

could have hired, they would have hired. My informal survey told me that we have a real shortage of engineers in North America. Let us look at the future. We know that the supply of U.S. born students is declining. We also know that many engineers in government will be retiring. Furthermore, in the past ten to twenty years government did not hire as many engineers as they had previous to that time. We have a reduction in supply and an increase in demand. We need to look for alternative sources of supply.

What type of engineers are needed in the future? I don't think it is a question of whether an engineer is foreign born or U.S. born, but a question of abilities. We need engineers with good technical skills, with related experience and with good communication skills. Just as a new U.S. graduate must be shown how to utilize his/her engineering education, foreign engineers must also be shown. The total effort for the U.S. graduates and for the foreign engineers may be the same; however, areas of emphasis for each one may be different.

In conclusion, let me say I don't think it is important whether a person's engineering knowledge has been acquired in the U.S. or in a foreign country. We should continue to use foreign engineers in the United States as we have done in the past and use them for their experience and their expertise, and also to compensate them fairly for their efforts.

There are differences between foreign and U.S. born engineers that can be minimized. This is a task that we can accomplish. Our anticipated supply of new engineers will fall short of our future needs. To achieve our goals we need engineers with good technical skills, related experience and communication skills.

Foreign Engineers--Implications for Transportation Engineering:  
Public Sector Perspective  
by  
George Gray  
CALTRANS District 4

I'm going to speak about the problems that we see as a major employer of the graduates of the various universities.

Since January of 1987, CALTRANS, the California State Department of Transportation, has hired about 1,150 entry-level engineers, 690 in 1988. About half of these are foreign trained or foreign born. Such major recruitment is probably having a significant effect on the pool of potential advanced degree students in the universities. This may become a problem that the universities and we, as users, will have to face in the future. Future masters and doctoral degree students may be siphoned off and we, as a possible employer of those students, should be sensitive to that possibility and consider how we can address the problem if it develops.

For the next several years we hope, with financing vagaries and the political process willing, to hire between 300 and 400 entry-level engineers per year. To give an idea of the diversity of this infusion, in our San Francisco District that now has by far the largest proposed construction program in the state, the makeup of the 376 new entry-level engineers whom we have hired in the last two years is about 8% foreign-born Hispanic, (we have another segment of native-born Hispanic), 9% Filipino, 4% black African, 5% Indian subcontinent, 3% Vietnamese, 11% Chinese, 15% Middle Eastern, and 5% other, including three emigres from Russia and three from Japan.

This diversity provides as example of why communication skills in English is important. It is not only communication between the native-born English engineers within our organization, but also it's the Indian speaking to the Vietnamese and the Russian speaking to the Filipino. So it is especially

important that these foreign-born employees have or develop good communications skills in English.

Of these 1,150 entry-level engineers statewide, only 67 or roughly 3% are foreign trained. Most of the foreign born are products of U.S. universities. Although we recruit nationwide, most of our recruits come from west of the Mississippi. Over the past two years, we've taken much of the graduating engineering classes from many of the western universities. In fact, last year it is estimated that we took 25% of the engineering graduates of all of the engineering schools in the United States who were looking for U.S. employment. To give an idea of the impact, from University of California, Berkeley, we had 69 (11 of those being foreign born), from University of California, Davis, 79. We recruited 20 from three universities in Arizona; from three universities in Utah, 23; from nine institutions in Texas, 59; from Missouri, 20; and from Washington, 11. That gives you an idea of the geographic areas encompassed. From some of the universities in California, we took virtually the entire graduating class.

To give a perspective of the talents these foreign-born engineers bring with them, we have, for example:

Rhodes Scholar from Ecuador with a Master's Degree from University of California, Berkeley.

Czech Ph.D. who has written engineering books in German.

Indian with extensive experience in teaching computer-aided drafting and design.

Three Middle Eastern Ph.D.s in Civil Engineering and one Ph.D. in Environmental Engineering.

Chinese Ph.D. pavement specialist.

Rumanian Ph.D. metallurgist and a Rumanian with extensive rail management experience.

Twenty-five Middle Eastern engineers with Master's Degrees.

Obviously a group with many and diverse talents. In fact, as a group we have no qualms regarding their technical competence and abilities. Further, we have found that many of the foreign-born engineers have positive job attitudes, possibly because they have been identified as role models in their countries of origin and in their own societies and have need to prove themselves in a new environment.

