The Correlation in Constituency Assessment Results from EC2000 Based Survey Questionnaire

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ABSTRACT: *EC2000 mostly focuses on eleven outcomes that serve as center of accreditation process for engineering programs at many U.S institutions. These eleven outcomes are not specifically defined such that engineering faculty can adapt the outcomes into their program in various ways.*

The Electrical Engineering Department at San Jose State University is currently in the process of course enhancement, which is the last loop of the three-loop curriculum review cycle. The three-loop curriculum review cycle includes the program objective reviewing loop, the course and program assessment loop, and the program enhancement loop.

We used a variety of methods to assess various aspects of our program in order to continuously improve its effectiveness in meeting the program objectives. The constituency surveys and the course/project surveys are the two assessment processes that took us lots of time and effort. In order to make the constituency survey results to be useful for the determination of the program enhancement methods, the survey questionnaire were carefully designed and reviewed. The survey questionnaire were designed in the way such that the assessment results fully reflect the desires of all constituencies, show the teaching effectiveness of the faculty, show the level of learning satisfaction from the students, define the levels of support to the defined outcomes from all constituencies, and are able to automatically stand-out particular outcomes that need to be improved.

We first evaluated the program objectives such that the set of outcomes from ABET criterion 3 is a subset of the program objectives. We added additional outcomes to ABET eleven outcomes to fully cover the program objectives. We mapped the defined outcomes into a set of assessable program performance tasks that when satisfied will ensure that the more broadly-stated outcomes have been achieved. The program performance tasks were then broken into different sub-sets of program survey questionnaire for the courses, projects, students, alumni, employers, and the faculty. We first assessed the faculty for the levels of support to the predefined outcomes and their corresponding expectation from the student learning. We then assessed the employers for the levels of support to these outcomes and their observations about the abilities of our graduates. We finally accessed our senior students and alumni for their learning desires and their levels of leaning satisfaction from our curriculum.

The survey results for program performance show stronger agreement between the employers and the students than between the faculty and the students. However there is well match in defining the levels of supporting the program objectives from the faculty and from the employers.

This paper summaries our assessment process together with the assessment results. The paper analyses the discrepancies among the results and discusses our arguments on these sets of assessment data. The paper also discusses our plan of developing new sub-sets of performance assessment questionnaire that will better direct assessment results to our program objectives.

1 INTRODUCTION TO SJSU

San Jose State University (SJSU) was founded in 1857 and is the oldest public institution of higher education on the U.S. West Coast. SJSU is a metropolitan university offering more than 134 bachelor and master degrees with 110 concentrations. The College of Engineering at SJSU offers nine engineering curricula leading to BS and MS degrees in aerospace, chemical, civil and environmental, computer, electrical, general, industrial and systems, materials and mechanical engineering, and aviation and technology.

The Department of Electrical Engineering (EE) at San Jose State University is one of major providers of engineers to Silicon Valley's high-tech industry. Our undergraduate curriculum includes 7 areas of concentration, including digital logic and system design, networking and telecommunication systems, fiber communication networks, communications engineering and digital signal processing, integrated circuit design and fabrication, analog electronics, RF and microwave, control and power electronics, and VLSI systems. Our mission is to provide a balanced education in fundamental principles, design methodologies, and practical experiences in electrical engineering and in general engineering topics, through which the graduate can enter into and sustain a life-long professional career of innovation and creativity.

2 UNDERGRADUATE ELECTRICAL ENGINEERING CURRICULUM AT SJSU

As other engineering curricula, the electrical engineering curriculum is developed based on its pre-defined program objectives. The program objectives include the technical educational objective and the broad social educational objective; both are periodically assessed, evaluated, and revised based on input from various constituents. The technical objective includes the preparation for the performance of the functions of engineering analysis, creative design, operation, the mastery of fundamental scientific principles, deep knowledge of engineering limitations and of their applications to particular problems, ability to make critical scientific and economic analyses, and the ability to organize knowledge and ideas into clear, concise, and convincing oral and written reports and presentations. In particular, the program objective intends to provide the graduate with the skills and understanding needed to design and build innovative new products and services which balance the competing requirements of competitive performance, cost, and practical constraints imposed by available technologies.

