third of our engineering faculty and administrator respondents are involved at any level (see Table 3.) At this point of the data collection, there is no direct industrial involvement in the selection or development of tools. These results may reflect the strong role that assessment consultants and/or campus collaborators from institutional research or colleges of education play in selecting tools.

Table 3 Stakeholder Involvement in Defining and Selecting Assessment Tools

Stakeholder	# of schools	Level of Involvement min	moderate	intense
Engineering faculty	5		2	3
Administrators (Deans, dept. chairs, program heads)	4	2	2	
Industrial advisors				
Co-op supervisors				

Selected Practices

Some NSF Coalition-driven efforts have involved industry in the development of assessment tools for the classroom. For example, the scenario assignments that were developed in the Synthesis Coalition grew out of scenarios provided by members of their Mechatronics Industrial Advisory Board. Not only did these industry participants provide the scenarios; they assisted in developing the scoring rubrics, and helped test them by completing the scenarios in order to establish expert levels of responses.

Under NSF's Action Agenda, a cross-coalition team is developing a set of measurable attributes for each of the eleven (a-k) ABET learning outcomes using a framework based on accepted educational research [11]. As part of the definitional activities, an external team of subject matter experts is reviewing each learning outcome and its associated attributes. Domain experts are solicited from both academia and industry. For example, experts in educating and managing multidisciplinary teams review the attributes identified for learning outcome "d" – *an ability to function on multidisciplinary teams*. The objective is to present a comprehensive set of possible attributes based upon the collective experience of the researchers; a thorough literature review; detailed reviews with engineering faculty, and industry practitioners.

D. Using Assessment Results

The use of assessment results represents the final step in the assessment process as well as the beginning of the continuous improvement process. Since formal program assessment is relatively new on most campuses, few of our respondents have had the chance to complete the entire assessment cycle and to actually use the results. However, many have included in their plan how the results will be used, and who will be involved in using them. As the results in Table 4 show, most of the use will be internal: in other words, only faculty and administrators will interpret and evaluate the results.

Table 4 Stakeholder Involvement in Using Assessment Results

Stakeholder	# of schools	Level of Involvement min	moderate	intense
Engineering faculty	4	1	2	1
Administrators (Deans, dept. chairs, program heads)	5		2	3
Industrial advisors	2		1	1
Co-op supervisors				

Selected Practices

As part of their accreditation preparation, the University of South Carolina had each department establish a formal process designed to apply assessment data for continuous improvement. Generally, each department has defined the roles that all stakeholders will play through out the assessment process. This includes the department chair, the faculty, industrial advisory boards, and non-academic units. Each step of the process is clearly defined so assessment data can be tracked from collection, to analysis, to report dissemination, to the final decision. For each assessment method, a formal review process is defined in terms of who will review and when, as well as what types of decisions may be reached. In their accreditation plan, industrial program advisory boards will help examine assessment data. After their review, they will make a set of recommendations to the departmental chair. These recommendations will be fed back to the faculty for action – should it be needed.

IV. Industry's Role in Assessment and Evaluation Activities

E. Assessing Student Abilities in the Classroom

For the purposes of this paper, assessment in the classroom refers to assessment activities that may be, but are not necessarily a part of the grading process. While all engineering faculty are involved in grading, as Table 5 shows, few innovative practices, such as performance-based assessments, were described. Additionally, none of the schools indicated that student classroom performance was incorporated into formal program evaluation. Any faculty assessment outside of grading was done on an informal basis, and the results are not collected for any purpose outside of those for the individual instructor.

Our preliminary results indicate a growing interest in having industrial representatives participate in the assessment of student performance in the classroom. As project based courses become more prevalent in engineering education, opportunities for industrial representatives to observe and provide feedback to students will increase.

Table 5 Stakeholder Involvement in Assessing Student Performance in the Classroom

Stakeholder	# of schools	Level of Involvement min	moderate	intense
Engineering faculty	15		3	12
Administrators (Deans, dept. chairs, program heads)				
Industrial advisors	7	4	2	1
Co-op supervisors				

Selected Practices

A common practice found in several of our sample institutions is the use of industrial advisors to evaluate and provide students with feedback on design projects. The procedure for these assessments range from very informal to highly structured. The more structured protocols ask external advisors to rate students or student teams on a number of attributes required for successful design projects. Several instructors incorporate these formal ratings into the final project grades. At Stanford, industry advisors are integral players in problem based learning courses. Here, along with faculty, they work with students as coaches and advisors, providing informal and formal feedback.

F. Evaluating Student Performance outside the Classroom.

Evaluation of student performance outside of the classroom refers to examining students' abilities in more natural settings such as in internships, jobs, and student activities groups. These settings offer programs the opportunity for authentic assessment, meaning that the student is engaged in real world problem solving. These are opportunities to observe students apply what they have learned in the classroom setting. As Table 6 shows, there are several campuses involving industry in this aspect of assessment. Employer feedback was mainly collected through a survey process (a holdover from previous assessment efforts required by ABET) or in the case of Iowa State University, a direct response to a request for this sort of information by their Board of Regents.

Table 6 Stakeholder Involvement in Evaluating Student Performance Outside the Classroom

Stakeholder	# of schools	Level of Involvement min	moderate	intense
Engineering faculty	5	1	2	2
Administrators (Deans, dept. chairs, program heads)	3	1	2	
Industrial advisors	5	3	2	
Co-op supervisors	7	3	3	1

Selected Practices

Many campuses described efforts to directly involve Co-op or internship programs in assessment. Several reported that they were in the process of working with the program to collect results from Co-op student's self evaluations as well as evaluations of student performance by their supervisors. Drexel University has established a system that has supervisors rate students on their Co-op performance in several categories, including critical learning outcomes. Employers rate student performance in problem solving abilities, planning and organizing, application of design concepts and engineering tools, and communication skills.

