The 2004 CWEA conference closing session views the future

Panel tackles question of improving the partnership between academia and the profession

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This is a summary of the closing session of the CWEA 2004 conference, held in Fresno. We are grateful to the panelists for the opportunity of presenting their views on the future of our profession. This article wouldn't have been possible without their support of providing the outlines of their presentations prior to the closing session and of reviewing the manuscript. Special thanks are due to Mike Selna, Glenn Daigger and James Clark, who also provided us with copies of their presentations, additional material and final comments and reviews.

On April 30, the closing session of the 2004 CWEA conference in Fresno brought together a distinguished panel of experts to offer their thoughts on moving "TOWARDS A BETTER PARTNERSHIP BETWEEN ACADEMIA AND THE PROFESSION." Even though the session was held on Friday afternoon well after the final technical session, an audience of over 100 was present to exchange views and concerns with the panel. Each panel member gave a 10-minute presentation discussing the relationship between academia and the conditions facing practicing engineers. During the break, the audience submitted questions, which were discussed with the panel in the second part of the afternoon. The speakers were, in order of appearance:

- Mike Selna, Deputy Assistant Chief Engineer for the Los Angeles County Sanitation Districts
- Gary Bleeker, Executive Vice President and National Director of Water for HDR Engineering, Inc.
- James Clark, vice president and senior project manager of Black & Veatch Corporation
- Robert Ooten, Director of O and M and Collections for the Orange County Sanitation District
- Michael Stenstrom, Professor of Civil and Environmental Engineering at UCLA
- Glen Daigger, a Senior Vice President of CH2M HILL

Reza Iranpour, from the City of Los Angeles Bureau of Sanitation, was the chair and moderator of the session.

Mike Selna began the session by exploring the question: "will the supply of qualified environmental engineers meet the future demand?" As shown in Figure 1, the demand side of the equation is driven by decaying infrastructure, population growth and changing regulations. Mr. Selna presented a summary of the ASCE infrastrucutre report card that rates the nation's wastewater infrastructure as D+. According to California population statistics, the state's population will nearly double by 2050. New treatment technologies such as membrane treatment and UV disinfection, which are emerging in response to more strict regulations add to the complexity and volume of work by environmental engineers. The supply side of the equation is dominated by declining enrollment in environmental

***Figure 1.** Excerpt from presentation by Mike Selna*

Growing demand for engineers	*Decreasing supply of engineers*
Decaying infrastructure	*Declining enrollment*
Population growth	*Curriculum shift*
Regulatory changes	*Aging work force*

engineering, a shift in curriculum away from traditonal water/wastewater engineering, and by the aging workforce (Figure 1).

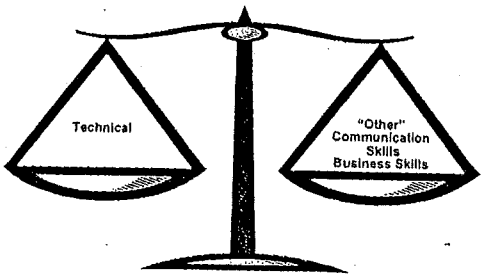
Selna presented results of a recent survey of major universities showing significant declines in the number of students enrolled in masters degree programs in environmental engineering. He also stated that while it is important to have breadth and innovation in the curriculum, core coursework in water/wastewater engineering is needed to prepare practicioners who will be prepared to work on infrastrucutre related problems. The aging workforce will soon decrease the numbers of environmental engineers who are available to manage the increasing demand. In conclusion, Selna offered a concrete proposal to stimulate enrollment in environmental engineering programs in the form of a loan pool. Prospective students could compete for funding with the understanding that if they would work for a funding participant, repayment of the loan would be avoided. He invited participation by prospective funding participants who may contact him for details.

Gary Bleeker's topics focused on additional considerations that have long been important to environmental engineering practitioners. In addition to citing the importance of technical skills in a manner similar to Mr. Selna's concern, he described two other key areas of skills as being equally important for a well-rounded engineer. One area, which he called "Management Skills," is the ability to deliver solutions that meet the goals of a project within its constraints, typically budget, schedule and environmental constraints. As the ability to mathematically optimize environmental processes alone is not enough, engineering students should be stimulated to develop the judgment and ingenuity that are required to balance projects' goals and constraints. These skills are equally important whether working for industry, for governmental agencies, or as a consultant.

"Team Building and Participation Skills" was the third key area discussed by Mr. Bleeker. Students need to be taught the ability to work as a team and to build consensus. He noted that environmental engineering projects are never the work of one person, but involve collaboration and cooperation between consultants and clients, or between multiple members of a design team. In addition, public involvement and environmental review processes require extensive interaction with public officials and public interest groups. These skills of personal relations and communication are as crucial for the success of a project and the career of a professional engineer as technical and management skills.

