# PROGRAM EDUCATIONAL OBJECTIVES AND ASSESSMENT: A SYSTEMATIC PROCESS FOR CONTINUOUS IMPROVEMENT

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**Abstract**

In a globalized economy it is important to have common standards in engineering education and practice. The newly established ABET Engineering Criteria (EC 2000) may serve as a basis for future world-wide engineering standards. One of these (Criterion 2) refers to Program Educational Objectives. The paper describes the design and implementation of a systematic process for defining and assessing Program Educational Objectives using faculty input, interviews with graduating seniors, alumni and employer surveys, and input from industrial advisory boards. The Program Educational Objectives for the Aerospace and Mechanical Engineering Programs at San Jose State University are discussed in the paper along with results from the first cycle of assessment.

Key Words – accreditation, program assessment, program educational objectives

## Introduction

In a globalized economy it is important to have common standards in engineering education and practice. The need for standardazation in engineering education has been recognized in several international fora. A major example is the Bologna Declaration[1], signed by the ministers of education from 29 European countries on June 19, 1999, who pledged to reform the structures of their higher education systems in a convergent way. This agreement reflectes an effort towards the standardisation or uniformisation of European higher education, for the purpose of (a) enhancing the employability and mobility of European citizens and increasing the international competitiveness of European higher education, and (b) eliminating any obstacles to the free mobility of engineering students, professors, researchers, and higher education administrators[2]. For similar reasons, many engineering schools around the world are requesting an evaluation of their programs by the USA Accreditation Board for Engineering and Technology (ABET) to determine if they are *"substantially equivalent"* to ABET-accredited programs and to make recommendations for program improvement[3]. Clearly, the newly established ABET Engineering Criteria (EC 2000) may serve as a basis for future world-wide engineering standards.

ABET EC 2000 include two new criteria for evaluating engineering programs[4]: Criterion 2, Program Educational Objectives (PEO) and Criterion 3, Program Outcomes (PO). Program Educational Objectives are defined with input from all program constituents and *describe the expected accomplishments of graduates during the first several years following graduation.* Program Outcomes, on the other hand, *describe what students are expected to know or be able to do by the time of graduation from the program*. A systematic process must be in place to assess the achievement of both the PO – before students graduate – and the PEO – after graduates leave the program. This process needs to be ongoing to ensure the continuous improvement of each program.

This paper describes the design and implementation of a systematic process for the definition and assessment of PEO, which is currently beeing used in the Aerospace (AE) and Mechanical (ME) Engineering Programs at San Jose State University. Results from the first cycle of PEO assessment are also presented and discussed. The assessment of the PO for these programs is discused in detail in an earlier[5] reference.

To better understand the significance of the PEO, the relationship between the University, College, and Department mission, PEO, PO, and course learning objectives (CLO) is illustrated in figure 1. Using engineering design as an analogy, one may view PEO as a set of mission requirements (specification) that fall within the broader vision, mission, and goals of the Department[6], the College[7], and the University[8]. Alumni will be able to meet the

expectations set for them in the PEO, if they have the skills described in the PO at the time they graduate. These skills are acquired mostly through the curriculum of each program. Hence, learning objectives in each course must represent a subset of the skills described in the PO.


Figure 1. Relationship between University, College, and Department mission, PEO, PO, and CLO.

**Definition of Program Educational Objectives**

As mentioned earlier, PEO reflect the career and professional accomplishments of graduates during the first several years after graduation. The process of definition and assessment of the PEO is illustrated in figure 2. Program Educational Objectives are revisited periodically to ensure that they continue to reflect current industrial trends.

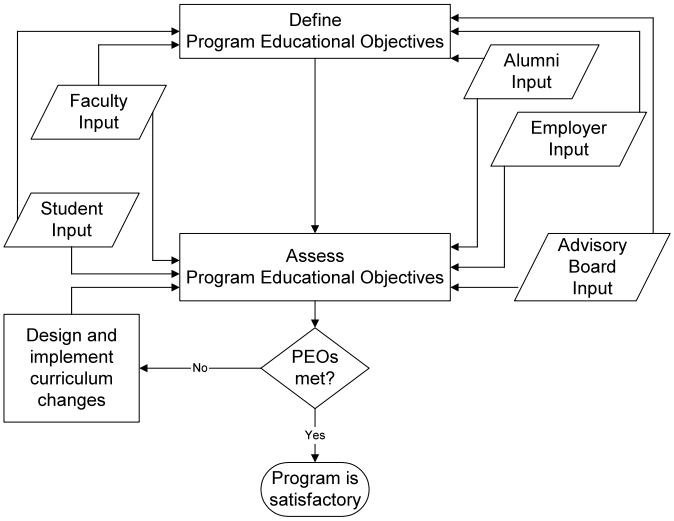


Figure 2. PEO definition and assessment process.

