Where Will We Get the Transportation Engineers and Planners of Tomorrow?

LESTER A. HOEL, FRANCIS B. FRANCOIS, AND GEORGE R. LLOYD

LESTER A. HOEL

New transportation professionals will have to work in a changing world with new technology. This new environment will place increasing demands on the education and training that they receive. New transportation professionals must, in effect, emerge with new skills.

Two reports provide an excellent starting point for those interested in this topic. One is a summary of a conference held in Williamsburg about 4 years ago dealing with transportation education and training: *Meeting the Challenge*. This conference examined education and training needs of transportation professionals in the future, recognizing that we had a crisis in research funding and in the number of students that were entering the transportation field. The report recommended the type of education that the transportation professional in the twenty-first century needs.

The other is TRB Special Report 207, *Transportation Professionals: Future Needs and Opportunities*. This study was also completed about 4 years ago and dealt with the impending personnel crisis expected from the loss of professionals who would be retiring in the late 1980s and early 1990s. Incidently, AASHTO participated very heavily in that report and provided the database. The professional study needs examined the current and projected supply of new graduates, particularly in civil engineering, as that source has continued to supply the bulk of professionals for the highway transportation field.

The study confirmed that a generational shift will occur in the highway transportation field during the next decade and that a third of the professional work force would be retiring. The study included a state-by-state analysis and showed that some states were worse off than the average and would face severe personnel shortages in the next 10 years.

The good news was that these changes need not necessarily create a severe crisis if agencies planned ahead. Because the losses would be at the upper levels, they would create room at the top for people within the organizations.

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The study found no current shortage of civil engineering graduates at the entry level. It did predict that if present trends of declining enrollments and a lower share of engineering graduates continued, a problem would exist within 3 to 5 years as the number of new jobs became greater than the states' historical share of recent graduates. That is exactly what has happened.

The report also noted enhanced opportunity in the highway transportation field for young people, but observed that it will be necessary to get the message out to those young people because other exciting fields such as computer science, aerospace, and electrical engineering have demonstrated needs and higher starting salaries.

The study examined and suggested several ways that agencies could cope with the coming turnover in professional ranks. These include developing improvement programs such as job rotation and managerial training to prepare younger employees for more senior positions.

The study also suggested that agencies periodically review their recruitment procedures and policies to ensure they are competitive. Students who are graduating and can choose to work for your agency or work some other organization will be looking at what your organization has to offer. They certainly will consider salary, but they will be interested in other considerations as well: work conditions, employee benefits, and opportunities for growth and development.

The TRB professional needs study also recommended using computers to increase productivity, and recommended employing consultants to handle specialized and peak loads. Today many state DOTs are using consultants and have incorporated computers into the workplace. The study suggested reassigning job responsibilities, modifying job entry requirements and making greater use of technicians, where appropriate; in other words, utilizing personnel in more effective ways.

In light to these studies, how is the problem being perceived today and what are we doing about it? One measure of the problem is its attention in the media, and by professional organizations. Within the last 6 months, *Engineering News Record* has devoted two articles to this subject. One dealt with the loss of senior highway personnel and focused primarily on the CEO problem and turnover at that level. The second focused on the entry-level problem with an article entitled, "Construction Moves to Groom Talent That Will Propel It into the 21st Century."

Just recently, *The Washington Post* had an article on this problem. I am sure many of you have seen it. Two of the people at the head table (Mike Meyer and Frank Francois) were quoted in that article. The title of the article was "Government Highway Engineers: A Vanishing Breed."

At the organizational level, AASHTO has completed a study of professional needs which we will hear about later, and ITE has recently published a report called "Attracting Students to a Professional Career in Transportation Engineering."

I would like to review some of the problems and strategies that have been identified in these articles and reports. All recognize the shrinking labor pool, that there are fewer young people to recruit. In addition, they foresee a further decline in enrollments in engineering, and greater attraction to nonconstruction disciplines by engineering students, where there is a perception of job security and higher wages.

