

Education Requirements for Transportation Consultants

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For the purpose of this discussion, it is assumed that the type of education primarily being considered at this conference is related to college studies leading to a bachelor of science degree. The papers interestingly cover not only what is being taught, and might be taught, but also what consumers want. This discussion is aimed at training for transportation consultants. However, the more the subject is considered, the more it appears that the training for transportation consultants is not basically different from that desired for all types of engineering consultants.

The ideal in recruiting transportation consulting personnel would be to locate people who have all of the educational backgrounds described in all of the other papers presented at this session--and more. Obviously, this is not reasonable and, perhaps, not possible.

WHAT IS TRANSPORTATION CONSULTING?

It is necessary first to consider what is encompassed in transportation consulting. Although there are some highly specialized transportation consultants in the United States, most of them engage in a broad array of services. Consultants are not usually needed unless (a) the problem is unduly complex; (b) special talents or experiences are required; (c) the magnitude of the job exceeds the capabilities available in-house; or, (d) third-party inputs are desired, or are required.

In transportation engineering consulting, there is almost no limit to the number of opportunities to use different professionals. It is not uncommon for such firms to offer services in planning, marketing, economics, safety, management, economic feasibility, environment, public transportation, computer software, and other areas in addition to conventional engineering disciplines. Within these organizations, it is natural to find an interesting mix of engineering backgrounds. Professional staffs consist of most types of engineers, and these range in educational backgrounds from baccalaureate to doctorate degrees.

The breadth of engineering is reflected in the manner in which the National Academy of Engineering groups its members:

1. Aeronautical/astronautical engineering,
2. Agricultural engineering,
3. Chemical/petroleum engineering,
4. Civil engineering,
5. Electrical engineering--communications/computers/control,
6. Electrical/nuclear power engineering,

7. Manufacturing engineering,
8. Mechanical engineering,
9. Mining/metallurgy/ceramics/materials engineering,
10. Operations research and industrial engineering, and
11. General engineering.

Some consulting firms are of sufficient size and have such diversified work loads that they need individuals who collectively have had training in all of these areas.

Over a period of about 35 years, Wilbur Smith and Associates has grown to an organization with more than 500 permanent employees. We still consider ourselves transportation consultants. Our marketing brochure lists the following areas in which we believe we are qualified to offer professional services:

1. Air transportation;
2. Architecture;
3. Design and construction management;
4. Economics;
5. Energy systems;
6. Environmental impact studies;
7. Financial feasibility studies;
8. Industrial development services;
9. Marine facilities, ports, and waterways;
10. Marketing;
11. Parking and terminals;
12. Planning;
13. Public transportation;
14. Rail transportation;
15. Research and development;
16. Systems analysis and model development;
17. Transportation planning;
18. Transportation safety;
19. Truck transportation; and
20. International.

These areas break down into approximately 130 subactivities. Consulting firms are unable to find all of the knowledge and resources that they would like to have in a single person. When they reach a relatively small size, consulting firms are likely to require teams to provide adequate services for most of their projects--teams made up of a number of disciplines and containing people with high levels of expertise in some disciplines. Putting all of the talents together as an effective team is the challenge.

Most consulting firms do not grow because they want to "be big," but, because in engineering consulting practices, there are strong tendencies toward peaks and valleys in availability of work. To a great extent, these peaks and valleys can be overcome, or minimized, if the firm is sufficiently diversified and personnel can be shifted from one field to another.

After periods of continuing growth, a transportation consulting firm might reach a certain size and become so diversified that the term transportation is dropped. Emphasis can be on transportation, or transportation can be just a part of total services offered--one ingredient in a mass of consulting activities. But

discussions here relate more to the qualifications and educational needs for those who are primarily in transportation activities.

Transportation engineering is perhaps more likely to be subjected to rapid changes in technology and demands than some of the founder engineering disciplines. Transportation has always been an important part of civilization, but our modern era of transportation (as it is normally perceived in consulting work) began with the railroads and waterway facilities. It expanded rapidly with the advent of the automobile and with public transport, typified by street cars and buses. Then opportunities came along in the field of air transport, and this has offered a rapidly developing opportunity for transportation consulting. All of the new transportation modes required terminals and extensive and innovative methods of finance. We are now on the verge of space transportation. When our government sends into orbit space laboratories and space platforms, the shuttle, for example, will become primarily a transport vehicle carrying equipment, supplies, people, and perhaps products to and from these types of facilities and earth.

The term transportation consultant is broad. Most of the consulting engineering firms that specialize in transportation offer a broad spectrum of engineering services. Therefore, this paper is intended to emphasize the educational background transportation consultants desire for engineers. However, this does not minimize the importance and opportunities for those in other disciplines.

