

Introduction and Summary
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The TRB Committee on Transportation Education and Training sponsored a session at the 1989 Annual Meeting of the TRB dealing with Foreign Engineers: Implications for Transportation Engineering. The session started with a presentation summarizing the findings of the National Academy of Engineering report, "Foreign and Foreign Born Engineers in the United States."

The remainder of the session focused more sharply on the implications for transportation engineering with comments by panelists representing viewpoints from segments of the transportation community including academic institutions, transportation consultants, public sector, and the transportation industry.

The presentation on the NAE report was made by Dr. Alan Fechter, Executive Director of the Office of Scientific and Engineering Personnel. The panel was composed of:

Dr. Lester Hoel, Chairman of the Department of Civil Engineering at the University of Virginia, who discussed the viewpoint of the academic institutions.

Dr. Walter Kraft, Senior Vice President of the firm of Edwards and Kelcey, who discussed the viewpoint of the transportation consultants.

Mr. George Gray, District Deputy Director of CALTRANS District 4 in San Francisco, who discussed the viewpoint of the public sector.

Mr. Michael Rougas, Assistant Vice President for Research of the Research and Test Department of the Association of American Railroads, who discussed the viewpoint of the transportation industry.

NAE Report

The impact of foreign born engineers on many aspects of our society, engineering profession, universities, other components of the economy and our culture was of sufficient interest that the National Academy of Engineering requested that the Office of Scientific and Engineering Personnel undertake a study of the issues associated with the phenomenon.

Dr. Fechter divided his presentation by first discussing the findings of the NAE report, followed by the issues these findings generated, and ending with the conclusions based on the findings and issues.

The report contained three major findings as follows:

The proportion of foreign born engineers in the U.S. work force has been increasing such that over the ten-year period 1972-82, the percentage went from 8% to about 18%.

An even more dramatic increase took place in the academic sector with the proportion of engineering faculty who were foreign born rising from 10% to about 50% between 1975 and 1985.

The largest proportion of foreign born engineering students, as well as in the work force, in the U.S. are from India and the Middle and Far Eastern sectors of the world.

The impacts of these findings were then examined.

The question of whether these foreign born engineers were needed for the U.S. economy was unequivocally answered in the affirmative. Without these engineers in the work force and

in graduate schools, we would have a very difficult time achieving national goals.

Another question dealt with the effect on engineering education since the presence of the foreign born in faculty ranks is so pervasive. Three concerns were raised, including (1) effect of language barriers, (2) effect on under-represented groups in engineering, i.e., women and minorities, because of different cultural attitudes of the foreign born, and (3) effect on the character of engineering education. These were difficult issues to address. There was a general consensus regarding the first concern in that particularly the foreign born teaching assistants do have adequate written and oral communication skills. However, with respect to the two other concerns regarding effects on under-represented groups in engineering and on the character of engineering education, it was difficult to arrive at a consensus, with little evidence available to support or to refute the allegations. Therefore, these concerns were classified as unresolved issues.

Another question dealt with whether it is a wise policy to subsidize the education of foreign born students. It was also unequivocally answered very positively "yes" since a large fraction of these students stay in the U.S. and contribute to its development. In addition, many of these students have had their education subsidized by the rest of the world through undergraduate education.

Final questions dealt with whether foreign born engineers displace Americans in the work force and in graduate schools and whether their presence has a depressing effect on wages. The response to both of these issues was negative. Although there was no evidence to support any significant difference in salaries of foreign born and American engineers in the academic or industrial sectors, foreign born graduate students apparently can survive significantly better than their American counterparts with the level of stipends provided by most academic institutions.

Based on the findings and concomitant issues, the NAE report contained the following recommendations:

1. It is essential that no restrictive policy be adopted to reduce the number of foreign born engineers from entering the U.S.
2. It is essential to make full-time graduate study in engineering more attractive to American students by providing adequate stipends.
3. It is essential that universities accept full responsibility that new faculty and teaching assistants have adequate proficiency with the English language before allowing them in the classroom.
4. It is essential to improve dramatically pre-college mathematics and science education in the U.S. as a means of increasing the pool of potential engineering students.

5. It is essential to develop more quantitative data to evaluate whether any differences exist in teaching effectiveness and attitudes towards female and minority students between American faculty and teaching assistants and their foreign born counterparts.
6. It is essential to determine what impact, if any, foreign born faculty have on the quality and character of engineering education.

University Focus

Dr. Hoel's remarks focused on the perspective of the university. In this regard, he posed pertinent questions which were responded to comprehensively.

A brief summary of the questions and answers follows:

Question No. 1 - "Why are we seeing so many foreign born students in our engineering programs?"