James Clark's discussion of professionalism provided additional perspective on the combination of skills and character desired for new entrants to the profession. In his introduction, he cited the importance of broadening the curriculum to balance technical skills and communication and business skills (Figure 2).

Figure 2.
Excerpt from presentation by James Clark



Students need to be well prepared for public speaking and presentations, technical writing and establishing interpersonal relationships. They also need the business skills to manage projects, which includes sufficient familiarity with contract law to be able to deal both with contracts for professional engagement and for construction. Mr. Clark noted that the need for a broader curriculum has remained the same for decades, but that the students have changed over the years. The challenge to academia and industry is to broaden the curriculum in such a way that the present generation of students will be attracted.

He also emphasized the importance of faculty mentorship to promote professionalism among students. Students should be encouraged to participate in ASCE/WEF student chapters and professional societies and develop other extracurricular activities, such as writing about their research, both in peer-reviewed journals and in more informal publications. There are many possibilities for students to become more professionally involved during their study, as Mr. Clark noted: ➢

- Stockholm Junior Water Prize
- WEF student chapters
- WEF Student & Young Professionals Committee
- WEFTEC Student Program
- Communicating with CWEA Professionals
- Participating in the Toastmasters

All of these might help students to develop their communication skills.

On the other hand, Mr. Clark emphasized the importance for students to develop design skills, and he encouraged participation in WEF-sponsored design competitions. He also noted that there is an important role for the professional community to nurture the students' skills once they enter the "real world." Entry-level engineers should be mentored and encouraged to participate in professional associations and conferences. They should have the opportunity for further training in their technical, communication and business skills.

In his conclusion, Mr. Clark pointed out that students and young environmental professionals also have the responsibility of taking charge of their own destiny. He said that professionalism is more than a 9-to-5 job of developing designs on the computer, and that young environmental engineers should make use of the many opportunities that are being offered during their studies and in their early careers.

Robert Ooten complemented the previous talks by discussing various economic and demographic issues that may have caused the shortage of environmental engineers and blue-collar trades that is currently experienced by the public utilities. One issue is that salaries in environmental engineering have tended to lag the pay in some other engineering and related fields, such as electrical engineering and computer science. In addition, years of downsizing and hiring freezes have had significant impacts in the ability of public organizations such as the Orange County Sanitation District to attract new talent.

There is now more preference for experienced engineers, because there is insufficient time and money for training young engineers. Although this may be a short-term solution, the downside is that future students are less motivated to enroll in environmental engineering courses. This may ultimately cause the abolishment of these programs and a depleted supply of new engineers and talent that will be felt when the current work force is eligible for retirement.

A similar situation exists for the supply of blue-collar trades. Due to the uncertainty in future employment of their students at public utilities, local colleges in Orange County have abolished certain specific training programs that prepare the students for working at these agencies.

It can be foreseen that these trends are not likely to be reversed any time soon if one considers the potential impact of California's current budget crisis on the future hiring policy of many public organizations. An additional problem specific for Orange County is that agriculture in this county is disappearing as metropolitan areas continue to grow. As a consequence, several local college programs that provided training in the blue-collar trades of agriculture have been abolished. This will have an important impact on the total pool of blue-collar trades in Orange County. In his final remarks, Mr. Ooten addressed his agency's succession planning. He estimated that up to 20% of his agency's workforce will soon be eligible for retirement, partly due to a retirement incentive that will be offered in 2005. He concluded by saying that the aging workforce is a general concern that many agencies are facing, which further emphasizes the need for strong educational programs at our local colleges and universities that will attract students.

Michael Stenstrom added his perspective on the current academic situation in which money is tight, most of the students are foreign, and new biological knowledge offers new opportunities for research, but poses questions of how to apply the resulting new understanding. As a currently active university professor, he is particularly familiar with the difficulty of finding support for academic research and for the cost of graduate education in general.

Nowadays, education is more and more considered a net present worth problem, with university administrators being more interested in the funds and

income a discipline can create rather than the relevance and impact of that discipline on society. In addition, new faculty members are under great pressure to publish and to create new income. He agreed with the previous speakers on the importance of giving students work experience before they complete their degrees and the need to prepare students to deal with the economic, political, legal, etc. issues that may arise in their work, as well as with the kinds of technical matters that arise in practice.

Another aspect is provided by the relative predominance of foreign students in graduate engineering programs in recent years. They have kept university enrollments up when there were very few students from the United States, but of course many foreign students return to their home countries when they complete their educations.