Input from students, faculty, alumni, employers, as well as the two advisory boards (one for each program) led to the following PEO for the AE and ME Programs, which reflect our constituents' expectations that our graduates should have:

1. A strong foundation in mathematics, basic science and engineering fundamentals, to successfully compete for entry-level positions or pursue graduate studies in AE / ME or related fields.
2. Contemporary professional and lifelong learning skills including hands-on laboratory experience, familiarity with computers, modern software, and information technology, to successfully compete in the local, national and global engineering market.
3. Strong communication and interpersonal skills, broad knowledge, and an understanding of multicultural and global perspectives to work effectively in multidisciplinary teams, both as team members and as leaders.
4. An understanding of the ethical choices inherent in the engineering profession to deal with issues such as public safety, honest product marketing, and respect for intellectual property.

**Achievement of Program Educational Objectives**

Program Educational Objectives are achieved primarily through the curricula, which provide students with a broad understanding of basic concepts, contemporary skills required by industry, extensive laboratory experiences, and many opportunities for hands-on, design projects.

Both programs build on a foundation of mathematics, science, and basic engineering skills (circuit analysis, statics, mechanics of materials, dynamics, fluid mechanics, and thermodynamics). Subsequently, students take courses across the disciplines that apply engineering principles to aerospace vehicle subsystems (AE) or mechanical engineering systems (ME) emphasizing teamwork, communication skills, open-ended problems, modern software, and laboratory experiments ranging from basic measurements to systems-level experimentation. Finally, seniors integrate all their skills in a year-long, team-based, design project subject to realistic constraints, such as economic, environmental, social, political, ethical, safety, liability, and manufacturability. Students often work in multi-disciplinary teams that include aerospace, mechanical, electrical, and computer engineers to design an aircraft or a spacecraft. For example, in a multi-year effort sponsored by local industry, several multidisciplinary teams designed, built, and tested a microsatellite (SPARTNIK) with the intent to launch it to space (1998-2004). Other multi-disciplinary projects include the design / build / test of a solar-powered, autonomous, unmanned aerial vehicle (UAV) and the design / build / test of a pulse-detonation engine (2004-2005). Additional exposure to economic, environmental, social, political, ethical, safety, liability, and manufacturability issues comes through case studies, guest speakers, and field trips.

Students take also a minimum of two (AE) or four (ME) elective courses plus a capstone course that allows them to explore one area in more depth and develop specialized skills or focus on applications of immediate use in industry. Some electives involve considerable computer-based skills, some involve laboratory hands-on experience, some involve significant design experience, and several require oral presentations and / or written reports.

In summary, both the AE and the ME curricula provide a basis for professional competence and the required knowledge to focus on a particular specialization upon graduation, in the work environment or in graduate school. Three options are offered in each program:

- For AE: aircraft design, spacecraft systems, space transportation and exploration.
- For ME: mechanical design, mechatronics, and thermal / fluids.

Student participation in engineering societies also supports achievement of the PEO. Currently, the following societies have local chapters at SJSU:

- Department-level: AIAA (American Institute for Aeronautics and Astronautics), SAE (Society of Automotive Engineers), ASME (American Society of Mechanical Engineers), ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers), AFE (Association of Facilities Engineering), and ΠΤΣ (ME Honor Society).
- College-level: AISES (American-Indian Science and Engineering Society), BASE (Black Alliance of Scientists and Engineers), MESA Engineering Program, (MEP), SME (Society of Manufacturing Engineers), SOLES (Society of Latino Engineers and Scientists), SWE (Society of Women Engineers), VESA (Vietnamese Engineering Students Association), and ΤΒΠ (Engineering Honor Society).

**Direct Assessment of the Program Educational Objectives**

As was discussed in the introduction, the PEO are closely related to the PO. Hence, one indirect way to assess the achievement of the PEO is through PO assessment. Mourtos[5] discusses this process in detail and presents assessment results for both the AE and the ME Programs. Table 2 shows the various methods used for direct assessment of the PEO. The results from each of these methods are presented in the following sections.