Answer - The nature of the profession of engineering is such that it can be entered within a shorter period of time than other professional programs, and it is perceived as a field which provides respect and social and economic rewards.

Question No. 2 - "What is the implication for our engineering programs?"

Answer - Deficiencies in communication skills and different cultural backgrounds represent two major problems in the education of foreign born students. These same problems can be significant with respect to using foreign born graduate students as teaching assistants in the education of undergraduate students.

Question No. 3 - "Why are there so many foreign born professors at our universities?"

Answer - University appointments are perceived as prestigious positions and the requirements for advancement are consistent with the attributes of the foreign born with respect to research and scholarly achievements.

Question No. 4 - "Is there a problem and, if so, what should we do about it?"

Answer - Yes, there is a problem, and our system of professional education in transportation can be strengthened if the following policies or actions would be adopted or taken:

1. To attract a larger number of U.S. students to pursue graduate studies, a greater salary differential should be provided for those who earn advanced degrees.
2. To attract a larger number of U.S. students to careers in teaching, adequate financial support should be provided.
3. Adequate background should be required in communication skills and an understanding of the socio-economic environment in the U.S.

4. Greater emphasis should be placed on teaching effectiveness in hiring and advancement policies.
5. The image of engineering as a profession should be enhanced.

Consulting Engineering Focus

Dr. Kraft's remarks focused on the perspective of the consulting engineering firm, and his comments addressed five questions as follows:

Question No. 1 - "What is a foreign engineer?"

Answer - For the purpose of Dr. Kraft's discussion, a foreign engineer was defined as a person who was not born or educated in the U.S.

Question No. 2 - "How have consultants used foreign engineers?"

Answer - Two positive experiences can be cited: (1) U.S. consultants who are engaged in foreign projects as a prime or subcontractor hire local engineers, and (2) foreign engineers employed in the U.S. help a firm meet its affirmative action program. Unfortunately, some foreign engineers have been improperly treated by U.S. firms by providing substandard wages and poor working conditions.

Question No. 3 - "How is the foreign engineer different than the U.S. born engineer?"

Answer - Six differences were identified, including: (1) consideration of whether an individual is legally employable and for what period of time; (2) cultural and religious differences may require considerations of different holidays, restrictive diets for food catering services, religious restrictions affecting working hours, and the need to provide orientation about U.S. culture and how it affects project development and acceptance; (3) work ethic can be described in terms of dedication, loyalty, and hard working; (4) work experience; (5) communication skill deficiencies; and (6) engineering expertise can be described as comparable to their U.S. counterparts.

Question No. 4 - "What is the anticipated future supply of U.S. born engineers?"

Answer - A shortage is anticipated for the foreseeable future.

Question No. 5 - "What types of engineers are needed in the future?"

Answer - Regardless of whether engineers are U.S. or foreign born, they should possess good technical and communication skills and pertinent experience. Good communication skills are of paramount importance for both U.S. and foreign born engineers, and it should be developed by daily applications during the academic year.

Public Sector Focus

Mr. Gray's remarks focused on the perspective of the public sector, and he stressed the problems encountered by CALTRANS as a major employer of graduates from a variety of universities.

CALTRANS hired 690 entry level engineers in 1988 with about one-half being foreign educated or foreign born. Over the next several years it is expected that between 300 and 400 entry level engineers will be hired each year, and it is expected that a high percentage will be foreign born.

The foreign born engineers come from a variety of countries and the greatest majority of them were educated in U.S. universities. This diversity of ethnicity illustrates why possession of communication skills in English is so critical as it provides a common language not only between U.S. and foreign born engineers but also between foreign born engineers.

Foreign born engineers characteristically have technical competence and positive job attitudes.

State DOT's throughout the nation are in a transitional phase in which foreign born engineers may be playing a key role. To illustrate the characteristics of this transition, Mr. Gray used as a microcosm the U.S. CALTRANS District 4 in San Francisco where substantial changes will take place including:

An emphasis on rehabilitating the existing infrastructure rather than providing new facilities.

30% of the 1985 work force of engineers will be replaced by 1990.

50% of the 1985 managerial staff will retire by 1990 to be replaced by current middle-management engineers.

A recent study revealed that there are five primary obstacles to a smooth transition including:

1. The large number of engineers who will retire, about 200 statewide per year, over the next decade while it is expected that enrollment in civil engineering programs will decline.
2. The instability of the budgeting process to provide an orderly recruitment of replacements.
3. The difficulty in providing sufficiently challenging activities to recruit and retain well-qualified individuals.
4. The paucity of middle-management ranks to advance into top managerial staff positions.
5. The social and cultural differences between the younger and older generations which are exasperated by the large number of foreign born engineers in the work force.