Transportation engineering, particularly in consulting practice, has some characteristics that are different from the more conventional, longer established engineering areas. In consulting, an individual must be willing to do everything possible to satisfy the wishes and demands of clients, including excessive hours of work, additional study, and research off the job in order to apply the very best experiences to the job at hand. In most consulting practices, the professionals are required to travel extensively. This travel might even be international. This, in turn, means a willingness to be separated from family for rather lengthy periods of time and a willingness to include in the work schedule a substantial allowance for business travel after or before a normal work day begins. Perhaps these are not characteristics that would be called training, but, in many cases, the educational institutions can be helpful in conveying to students these characteristics with their own evaluations.

GENERAL OBSERVATIONS ON EDUCATION

Consulting engineering firms need individuals who have a broad spectrum of talents. They need the traditional talents and they need people who are innovative. It is generally agreed that innovation cannot be forced, but it can be fostered by universities and by employers. Consulting engineering firms prefer individuals who are willing to cooperate and help move the firm forward by offering new and more marketable services. In consulting, growth is essential. The consulting firm, therefore, wants men and women who have ambitions and who have high personal and professional goals.

In personal qualities, discussions go beyond the responsibilities of educators, but all consulting firms, and for that matter all businesses, are very much interested in knowing something about the basic qualities of the engineers they employ. They know that the quality of the student is an important factor in where

the student is going and how he or she plans to get there. Educational institutions can provide useful information on how students are selected.

Consulting engineering organizations are businesses. In most instances they must make a profit; therefore they need people attuned to the business side of their activities to be concerned about such items as overheads, profits, budgets, schedules, salary ranges, and so forth. One or more courses in business administration would be desirable.

Consultants, perhaps more than those in some other businesses, need to constantly look ahead for new and changing markets. A talent for selling or marketing is valuable among employees. It follows then that business courses in marketing would be helpful.

A conference of this type may appear to be minor, but consultants can have deep concerns about the inability of engineers, and other professionals, to express themselves in both written and oral communication. Practically every consulting job requires reports, and the results of the consultant's work in most cases is heavily dependent on the manner in which these reports convey findings and recommendations. Clear, concise report writing is essential. Engineers should know how to write coherent, articulate reports and how to personally present their findings and recommendations.

Civil engineering courses appear to offer the best background for undergraduate training for transportation consultants. Such courses offer a highly desired variety in engineering education; they permit a greater opportunity than most engineering disciplines for electives so that basic courses in such areas as traffic operations, traffic control, and transportation economics can be inserted.

Most U.S. transportation consultants are active in international projects overseas. There are interesting opportunities for transportation consultants abroad, and this can have an important influence on the makeup of some of the firm's personnel. In addition to what engineers, or other professionals, might have learned in basic education, if they are to be proficient in international work, they need to know about international regulations and controls. This would include such subjects as foreign exchange, taxation, regulations of professional practice, and risks that are peculiar to working in other countries. Curricula in these areas would be helpful. Today, most of the larger colleges and universities offer a variety of courses in international studies that could be valuable to a student entering transportation consulting practice.

Some engineering schools increasingly are providing greater opportunity for students to study in and co-mingle with students in other parts of the total university; they are encouraging students to pursue a broadly based educational experience. This approach offers engineering students essential modes of thought to better deal with wide varieties of human issues.

In engineering at Duke University, about 50 percent of a student's total undergraduate effort is in what are normally considered to be nonengineering courses. The training in nonengineering courses offered at Duke appears to be about double the amount permitted and required in many other fine engineering schools around the country. This type of broad training can be valuable to consultants.

Special training for transportation engineers, or transportation specialists, appears to be more a matter of training students in the best means of bringing the general (and broad) knowledge of engineering and related courses to bear on transportation needs and transportation issues.

However, where high specialization is required in transportation employment,

or careers, it appears desirable to provide this specialization at the graduate level rather than in the undergraduate curricula. There are so many courses available at the graduate level that there is little need to attempt to describe the courses that should be offered. Whatever specialization is required of transportation consultants, it is almost certain that they can acquire the appropriate courses in the standard graduate curricula.

The question might be asked: Where does proliferation of training needs for engineers end? This is not an easy question to answer because events are always occurring to change the status quo. In a recent article in Consulting Engineer (1) it is pointed out that a somewhat alarming court decision has recently been rendered in the state of Kansas. The court ruled that, unlike medicine and law, engineering is an exact science and that engineers may be treated as ensurers of a result (i.e., libel even without proof of negligence). The court ruling states that "(a) person who contracts with an architect or engineer for a building of a certain size and elevation has a right to expect an exact result." Changes in conventional understandings of liability responsibilities and the general attitude that prevails in current society to "blame everybody else" suggests that engineers are one of the professional groups that can be highly vulnerable when anything goes wrong or can be assumed to go wrong (1). Do transportation engineers need legal training? Where does the proliferation of educational needs end?