Mentors and role models for women and minorities are lacking. If everyone else is going to other fields, they are not likely to be any different. A failure to motivate students at an early age to pursue math and science and the lack of involvement by industry and government to support education and training is also cited. A lack of certain skills, particularly in design, hazardous waste management and other areas; an unwillingness to transfer to high-cost locations; and reduced image of public service are further impediments. Engineers simply do not see the career ladder leading to the top as they used to.

Other problems include perceived lack in quality and fewer role models in engineering schools owing to the increased number of foreign nationals who are teaching. We are also seeing an increased number of foreign nationals who are studying. A survey of U.S. engineering schools with transportation programs today would show that half of all the students at the graduate level (Masters or Ph.D.) have a first degree from another country.

Now, what are we doing about it? We are certainly boosting efforts to nurture and recruit young professionals, developing new approaches to keep employees in place and happy, and increasing our presence on campus with more aggressive recruiting. Our field has fewer recruiters than other disciplines and our students are aware of this. They look at the private sector recruiter and ask where the jobs are.

Students need more personal contact with the people in the field. Attending career days, visiting minority schools, linking senior people with new recruits, mentor programs, going after underutilized sectors of the engineering profession, hiring people who have taken early retirement, and paying higher salaries are all important strategies.

Money, however, still is a principal factor. Adding other financial incentives may be necessary, along with accommodating the new phenomenon of the two career family with day care and other modifications in the work environment so that two career families can manage. Providing sabbatical leaves away from the job, tracking high-performance employees, giving recognition, and assuring continuing training of the better people are also means of attracting personnel.

We must also become involved in developing the engineering curriculum, promoting 5-year programs that include business and communication skills. Direct involvement in the high schools is needed, as is development of professional society media materials, to let young people know the excitement and the challenges of this profession.

To summarize, I believe the next decades will be challenging ones in transportation. Our new professionals must have broad-based skills, particularly analytical skills, communication skills, skills in dealing with computers and a perception of where we have been, how we got there, where we are going. Then they must understand the world around them because the 1990s will be the global decade.

Our transportation organizations must create an attractive environment to ensure that employees remain current through continued education and job rotation, but they must also provide adequate compensation. Educators and practitioners must convince young people of the challenges in this field and begin to attract high quality young people to the profession.

This message was first delivered in the TRB transportation professional needs study of 1985 and it is being echoed by various sectors of the industry today. We have thoroughly described and documented the problem. What is needed now is to get busy. Employers, universities, faculty, professional organizations and associations, the federal, state and local government, all of us, must work as a team to solve the problem.

Francis B. Francois

Let me tell you a little about what is happening inside AASHTO, and then make a few observations.

Many debates are indeed taking place on the issue of training transportation professionals, and recruiting and retaining them over time. Les has covered this topic well. Perhaps I can add to the discussion by reviewing some of statistics on civil engineering students that I think are particularly interesting.

The trend over the past 12 years has not been very encouraging. In 1976, the total of all engineering degrees awarded in this nation was 37,970. By 1981 the total was nearly 63,000 engineering degrees, of which some 10,000 were in civil engineering; in 1987, only 8,000 of the 75,000 engineering degrees, were in civil engineering. We actually lost ground.

So, it is quite clear that we are not attracting the people into the engineering field that we should be. As Les has outlined, a number of groups are looking at this issue, including the National Society for Professional Engineers and ASCE. It was one of the topics at ASCE's conference on 21st Century Highways held recently in San Francisco. Also reviewing the problem are ITE, TRB and others, including AASHTO.

Obviously, many factors are involved. Within AASHTO, we decided last year to look at what is happening in the states and gather information from our member departments. Last July we surveyed all our member departments and in December published the results in a report that summarizes the responses from 41 states, Puerto Rico, and one Canadian Province. Some states, therefore, are not included, which means the results are somewhat understated. All our member departments should now have a copy of the report, which is entitled *Transportation Professionals: Recruitment and Retention.*

The report analyzes a number of areas at the state level, including salaries, recruitment problems, etc.; our results gen-

erally conformed to the conclusions outlined in the previous paper in this proceedings.