Located at Silicon Valley, our goals of education must weight a little more in motivation to keep abreast of the new developments in science, technology, commercial, and to continue to grow intellectually in both professional and cultural areas throughout life. The evolution of our electrical engineering curriculum has been characterized by a continuous process of assimilation of new scientific and technological knowledge as well as new business model. Moreover, since many of our alumni progress themselves into managerial and executive positions in industry, our curriculum also intends to prepare the students for an understanding of human relationships and the principles of economics. Since an engineer must continue to learn throughout his/her life, our instructional goal is also to motivate the students for learning on their own initiative.

The broad social educational objective of our curriculum includes the development of leadership and professional ethics, knowledge of social evolution related to technology, and the development of personal philosophy to insure the satisfaction in pursuing a productive life. Our curriculum was developed with the intention of preparing graduates for immediate employments but also for graduate studies by means of the required and technical elective courses with a reasonable degree of flexibility.

Our undergraduate upper division curriculum in electrical engineering includes 18 required technical courses (including 2 senior design project courses) and 24 technical elective courses, which cover seven specific areas in electrical engineering. About half of our courses have either laboratory components and/or final design projects. Although we understand that the development of a smaller number of appropriate experimental problems by the students themselves under effective guidance will have much greater educational value, our current laboratories truly are not quite yet in the good state due to difficulties in lab security and equipment maintenance. However, the art of measurement and analysis that include accuracy, precision, errors, as well as the appreciation of accuracy economically justified and the understanding of statistical methods are all covered in our laboratory experiments. Many of our courses use laboratory reports and final project presentations as major opportunities for students to develop skill in written and oral presentations of engineering information.

The requirements for a BSEE degree at SJSU include 62 semester units of lower division courses and 73 semester units of upper division electrical engineering courses. The 62 units lower division courses include 32 units in general and physical education and 30 units in basic science and mathematics, including mathematics, chemistry, and physics. The seventy-three units upper division courses include 19 units in basic engineering, 38 units from the required electrical engineering courses (core), 4 units from senior design project and skill exit exam, and the remaining 12 units are for technical elective courses in

electrical engineering. By proper choice of upper-division technical electives and senior design project, students may specialize in the areas of (1) RF/Microwave, (2) Digital Logic and Systems, (3) Analog Electronics, (4) DSP, (5) Integrated Circuits Fabrication, (6) Integrated Circuits Design, and (7) Communication and Networking. Before entering the first required upper division electrical engineering course, students are required to pass a "Basic Circuit Analysis" course following by passing a "Circuit Concepts and Problem Solving" examination. This exam is equivalent to one-unit, credit/no-credit junior-level course and is served as an "entry exam" for electrical engineering majors.

3 THE PROGRAM OUTCOMES AND ASSESSMENT

The program outcomes are statements that describe what students are expected to know and are able to do by the time of graduation. The program outcomes are used to ensure that the program curriculum is aligned with the program objectives and must be frequently assessed in order to guarantee the quality of the graduates. Unfortunately the eleven ABET program outcomes 3a to 3k are stated in somewhat general terms and are not directly amenable to assessment. In order to guarantee that our program meets ABET qualifications, we first evaluated our program objectives such that eleven outcomes from ABET criterion 3 are a subset of our program objectives. From the evaluation results, we added additional outcome "3l" to the eleven ABET outcomes. Outcome 3l states for the need of "one or more technical specialties that meet the needs of Silicon Valley companies." These technical specialties were determined based on feedback information from the Electrical Engineering Advisory Committee.

In order to assess the level of achievement of the various program outcomes, each program outcome was broken into several more detailed sub-outcomes. This set of sub-outcomes was then used for the design of a set of program assessment questionnaire. This set of program assessment questionnaire was developed not only to rate the performance of sub-outcomes but also to value them. The responses from the surveys were then mapped to the twelve program outcomes. For each assessment cycle, the program outcomes were assessed to students at senior and junior levels, alumni, employers (supervisors, managers, recruiters, and technical leads), and also to the faculty. For each constituent and each program sub-outcome, responses from two assessment categories listed in Table 1 below were requested for:

Table 1 - List of program sub-outcome assessment categories

Ass. #	Constituency	Rate the program performance (Category A)	Value the program outcomes (Category B)
1	Juniors	How capable are you in meeting the particular objective?	How important is the objective as a goal of BSEE education?
2	Seniors	How satisfied are you with your education at SJSU for the particular objective?	How important is the objective as a goal of BSEE education?
3	Alumni	How satisfied are you with your education at SJSU for the particular objective?	How important is the objective as a goal of BSEE education?
4	Employers	Performance of SJSU BSEE graduates for the particular ability/knowledge?	How important is the objective as a goal of BSEE education?
5	Faculty		How important/priority that EE faculty would like to support the objective listed as a goal of BSEE education?

