

Role of Advanced Technologies in Transportation Engineering

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ABSTRACT: Transportation engineering is a major component of the civil engineering profession. It involves planning, design, construction, maintenance and operation of transport facilities. Advanced technologies in the area of information systems, automation, and telecommunications have the potential of achieving cost savings and productivity improvements as well as enabling new developments in transportation. The purpose of this paper is to review the areas where advanced technologies can significantly affect the way transportation engineering is practiced. Strategies for implementation of the necessary changes in practice are also discussed, along with the expected impact on civil engineering curriculum. The emphasis of the paper is on surface transportation.

I. INTRODUCTION

Role of Transportation engineering in civil engineering

Transportation engineering is a major component of the civil engineering. Its importance within the civil engineering can be judged by various number of divisions which are directly related to transportation. Air transportation, Highways, Water ways, Port and Urban transportation. Transportation always plays an important role in developing the society, originally with regard to land and air based systems as well. It is the transportation engineer's responsibility to plan, design, build, operate and maintain these systems of transport, in such a way as to provide safe, efficient and convenient movement of people and goods. Most of the civil engineers are engaged in the practice of transportation engineering are employed by transportation agencies and associated contractors and consultants.

Major components of Transportation engineering

Transportation engineering, as practiced by civil engineers, primarily involves planning, design, construction, maintenance, and operation of transportation facilities. The facilities support air, highway, railroad, pipeline, water and even space transportation. Each having their own individual importance.

A review of descriptions of the scope of various committees indicates that while facility planning and design continue to be the core of the transportation engineering field, such areas as operations planning, logistics, network analysis, financing, and policy analysis are also important to civil engineers, particularly to those working in highway and urban transportation.

Need for improved productivity and performance

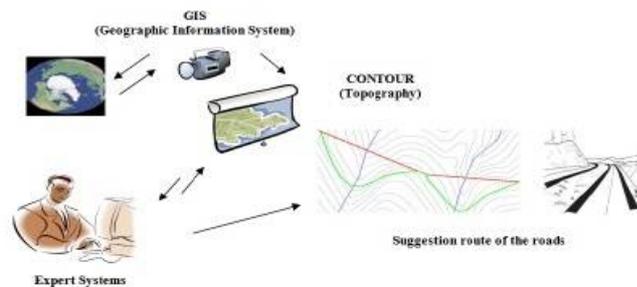
The ultimate objective of in the areas of transportation facilities is to develop technological innovations that will result in substantial improvement in the quality of transportation services, including productivity and performance. Some of the major areas that can greatly benefit from the use of advanced technologies include the following: facilities condition assessment, repair, maintenance, and rehabilitation techniques, materials and management of facilities. It should be pointed out that technological innovations are needed not only for better planning and design of transportation facilities, but also for improved operation and delivery of transportation services in terms of efficiency and safety.

II. OVERVIEW OF SOME ADVANCED TECHNOLOGIES AND TRASPORTATION APPLICATIONS

Knowledge-Based Expert Systems

Knowledge-based expert systems (KBES) evolved from research in artificial intelligence with the overall objective of producing intelligent behaviour with computers. Numerous artificial intelligence research areas exist, including theorem proving, automatic programming, vision, learning, natural language processing, and others. KBES differ from these other areas by the restriction to a limited problem solving domain such as diagnosis of malfunctions in particular equipment types.

The systems are finding a wide range of suitable application areas. Several reviews of transportation (Ritchie 1986; Yeh 1986) and civil engineering (Kim 1987; Kostem 1986; Sriram 1986) applications exist. Applications have included a variety of areas such as design (Harris 1987) diagnosis (Ritchie et al. 1986), vehical control (weisbin 1986) and operations control (Hendrickson 1987). As computer hardware and software develops and as more experience is accumulated, KBES will become a common alternative to conventional programming. The integration of expert systems and conventional programming approaches is likely to be particularly rewarding in this regard (Glover 1986; Hajek 1986).



Vehicular Navigation, control and location

Recent advances in technology provide some significant new opportunities in the vehicular control area and by extension to the entire area of vehicular operations. New sensors and control procedures make continuous monitoring of locations possible and even introduce the possibility of wide spread automated vehicle control. For example several rail roads have installed NAVSTAR satellite receivers so that precise locations of all locomotives are available at all times. Transit agencies have experimented with passive sign post systems to provide similar information on bus locations. The use of autonomous ground vehicle have become economical in applications such as warehousing and factory materials movement.

With these hardware developments, a variety of control and other operations information become of interest. Immediate dispatching and routing of vehicles in response to current locations and demands requires new management strategies. Integration of sensing and control procedures provides many new challenges. Although operations of automated vehicles in uncontrolled roadways may still be a distant prospect, applications in automated guide ways or maintenance activities are realistic possibilities. Better sensing and control of road ways may prevent the familiar backward bending. Congestion phenomenon prevalent on road ways. For the transportation engineering, these new technologies present challenges to devise effective vehicle control strategies, to design more efficient and capable transportation systems and to improve system operations over a travel network.