Our survey found that some departments currently have no recruitment problem, while others do. Of 41 departments responding, just about half said that they have no current problem. About half of those, however, expected to have a problem in 5 years. The greatest area of variance in terms of recruitment is in general civil engineering, but vacancies also exist in the specialties. We specifically tried to identify the number of vacancies existing at the time of the survey. Vacancies, of course, can change month by month, but at the time of the survey period, approximately July through September of 1988, about 390 vacant civil engineering general slots existed. Vacancies for construction engineers were next at 118, followed by design engineers, 91; traffic and maintenance engineers, 70; right-of-way engineers, 69; materials engineers, 52; and bridges and structures engineers, 50.

So, most of the specialties had shortages, but the greatest problem remains simply getting enough new people into the transportation field. Some states went into great detail on their recruitment activities. Carl Williams from California reported in our survey, for example, that his department had hired approximately 1,100 engineers nationwide since September 1987, making civil engineering very much a growth industry in that state.

Florida reported that all districts were having problems recruiting registered professional engineers. The State of Washington said that "the pool of traffic engineering specialists is diminishing inverse to our increasing needs."

We also looked at salary levels because this is one of the big issues. The survey asked for starting salaries for a B.S. degree and starting salaries for an M.S. degree, for both civil engineering generalists and specialists in areas where the states say they have problems. One intriguing result is that salaries are essentially flat across the board: civil engineering generalists, bridge and structures persons, and other specialists all receive the same entry-level salary. There is no differential, moreover, at least in the first year, in the salary level for a B.S. and an M.S. degree. So, there is little incentive to go to school an extra year if it merits no additional pay. I am sure that at least some people who look at this situation have this attitude. After a few years, however, things improve. The ranges for starting salaries are quite wide. Of those states reporting, the low for a starting civil engineer was in Indiana, $16,749. The high was in Alaska, $28,326. In Puerto Rico, the starting salary was $13,044.

After 2 years, things improve generally everywhere. The lowest state salary for civil engineers after two years of employment was in North Dakota, $19,565; in Alaska, at the other extreme, it was $33,648 plus all the oil you can eat, I think. The average reported salary after 2 years had gone to $28,807. So a person can up fairly quickly, but even so, the overall scale is quite low.

Asked whether starting salary is a problem for civil engineers, only 12 states said "yes." Now, either they do not know they have a problem or they do not have one. I am not sure which. In any case, many states perceived no real need for help on the starting salary issue.

The survey found that computer specialists with B.S. degrees are generally paid higher salaries than civil engineers in some nine states, and lower in other states. The highest salary reported for this category was in New Hampshire, $30,751; Alaska reported $30,216. The lowest starting salary for a planner was in West Virginia, $13,872; the highest was in Massachusetts, $30,737. Landscape specialists received $16,380 in Arkansas, compared with $32,215 in Massachusetts.

The largest number of "yes" responses was to the question of whether it is hard to recruit planners. Seven states and Puerto Rico said that they cannot get planners at the salaries they are paying.

We need to remember that these job descriptions obviously vary from state to state, as do salary levels. Also, the data are for one point in time, 1988, and salary structures can change.

We also looked at recruitment practices. What is it that the states are doing, and what techniques do they use? Les Hoel reviewed some of them in the previous paper. Summer employment is one practice used by many states. About 31 states use it in some form, bringing in students during the summer with the hope that they will return and stay. On the other hand, few member departments go out into the high schools and talk about engineering. Twenty-eight respondents did not, but some are now looking at it. About 30 states actively work with college students other than at recruitment time.

Another interesting program used by 11 departments is to operate an arm of the state highway agency within the civil engineering school, where students can do real work on the state highway network.

Student mentor programs, which groups like the National Society of Professional Engineers and others view as extremely important, are almost nonexistent. Only five states say that they do much in this area.

Some 13 states now use predevelopment career programs, and others are looking at them. In these programs, the departments deliberately go out and recruit students, get them involved on more or less a contract basis while they are in engineering school, and then stay with them so that they ultimately come into the agency and develop a career.