Assessment at the course and project level requires that the program sub-outcomes further be refined into detailed assessable criteria called the course outcomes. The course outcomes allow the student performance to be directly attributed through specific deliverables such as exams, reports, presentations etc. and also be indirectly attributed through survey questionnaire. For each course, a number of course outcomes were also assessed by a particular set of survey questionnaire and the results were mapped to one or several program sub-outcomes. The responses were then again mapped and included into the twelve program outcomes. It is therefore possible to relate assessment at the course level to the overall program level. The routine course surveys are performed at the end of each semester and the cycle course surveys are performed during the assessment period. The routine course assessment results are used by

instructors for the continuous course improvements, but the cycle course assessment results are the target of evaluation by the program committee to enable program level monitoring and improvement in meeting the overall program objectives. We also assessed student performance by senior exit examinations, student conference presentations, and senior design projects and reports. The student conference assessments have been performed at the end of the program and mainly concentrates on the writing and oral communication skills, which are part of ABET criterion 3g. For the senior design projects, beside the program technical outcomes they also contribute to outcomes 3f, 3g, 3h, 3i, and 3j, which include the communication skill, the recognition of life-long learning and of professional and ethical responsibilities, the knowledge of contemporary issues, and the understanding of the impact of engineering solutions in a global and societal context. Table 2 lists our current course and project assessment subjects. We plan to customize our course and project assessment questionnaire such that students can also respond to the level of important of a particular objective covered in the course.

Table 2 - List of course/project sub-outcome assessment categories

Ass. #	Assessment form	
6	Course assessment by students	How satisfied are you with particular objective covered in this course?
7	Course assessment by course coordinators	Levels of supports for particular objective covered in this course
8	Project assessment by project advisors and coordinators	Levels of supports for particular objective covered in the senior design projects
9	Team-work assessment by students	How satisfied are you with team-work, professional attitude, and ethical responsibility among the team members
10	Communication assessment by faculty	▪ Student performance on oral presentation ▪ Student performance on writing report

The assessment system implemented for Electrical Engineering Department at SJSU was designed to evaluate the program objectives not only to meet ABET eleven outcomes but also to automatically provide the faculty information regarding technical needs among Silicon Valley companies, as addressed in assessment 4B and as discussed below. Due to the great and fast changes in commercial technology and the equally great advances in engineering practice over the past fifteen years at Silicon Valley, there are questions if we have produced an equivalent counterpart in the reorganization of our engineering curriculum. To answer ourselves these questions, a number of local employers of engineers were invited to serve on Electrical Engineering Advisory Committee. The committee met with the department chair and ABET committee at the starting of the enhancement process to provide their feedbacks on the assessment results and also on the program objectives.

4 ANALYZE THE ASSESSMENT RESULTS

The consistency and completeness in implementing our program objectives can be re-evaluated by comparing the averages from program assessment 5B with the ones from assessments 7 and 8 (7&8). The results from the program assessment 5B show the standard set to the program objectives based on faculty opinions. The results from assessments 7&8 show the resource available in our curriculum to implement the program objectives to the desired standard level. Since outcomes 3f, 3g, 3h, 3i, and 3j are in fact mainly supported by general education and lower division courses, standard analysis should not be performed on these outcomes but only the program performance analysis as discussed later in this paper. Standard analysis should only performed on the outcomes that are directly supported by our curriculum, which are outcomes 3a, 3b, 3c, 3d, 3e, 3k, and 3l. Figure 1 shows the comparison between these two assessment results.

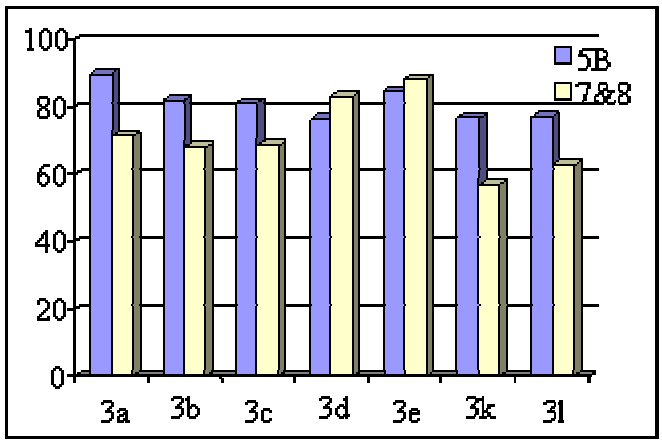

Figure 1 - Results of assessment 5B and (7&8)