Table 2. Methods used to assess PEO.

| | Faculty assessment | Exit interviews | Employment data | Graduates completing M.S. & Ph.D. degrees | Alumni survey | Employer survey | Advisory Board input |
|---|---|---|---|---|---|---|---|
| PEO 1 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| PEO 2 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| PEO 3 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| PEO 4 | ✓ | ✓ | ✓ | | | ✓ | ✓ |

**Faculty Assessment**

Two department meetings were dedicated to the assessment of the PEO by the faculty. Each PEO was presented and faculty members shared their opinion on how well the two programs meet this PEO, based on their interactions with students in their courses. A summary of the results, along with the scale used to record faculty input is shown in table 3.

Table 3. Faculty assessment of the Program Educational Objectives.

| | Average | F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 | F9 | F10 | F11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PEO 1 | ***3.05*** | 3 | 3 | 3 | 3 | 2.5 | 3 | 3 | 2.5 | 4 | 4 | 2.5 |
| PEO 2 | ***3.55*** | 3 | 4 | 3.5 | 4 | 2.5 | - | 3.5 | 4 | 3.5 | 4.5 | 3 |
| PEO 3 | ***3.15*** | 3 | 2.5 | 3 | 3.5 | 3 | - | 3.5 | 3 | 3 | 4 | 3 |
| PEO 4 | ***2.67*** | - | 2.5 | 3 | 3 | 2 | - | 3 | 2 | 2.5 | 3 | 3 |

5: Students truly excel in these skills. 4: Students have strong skills in this area. 3: Students have adequate skills in this area.
2: Students do not have adequate skills in this area. 1: Students do not have any skills in this area.

In general, the faculty was of the opinion that most of our students:

- (PEO 1) Have adequate skills in mathematics, science, and engineering fundamentals to compete for entry-level positions but do not have adequate skills in this area for graduate studies. This observation is reinforced by the fact that most of our students seek employment after graduation and only a small percentage continues their studies in graduate school. Nevertheless, the faculty felt that a small percentage of our students do excel in this area.
- (PEO 2) Are well prepared in contemporary professional and lifelong learning skills to compete in the local, national and global engineering market. They are more capable in conducting experiments and building models than they are in the design of experiments, data analysis and interpretation.
- (PEO 3) Are excellent presenters but only adequate writers. Our rigorous general education program and multicultural campus environment provides them with broad knowledge, as well as understanding of multicultural and global perspectives. They work well in teams and many of them have excellent leadership skills.
- (PEO 4) Have a good understanding of the ethical issues that arise in their profession. However, there is a need for greater sensitivity to copyright intellectual property. Although not encompassing the majority of students, faculty has deep concern with a fraction of students that compromise academic integrity.

**Exit Interviews with Graduating Seniors**

Twenty-four (24) AE and 39 ME graduating seniors were interviewed in the period from fall 2003 through spring 2005. To ensure that students felt comfortable sharing their views about the two programs, AE seniors were interviewed by ME faculty and ME seniors were interviewed by AE faculty. Students were asked three open-ended questions during these interviews. A summary of their most frequent responses is shown below.

*Question 1: What do you think are the most important skills for an AE / ME to compete successfully for entry-level positions in industry or entry to a graduate program?*

AE seniors identified the following as their top seven skills. The numbers in parentheses show the percentage of respondents who selected each skill.

- Team skills (67%)
- Communication skills: presentation, report writing, documentation, ability to debate (67%)
- Technical skills: aerodynamics, propulsion, aircraft / spacecraft design, etc. (46%)
- Computer / programming skills: Computer Aided Design, Computational Fluid Dynamics, Finite Element Analysis, MATLAB, Satellite Tool Kit, etc. (46%)
- Lifelong learning skills: ability to find resources, learn new things, adapt to new learning and work environments, conduct research, etc. (33%)
- Experimentation / hands-on skills: wind-tunnel testing, shock-tunnel testing, etc. (29%)
- Problem-solving skills (17%)

ME seniors identified the following as their top six skills. The numbers in parentheses show the percentage of respondents who selected each skill.

- Communication skills: presentation, report writing, documentation, ability to debate (64%)
- Team / interpersonal skills (46%)
- Project skills: ability to carry out a project, design/build/test a product, etc. (38%)
- Basic engineering science skills (36%)
- Management / leadership / business skills / engineering economics (23%)
- Professionalism: attitude towards responsibilities, good work ethics, etc. (23%)

It is interesting to note from these responses that AE seniors consider PEO 1, 2, and 3 important (they did not mention the 4th PEO), while ME seniors consider all four of the current PEO important.