A major factor in the future importance of foreign engineers and the staffing of the state D.O.T.'s is the transitional condition of the average organization. As a group, the state D.O.T.'s are going through a period of massive changes in:

1. Engineering staff with, in our district of the State of California, 30 of the 1985 work force of engineers being replaced due to retirement by 1990.
2. Role, where maintenance and reconditioning of the aging existing facilities is becoming more important than providing new facilities.
3. Management, with, again in our district, 50% of the 1985 managerial leadership to be retired by 1990. This really

means that, considering the promotion of the present younger middle-management engineers, virtually all of the present management positions within the organization will be staffed by recently appointed people by the early 1990's.

In 1987, an in-house report identified that there are five primary obstacles to a graceful transition and renewal of staff. The first of these is the sheer number of engineering professionals who will retire over the next decade (about 200 statewide per year) and the declining enrollment in the civil engineering programs.

The second, is the difficulty in sustaining a systematic and orderly recruitment program in the face of on-again off-again budgeting. As you are aware, in the United States, the political process is such that as you come closer to the time when those in power run for re-election, the work forces of various governmental entities tend to be frozen or reduced if it is at all feasible. However, when new candidates come in, you may have a little window of opportunity to add to the staff, if everything goes well.

The third obstacle is difficulty in recruiting and retaining top-flight professionals given the perception that challenging work is in short supply. This is related to shifting from building new facilities to the reconditioning of old. Many of the younger people want to build something from the unadulterated ground up rather than take something that is already there and convert it for a present-day use.

The fourth obstacle is the thin ranks of mid-career professionals from which to promote managerial leadership of the next generation, and the fifth obstacle is, the profound social and cultural differences between the engineers of the older and younger generations. The author of this report was not thinking of foreign engineers vis a vis native engineers as much as he was thinking of the social and cultural differences between the generations. Those of my generation tended to be, as Les Hoel said, up from the blue-collar ranks. For instance, my parents were blue collar from Nebraska and the next generation back from Czechoslovakia and New England. These generation differences are compounded when considering the social and cultural differences that the foreign engineers inject into this milieu. It is a significant problem.

I worked for two years in Vietnam for a consulting engineering firm and recently for four years in Saudi Arabia. These experiences have given me some insights into the problems that can arise from cultural differences. In some cultures, the engineer is a technical practitioner and not necessarily involved in determining alternatives and impact, as is expected of the U.S. engineer. On the other hand, in Vietnam, most engineers wouldn't think of going out and looking through a transit, as we U.S. trained engineers were expected to do in our early years. In Vietnam, the engineer was supposed to develop the plans and see that the work was done but not do any hands-on work. An engineer was expected to be a technical practitioner but without hands-on involvement.

Also, in some cultures, social training inhibits consensus building where elders are involved. That was certainly true in Vietnam and to an even larger extent in Saudi Arabia.

Another difference is the depth of family responsibilities. In Saudi Arabia, we had examples of senior Saudi engineers that were very capable, but whose ability to be on the job was hindered because of family responsibilities. In one case, the engineer was the oldest son. When his father passed away, he took over as head of a very large extended family. These family responsibilities made it very difficult for him to carry out his engineering responsibilities.

For some cultures acceptance of members of the opposite sex (or minorities to that culture) in an equal working relationship is difficult. We have, so far, only anecdotal instances of these problems as a factor in our organization.

But I'm afraid the underlying social problems may still be there and we should be sensitive to this and work to assure that they are recognized and minimized.

We also, as expected, have identified communication problems. Although almost all of the foreign-born engineers, including those foreign trained, are competent in technical English, we are finding some are not linguistically able to work with citizen and similar groups. Working closely with local citizen groups is a growing and important part of our process. In addition, writing skills are often in need of improvement, a condition that too often also applies to native-born Americans. I urge the universities, and I'm sure that I don't have to worry about urging the two universities represented here, to address the communication problems, i.e. English writing and linguistic skills.

At present, Caltrans is providing some English-as-a-second-language courses to help remedy the communication problems. We realize the needs in this area will probably call for further remedies. I wrote a note to myself that we should broaden our Toastmasters Club involvement in the District and maybe have a special effort to get our foreign engineers involved. As I mentioned, 60% of our entry-level engineers are now foreign born. We've been especially sensitive to this for years in the San Francisco region. In the past, I could walk down the halls in the design area and hear Chinese now and then, but now I hear a polyglot of languages and we have to be alert that we aren't developing cells of engineers with similar native backgrounds; such inbreeding could hinder their full development. For instance, with the Middle Easterners we have to be sensitive to which ones are Sunni and which ones are Shiites to be able to be sure that we are not developing some future problems.