The results show that the available resources to implement outcomes 3a, 3b, 3c, 3k, and 3l to the standard level as the faculty defined are somewhat low. Performing correlation between these two sets of data for the program objectives assume that the program objectives are fully based on the faculty, which may not be the case. In order to define the enhancement process for this set of assessment, the program objectives must be re-evaluated by all constituencies of the program and the results of assessment 5B can be modified based on the evaluation. Possible enhancements can be made by minor modifications of some required courses and senior design projects to match the results of 7&8 to the results of 5B.

The results of previous cycle enhancement can be evaluated by comparing the averages of assessments 2 and 3 as shown in Figure 2. The figure shows that the results of 2B and 3B are somewhat similar but the results of 2A are higher than 3A for outcomes 3b, 3d, 3f, 3k, and 3l. Since the majority of alumni we surveyed are graduates in the past 1 to 5 years, the alumni ratings should direct to the quality of our previous curriculum. From the definition of these outcomes, we can conclude that the discrepancies are due to our major curriculum enhancement performed during school year 2000-2001. We have improved most of our laboratory components, revised senior design projects such that team-work and professional and ethical responsibility are strongly addressed. We have strongly addressed honesty policies to all course syllabi, starting the 2000 school year. The figure shows that the results of our previous enhancement are positive and recognized by the students. With the above arguments, it is reasonable to use the results of assessment 2A as the program rating from students and the results from assessment 3B as the "desired program objectives" from the student points of view. The assumption that alumni opinions on the “desired program objectives” are more practical and accurate than the senior ones due to their recent working experiences seems reasonable.

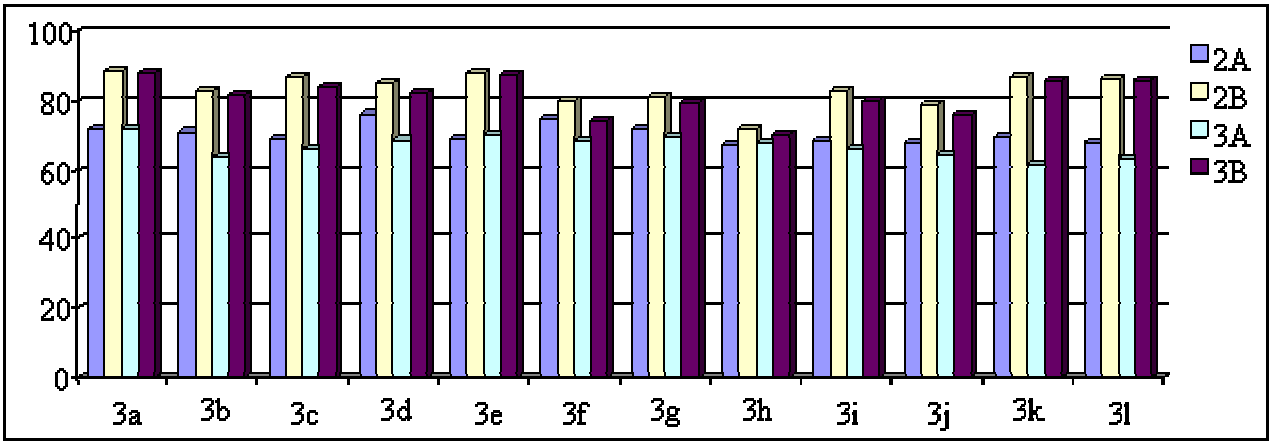

Figure 2 - Results of assessments 2 and 3

The above discussions can be ensured by comparing the results of assessments 3 and 4 as shown in Figure 3. The figure shows that the results of assessments 3 and 4 are very much similar and that adds one

more level of support to the discussions made above. In general, the assessment results can be summarized as below:

- The results from assessment 5B represent the standard program objectives defined by the faculty
- The combinations of the results from assessments 7&8 represent the status of our curriculum to implement the desired program objectives
- The results from assessments 2A, 3A and 4A represent performance of our curriculum rated by other constituents but faculty
- The combinations of the results from assessments 3B and 4B represent scores on the "desired program objectives" supported by other constituents but faculty