Cultural differences between native born and foreign born engineers manifest themselves in a variety of ways including:

In many foreign cultures the engineer is considered to be a theoretician who is divorced from field activities and the evaluation of alternative impacts.

The correlation of age with wisdom and competency.

Family responsibilities transcending professional obligations.

The rejection, as equals, of members of the opposite sex and ethnical minorities.

Deficiencies in communicating skills.

Industry Focus

Mr. Rougas' remarks focused on the perspective of railroad engineering as a microcosm of the transportation industry. The needs of the railroad industry for engineers fall into three categories as follows:

1. Research - Even though much of railroad research is carried out by the Association of American Railroads, major railroads do have research departments.
2. Office Engineers - From various engineering disciplines involved in analysis and design activities.
3. Field Supervision - Requiring the ability to interact with a highly unionized work force. In addition to requisite technical skills, communication skills are of prime importance.

In each of the categories, foreign born engineers have performed well.

Audience Contributions

After the panelists completed their comments, discussion was initiated, and, unquestionably, the audience contributed significantly to the success of the session. Although the audience's comments mainly reinforced those made by the participants, other considerations were identified, including:

1. The great goodwill and economic benefits to the U.S. that are derived from having foreign born engineers who return to their countries after working or being educated in the U.S.
2. The need to provide a greater differential in compensation between recipients of bachelor and advanced degrees in order to attract more American students to graduate study.
3. The need to consider a five-year program for educating engineers. However, the point that was made was not the traditional debate that has been going on for many years about the five-year professional degree being required for technical competency, but that deficiencies exist in the process such that engineers are not being broadly enough educated embodying the concepts of humanism.

In addition, the importance of communication skills was reiterated by members of the audience and discussion led to a variety of suggestions to help overcome these deficiencies including:

1. The need for greater awareness and attention to the problem by the Engineering Societies. One way in which this can be manifested is through ABET accreditation units.
2. The need for foreign born students to associate with Americans to a greater extent outside of the classroom or laboratory. This would force them to use the English language rather than their native language by gravitating towards their own people.

3. The need to make communications an everyday part of the learning experience. It is necessary to use various techniques in both the universities and the work place in developing improved communication skills for primarily the foreign born engineers.
4. The need for state professional engineering boards to require English proficiency as part of the evaluation process.
5. The need to emphasize the role of communications in averting engineering and scientific disasters.

Summary of the Report:
Foreign and Foreign-born Engineers in the United States
by
Alan Fechter
National Academy of Engineering

I am delighted to be here at the Annual Meeting of the Transportation Research Board with this distinguished group of transportation experts to talk about foreign and foreign-born engineers, a subject that involves engineering personnel who work in transportation areas, but which goes much beyond these personnel in terms of its implications. I will try to summarize this report, but there may be points at which my views will creep in. When that happens, I will certainly try to tell you. Of course, my views do not necessarily represent the views of the Committee or the National Academy of Engineering or the National Research Council of which the Office of Scientific and Engineering Personnel is a part.

The study was commissioned because of the rising concern about the growing prominence of foreign personnel both in our engineering work force and in our engineering educational system, particularly in the graduate schools. What the Academy of Engineering asked the Committee to do was (1) to develop all of the relevant issues that might be appropriate to that growing prominence, (2) to assess those issues as best it could, and (3) where possible, to arrive at conclusions about whether this is good or bad for engineering and for the country. The Committee commissioned seven papers, which were presented at a workshop. It gathered every statistic it could find that related to the subject. Finally, it met several times to review the evidence, to review the papers, to review the discussion that took place at the workshop, and to try to develop a report through which its findings could be disseminated.

I am going to talk about the findings briefly, move from the findings to the issues these findings raised, and then turn to the conclusions the Committee reached based on these findings and their deliberation on these issues and to some of the conclusions they didn't reach because they couldn't. And again, I'm highlighting the report. The report contains lots of information so what I present is clearly my perception of what I think are the important findings and recommendations.

There are three major findings. The first was that the proportion of foreign-born engineers (not necessarily foreign citizens, but foreign-born engineers, including both foreign citizens and naturalized American citizens) in the United States work force has been increasing. We were able to find data for the period 1972 and 1982 which described comprehensively the engineering work force in the United States. Thus, over that period, we were able to track the growth. The prevalence of these foreign-born engineers went from roughly 8% to roughly 18% over that period. The largest increase that took place among the foreign born was the increase in the naturalized citizens. So what we are experiencing is no different from what we have experienced in the past; immigration of foreigners to this country in areas of employment opportunity.