We asked if the department does anything about career development after it employs engineers. Twenty eight states reported that they have formal programs that tend to move new recruits through the positions within the agencies. We asked for details on these programs, such as whether the program offers tuition reimbursement for postgraduate college courses. Some 28 said "yes," to this question and 9 said "no." We also asked whether the program routes the employee through all or several offices of the department in an organized manner. Almost all of the programs do. Some 22 of the states responded that the employee is allowed a choice in assignment after completing the program.

We also asked for quite a bit of information from the states on their current practices on the use of educational materials, outreach materials, etc., and what kind of things they thought might be taken up nationally by AASHTO and others to help matters.

What has happened since the survey? Well, two or three things. One of those is that we sent copies of the survey report to all the nation's civil engineering school for their comments. We received 30 or 35 responses, some very general and some in great detail, commenting on the various subjects in the report. This year, AASHTO made this one of its emphasis areas. President Pitts nominated it as such and our Policy Committee endorsed it. We have since been working quite a

bit in this area. One of the first things we did, as AASHTO often does, is to create a task force on transportation professionals' development and recruitment. It is chaired by Hal Kassoff, director of the State Highway Administration in Maryland, which is recognized as one of the agencies that has done a better job nationwide in bringing people in, training them, and keeping them with the agency.

This task force held its first meeting about 2 weeks ago, and has proposed a three-stage effort to improve the overall quality and supply of transportation professionals. The implementation of that three-stage program will be before AASHTO in the coming months.

We hope to complete the first stage of that program, the one that is felt to be most urgent, by this fall. It is a guide on the recruiting and retention of graduate civil engineers by state transportation agencies. The task force has already produced an outline for this guide. Let me just run through it briefly.

One chapter,of the guide will deal with the formulation of a departmental recruitment and retention strategy, and it will discuss a number of strategies that might be employed by the agency.

Chapter 2 will be devoted to developing and promoting career opportunities at state transportation agencies; it will renew career development programs, scholarship programs, rotational programs, and other things we spoke of earlier.

Chapter 3 will discuss how to cultivate university contacts, drawing on the information we got from the engineering schools, and those practices that the states have found to work. A manual discussing how best to go about this proposal is producing attractive and effective marketing materials. The task force emphasizes Les Hoel's point that our departments of transportation are not present very often on college campuses, and that when we do appear we often do so poorly.

We think that by drawing on the ideas that have worked for our agencies and laying them out for other people, we can accomplish a great deal. Looking at recruitment tactics, we can improve our approach. The response we get in talking to the engineering schools about this area is that for the most part state DOTs are often pure amateurs when it comes to competing against large engineering firms and private industry, that we just do not approach it in a logical way. We can do more with student employment, for example.

As I said, we hope that this effort will result in a draft guideline sometime this fall, one that we can take in front of the AASHTO Executive Committee and that ultimately will give us a handbook that can go to each department's phase of the task force program.

On top of that list is entry-level recruitment and training. It is intended that Project 20-24, the advising panel, which is under the chairmanship of Charles Miller of the Arizona Department of Transportation, will begin to focus more on this area also. Thus, both our task force and Project 20-24 are looking at some of the same issues, and there is a merging of ideas.

One very interesting topic that came up at the task force is that we have all been looking at what college professors, the people in the DOTs, and adults in the general public think about the engineer shortage. Yet no one, to our knowledge, has bothered to ask the students what they think. There is simply no research on this. So, one of the things we are proposing to do is to reach down to the junior high level and do some polling, bring some focus groups together, and see what is on the minds of those students that we are not attracting. We want to talk to them, let them tell us what is bothering them, so that we can respond to it.

So, to summarize the review of Les's comments, problems do indeed exist: The turnover problem is real. The recruitment problem is real, and the problem of not enough people to recruit is real.

The graduate student situation in science and engineering is very unhealthy. It is true that about half of all engineering graduate students are foreign students currently. This is not because they are displacing U.S. students. If that half was not there, most of our graduate schools would close for lack of students.

Whatever the reason, we have a real shortage of graduate students in engineering. Part of the problem is the student financing methods, especially loans. When a student has already acquired a $40 to $50 thousand debt after 4 years of engineering school, how much more education and time can he or she take before starting to earn and paying it back?