OTHER TRAINING CONSIDERATIONS

In the United Kingdom, the belief for a long time has been that, to make the best use of graduate engineers, it is essential to have adequately trained technicians. The recognition of this belief has been so far-reaching that a joint training scheme for civil engineering technicians is run by the Institution of Civil and Municipal Engineers, the Association of Consulting Engineers, and the Federation of Civil Engineering Contractors in London. These groups stress that the objective is to train technicians to support professional engineers; they recognize that technicians and professionals are all a part of the team and that they must work together for each to be most effective. Principal subjects covered in the training are broadly categorized as (a) traffic investigation and transportation studies, (b) traffic engineering techniques, and (c) overall administrative and management considerations for technicians.

Many states now have well-organized technical training schools (which I believe in most instances have training levels comparable to junior college). Emphasis is on vocational training, but standard basic courses are offered also. Credits for completing the courses are transferable to college credits in most instances. This is timely. Transportation consultants would like training of this type to continue because it is important for maximum overall productivity.

In-house training is always an important consideration in the plans of consultants although it becomes extremely difficult to fit it into active businesses. Many of the training needs of consultants are provided, however, through various types and forms of in-house training programs.

Increasing information in handbooks reduces some necessity for detailed training in transportation. Once the engineer has information available in handbooks, he is normally able to apply it to transportation problems and issues, whatever his basic educational background.

CONCLUSIONS

Understanding the inner-connectives in transportation might be more important to the transportation consultant than understanding too thoroughly each of the individual pieces. Thirty or 40 years ago, a professional was likely concerned with such relatively simple tasks as planning traffic signals and the erection of signs. Today, the professional is in the midst of very complicated planning, design, and management of projects. Under such circumstances, it is easy to understand why some young professionals who are entering the field of transportation consulting might be confused by the great breadth in diversification in opportunities. The smorgasbord of professional activities and opportunities can to a degree be overwhelming. These situations can be overcome by giving full attention to personal achievements and advances and also to advances in the overall interest of the profession.

Cutting across many scientific and technical disciplines, the transportation engineer might be called an interdisciplinarian. His activities are totally entwined with those of others. He has to learn to work effectively with planners, economists, mathematicians, computer experts, systems analysts, and others who have a substantial interest in and special talents or solutions to ever-growing transportation problems.

Consultants usually need a cross section of all engineering, plus a number of other disciplines in order to take advantage of the many and diverse opportunities in the broad field of transportation. It has been well stated that "education offers the tools--basic skills and disciplines--but success requires self-knowledge, ambition, and personal goals." More specifically:

1. Needs vary greatly with the scope of services offered by the consulting firm and with the size of the firm. Big firms can afford to employ professionals who have become highly specialized in their college education such as computer engineers, geologists, environmentalists, market analysts, and safety engineers. Both the small and the large firms need professionals who have had more generalized training courses, such as those offered in civil engineering, economics, business administration, and planning. They need a backlog of engineering generalists. Specialization in these courses may or may not be desirable.

2. Within the formal college curriculum for engineers, it appears that the basic technical education provided is satisfactory to meet the general needs of transportation consultants. It must be recognized, however, that it is not possible to complete in a 4-year period some of the materials that might be included in curricula for engineers.

3. Where there is flexibility in the curriculum, the transportation consultant would like courses in the following areas inserted: business administration, marketing, communications, and international issues.

4. For transportation consultants, it is highly desirable to have individuals who have not only received basic technical engineering educations, but who also have considerable knowledge in communications, computer applications, and also in socioeconomic and political relationships that interface with engineering and transportation. Engineers who have a high level of training in nonengineering courses are generally preferred by transportation engineering consultants.

5. Outside the scope of training courses, the consultant is interested in the basic standards for admission to a given educational institution. In addition, they would like to have students who have, in some way during their college

career, been told frankly about the advantages and disadvantages of consulting practice.

6. Changes are occurring rapidly and each generation of engineers is likely to be different from the last. Changes in transportation engineering are occurring at a very rapid rate, and this should continue for many years into the future. There can be no status quo in training needs.

7. Consulting organizations can make engineers and other professionals more effective because they have available resources of trained technicians.

8. In-house training programs are especially important in transportation consulting because of the large number of variables in the work and the unusual conditions that arise.

9. Civil engineering appears to be the best course of study to produce transportation generalists that are needed by consulting firms of all sizes. This is the training that should be emphasized at the undergraduate level. Courses in both engineering and nonengineering subjects sought by some consultants should be provided at the graduate level.

In highly specialized consulting firms, there are likely to be notable deviations from the requirements enumerated previously because these requirements are intended to relate to medium to large firms.

Because it is not possible to expand or greatly change the curricula of most engineering courses, it might be advisable for universities to emphasize to students the need for continuing education when they enter transportation consulting. Encouraging students to participate in professional conferences, including the preparation and presentation of technical papers, and to become a part of the transportation profession as soon as they are qualified can be valuable to consulting organizations.

REFERENCE

1. J.F. Forster and D.A. Ostrower. Engineering: An Exact Science? Consulting Engineer, Sept. 1984, p. 70.