The second area that will require further analysis on our part and may call for special in-house training, includes adding cultural differences topics to our basic supervision courses.

Also, as a major user of graduates, we need to reconsider our, CALTRANS, present lack of full support of our employees who desire to further their university education and also we need to improve our support of the university engineering programs.

We also should encourage our existing staff engineers to become mentors for potential engineering students before they make their career choices in the universities. I know in my case, when I was a young Army recruit, 17 years old and away from home, it happened that friends of my family knew somebody in the city near my base. I was invited to Thanksgiving dinner and the friend happened to be a senior engineer in what was then the Bureau of Public Roads, now known as the FHWA. That contact continued and it affected my career. We find our staff are not doing enough to avail themselves of the opportunities to help increase the number of students in engineering. For instance, involvement in career days that are given in the various high schools. We hope to work more to encourage involvement in that direction.

Before I close, I would like to digress from my main theme to comment on the importance of engineering in the overall scheme of international relations. In Saudi Arabia, for instance, Canadian Bell is very respected because it set up the modern telephone system. Also much of the Saudi's high regard of U.S. technology is due to American engineers, notably those associated with Aramco, who provided the first hospitals, built the first schools, established the first electric light plant and built the first roads in the kingdom. The American engineer has, over the years played an important role in developing countries. It is fitting that many foreign students, impressed by this American role, have found it logical to seek their engineering education in this country. So, not only U.S. trained native students returning to the mother country give a good connection between the countries but the engineering works that we have been able to provide within their country have certainly gained us friends.

In closing, I would like to quote from the NAE report. "Very significant, positive aspects arise from the presence of foreign-born engineers in our society. It must be recognized that with these foreign engineers, the United

States is attracting an unusually gifted group of individuals with high intellectual competence and diligence. The diversity of intellectual background and experience that other foreign-born engineers have brought in the past greatly contributed to the U.S. engineering competence. There are no reasons to believe that the new immigrants will not contribute similarly."

Thank you.

Foreign Engineers--Implications for Transportation Engineering:  
Transportation Industry Perspective

by  
Mike Rougas  
Association of American Railroads

First, I would like to make a comment of personal nature. I was born in Pennsylvania. When I was 2-1/2 years old, my parents returned to their native Greece. I was brought up in Greece just like any other Greek child. I attended elementary school and high school there and I returned to this country when I was 19. I was too young to remember leaving this country and I learned no English until after I returned. In fact, I returned reluctantly. I thought that perhaps my case would be missed by the statistical categories which were mentioned earlier. The presentation was so thorough though, that even my special case is included in one of the several categories mentioned. I am sure this is not the reason I was invited by Dr. Pignataro to speak to you, because he was not aware of my background. The reason why I brought it up at all was to make you aware that I have seen both sides of the fence so that you can phrase your questions any way you like.

Second, I must confess that I do not feel comfortable representing the transportation industry before you today. Although I have been a railroad person all my life, railroads are only part of the huge transportation system we have in this country. I do feel quite comfortable talking about railroading to you and I hope that what I tell you is somewhat parallel to the experience of the transportation industry at large.

After a 36 year involvement in it, I would say that railroading may be defined as a huge engineering undertaking. Although it requires the services of other professions, its demand for engineered solutions to the available alternatives is insatiable. For this reason, the industry generally needs top engineering talent. This may not be obvious to the general public, but it is true. The demand for engineers fluctuates somewhat. Since the deregulation act of 1980, the railroads have become a lot more competitive and more efficient, and in the process, they have reorganized. As a result of this restructuring, the management staff has shrunk and the engineering positions are not as plentiful as they used to be. Some railroads, though, are hiring a few engineering graduates. I believe the long term trend will improve.

I have met and worked in our industry with foreign trained engineers, foreign born engineers trained in this country, and some with training here and abroad. My observation has been that, in general, they have performed very well.

In the railroad industry, the demand for engineering talent falls in three categories. One is research. Major railroad companies have research departments where they employ engineers. Most of the research for the industry, however, is done by the Association of American Railroads. It is in the railroad research field that I have met many foreign engineers and, in my opinion, they have performed very well.

The second type of engineering positions for which normally there is a demand is for filling vacancies in the engineering departments of individual railroad companies. These departments require civil, mechanical, electrical,