I do not know all the answers, but clearly more research grants is one way. AASHTO is working currently on the research agenda for the future, and this issue is something that needs to be included.

Many changes are coming. We have talked about many of them here, including air quality issues. What happens if we change fuels? What happens if liquid fuels as we know them vanish, as some say may happen at the turn of the century or beyond? The Los Angeles air quality plan, coupled with new sources of electricity and superconductivity, should make the electro-vehicle operational. Then what do we do with our current fuel-based user taxes? We will need a new approach to funding. New members, moreover, will present new engineering issues.

Intelligent vehicle and highway systems, computers, and many more developments say that the engineering curriculum must change. ASCE, under a project that Harold Michael of Purdue University has been working on, has tried to identify what the civil engineer of tomorrow is going to look like. He or she will look very different from today, reflecting many of the things that Les was saying earlier.

Typically, tomorrow's civil engineer will have much more of a world view than we have had; a world view on transportation issues from our standpoint. I heard the other day, for example, about a leading West Coast shipping company that uses the Port of New York but has no ships actually going into New York Harbor. Rather, it brings goods from the Pacific Basin and ships them by land across the United States to New York Harbor. From there the goods are shipped by other companies to Europe, and vice-versa. This is the type of new development in transportation with which we have to deal in this country, new ideas on why and how we move freight.

Tomorrow's civil engineer will also deal more with quality of life issues. Tomorrow's civil engineers will be more managers of resources than they have been in the past, and technicians will be employed to do much of what we see now as civil engineering. Tomorrow's civil engineer and transportation professionals, above all, will need to be communicators.

So, we clearly have a lot to do. AASHTO is trying to work with some of the problems. Many things must be done if we are going to get and keep the kinds of transportation professional people we need.

GEORGE R. LLOYD

Both preceding speakers have articulated the problems associated with the current shortage of engineers very well. They have both summarized the approaches to the problem that we in the engineering community are taking, and I will not dwell on that further. Instead, I would like to look briefly at some of the activities of the private sector, and discuss the probable effectiveness of some of these activities.

These same shortage issues are being articulated in the popular press in somewhat different terms than we in the technical community have used. Just in the last week, I read an article in the *New York Times*; one in the *Boston Globe*; a Mobil Corporation editorial in the *New York Times*; and several *Engineering News Record* articles. They were all reporting the results of a National Science Foundation study showing that there would be 96,000 too few engineering baccalaureate degrees by the year 1990 and some 700,000 too few bachelors in engineering and science by the year 2010.

Many explanations have been given for these data. As a community, we understand the raw numerical shortage of individuals. I would like to look at how we are currently attracting people to the engineering disciplines, whether transportation engineering or other related technical fields.

AASHTO has certainly addressed the issue here today. The NSPE, ITE, SAME and other professional organizations have also perceived the seriousness of the problem, and articulated solutions. The private sector is also addressing the problem. On a corporate level, we are involved in Headstart Programs, JUMP programs, and others that attract students at the high school level into an engineering work environment. The hope is that some of these individuals will be impressed with what they see, and continue their education in the technical disciplines.

Within the corporation, we support fellowship programs designed to improve internal technical skills and also attract entry-level people with the offer of chances to improve skills. Other firms are using similar programs to make employment as a working engineer more attractive.

I think at this time it is worthwhile to take a look at what we are doing, a back-check if you will. We have sent a loud message that a numerical shortage of skills exists. We have postulated some solutions. We have articulated programs to implement these solutions. We are spending money and other resources to solve this perceived problem.

All these things are happening at the macro level. I would like to look at the micro level, to see how our message is coming across. To look at how some of our programs are being implemented, and see if the results from the other end of the pipeline will be as we had hoped.

I recently read an article containing remarks delivered at a conference by Bob Gibson, president of the National Society of Professional Engineers. He states that

> Our experience dictates that new hires must be technically competent, but they must also be behavioral scientists and they must be pragmatic managers all rolled into one package. The current crop of engineering school graduates does NOT meet these standards.

