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ABSTRACT

This paper discusses the changing role of civil engineers in developed nations. Transportation facilities generally follow a four phase approach before construction: long range systems planning, corridor location study, design location study, and final preparation of plans. Traditional engineering education emphasized the latter two phases but now all phases are treated equally. Thus, the impact of environmental, social, and economic concerns on the initial planning phase of construction must be assessed by engineers. This new emphasis has engendered citizen participation in engineering decisions. Curricula must provide students not only the mathematics and sciences of engineering, but also social and environmental understandings as well. (MR)

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IMPACT OF TRANSPORTATION ON THE ENVIRONMENT AND QUALITY OF LIFE

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INTRODUCTION

Engineers, and particularly engineering educators, play a most important role on the impact on the environment and the quality of life. Although this role is not new it has become more evident through the engineer's revolution from the position of "design by parts" to the "systems approach" during the past three decades. The latter process has exposed new areas such as community effects, citizen participation, attitudinal surveys, etc. to transportation engineers that were never envisioned by the traditional civil engineer a score of years ago. This situation is ubiquitous to all engineering disciplines and this generation of engineers will witness an expansion of their responsibility to society. However, the degree of consideration of the effects of engineering projects on social institutions will vary from country to country in the world. Whereas developing countries place a primary concern on hard technology, United States is in the position of assessing the technological output on the impact of the environmental, social and economic concerns of the affected public.

The role of the engineering educator is one of vision. The basic questions must be answered, "What constitutes a curriculum that our students take to insure their ability to solve both current and future engineering problems that impact society?"

TRANSPORTATION FACILITIES/ENVIRONMENTAL PROCESS

In the United States practically all major transportation facilities in both the urban and rural segments follow a four phase approach prior to their construction. Basically the initial phase is long range systems planning, which includes: organizational arrangements; definition of goals and objectives; data collection; forecasts of transportation and land use parameters; development of regional alternatives; environmental, social and economic (E.S.E.) evaluations; citizen participation; and, plan adoption. The E.S.E. effects are discussed in detail in the following section of this paper.

After the plan has been adopted a corridor location study is undertaken as the second phase, which involves: governmental coordination; environmental impact statement on alternatives, which also includes the "Do Nothing", within the corridor; and, citizen participation. The result of this phase is to either proceed to the succeeding phase or to reinitiate the initial phase.

The third phase is the design location study, which results in the refinement of the line through consideration of citizen participation and basic preliminary engineering concepts. Many planners consider this as the last time citizens can give input to the process but in reality it is often the beginning of citizen involvement.(1) Again, this phase results in either continuation or a restart of the entire process.

The fourth phase represents the traditional final design that calls for the preparation of construction and right-of-way plans ending with a construction contract.

Several noteworthy points prevail through the above approach that have evolved over the past decade. First, the requirement that engineers consider the environmental, social and economic effects and second, the requirement that citizens become an integral part of the process. Although the latter is considered a requirement from the legal viewpoint, that is, the 1970 National Environmental Policy Act and various Federal Aid Highway Acts, most transportation engineers agree that they would be incorporated in most progressive states.

The transportation engineering educator recognizes the change of emphasis, that is, the latter two phases were of prime concern in curricula prior to 1960 and now equal concern is given to all phases.

E.S.E. EFFECTS

Before discussing the environmental, social and economic effects of a transportation facility, the engineer recognizes that a question of scale arises. That is, what analyses are made for the macro, meso and micro systems? As one decreases the scale it becomes apparent that the accuracy of the various predictions tend to increase due to the change from generalities to specifics. In addition two time frames are present, that is, the estimated time of completion and the design target year.

The E.S.E. effects do not create a homogeneous impact on all projects. It should be remembered that these effects are considered in light of the first step in the total process, that is, determination of goals and objectives. It is obvious that different goals and their accompanying objectives toward implementation can and will create conflicting missions. For example, goals that cite creation of employment and improvement of economic base will develop a different set of facilities than goals that cite low population densities and preservation of open space.

A simplified classification of the E.S.E. effects might be one of engineering sciences and social sciences. The former might be illustrated by the required noise pollution and air quality studies. Both studies require: (1) an evaluation of ambient conditions, (2) prediction of future conditions, (3) a comparison with standards, and (4) evaluation of significant impacts even though within standards. The studies must address the following questions:

1) What is the anticipated impact on air and noise quality if the proposed project were built? If not built?

2) What adverse effects on air and noise quality could not be awarded if the proposed project were built? If not built?

3) How would the relationship between local short-term uses of the air resources and the maintenance and enhancement of long term productivity be affected if the project were built? If not built?

4) What irreversible and irretrievable commitments of the air resource would be involved if the project were built? If not built?

5) What air and noise mitigation measures could be implemented to minimize the impact if the project were built?

