Response to EAC Draft Statement
Environmental Engineering

1. CRITERION 2: PROGRAM EDUCATIONAL OBJECTIVES (WEAKNESS)

The program evaluator identified two areas where clarification and/or remediation was required. 1) Several of the published objectives seemed to be oriented to attributes that students will have upon graduation, rather than after a period of time at the workplace. 2) The review of the PEOs seems to be excessively driven by the faculty rather than by the constituencies.

In the following sections, clarification and remedial action in each of the two areas of concern are presented. Note that our constituencies are CEE undergraduate students, departmental faculty and lecturers, program alumni, and their employers, and Advisory Board members.

1.1 Rewording of our PEOs

As described in Section 2 of our self-study, it has always been clear to us that the PEOs reflect broad career accomplishments that we would like our graduates to achieve within 3-5 years of graduation. These are clearly distinct from program outcomes. We acknowledge that the wording of the 2006 PEOs may have been confusing, blurring the line between accomplishments which are typically objectives, and preparation of graduate towards certain endeavors, which is typically an outcome. The ABET review provided an opportunity to review our PEOs.

After the ABET site visit, we sought input from all of our constituencies and reworded our PEOs to ensure they meet ABET Criterion 2. More specifically the following was accomplished since the site visit:

1. The CEE faculty discussed the comments made by the ABET reviewer in several faculty meetings. The existing PEOs as well as the process by which we arrived at the PEOs were reviewed and discussed, and specific improvements to the process and to the PEOs were proposed.
2. Selected constituencies were then consulted to provide input of the PEOs and propose revisions.
3. A survey of our constituencies was conducted to determine the importance our constituents give to selected accomplishments.
4. The feedback served to draft revised PEOs.
5. Approval of the revised PEOs was voted by the CEE faculty.
6. The revised PEOs were presented and approved by the College of Engineering Executive Committee.
7. The revised PEOs were published on our web site (see http://www.engr.ucr.edu/chemenv/abet/env.shtml). These new PEOs will be published in UCR's general catalog for the new academic year.

In crafting revised PEOs, we identified the fact that the revised PEOs needed to be faithful to core values and objectives for our graduates in their early careers that have spelled out, both in the past and through the most recent polling by CEE faculty and CEE program constituencies.

Thus, the revised PEOs do not represent a totally new direction for the program, but rather a rewording of broad career objectives and career accomplishments for our graduates. They read as follows:

The program educational objectives are to produce graduates who demonstrate in their careers and professional pursuits, the following:

- An ability to apply mathematics, engineering principles, computer skills, and natural sciences to environmental engineering practice.
- Application of fundamental environmental engineering principles at an advanced level, and competence in synthesizing knowledge from multiple disciplines to develop and evaluate design solutions.
- Engagement in environmental engineering careers in diverse areas including sustainability, air quality and pollution control, water quality engineering, bioremediation, and green engineering.
- Pursuit of graduate education and research in environmental engineering at major research universities.
- Exercise of professional responsibility and sensitivity to a broad range of societal concerns, such as ethical, environmental, economic, regulatory, and global issues.
- Effective performance in a team environment, outstanding communication, and involvement in personal and professional growth activities.

1.2 Process for Establishing and Reviewing the PEOs

The process for establishing the PEOs was described in Section B 2.3 of the self-study. In short, our program educational objectives evolved from those set at the inception of the ENVE program and our first ABET visit in Fall 1994. Over the years, these educational objectives were modified, most importantly in 2000 and 2003 based on inputs from faculty, results of surveys, and input from selected constituencies. Since our program is relatively young, and since there is a significant lag between any change and measurable effects, changes to the PEOs have been relatively subtle after the 2003 changes.

Even so, as was stated in the Self-Study, a yearly review of PEOs is formally conducted by the faculty at the annual faculty retreat. Also, each year, the departmental Advisory Board provides input at the annual meeting. It is true that although we conducted several surveys on the degree to which the PEOs were achieved, there was no formal mechanism for feedback on the PEOs themselves by undergraduate students, by program alumni, and their employers. These are important constituencies.

Thus, subsequent to the ABET visit, we modified our process to formally include all of our constituencies (CEE undergraduate students, departmental faculty and lecturers, program alumni, and their employers, and Advisory Board) in the review and development of our PEOs. The revised process conducted since the ABET visit was presented in the previous section and is not repeated here.