Later on at the same conference, General Henry Hatch, former U.S. Army chief of engineers, stated that

> American-schooled engineers have difficulty communicating with their foreign peers. They possess an insufficient knowledge of the internationally accepted metric system. They have a poor understanding of foreign cultures, and they often have differing professional expectations in such areas as ethics and the pace of work. Possibly, the worst of it is engineering arrogance among U.S. practitioners, who mistakenly believe that the American way is the only way. There are other solutions.

What I am getting at is that we have calculated some numerical shortage, and we have come up with ways to address that numerical shortage. We have perceived some lack of needed skills, and come up with programs intended to get around the problem. I think, though, that we should now look at the quality side of the equation, in addition to the quantity side, and be sure that the things that we are doing are, in fact, having the effect that we intended. In particular, I would like to discuss some of the current trends in my own practice.

My practice has relied heavily on automation of the design process. At a typical magazine stand, you can find about 25 periodicals devoted to that subject. The process is called CAD, CADD, CAE, CAM, CAD/CAM and a host of other alphabet soup acronyms. All the publications go on at great length about "automating the design process." But what exactly does that mean?

The meaning we find at the engineer's level is not quite what we were all led to believe a few short years ago. Yes, I believe that computers are getting us a better constructed product. That is so because we are more exhaustively analyzing alternatives in the construction process, and we are analyzing them in greater depth.

We are getting a constructed product that is more cost effective, that is not going to be functionally obsolete as quickly, and that is more durable in the construction form. At the designer level, however, at the practicing engineer's level, we require MORE manpower and we require better manpower, smarter manpower, to ensure that the information that the computer generates for us is realistically used and is understood and fed into the construction process.

Expecting that computer-generated improvements in productivity will reduce the need for skilled engineers and technicians is not realistic. The classic labor saving from automation does not cross over into the design professions. Automation is resulting in a more efficient deployment of capital, but we are not saving engineering labor. Quite the opposite, we need more and smarter engineers to take advantage of this tool. Perhaps in addressing the sheer numerical shortage of engineers we should also be focusing on the quality of the education each engineer receives.

It has become faddish to analyze this problem by looking deeply into our national psychology and wringing our hands at how the Japanese educational system, or the Taiwanese work ethic, or something else is leading to our downfall. We see articles stating that our educational system is a flop; our industrial base is antiquated; Americans are lazy and on and on.

I would like to present some of my own observations on this subject, and see if they are not similar to yours. I would like to examine whether the problems are as deep as they seem, or perhaps the interpretation of our needs has not been well articulated.

I have a daughter who is in kindergarten. Computers are very popular in kindergarten. I also happen to have computers

around my house. I walked into my home office one day to see what was causing the loud banging noise. What I discovered was that my kindergartner was banging the $200 mouse up against the side of the $6,900 display to take out her frustration. When she saw me, she angrily told me that "the computer crashed, again!"

What she meant was that she could not get the CAD software to work. Her diagnosis was cute, but technically incorrect. The little tyke handed the computer a bunch of garbage and the computer balked at processing it, but the computer had not crashed at all.

I thought that it was rather clever of her, though, to come up with that technological term for her problem, at least until I discovered the source. A few weeks later I was in her school for open school week. School officials proudly drag you through the "computer center." It was quite a sight. There was every brand of computer, with all the screens colorfully lit with some educational software or other. All except for one screen, which was blank, except for that familiar little blinking "C:>" prompt.

When asked about the errant screen, the teacher said, "Oh, yeah, that darn machine is always busted. Mr. Somebody is the only one who knows how to fix it when it crashes, and he is not here tonight."

Well, that was where my daughter learned to say that the computer "crashed." The real problem was that the teacher did not know a DOS prompt when she saw one, or how to start an executable program, or even how to find one to start.

In fact, the teacher was a little frightened of all those machines. And the teacher is supposed to be the one imparting information about computers to kindergartners. What I learned was, for me, very revealing. I had gladly paid school taxes all these years. I have been guest speaker at all of the schools over the years, and I have talked to students to see what they were doing and why, but I never bothered to find out what the grade school teacher knew about the subject. No one had bothered to tell the teacher what a DOS prompt was or how a PC works.