Another significant concern is that environmental engineers have known very little about most of the organisms that they exploit in waste treatment, so he said that he is interested in applying new microbiological and molecular biological knowledge to environmental engineering, but recognizes that finding useful applications may be difficult.

Glen Daigger came last because his note to the session organizers offered to discuss some concrete questions about responding to the many issues and challenges presented by the previous speakers.

As illustrated in Figure 3, he started his presentation by first describing the professional engineer: the ability to apply science ("systematic knowledge"), the ability to apply empirical knowledge and to deal with uncertainty (inherent to all engineering projects), and the ability to be professional by relating to the needs of the public. To produce an educated and capable professional, however, a partnership between academia and the engineering practice is needed. Figure 4 demonstrates that a command of technical fundamentals and interpersonal skills are elements of the formal education at college or university, but the first job is as important, since it allows the young engineer to obtain empirical knowledge and "street-smarts." Social science fundamentals are not part of the engineering curriculum and they are usually not provided during the first job; however, they are an essential part of the engineer's education as well.

As a prelude to the discussion with the audience, Dr. Daigger addressed several issues from previous presentations and raised additional questions. Referring to the presentation by Dr. Stenstrom, one issue was the underfunding of university programs and the financial hardship of new faculty members. Research grants have become the largest single source of funding, so many engineering faculty lean more towards science than engineering, as most of these grants are used for research. Although this is understandable from an economic point of view, a result is that new faculty members and their students have less opportunity to build up empirical knowledge.

Another point was related to Dr. Stenstrom's discussion of foreign students. Internet communication ➢

Figure 2.
Excerpt from presentation by Glenn Daigger

WHERE CAN THE ELEMENTS REQUIRED FOR A SUCCESSFUL ENGINEER BE ACQUIRED ?

	All Required for Registration		
	Formal Education	Continuing Education	Professional Experience
"Street Smarts"			✔
Interpersonal Skills	✔	✔	✔
Social Science Fundamentals	✔	✔	
Applications Experience	✔	✔	✔
Technical Fundamentals	✔	✔	

Figure 3. Model of a professional engineer

Professional	*Engineering*	
Ability to relate to needs of people	*Science - "systematic knowledge"* ⊕	*Applications knowledge:* • *Empirical knowledge* • *Dealing with uncertainty*

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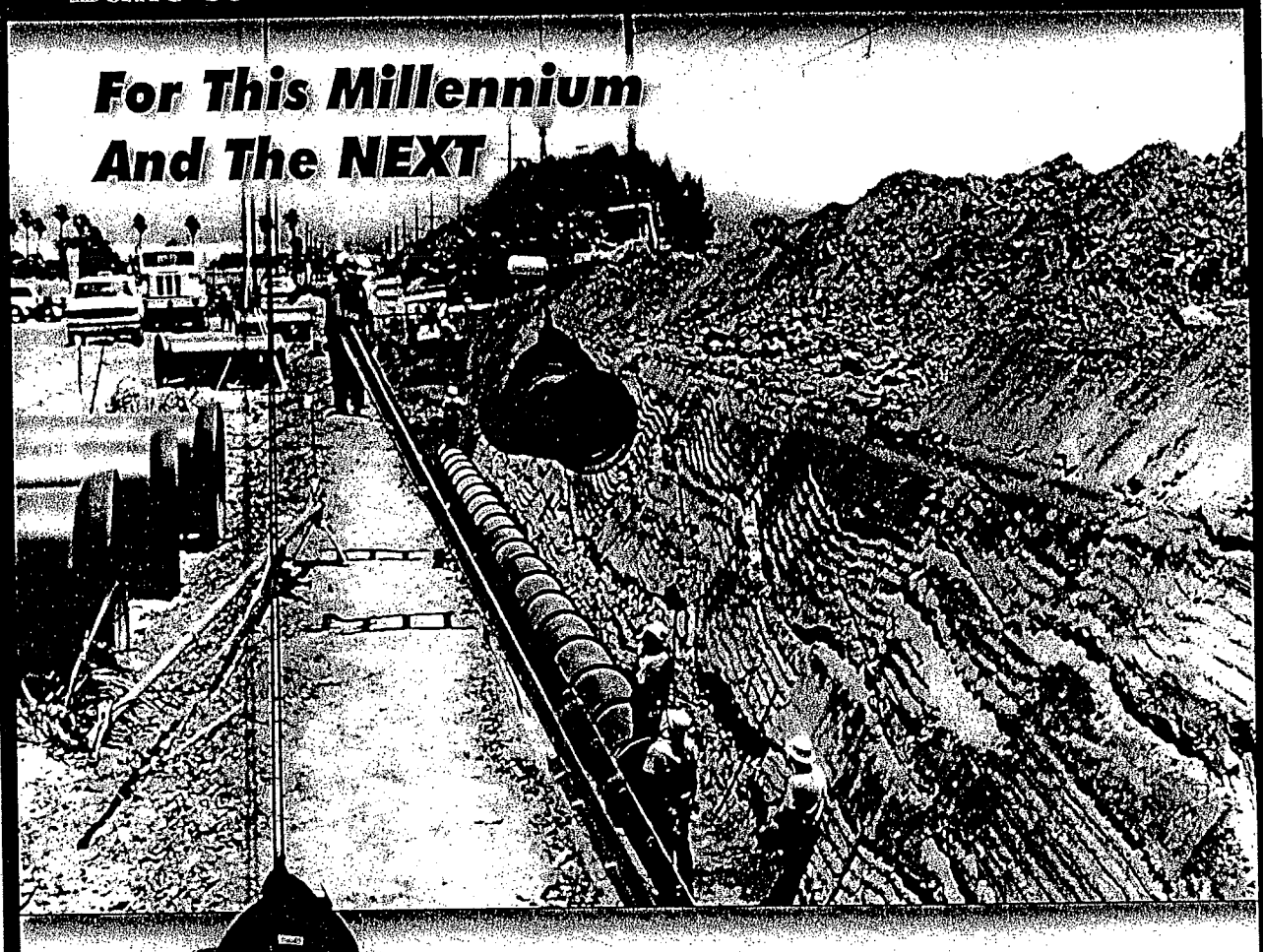

