UNIVERSITY RESPONSES TO MULTIDISCIPLINARY EDUCATION

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This paper considers two facets of the response by universities to multidisciplinary education in transportation systems planning. The first deals with the educational content of training programs, and the second discusses the mechanisms for carrying out effective transportation planning education within the university.

•THE EDUCATIONAL OBJECTIVES of programs in transportation systems planning are first to transmit the state of the art and second to develop a capability to analyze and evaluate alternative transport solutions. On the one hand, education should teach the fundamental concepts, theories, methodology, practice, experience, and research results so that the student can begin professional practice. On the other hand, because the field is so rapidly changing in both methodology and scope, formal education is soon outmoded and specific planning techniques and methods become less vital than is the ability of the transportation planner to respond to changing environmental conditions.

As an illustration of the dichotomy between state of the art and obsolescence, it was not many years ago that transportation planners were taught how to locate highways on the basis of least cost solutions by considering costs and benefits to the users of the system. Today that approach is outmoded; we have become greatly concerned with the quality of our environment and the way in which transportation facilities influence that quality. Furthermore, we have learned that gross benefits conceal the distribution of benefits. Some sectors of society have experienced negative beneficial effects from freeway locations both in terms of housing relocations and in terms of the reduction in mobility, which has created problems for persons without access to an automobile.

Further, transportation planning has considered primarily needs at the regional level, and approaches have been developed principally to determine locations for freeway corridors and major transit systems. That level of planning, however, is highly ineffective for the day-to-day decisions that must be made at the local level, and we are now seeking ways to make the transportation planning process more responsive to the immediate problems of urban areas and to reflect the short tenures of policy-makers. In the next decade, as transportation planners become more concerned with short-range planning they should be more effective in communicating the professional advice that is so sorely needed.

The transportation planner has the task of developing alternative plans and measuring the effectiveness of these alternatives such that the implications of each are clearly understood by the decision-makers. Education can serve the roles of developing an awareness of the issues that are relevant to the decision-making process, including the political, social, and economic environment within which the planner operates; of coupling these with the conceptual and quantitative tools that are necessary to evaluate their consequences; and of presenting these in a manner so that decisions can be made.

UNIVERSITY RESPONSES IN CONTENT AREAS

University responses to transportation systems education have occurred in both content and organization. Three elements in transportation systems planning education are selected to illustrate university responses in content areas. These are emphasis on a multimodal framework, systems analysis for evaluation of alternative designs and policies, and the focus on mathematical modeling and computer analysis.

Multimodal Network Analysis

The emphasis on a multimodal framework for the examination of alternative systems contrasts with the more traditional approach in which individual components, modes, or pure technologies such as railroads, rapid transit lines, highways, airports, and waterways are analyzed separately. The single-mode viewpoint considers a set of alternatives within a limited framework and seeks to select that alternative for which a least cost solution can be defined. For example, earlier education in highway design and location placed heavy emphasis on the balancing of cut and fill in order to ensure the least cost solution from the perspective of moving materials, without taking account of other related factors that were ignored or considered to be outside of the system. In a multimodal approach to the problem, a wider range of alternatives is developed because the interaction of modes is considered as is the possibility of altering operating policies. Accordingly, the interfaces of modes become an important consideration because often the most critical and complex problems will occur at these points.

Systems Analysis

Systems analysis has become widely accepted and, in the context of transportation systems planning, represents a definition of the goals and objectives to be achieved by the system; development of the means for measuring the effectiveness of candidate plans; formulation, description, testing, and evaluation of alternatives; and selection of an alternative for implementation. The systems approach as a formal educational tool is valuable in that, aside from its logic, it serves to make explicit each of the fundamental elements in the planning process and as such develops a basic awareness of the major issues involved in the selection process. We are not able to develop optimal plans in a mathematical sense in transportation systems planning, and, accordingly, systems techniques will not replace the need for judgment, intuition, compromise, and common sense. On the other hand, applying the systems approach to transportation planning has the effect of improving the student's ability to understand problems and to develop solutions by clarifying primary objectives, key assumptions, important parameters, and the sensitivity of each alternative to major policy variables. Nothing is more difficult to accept than the knowledge that the problem is not clearly defined and that the measures of effectiveness are not fully understood; yet it is the precipitous plunge into the problem that can cause major difficulties for the profession.

Mathematical Models and Computers

Transportation planning education has perhaps evolved most rapidly in the area of mathematical modeling and related computer capabilities required to carry out the results. Advances in transportation planning, which have permitted the solution of large-scale problems, have drastically changed the way in which we think about problem-solving; these would not have occurred without computer capability. Mathematical models for trip generation, trip distribution, and travel assignment were perhaps the earliest breakthroughs in transportation planning, and the resultant computer programs compose an integrated package for transportation analysis. Intensive development of these computer models has produced a counterreaction, which indicates that there may be too much emphasis on model development and data gathering and not enough on generation and evaluation of alternatives or on quickly producing usable results. These shortcomings are evident both in regional transportation studies, which often consume extensive resources—money and time—before they are able to produce a regional plan, and in small-scale studies in which the models and computer programs are unintelligible to decision-makers at the local level. Education must develop a mechanism for coupling the abilities of computer models with immediate needs to produce usable plans and relevant information for decision-making.