*Question 2: Do you feel that the AE / ME program prepared you adequately in the skills you consider important? Which courses prepared you for these skills?*

The responses given by AE graduating seniors fell in two broad categories:

- 71% of the students felt that the AE Program had prepared them adequately in the skills they identified above. The courses they identified as instrumental in preparing them for these skills were Aircraft / Spacecraft Design, Aerodynamics, Aerospace Propulsion, Aerospace Vehicle Dynamics and Control, Rigid Body Dynamics, Thermodynamics, Heat Transfer, and Experimental Methods.
- 29% of the students felt that the AE Program did not prepare them adequately in communication skills.

The responses given by ME graduating seniors were as follows:

- 51% of the students felt that the ME Program had prepared them adequately in communication skills. The courses identified as instrumental in preparing them for these skills were the Senior Design Project, Experimental Methods, Engineering Reports, Mechanical Engineering Design, and Mechanical Systems Design. 13% of the students felt that the ME Program did not prepare them adequately in communication skills.
- 31% of the students felt that the ME Program had prepared them adequately in team / interpersonal skills. The courses identified as instrumental in preparing them for these skills were the Senior Design Project, Mechanical Engineering Design, Mechanical Systems Design, and Mechatronics. 15% of the students felt that the ME Program did not prepare them adequately in team / interpersonal skills.
- 28% of the students felt that the ME Program had prepared them adequately in project skills. The courses identified as instrumental in preparing them for these skills were the Senior Design Project, Manufacturing Processes, and Mechatronics. 5% of the students felt that the ME Program did not prepare them adequately in project skills.

- 31% of the students felt that the ME Program had prepared them adequately in basic engineering science skills. The courses identified as instrumental in preparing them for these skills were Thermodynamics, Heat Transfer, Mechanical Engineering Design, Mechanics of Materials, and Fluid Mechanics. 5% of the students felt that the ME Program did not prepare them adequately in basic engineering science skills.
- 5% of the students felt that the ME Program had prepared them adequately in management / leadership / business skills and engineering economics. The courses identified as instrumental in preparing them for these skills were Mechanical Systems Design and General Education courses. 15% of the students felt that the ME Program did not prepare them adequately in these skills.
- 10% of the students felt that the ME Program had prepared them adequately in professionalism and ethics. The only course identified by more than one student as instrumental in preparing them for these skills was the Senior Design Project. 8% of the students felt that the ME Program did not prepare them adequately in these skills.

These results provide an important piece of evidence of the effectiveness of the AE and ME coursework in general and certain courses in particular, in terms of their contribution towards the achievement of the PEO. The majority of the seniors feel that both programs achieve PEO 1, 2, and 3. On the other hand, of the ME seniors who identified professionalism and ethics as important skills, only half felt adequately prepared in PEO 4 (professionalism and ethics). This is important feedback, which should be used to make the necessary changes in the ME Senior Design Project and perhaps in other courses as well, to increase student confidence in this area.

*Question 3: Do you have any comments, positive or negative, about the AE / ME program?*

The responses given by AE seniors were summarized as follows:
On the positive side:
- 25% indicated that AE was a very exciting educational experience.
- 13% said they enjoyed a close relationship with AE faculty members.

On the negative side:
- 17% indicated that the equipment in some of the labs is old and does not function properly. This comment was probably referred to an old smoke tunnel in the aerodynamics lab, which has since been replaced with a new water tunnel.

Finally, the more common suggestions were to:
- Hire more AE faculty (17%)
- Add an undergraduate Computational Fluid Dynamics (CFD) course because employers require it in many cases (13%)

While a new undergraduate CFD course was offered for the first time in Spring 2005, the hiring of a third AE faculty member has yet to materialize.

The responses given by ME seniors were summarized as follows:
On the positive side, students' top choices were:
- The effectiveness, responsiveness, knowledge, and availability of the faculty (33%)
- The overall quality of the ME Program (23%)
- The laboratories (18%)

On the negative side, students' top concerns were:
- The quality of teaching from some of the faculty (15%)
- The inadequacy of some of the labs and college facilities (15%)

Responding to these concerns is very difficult. In regards to the first one, the current faculty culture is a major obstacle. In regards to the second one, economic constraints are the limiting factor.

**Employment Data of BSAE and BSME Graduates**

Twenty (20) AE and 56 ME alumni surveys were received through Spring 2005. The most frequent job title among the AE respondents was *systems engineer* followed by *test engineer* and *aeronautics / aircraft design*. Alumni were asked to indicate all the jobs they held since graduation, hence the total number of jobs shown is greater than the number of surveys received. The most frequent job titles among the ME respondents were *design engineer*, *systems*

*engineer,* and *mechanical engineer*. The types of jobs our graduates hold indicates that both programs prepare them well for these positions.