It is interesting to note the various design dilemmas facing the transportation engineer in both the conceptual and preliminary design of a transportation facility. For example: minimum emissions are related to design features which provide uninterrupted vehicular flow, but low speed is preferable from the pedestrian point of view; and, depressed sections of highways allow for the accumulation of air pollutants, but act as noise attentuators and is generally considered more aesthetically acceptable.

The soft sciences for social and economic effects include analyses of people displacement, proximity effects, community effects, accessibility effects, land use planning and transportation for the disadvantaged. Again, the macro, meso and micro scale arises in terms of effects of a transportation facility have on regions, communities and individuals. A recent report reached tentative conclusions on the social and economic effects of highways in the United States, which are relevant. "For example, residents displaced by highway right-of-way are being located satisfactorily. However, residents in close proximity to highways may have noise, air pollution, or safety problems, and these disadvantages may be reflected in lower property values. Accessibility effects of highways, unlike proximity effects, are ordinarily positive. The benefits of highway accessibility often outweigh the disadvantages of highway proximity, even for residential property. Whether benefits or disadvantages occur near highways depend primarily on the land use involved. Industrial or commercial uses along highways ordinarily benefit."(2)

E.S.E. PERSPECTIVE

The environmental, social and economic effects of transportation facilities must be viewed from both a historical and geographical vantage point. Before 1960 little consideration was given to the affected members of a community in the United States during the planning process. The development of transportation plans consisted primarily of a massive data collection and analysis which resulted in the "optimal" program for the area, as perceived by the planners. The Federal-Aid Highway Act of 1962 stipulated that after July 1, 1965 all federally aided highway projects in urban areas with a population exceeding 50,000 people must be based on a "cooperative, comprehensive and continuing planning process".(3) The Act required that a public hearing be held in order to allow concerned citizens the opportunity to express their needs and desires, and it recognized that transportation planning should be a dynamic process that reflects the changing attitudes, desires and needs of the affected community. Most people agree that the earth day celebrations of the late 1960's gave impetus to the National Environmental Policy Act of 1970, which legally binds the engineer to an indepth analysis of the interface between the public works projects and the environment. The Federal Highway Act of 1970 required all states to submit to the U.S. Department of Transportation an Action Plan, which describe the processes each state would employ in order that adequate consideration is given to possible social, economic and environmental effects of proposed highway projects in the best overall public interest.

The geographical vantage point often leads to a diversity of goals and objectives among regions. This, in turn, will lead to a shifting of emphasis on the various E.S.E. effects. For example, an economically depressed region formulates the goal of job creation and ranks it considerably higher than improved land use. The latter goal may be of prime concern in a progressive urban region.

World wide, underdeveloped countries generally rank the economic effects of transportation facilities much higher than the environmental and social effects. Their economic considerations are more expansive, for example, it includes the physical shape the country will achieve, the militaristic and defensive strategies and political control. In addition, they recognize the immediate economic impact caused by the expenditures and employment during the construction of the facility and the long range implications on industrialization and the creation of service industries that follows the basic production industries. The underdeveloped countries are cognizant of the role of transportation, which might be related in a U.S. Congressional Committee report that cites transportation as the most important industry in the world.(4)

CITIZEN PARTICIPATION

It becomes apparent when overviewing the social effects of transportation facilities that there are many subjective areas that are integrated with engineering decisions, for example, route location. How does an engineer receive input from the affected community? Federal legislation lists certain requirements for public involvement, but other factors exist that make citizen participation a necessary element in the transportation process. As evidenced in Boston, San Francisco, Philadelphia and Washington, D.C. hostility toward the construction of freeways has caused years of delay. From the viewpoint of plan implementation the transportation engineer must take a position that ranges from tolerance to positive citizen involvement in plan preparation.

The involvement of citizens is an emerging process and at this time the question of efficacity on current techniques and processes is being evaluated as well as developing new approaches.(5)

ENGINEERING EDUCATOR'S ROLE

The engineering educator recognizes the dynamic process that constantly occurs in the engineering profession, such as previously described, and recognizes a triumvirate of responsibilities. The first calls for the personal requirement of keeping abreast in the field and the procedures are easily recognizable, however, the latter two directs attention to the student. How does the educator train students for meaningful contribution to the near term engineering professional practice and how does the educator educate students for their life long role in the profession?

As one reviews these questions in reference to the impact of transportation on the environment and quality of life it becomes apparent that the educator must bring into the classroom present day problems such as perplex environmental, social and economic assessment system scenarios. However, serious student involvement requires a background in the basics of mathematics, science and humanities. Engineering educators have done this since time immemorial and the educator must perceive the emphasis within the basics. For example, is the trade off of statistics and operations research for certain traditional engineering mathematics and the accentuation of communicative skills within certain humanities of merit? The question of emphasis must be addressed by the educator for implementation within the norms of the academic institution's goals and objectives.

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