A working familiarity with mathematical techniques such as probability theory, linear and dynamic programming, mathematical statistics, and economic models is an essential part of transportation systems planning education, and these tools combined with a strong computer capability in the analysis process are a fundamental element in the transportation planner's education. They complement the systems approach by broadening the spectrum factors and alternatives that can be considered in the planning process, by requiring a quantitative coupling of the objectives of the plan and the means for measuring them, by incorporating the appropriate mathematical techniques for selecting alternatives, and by developing a clear understanding of the relevant issues for decision-making.

Thus, from a substantive point of view it appears that educational programs in transportation systems planning have emphasized multimodal network analysis, which considers the transportation system in terms of its performance characteristics; systems analysis, which views urban transportation planning as an integrated process rather than as a set of isolated problems; and, finally, mathematical modeling and computer applications, which represent the fundamental tools of transportation systems planning.

UNIVERSITY RESPONSES IN ORGANIZATION

How are elements of transportation systems planning education integrated within the university so that the student has access to the appropriate academic programs as well as interaction with a variety of disciplines that these programs represent? Several approaches are discussed below.

Multidisciplinary Courses

In addition to the appropriate academic course offerings, an effective means of partially achieving an integration of disciplines is through project-oriented multidisciplinary courses. To be successful, however, these courses should meet certain criteria:

1. Coherent integration of projects and a group of students who are motivated to work well together,
2. Adequate but manageable problem statements, and
3. Careful coordination of the efforts of a large group within the structured framework of an academic course.

Centers and Institutes

Another and more flexible technique is to provide students with the opportunity to work on multidisciplinary research projects with groups from economics, political science, social science, urban planning, engineering, and the like. Exposure on an operational level to the interrelated inputs of other disciplines is an essential ingredient in educating the student to make the necessary adjustments in perspective and viewpoint in order to contribute to the product of a diverse group. Interdisciplinary projects can be made more effective through an organizational structure within the university but external to traditional departments that function within a workshop framework with access to problem statements from interdisciplinary technological areas. Accordingly, transportation centers and institutes have been created in universities with the goal of providing an organizational framework within which faculty and students of diverse academic disciplines can join together to effectively deal with educational and research aspects on a particular problem. The difference between the interdisciplinary research institute and the more traditional mission-oriented special-purpose research institute is that the former has been created to enable the university to effectively operate on a problem area basis regardless of academic disciplines, whereas the latter has usually been more closely associated with one of the traditional disciplines, and, except for a marginal loss to the academic community, their primary purpose is not impaired if they institutionalize and drift away from the university.

The primary purpose of the interdisciplinary institute, however, is education, and its bonds with the faculty and graduate student body are weakened as it becomes institutionalized. The interdisciplinary institute also provides a link between the university and the outside world by providing the framework to aid in identifying and organizing research projects such that immediate problem areas may be brought into the school and such that diverse disciplines needed to make an organized attack on the problems can be mobilized.

Advantages of Multidisciplinary Approaches

There are many advantages to the multidisciplinary approaches that have been incorporated in transport systems planning programs. Among these are the following:

1. Provide students with experience in dealing with large-scale and complex problems;
2. Focus educational experience on problem solving for which there is no "right" answer and illustrate the difficult task of trading off conflicting objectives;
3. Expose the student to the task of developing recommendations with inadequate or insufficient data and severe time constraints;
4. Familiarize the student with the capabilities, viewpoints, and approaches of other disciplines;
5. Develop a sensitivity and respect for the limitations of a group effort and what it can accomplish; and
6. Encourage students to organize and to share responsibility and credit.

Organization of Traditional Departments

From the point of view of transportation planning education as it relates to university departments, such as civil engineering, we have seen a variety of organizational approaches. For example, some departments have been considerably restructured along less traditional lines by embracing other professional areas relevant to urban transportation planning such as economics, public policy, geography, and traffic engineering. On the other hand, some transportation planning programs have developed along independent lines, resulting in the creation of separate departments or divisions that accept students from diverse backgrounds such as engineering, science, architecture, and the social sciences, usually with the requirement that the student have a quantitative orientation. Another means of accomplishing the multidisciplinary requirement is simply to offer courses to the student on a wider range of subject matter to permit him to become more conversant with the many fields relevant to his primary interest, transportation planning.

SUMMARY

This paper has outlined university responses to multidisciplinary education for transportation systems planning both in terms of the content and approach to subject matter and in the ways in which universities have become restructured to meet new demands and changing conditions. The approaches that have been described are being implemented in programs at both the graduate and undergraduate levels. At the graduate level emphasis is placed on professional training as it relates specifically to transportation systems planning; at the undergraduate level there is increased awareness that an incoming student must be motivated early in his academic career by becoming involved in real problems that allow him to see the manner in which his career will develop. For example, in many curricula, course offerings at the graduate level soon filter down to the senior level and later become available to freshmen and sophomores. We have been experimenting with course offerings in systems engineering and various introductory courses in transportation, systems, and planning in an attempt to provide undergraduate students with a sense of the relevance and connection with professional objectives.

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