This is not a gross problem, nor a macro problem. It is a micro level problem. Our message is not being translated properly at the local level, but it is probably something we could all help to solve in our local school districts.

I also happen to have two daughters who are of college age. In fact, they are past college, and both have completed higher education. They are both math majors, and have both done graduate work. They are very bright and they have some of the same characteristics as some of the recent hires at the office. The college grads from engineering schools are very good at technical subjects. They are very bright. They can solve problems far more efficiently than I could at a similar stage, and the colleges are to be commended for their ability to impart technical skills.

What they cannot do is write a report, or speak or write coherent English. I can trust them to solve engineering problems. I cannot trust them to explain that solution to someone else. I can turn them loose with a computer, and they will solve a problem. I cannot turn them loose with a client, unless I am standing there with a muzzle for them. They will not communicate their ideas, they will not listen and hear the ideas of others. They are talkers, but not listeners. They are not really communicating.

I then thought over my daughters' college experience, to see if I could fathom a reason for the communication skills going so badly awry. In their freshman year, I remember being very impressed with the curriculum. They had history, science, literature, language, and of course, math. By their sophomore year, it was philosophy, economics, Western civilization, and math and more math. By the time they got to graduate school, what they were taking was Easypass 1.1 and Easypass 2.1, and then math, math, math, math, and math. It is not surprising, then, that the students who came out the other end thought that Wagner was a colorless alcoholic beverage, or that Edgar Allen Poe was a Wall Street LBO firm, nor that they cannot hold a meaningful conversation or write a literate report.

The students will learn, of course, in time to sort out those things that are important beyond the mere technical subjects. But perhaps the college curricula, and particularly the ordering of the college curricula, is worth looking at, to see if our message about the kinds of people we need is being properly translated. Maybe the arts and humanities ought to be taught last, so when they have their grounding in technical subjects, they are then forced to grapple with the harder subjects, and see the relevance of what they are doing in the context of history.

We send messages in the work place, also. We are sending messages to these new hires, and my kids for one are reading the messages loud and clear. The overt message is that "we need more engineers." One look at their career path, however, will show that they do not believe us, and that they are avoiding the traditional engineering disciplines. Instead, they are becoming managers or analysts, and handling other resources. And it does not take a very long conversation with them to discover why. My daughters may not yet have learned to appreciate great literature, but they can crunch all of the information out of the *Wall Street Journal* in about 15 minutes. They are no dummies when it comes to their pocketbooks.

Look at what we are doing in the engineering community, in the state highway and transportation departments, the users of all of that engineering talent that we keep saying we need. What we see are things like salary caps and freezes on reimbursement. When the State agency can no longer hire talented employees, they give work to the consultants, but then they impose on them the same salary caps.

Entry-level people are no dummies. No one ever told Ivan Boesky that he was going to have his salary capped. He might have other problems, but he never had that one. The message is loud and clear. It becomes even more barbed when the corporate marketer, lawyer or accountant is excused from the salary cap, but not the engineer.

The message to the prospective engineer is that the starting salary may be acceptable, but there is a limit as to how far you can go. Your starting salary may be good, but your ending salary is already known, and that may not be so good.

We also impose overhead limits on engineering design firms. Do an audit, and take a look at what gets squeezed out of the engineering overhead budget. Invariably, it is the technical development items. The technical conferences, the seminars, the training sessions. Inhouse research and development is a thing of the past in the engineering community.

The overt message about the shortage of engineers is being heard, as evidenced by the attention in the popular press. But the covert message, the real message, to the prospective engineer, is also being heard loud and clear. At the practitioner's level, we are still saying "don't bother—no money here." I

do not believe that that is the message that we are intending to send.

In summary, I ask that you look at the message that you are sending to prospective engineers. See if it is the right message. Be more demanding in your standards for professionals, rather than less demanding. But look in personally on the results of those demands. Look at the way your message is being interpreted and communicated in your workplace. And look at your community and your schools as well. Be sure that the message getting through from kindergarten to graduate school is the one you thought you sent. And be sure that the messenger is prepared to interpret your message properly.