Table 4. AE alumni job titles

| Job Title | # of alumni |
|---|---|
| Systems Engineer | 7 |
| Test / Instrumentation Engineer | 4 |
| Aeronautics / Aircraft Design | 3 |
| Dynamics & Controls | 2 |
| Flight Operations | 1 |
| Structural Analysis | 1 |
| Aerodynamics | 1 |
| Other engineering jobs (non-AE) | 10 |

Table 5. ME alumni job titles

| *Job Title* | # of alumni |
|---|---|
| Design Engineer | 11 |
| Systems Engineer | 9 |
| Mechanical Engineer | 8 |
| Consultant / Contactor | 4 |
| Project Engineer / Manager | 4 |
| Applications Engineer | 3 |
| Quality / Reliability Engineer | 3 |
| Product Development / Support Engineer | 3 |
| Other engineering jobs (non-ME) | 17 |

**M.S. and Ph.D. Degree Completion Data**

Most of our students seek employment after graduation. Nevertheless, our alumni survey shows that 32% of the AE respondents and 25% of the ME respondents were enrolled in a graduate program at the time they filled out the survey, most of them at SJSU. An additional 16% of the AE respondents and 26% of the ME respondents had already completed their M.S. degree. One AE graduate had completed his Ph.D. degree and was a professor at another university.

**Alumni Surveys**

Aerospace Engineering respondents had graduated with a BSAE as early as 1989 and as late as 2004. Two of them had received also a BSME from SJSU. Table 6 shows a summary of their responses. The majority of the respondents agreed that the skills described in the PEO are important in the work they do and that the AE Program had adequately prepared them in these skills. Statement 3-6, which pertains to an *understanding of multi-cultural and global perspectives in engineering* (PEO 3), had the lowest agreement rating of 53%.

Table 6. Summary of AE alumni responses on the importance and achievement of the PEO (N=19)

| | | Agree | Not sure | Disagree |
|---|---|---|---|---|
| 1-1 | The AE Program has given me a strong foundation in *mathematics.* | 13 | 2 | 4 |
| 1-2 | A strong foundation in mathematics *is important* for the kind of work I do. | 15 | 2 | 2 |
| 1-3 | The AE Program has given me a strong foundation in *science* (physics, chemistry, materials, etc.). | 17 | 1 | 1 |
| 1-4 | A strong foundation in science *is important* for the kind of work I do. | 15 | 1 | 3 |
| 1-5 | The AE Program has given me a strong foundation in *engineering* | 18 | 1 | 0 |

| | | | | |
|---|---|---|---|---|
| | *fundamentals*. | | | |
| 1-6 | A strong foundation in engineering fundamentals *is important* for the kind of work I do. | 18 | 0 | 1 |
| 1-7 | The AE Program has given me a strong foundation for *graduate work.* | 11 | 7 | 1 |
| 2-1 | The AE Program has prepared me well for *hands-on laboratory work.* | 11 | 5 | 3 |
| 2-2 | Hands-on laboratory work *is important* for the kind of work I do. | 12 | 3 | 4 |
| 2-3 | The AE Program has given me the necessary skills to work with *computers* (doing design, simulation, data acquisition and processing). | 14 | 1 | 4 |
| 2-4 | Computer work (design, simulation, data acquisition and processing) *is important* for the kind of work I do. | 17 | 0 | 2 |
| 2-5 | The AE Program has given me the necessary skills to *find information* and *learn on my own*. | 18 | 1 | 0 |
| 2-6 | The ability to find information and learn on my own *is important* for the kind of work I do. | 19 | 0 | 0 |
| 3-1 | The AE Program has given me good communication skills. | 14 | 3 | 2 |
| 3-2 | Good communication skills *are important* for the kind of work I do. | 19 | 0 | 0 |
| 3-3 | The AE Program has given me good *interpersonal, team,* and *leadership skills.* | 14 | 3 | 2 |
| 3-4 | Good interpersonal, team, and leadership skills *are important* for the kind of work I do. | 19 | 0 | 0 |
| 3-5 | The AE Program has given me a *broad knowledge* as well as *an understanding of multicultural* and *global perspectives* in engineering. | 12 | 0 | 7 |
| 3-6 | A broad knowledge as well as an understanding of multicultural and global perspectives in engineering *are important* for the kind of work I do. | 10 | 6 | 3 |
| 4-1 | The AE Program has given me an *understanding of the ethical choices* inherent in the engineering profession to provide for issues such as public safety, honest product marketing, and respect for intellectual property. | 15 | 1 | 3 |
| 4-2 | An understanding of the ethical choices inherent in the engineering profession to provide for issues such as public safety, honest product marketing, and respect for intellectual property *is important* for the kind of work I do. | 18 | 1 | 0 |