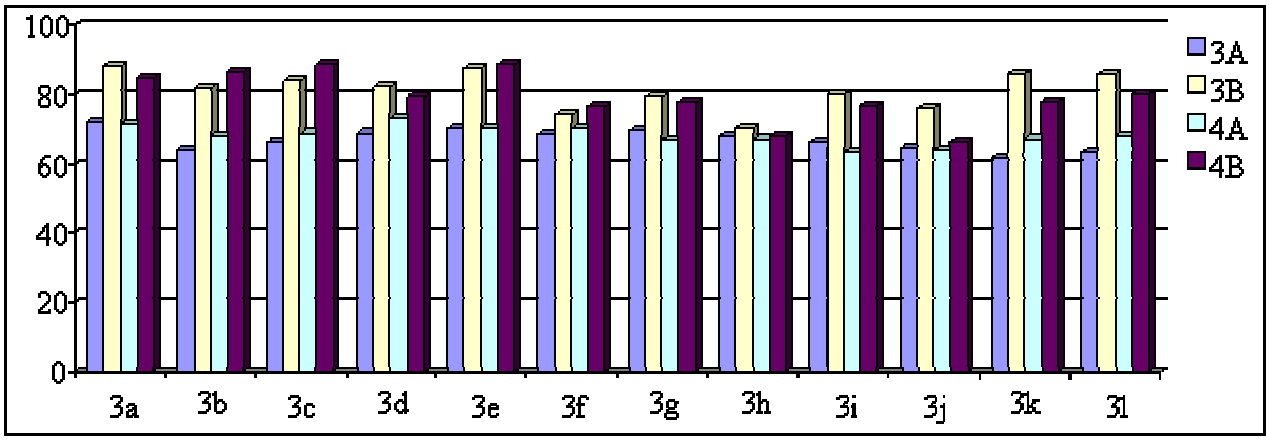

Figure 3 - Results of assessments 3 and 4

Re-evaluation of the program objectives can be performed by comparing the results of assessments 4B and 5B as shown in Figure 4. An ABET retreat can be organized to discuss the discrepancies between the two target objectives among constituencies if any. The ABET retreat will be able to bring to the conclusion if modifying the scores on assessment 5B is necessary, which leads to the updates in levels of support to some particular objectives via the program outcomes. Figure 4 however shows that the program objectives supported by the faculty and the employers are very much similar, except outcome 3a where the level of support from faculty is higher than from the employers. This discrepancy is reasonable due to different perspectives between the employers and the faculty as expected.

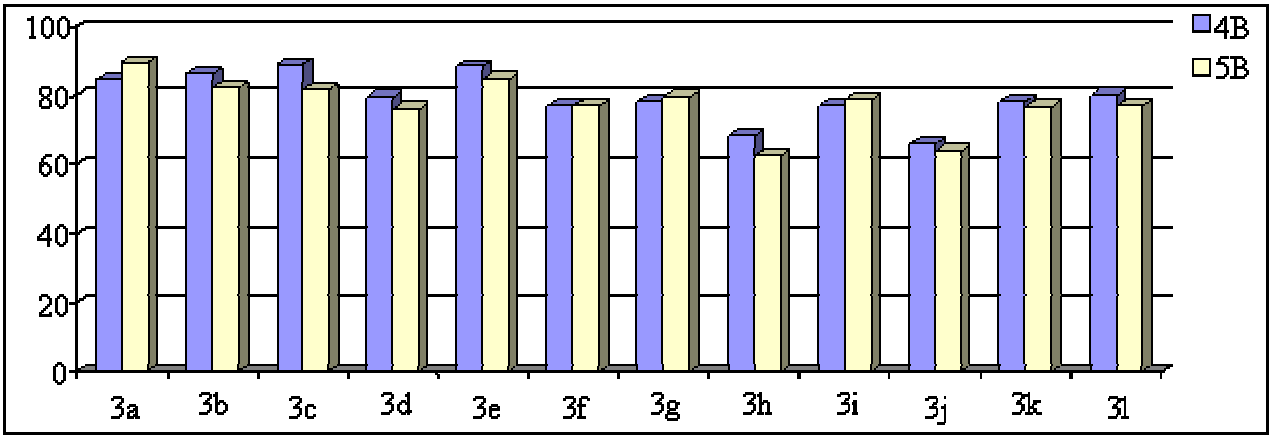

Figure 4 - Results of assessments 4B and 5B

With the standard program outcomes defined in 5B, Figure 1 then can be used to isolate particular outcomes that need to be improved. The figure shows that outcomes 3a, 3b, 3c, 3k, and 3l need to be stronger addressed in our curriculum. Enhancement for these outcomes can be implemented by having more supports to these outcomes in some required courses and projects, including the lecture materials, homework assignments, and the exams.