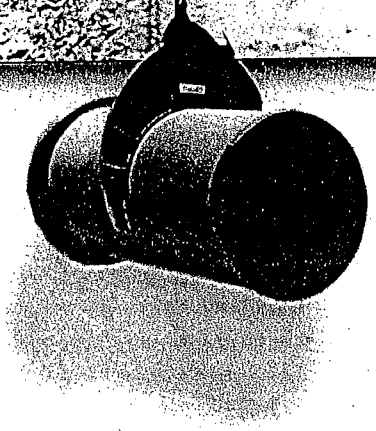

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technology now makes it possible to "off-shore" engineering tasks in a way that could not be done a few years ago, so that engineers who live in the United States are competing for work against people who returned to their home countries after being foreign students, and against anyone else who is able to work remotely for a lower price.

Thus, there are economic pressures to treat engineering services as a commodity, rather than as professional work. Hence, one of his questions for responding to the present challenges was whether efforts need to be made to elevate the engineering profession to a status more like that of the medical profession. In particular, he asked whether it would be wise to change the current emphasis on the Master's degree as the professional degree in civil engineering in general, not just environmental engineering. An increase of the status of the environmental engineering profession by raising salaries would be another option to attract new talented engineers. He challenged the audience to think about what an academic/industry partnership would look like if they wanted to encourage a better model for developing young professionals.

The second part of the afternoon was a discussion between the audience and the panel. Everyone in the audience was given the opportunity to submit written questions, which were centrally displayed for review and prioritization by the same audience. This format ensured a lively discussion between the audience and the panel members. In the following, we bring a selection of the various issues that were brought forward by several members of the audience, including Dr. David Jenkins (UC Berkeley), Dr. J.D. Neetling (HRD), Joe Haworth and Michael Creel (L.A. County Sanitation Districts), Mary Hoda (City of Fresno), Pamela Neronha (Water Dynamics), Justyna Kempa-Teper (Kennedy/Jenks Consultants), John Quigley (City of San Diego), Margaret Regan (CH2M HILL), Leon Holiday (Coachella Valley Water District) and others.

One of the first questions addressed the expectations of some panel members regarding the engineering curriculum that universities should offer their students. Since the Bachelors program entails only four years, it was questioned whether it is reasonable to expect that engineering students are fully prepared as professional engineers at the time they receive their degree. In short, we should be happy if they have a full understanding of the engineering fundamentals and are capable of clear communication. As such, employers have the important role of further training and educating their new employees, in particular in those skills that go beyond the technical skills.

In relation to this issue, it was noted that universities have possibilities to engage students in practical research by establishing partnerships with other organizations. An example of such a partnership is the temporary employment of environmental engineering students by public utilities to conduct their masters or Ph.D. projects. This would be beneficial for all parties involved. The students would have the opportunity of gaining empirical knowledge in the real world while at the same time earning additional income. On the other hand, the utility would be able to address some of its problems at a relatively small cost, while the quality of the work is ensured by supervision of the professor.