ME respondents graduated with a BSME as early as 1987 and as late as 2004. Table 7 shows a summary of their responses. The majority of them agreed that the skills described in the PEO are important in the work they do. With the exception of two areas, the majority of the respondents also agreed that the ME Program had adequately prepared them in these skills. The two areas with low agreement ratings were:

- Preparation for graduate work (statement 1-7, PEO 1) with an agreement rating of 42%.
- Broad knowledge as well as an understanding of multi-cultural and global perspectives in engineering (statement 3-5, PEO 3), with an agreement rating of 44%.

Table 7. Summary of ME alumni responses on the importance and achievement of the PEO (N=56)

| | | Agree | Not sure | Disagree |
|---|---|---|---|---|
| 1-1 | The ME Program has given me a strong foundation in *mathematics.* | 43 | 9 | 4 |
| 1-2 | A strong foundation in mathematics *is important* for the kind of work I do. | 40 | 9 | 7 |
| 1-3 | The ME Program has given me a strong foundation in *science* (physics, chemistry, materials, etc.). | 49 | 6 | 1 |
| 1-4 | A strong foundation in science *is important* for the kind of work I do. | 50 | 5 | 1 |
| 1-5 | The ME Program has given me a strong foundation in *engineering fundamentals.* | 53 | 3 | 0 |
| 1-6 | A strong foundation in engineering fundamentals *is important* for the | 54 | 2 | 0 |

| | | | | |
|---|---|---|---|---|
| | kind of work I do. | | | |
| 1-7 | The ME Program has given me a strong foundation for *graduate work.* | 23 | 29 | 4 |
| 2-1 | The ME Program has prepared me well for *hands-on laboratory work.* | 41 | 9 | 6 |
| 2-2 | Hands-on laboratory work *is important* for the kind of work I do. | 46 | 2 | 8 |
| 2-3 | The ME Program has given me the necessary skills to work with *computers* (doing design, simulation, data acquisition and processing). | 37 | 7 | 12 |
| 2-4 | Computer work (design, simulation, data acquisition and processing) *is important* for the kind of work I do. | 46 | 2 | 8 |
| 2-5 | The ME Program has given me the necessary skills to *find information* and *learn on my own*. | 42 | 10 | 4 |
| 2-6 | The ability to find information and learn on my own *is important* for the kind of work I do. | 55 | 1 | 0 |
| 3-1 | The ME Program has given me good communication skills. | 36 | 13 | 7 |
| 3-2 | Good communication skills *are important* for the kind of work I do. | 52 | 3 | 1 |
| 3-3 | The AE / ME Program has given me good *interpersonal, team,* and *leadership skills.* | 37 | 13 | 6 |
| 3-4 | Good interpersonal, team, and leadership skills *are important* for the kind of work I do. | 53 | 3 | 0 |
| 3-5 | The ME Program has given me a *broad knowledge* as well as *an understanding of multicultural* and *global perspectives* in engineering. | 24 | 15 | 17 |
| 3-6 | A broad knowledge as well as an understanding of multicultural and global perspectives in engineering *are important* for the kind of work I do. | 36 | 11 | 9 |
| 4-1 | The ME Program has given me an *understanding of the ethical choices* inherent in the engineering profession to provide for issues such as public safety, honest product marketing, and respect for intellectual property. | 31 | 14 | 11 |
| 4-2 | An understanding of the ethical choices inherent in the engineering profession to provide for issues such as public safety, honest product marketing, and respect for intellectual property *is important* for the kind of work I do. | 51 | 4 | 1 |

**Employer Surveys**

Only two AE and six ME employer surveys were received through Spring 2005. The small number of surveys does not allow for any safe conclusions to be drawn. However, it is noted that the comments about both the AE and the ME graduates hired from SJSU were positive. The ME employer surveys came from companies that had hired 14 of our BSME graduates. Table 8 shows a summary of their responses. The majority of them agreed that the skills described in the PEO are important in the kind of work they do. Moreover, the employers who responded agreed that the ME program had adequately prepared our graduates in most of the skills implied by the PEO. However, in some of the skills, such as hands-on laboratory work (statement 2-1, PEO 2), broad knowledge / understanding of multi-cultural and global perspectives (statement 3-5, PEO 3), and understanding of ethical choices (statement 4-2, PEO 4)], the agreement ratings were low.