The enhancement process at the course and project level to satisfy the standard program outcomes can be made by comparing the results of assessments 2A with 5B as shown in Figure 5. The figure clearly

shows critical outcomes that need to have special attentions from the faculty. Once the critical outcomes have been defined, the enhancement for these outcomes can be made at the course level by the course coordinators. Detailed information regarding performance of a particular course can be obtained by comparing the results of assessments 6 and 8 to the results of assessment 7.

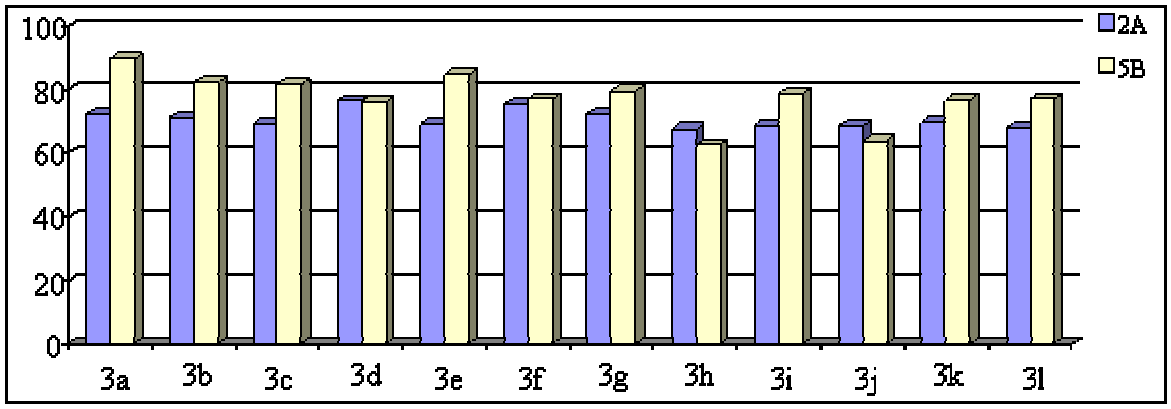

Figure 5 - Results of assessments 5B and 2A

Outcomes that are not directly and are not mainly supported by our curriculum, but from the student backgrounds, general education, and lower division education, include outcomes 3f, 3g, 3h, 3i, and 3j. The curriculum however still can be enhanced to improve these outcomes directly by several means. As examples, outcomes 3f, 3g, 3h, 3i, and 3j can be more supported by the senior design project by increasing the standard of the project proposals, reports, final presentation, and by broadening the seminar topics presented in the senior design project courses. Seminar topics presented in the senior design project courses can include the interview skills, engineering ethics, life-long learning, social context in engineering, team building, and contemporary issues. The invited seminar speakers can be guest speakers from local industry, faculty, university service personnel, and federal and state funding agencies. Moreover, outcome 3f can be more supported by the enforcement of the department honesty policy to all courses and more involvement of student organizations into the department academic activities. The enhancement of outcome 3g can also be accomplished by putting more weight on the student reports and presentations, and encourage several technical elective classes to have final presentations and final project reports as part of the course objectives.

5 CONCLUSIONS

The problem of the evaluation of engineering education should always be in the consciousness of engineering faculty members. Each instructor should personally consider this task as his/her responsibility and approach it with intellectual vigor and full consideration for all situations. Assessment results are extremely valuable to all constituencies, not only to prove if goals were met but also to support changes in engineering education, to update the course contents, to develop new enterprises, and also to remind and group faculty members into common goals. Design a mechanism to minimize assessment effort and make it attractive to all constituents is a difficult task. The assessment mechanism must be designed in the way such that assessment results are trustable and can be interpreted as much uniformly as possible among the evaluators. In order to utilize the usage of the assessment results for the enhancement process, plans should be made to define the ways of interpreting and using the assessment results before performing the assessment process. The correlation between assessment results also must be defined in the early state of assessment and enhancement cycle.

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