Examples are the internship programs offered by the Los Angeles and Orange County Sanitation Districts and the Bureau of Sanitation of the City of Los Angeles. In the latter case, undergraduate, graduate, and postdoctoral students have the opportunity to work on specific projects that are conducted at the City's wastewater treatment plants. Likewise, universities can develop industrial-oriented educational programs to prepare students for meeting industrial demands. For instance, the Environmental Science and Engineering (ESE) program at UCLA is very intensive and oriented on the practice of engineering. ESE graduate students take series of core and problem courses, while Ph.D. students will need to do an internship for at least two years in a governmental agency, national laboratory or the private sector.

Another issue brought forward by the audience was the concern for growing competition from engineers from other continents, as they are often capable of delivering their services at a lower cost than domestic engineers. In response, it was noted that the outsourcing of engineering work in the wastewater industry is still relatively rare, but there is some reason for concern because engineering services are ➢

more and more often considered to be a commodity. Still, the nature of engineering work at wastewater treatment plants is often very specific, unlike for instance in the energy industry, so that the physical presence of the engineer at the wastewater treatment plant and direct interaction with the client are crucial for the success of the project.

One of the questions of the audience was: "How can industry encourage practical research?" One of the panel members confirmed the importance of conducting practical research by students and faculty members of universities, but cautioned about the institutional barriers that may lie ahead when trying to establish a partnership between, for instance, a university and a public utility. Examples are, for instance, insurance issues when students are temporarily employed by the utility, as well as potential conflicts of interest when confidentially of the research results is requested by the utility. The panel also emphasized the importance of the Water Environment Research Foundation (WERF). This organization provides funds for very important research that is relevant for the wastewater industry across the nation, but, unfortunately, these funds are very small compared to the potential advantages for the wastewater industry and society.

Although the panel focused their presentations mostly on academia and the environmental engineering curriculum, several questions from the audience were related to operators and technicians at wastewater treatment plants. One response was that the training of operators is a responsibility of local community colleges rather than university. Nevertheless, it was generally agreed that frequent interaction between academia and operators is crucial for faculty and students to learn what is really happening at the plants. Rather than seeing operators and engineers as two different entities (e.g., blue versus white collar), it would make much more sense if they work together as a team as the ultimate goal for both trades is the same. However, as Mr. Clark pointed out in his presentation (Figure 5), a prerequisite for such teamwork is that the engineer is capable of effective communication, which is not always the engineer's strongest ability.

The closing session ended half an hour later than scheduled. Nevertheless, several groups continued

their discussions outside of the conference room. This exemplifies the importance of the topic as well as the great contributions from the panel and the audience. Since there was not enough time to discuss all the questions that were brought forward by the audience, we list some issues below that were not fully discussed or were barely mentioned, in the hope that they will stimulate additional consideration of how to improve the partnership between academia and the engineering profession:

- Why is it important for senior management to be registered engineers?
- Should it be emphasized to the government that enrollment of environmental engineers is declining and that university budgets for engineering education should not be cut further?
- How can we get high school students interested in environmental engineering rather than in more glamorous fields like computer science?
- How can you teach engineers to communicate with the public, operators and maintenance more clearly?

If one steps back and looks for a wider perspective on all of this, it seems fair to say that few people in any technical field are satisfied with the relationship between industry and academia in their field. For example, an editorial by Donald Kennedy in Science (v. 302, p. 1293, 21 Nov. 2003), titled "Industry and Academia in Transition," commented on the breakdown in biology (at least in medical and pharmaceutical areas) of the old arrangement under which universities did basic research and industry carried out the development needed to convert the research results into commercial products. On the other hand, that particular arrangement has usually not been characteristic of environmental engineering, where the nature of research and development is a little different.

Figure 5.
Excerpt from presentation by James Clark

In 1976, Samuel Florman's The Existential Pleasures of Engineering cited the need for a broader curriculum

Engineers have a high level of mental energy and are "Intelligent, energetic, unassuming people who seek interesting work"

But... "The typical engineer avoids introspection and dislikes ambiguity. Although he gets along well enough socially, he would rather deal with things than with human beings."

Perhaps the most instructive comparison between environmental engineering and many other fields is the great contrast in the time scales with which the respective fields must deal. Computer capabilities continue to change rapidly, and patent protection for a new pharmaceutical lasts only for a few years, but the work of environmental engineers lasts for decades or centuries, and the effects of some types of pollutants may last for millennia. Perhaps the key to dealing with the specifics with which most of the time of the closing session was occupied is for industry and academia in environmental engineering to recognize their common interest in convincing government, the corporate world, and technically oriented potential students of the importance of considering a career in water quality.