Table 8. Summary of ME employer responses on the importance and achievement of the PEO (N=6).

| | | Agree | Not sure | Disagree |
|---|---|---|---|---|
| 0-1 | We are very satisfied with the SJSU mechanical engineers we have hired. | 6 | 0 | 0 |
| 1-1 | SJSU mechanical engineers have a strong foundation in *mathematics.* | 5 | 1 | 0 |
| 1-2 | A strong foundation in mathematics *is important* for the kind of work we do in our company. | 5 | 1 | 0 |
| 1-3 | SJSU mechanical engineers have a strong foundation in *science* (physics, chemistry, materials, etc.). | 5 | 1 | 0 |
| 1-4 | A strong foundation in science *is important* for the kind of work we do in our company. | 6 | 0 | 0 |

| | | | | |
|---|---|---|---|---|
| 1-5 | SJSU mechanical engineers have a strong foundation in *engineering fundamentals.* | 5 | 1 | 0 |
| 1-6 | A strong foundation in engineering fundamentals *is important* for the kind of work we do in our company. | 5 | 0 | 1 |
| 2-1 | SJSU mechanical engineers are well prepared for *hands-on laboratory work.* | 3 | 3 | 0 |
| 2-2 | Hands-on laboratory work *is important* for the kind of work we do in our company. | 4 | 2 | 0 |
| 2-3 | SJSU mechanical engineers have the necessary skills to work with *computers* (doing design, simulation, data acquisition and processing). | 5 | 1 | 0 |
| 2-4 | Computer work (design, simulation, data acquisition and processing) *is important* for the kind of work we do in our company. | 5 | 1 | 0 |
| 2-5 | SJSU mechanical engineers have the necessary skills to *find information* and *learn on their own*. | 5 | 0 | 1 |
| 2-6 | The ability to find information and learn on their own *is important* for the kind of work we do in our company. | 6 | 0 | 0 |
| 3-1 | SJSU mechanical engineers have good communication skills. | 6 | 0 | 0 |
| 3-2 | Good communication skills *are important* for the kind of work we do in our company. | 6 | 0 | 0 |
| 3-3 | SJSU mechanical engineers have good *interpersonal, team,* and *leadership skills.* | 5 | 1 | 0 |
| 3-4 | Good interpersonal, team, and leadership skills *are important* for the kind of work we do in our company. | 5 | 1 | 0 |
| 3-5 | SJSU mechanical engineers have a *broad knowledge* as well as *an understanding of multicultural* and *global perspectives* in engineering. | 2 | 3 | 1 |
| 3-6 | A broad knowledge as well as an understanding of multicultural and global perspectives in engineering *are important* for the kind of work we do in our company. | 4 | 1 | 1 |
| 4-1 | SJSU mechanical engineers have an *understanding of the ethical choices* inherent in the engineering profession to deal with issues such as public safety, honest product marketing, and respect for intellectual property. | 3 | 3 | 0 |
| 4-2 | An understanding of the ethical choices inherent in the engineering profession to deal with issues such as public safety, honest product marketing, and respect for intellectual property *is important* for the kind of work we do in our company. | 2 | 4 | 0 |

**Advisory Board Input**

It was decided that each program should have its own advisory board, so that all the sub-disciplines and industry sectors within each program could be adequately represented. The members of each board were carefully selected from industry to represent all levels of experience and practice, from freshly employed graduates to seasoned engineering veterans in supervisory roles. Each board convened for a full day to accomplish two objectives: (a) validate our definition of the PEO, and (b) determine whether the PEO are addressed well through the current AE and ME curricula and if not, make recommendations for improvements. The results of their input are summarized in tables 9 – 12.

Table 9. PEO importance rating by the AE Advisory Board

| | Average | BM1 | BM2 | BM3 | BM4 | BM5 | BM6 |
|---|---|---|---|---|---|---|---|
| PEO 1 | ***5.0*** | 5 | 5 | 5 | 5 | 5 | 5 |
| PEO 2 | ***4.2*** | 4 | 4 | 4 | 4 | 4 | 5 |
| PEO 3 | ***4.2*** | 5 | 4 | 3 | 5 | 3.5 | 4.5 |
| PEO 4 | ***4.0*** | 4 | 4 | 4 | 4 | 4.5 | 4 |

How important is this PEO?

5: Very important. 4: Important. 3: I am not sure. 2: Not important. 1: Irrelevant / should not be included.