Regarding the input of our constituencies, which is the main point made by the reviewer, a web-based survey was sent to all our constituencies (except for the CEE the faculty whose input was deliberately collected separately so as to separate its input from this of other constituencies). The results of the survey are presented in the table on the next page. They show a strong need for demonstrated application of math, engineering and computer skills at the workplace (Q1, Q2, Q4, Q5), and very strong needs to reach effective team work abilities and communication (Q7, Q8). The results highlighted that alumni found that the ability to apply natural sciences at the workplace was not a very important educational objective (Q3). Also surprising was that interdisciplinary career paths (Q11) scored low with the Advisory Board. The comments section where additional desirable accomplishments could be listed by respondents provided interesting views about the need for professional preparation of graduates in order for them to become successful professionals. These are captured in the CEE core values and in our PEOs, and together with upcoming feedback, they will continue to guide us in our continuous improvement process.

Overall, the survey was found to be an effective means to collect feedback from a diverse pool of constituencies. This kind of survey will be continued in the future. As mentioned earlier, the results of the surveys were used to formulate the revised PEOs, which have now been adopted.

The CEE faculty and CEE ABET Committee are convinced that the revised process now includes all constituencies is an improvement over the past practice and that it is in full compliance with ABET Criterion 2.

2006-2007 Program Educational Objectives (PEOs) Survey and Feedback

You have been invited to take this anonymous survey because you are a current undergraduate student, program alumnus, employers of one of our graduates, or a member of our Advisory Board. As part of our continuous improvement and accreditation process, we are consulting our constituencies for input to help us revise our PEOs. Thank you for your input.

Please indicate below the degree to which you think the following accomplishments are desirable/important for our graduates in <u>their early careers</u>.

Rating: 1=not important, 2=relevant but not essential, 3=desirable, 4=important, 5=very important

Question 1. An ability to apply mathematics and engineering principles at the workplace
Question 2. An ability to apply computer skills at the workplace
Question 3. An ability to apply natural sciences at the workplace
Question 4. Application of fundamental chemical or environmental engineering principles at an advanced level
Question 5. Competence in synthesizing knowledge from multiple disciplines to develop and evaluate design solutions
Question 6. Exercise of professional responsibility and sensitivity to a broad range of societal concerns, such as ethical, environmental, economic, regulatory, and global issues
Question 7. Effective performance in a team environment
Question 8. Outstanding communication skills
Question 9. Involvement in personal and professional growth and development activities
Question 10. Suitable preparation for entry into graduate programs and research at major research universities
Question 11. Engagement in an interdisciplinary careers path

Table 1. Results (±standard deviations) of the PEOs survey conducted early 2007. Note that because of the close connection between the chemical and environmental engineering programs, the survey does not distinguish between chemical and environmental engineering constituencies. (N=number of responses)

	Quest. 1	**Quest. 2**	**Quest. 3**	**Quest. 4**	**Quest. 5**	**Quest. 6**	**Quest. 7**	**Quest. 8**	**Quest. 9**	**Quest. 10**	**Quest. 11**
Current students (N=11)	4.5±0.5	4.4±0.6	4.1±0.6	4.8±0.4	4±0.7	4.3±0.5	4.6±0.5	4.5±0.6	4.1±0.6	4.6±0.6	3.8±1.1
Alumni (N=21)	4.3±0.7	4.7±0.5	3.3±1	3.4±1	4.2±0.9	3.8±1.2	4.6±0.6	4.5±0.7	4±0.8	3.8±1	3.9±1
Employers (N=9)	4.6±0.5	4.6±0.7	4±0.7	4.3±0.7	4.6±0.7	4.4±0.5	4.7±0.4	4.5±0.7	4.2±0.6	4.1±1.3	3.8±0.9
Advisory Board (N=10)	4.6±0.5	4.4±0.9	4.2±0.6	4.6±0.5	4.1±0.7	3.9±0.8	4.5±0.7	4.2±0.7	3.6±0.8	3.2±0.9	3.2±1
All (N=51)	4.4±0.6	4.6±0.6	3.8±0.9	4.1±0.9	4.2±0.8	4±0.9	4.6±0.5	4.4±0.7	4±0.7	3.9±1	3.7±1

List other career and professional accomplishments you feel are important, or any comments you wish to add:
Results:

- Flexibility in the working environment
- Computer programming, Foreign language skills and as broad as possible curriculum are in my opinion essential for early success in the workplace.
- A desire to continue learning new things. To be willing to except new task outside of the areas of their training. My example: I was educated as an Environment Engineer. As a design engineer I had to investigate cases of employees injured on the equipment. I also spend a year or more working on the redesign on cone crusher.
- A desire to solve the problem correctly. A passion for getting it right. This isn't something easily taught. It is usually passed on by example; from a professor that has true passion and desire to pass it on. If you have a professor like that on your staff, you must have that professor teach the class that is required by all students, such as a laboratory class where there is more interaction that just lecturing. Engineering is more than a job, it is a responsibility to society. The students coming out these days don't seem to hold that value. It needs to be reinforced.
- Ability to contribute to the profession, very broadly defined
- An unstoppable, career-long, desire to examine, explore and invent. A will to build and create.
- Communication is the most important aspect - both verbal and written. Breaking down technical information to pieces of information that relates to real world. Common sense evaluation of the problem presented is the most important skill most undergraduates these days are lacking, but is the most needed in the work place.
- Creativity
- I think the program prepared the students more for entering a graduate program versus entering the workforce. The few graduates who chose to enter the workforce were on their own to gain experience before graduating. More emphasis should be placed on preparing students for entering the workforce.
- How to go about creative and innovative problem solving, and how to lead others with integrity and inspiration. Becoming a balanced and dynamic engineer and person in the workplace is a necessity.
- I feel there needs to be a much stronger focus of professional and personal development. Particularly in a scientific field, where, say, personality is not a strong suit, we don't want our students to be taken advantage of by the strong social culture in the US. The program is intense for the students, and having gone through it years ago, we may forget how difficult and time consuming it was. I think there should be more effort to teaching the students how to network to develop their sales, communication, and presentation. More than just "lab presentation". Make industry night mandatory for example. It is far too easy to churn out followers, instead of leaders.

2. CRITERION 3: PROGRAM OUTCOMES AND ASSESSMENT (CONCERN)

The concern of the reviewer is that "the process in place for direct assessment of program outcomes seems not to be capable of distinguishing the performance of one program outcome from another. […] The program should modify the assessment process to establish a unique or nearly unique association between program outcomes and student work."

This is an issue which has stirred considerable debate both in the department and at the College level, since all programs use a very similar assessment method to evaluate the program outcomes. Although we strongly believe that the assessment method allows us to distinguish the success in individual outcomes without interferences from other outcomes, we are sensitive to the reviewer's concern.

Our assessment method has been elaborated over the past few years, and has been subject to many discussions, most of them at the College level, since the core principles of our assessment system are common to all programs. The system evolved over time. We were heavily inspired by a paper titled "Designing and Teaching Courses to Satisfy the ABET Engineering Criteria" by Felder and Brent. We use the same matrices that correlate course objectives to program outcomes, and use individual problems and student work (not course grades) to assess the degree to which each course objective was met, and therefore, by association, the degree to which each program outcome was reached. In devising our assessment method for continuous improvement, we were mostly guided by three main objectives. The assessment method should 1) allow us to determine whether all program outcomes are covered adequately at a sufficient level, 2) allow us to determine whether students demonstrate proficiency in these outcomes, and 3) guide us with our continuous improvement process.

We have demonstrated that our method does well in all three aspects. Over the past years, we have put the system to the test, and our data show that it works well. Two of our faculty in the College-wide ABET Committee are experts in data-mining, and they stated that what we do makes sense, and that the observations made are relevant. We also see a agreement between data collected from our direct assessment method, and our other assessments, for instance the exit survey.

However, it is also evident that the matrix method is quite complex, with several layers of calculations between inputs and outputs, which may have been a factor in the reviewer's concern. Thus, we believe that the best response to the concern is a very careful evaluation of our assessment method over the 06-07 academic year to demonstrate the unique association mentioned by the reviewer. This is an ongoing process which includes evaluation of data significance, and determination of the sensitivity of the output to the degree of orthogonality of the course assessment matrices. A correlation with an alternative assessment method will be attempted. This evaluation will be completed at the end of AY 06-07 and will be presented at the next scheduled ABET evaluation.

3. CRITERION 8: PROGRAM CRITERIA (CONCERN)

There was a concern about the criterion that a "majority of those faculty teaching courses which are primarily design in content are qualified to teach the subject matter by virtue of professional licensure, or by education and equivalent design experience". While the criterion was said to be satisfied, the possibility that changes may weaken this criterion was raised by the reviewer.

The Chair of the Department who makes teaching assignments has taken note of the concern and will be carefully monitoring the situation. In addition, future hiring in environmental engineering will consider professional licensure and education in design experience in hiring decisions. This will ensure that the criterion remains satisfied.