G. Evaluation of Academic Programs and Curricula

Curriculum and academic program evaluation refers to the use of assessment and evaluation results in order to measure the success of the program in meeting its goals. Frequently, this evaluation is a part of the long term planning process for departments and colleges and differs from traditional curriculum review processes in that it is designed to meet the needs of the department rather than the institution. Often however, there is a large overlap between the two processes. Table 7 illustrates stakeholder involvement in curriculum review at the departmental level.

Table 7 Stakeholder Involvement in Evaluating Academic Programs and Curricula

Stakeholder	# of schools	Level of Involvement min	moderate	intense
Engineering faculty	8	3	4	1
Administrators (Deans, dept. chairs, program heads)	3		1	2
Industrial advisors	3	2	1	
Co-op supervisors				

Selected Practices

Columbia University has instituted an academic review process whose objective is to critically review a department's past performance as well as future plans. Faculty are intensively involved in the process. Overall responsibility for coordinating and monitoring the review process resides with an Academic Review Committee comprised of all academic department chairs, administrative directors and the Vice Dean, who serves as chair. Each department designates a small group of faculty and staff who are responsible for conducting and reporting on the self-study review of the department. This designated subcommittee ensures that all faculty and staff are actively involved in the review process.

An important element of the review process is that the subcommittee recommends and subsequently meets with an elite group of external reviewers (both industrial and academic leaders) who provide feedback from their expert perspective. Throughout the self-study period, faculty and staff are encouraged to meet with any other individuals who may provide value to the department's review.

H. Evaluating the Assessment Program

The data regarding the evaluation of the assessment program itself reflects once again, that the institutions responding to the survey have not been involved in this process long enough to face this issue. As we examined campus plans for taking on this task it seemed to fall into the faculty and administrative realm of responsibilities. As Table 8 clearly shows, industry is not involved in helping any campuses review and improve their assessment programs.

Table 8. Stakeholder Involvement in Evaluating the Assessment Program

Stakeholder	# of schools	Level of Involvement min	moderate	intense
Engineering faculty	5	3		2
Administrators (Deans, dept. chairs, program heads)	4	3	1	
Industrial advisors				
Co-op supervisors				

V. Conclusions

Although we have not completed our data collection, we can make some observations regarding the role of industrial stakeholders in campus assessment planning processes based on our current sample.

First, industry has been kept to the periphery of the planning process. While most campuses report that they have industry advisory boards, the role of these boards tend to be limited to reacting to pre-defined learning outcomes or program objectives. None of the campuses we interviewed involved industry in the development or selection of assessment tools. This seems a particular loss of expertise for many campuses, given industry's experience and expertise in personnel evaluation. Only one campus reported involving their industrial board in using assessment results for making recommendations or decisions.

It appears that some of industry's limited involvement in the assessment process is due to a lack of trust on the part of the faculty. Many faculty and administrators have the attitude that practitioners from industry do not understand what is required to educate an engineer. As one dean put it, there is a fear that employers will focus on vocational or employability needs, with no emphasis on theory or foundational principles. Others repeated this sense that industry should not become "over" involved in matters of the curriculum for the reasons stated above. On the other hand, when industry was involved as a partner rather than simply a sounding board, the campuses reported that the industry representatives had something to contribute and did not feel that their recommendations were skewed in a vocational direction. On the contrary, industrial representatives appreciated the need to balance theory and practice and reported that they felt their participation was useful to their organizations as well.

Another factor that acts as a barrier for involving industry as full partners in the assessment process is the lack of understanding of their value to the process. A common remark heard across institutions is that the role of the advisory board is not clearly defined. Colleges and departments do not know how to capitalize on this external resource and industry does not know how to contribute. The fact is that asking industry to take a proactive role in the various assessment activities is an excellent way to capitalize on their knowledge as well as orient them into the academic environment. When industry involvement is structured properly, practitioners can add a great deal of value to such assessment activities as the definition of student learning outcomes and the review of program plans. While they may not understand curriculum issues to any great extent, they have a real understanding of what knowledge and skills are important for today's engineer. In addition, many industrial partners will have insight into emerging technologies that will have an impact on future engineers. Campuses with strong guidance by an assessment professional seem to have created stronger partnerships than those with less consistent guidance. Without this guidance, campuses tend to rely on surveying industry constituents, or depend on advisory boards that were designed for purposes other than assessment.

In terms of involving industry in the direct assessment of student performance, schools are making great strides. Industrial representatives involved in design projects and capstone courses tend to be involved in the grading process, and are providing professional feedback to students as well. In addition, industry clearly plays an important role in helping us evaluate student performance outside the classroom. Many campuses report exploring how to best to include information from internships and the Co-op program in their assessment efforts. However, these projects and courses are resources yet untapped for program assessment purposes. There is a great opportunity to systematically collect data from such projects as capstone courses and internships to provide an aggregate look at program and curriculum effectiveness. As for involving industry in program evaluation and evaluation of the assessment process itself, this area

requires time to evolve. Lack of involvement here is perhaps more a reflection of the fledgling nature of our assessment programs than any thing else. From a continuous improvement perspective, most campuses have simply not come far enough down the path to check to see how they are doing.

Thus our preliminary results show that campuses are very much still in the planning stages of assessment. Some have made tentative plunges into collecting information, but for now the focus has been internal. However, the experiences of these people show that direct and pro-active involvement of critical stakeholders can add value to the assessment of student learning and program effectiveness.

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