Table 10. PEO assessment by the AE Advisory Board

| | Average | BM1 | BM2 | BM3 | BM4 | BM5 | BM6 |
|---|---|---|---|---|---|---|---|
| PEO 1 | ***4.0*** | 4 | 4 | 4 | 4 | 4 | 4 |
| PEO 2 | ***4.1*** | 4 | 3.5 | - | 4 | 4 | 5 |
| PEO 3 | ***4.6*** | 5 | 5 | - | 4 | 4 | 5 |
| PEO 4 | ***4.0*** | 4 | 4 | - | 4 | 4 | 4 |

How well is this PEO addressed through the AE curriculum?
5: Very well. 4: Well. 3: Adequately. 2: Not adequately. 1: It is not addressed at all.

The response of the AE Advisory Board was almost unanimous that all four PEO are important (table 9) and that all four PEO are addressed well through the AE curriculum (table 10). The Board made the following recommendations intended to further strengthen the quality of the AE Program:

a. Introduce an aircraft systems course as an elective.
b. Require linear algebra (Math 129A) of all majors.
c. Introduce an AE Seminar where guest speakers from industry highlight the latest advances in the field as well as opportunities for employment.

Table 11. PEO importance rating by the ME Advisory Board

| | Average | BM1 | BM2 | BM3 | BM4 | BM5 | BM6 | BM7 |
|---|---|---|---|---|---|---|---|---|
| PEO 1 | ***5.0*** | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| PEO 2 | ***3.5*** | 3 | 4 | 4 | 4 | 4 | 3 | 3 |
| PEO 3 | ***2.2*** | 3 | 2 | 1 | 3 | 2 | 3 | 2 |
| PEO 4 | ***2.2*** | 2 | 2 | 2 | 3 | 3 | 2 | 2 |

How important is this PEO?
5: Very important. 4: Important. 3: I am not sure. 2: Not important. 1: Irrelevant / should not be included.

Table 12. PEO assessment by the ME Advisory Board

| | Average | BM1 | BM2 | BM3 | BM4 | BM5 | BM6 | BM7 |
|---|---|---|---|---|---|---|---|---|
| PEO 1 | ***5.0*** | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| PEO 2 | ***4.8*** | 4 | 5 | 5 | 5 | 5 | 5 | 5 |
| PEO 3 | ***4.2*** | 5 | 3 | 5 | 3 | 5 | 4 | 5 |
| PEO 4 | ***3.2*** | 3 | 3 | 3 | 3 | 5 | 3 | 3 |

How well is this PEO addressed through the ME curriculum?
5: Very well. 4: Well. 3: Adequately. 2: Not adequately. 1: It is not addressed at all.

The response of the ME Advisory Board was unanimous regarding the importance of PEO 1 (table 11). However, several members were not sure whether PEO 2 was important and they seemed to agree that PEO 3 and 4 are not important. In regards to how well our current ME curriculum addresses these objectives, the Board found that the first three PEO are addressed very well, while the last one is addressed adequately (table 12).

**Assessment Summary**

Attempting to summarize and interpret the various inputs from all the constituents is not an easy task, especially when this input is sometimes conflicting. Nevertheless, it is worth the effort since the purpose of program assessment is to (a) establish strengths and ensure a continuation of the practices that maintain these strengths, and (b) reveal weaknesses and inform the necessary changes for correcting these weaknesses.

In regards to the appropriateness of the PEO: The constituents established that the PEO defined are appropriate for both programs. An interesting exception to this was the input from the ME Advisory Board, which ascertained that only PEO 1 and 2 are important. Along similar lines, ME employers indicated that they do not consider an understanding of ethical choices essential for the kind of work they do. Nevertheless, PEO 3 and 4 will be maintained for the ME Program because (a) they were affirmed by all the other constituents, and (b) they contain important skills spelled out by ABET in the 11 outcomes of Criterion 3 (ex. communication, broad knowledge, ethical understanding, etc.).

In regards to the achievement of the PEO: In general, the constituents agreed that both programs meet all four PEO, albeit with some weaknesses in (a) mathematics and science skills adequate for entry into a graduate program, (b) writing skills, (c) professionalism and ethics, (d) management and business skills, and (e) broad knowledge and understanding of multicultural and global perspectives (ME).

## Conclusion

The paper described the design and implementation of a systematic process for defining and assessing program educational objectives and presented the results from the first cycle of assessment for the AE and ME Programs at San Jose State University. The two programs were evaluated in 2005. ABET evaluators found the approach described here most comprehensive and expressed their satisfaction that together with the outcomes assessment[2] it can indeed be used to ensure the continuous improvement of the programs. Obviously, for this to happen, the loop in figure 2 must be closed by designing and implementing curriculum changes to address the weaknesses identified.

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