Computer based route findings and electronic trail finding can both be used as part of AHS. The first simulates human thinking and can be employed on a smart vehicle. The second uses electronic control system installed on the vehicle to trail the two wire guided route by detecting the signal phase difference. Additional applications of automation in transportation include methods for reducing the demand, such as electronic road pricing and automatic vehicle monitoring (AVM). That can be used to dispatch, monitor and control vehicles to optimize a fleet performance.

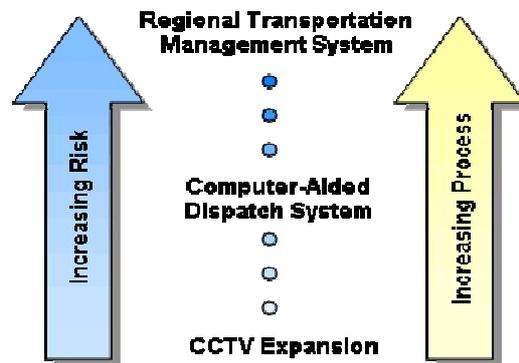
Traffic control strategies can be classified as pre timed and online (Real time). Pre timed (open loop) Control strategies are applicable to study state flow conditions. Real time control is available in traffic system that experience frequent state transitions and rapid flow variations, i.e in most urban systems. The need for developing real time control methods for traffic system is evidenced by the excessive amounts of delays, energy consumption, pollution levels and other user are indirect cause resulting from highway congestion in urban areas. Much recent work has been done in this area. However one of the major difficulties in real time control is associated with the lack of realistic, yet sufficiently simple and effective, models describing the traffic dynamics in critical roadway components of the free way corridor. Major modelling problems that have not been resolved include treatment of interrupted floor, especially in merging, diverging and weaving areas and consideration of lane changing effects and geometric variations. Additional problems include the problem of ramp diversion, the lack of an online demand predictor, and an online determination of the free way origin destination matrix.

Computer-Aided planning and design

Traditionally, transportation has been a test bed for new theories and methods of design. Transportation applications provide a context for new developments such as mathematical programming or econometric model of discrete choice analysis. As a

new wave of computer-aided planning and design theory develops, transportation can provide another application area. With limited budgets, effective planning and design have become more important.

Computer-aided planning and design system are evolving to incorporate constellation of analysis, evaluation and synthesis application programmes with shared data and inter process communication. Graphic displays, knowledge based expert systems, and data bases as well as conventional analysis programmes, are all important components. Theories of design synthesis and creativity are finding an important role in the design of such systems. Both technological developments to aid computer performances as well as new concepts of design are appearing and available for application and further development.



After considerable effort devoted to planning and design system development in the past 30 years, transportation has not experienced wide spread application of the new integrated design systems. This is now changing particularly for private sector operations planning. A similar effort in traffic systems, transit providers, port facilities and other systems of interest transportation engineers can be expected.

Machine vision and image processing for vehicle detection

The advantages of vehicle detection through image processing over detection by existing loop detectors are several. In particular, an imaging detection system has multi task capabilities i.e, it can be simultaneously detect traffic, derive traffic measurements, perform surveillance, detect incidents, recognise special vehicles and alter a human operator among others. The system does not disturb the pavement thus improving reliability and can perform the functions of multiple detectors.

Application of advance image processing technology to traffic surveillance has been pursued by the federal highway administration. The major problem with all existing systems, all experimental is that they employ fixed geometry sensors, this implies that the points of the roadway being measured cannot be changed unless the camera is physically moved. Therefore existing systems cannot extract all the necessary traffic information's and therefore are not better than loop detectors.

III. STRATEGIES FOR IMPLEMENTATION

Organizational strategies

Transportation related organizations face both challenges and opportunities in responding to the role of advanced technologies in transportation engineering. The challenges concerned adjusting organizational frame works. To best choose on the implement new tools and opportunities relate to tremendous increase in productivity.

This double edged situation has been clearly observed in recent years as civil engineering firms and agencies have faced the micro computer revolution. Some have adjusted their organizational structures and shifted resources to take full advantage of computer assisted drafting and design(CADD), database development and so on benefited as a result. Whatever the nature of organization, it must be prepared to alert its way of doing business in order to accommodate new technologies. This will certainly require effective planning and commitments of resources.

Research and development priorities

Several initiatives are already underway to establish research agenda in transportation engineering applications of advanced technology. Among these is project 3-38(1) funded by the national cooperative highway research programme of transportation research board. This project is assessing alternative technologies to relieve urban traffic congestion. The long term goals of this effort are a mid 1990's pilot demonstration, and a large scale of research programme similar to the current strategic highway research programme. In addition the federal highway administration and the national science foundation are each funding several projects involving expert system applications to highway problems.

IV. CONCLUSION

Advanced technologies in the area of information system, automation on telecommunications provide civil engineers with extraordinary opportunities for improving planning, designing, construction, maintenance, and operation of transportation systems. New tools and technologies have the potential of achieving cost savings and productive implements as well as enabling new development in the transportation.

Transportation accounts for the major portion of infrastructure investments. In order to maintain and preserve the highways, bridges, rail roads, ports, harbours, pipe lines and air ports as well as to plan for future developments in space transportation, civil engineers must seize the opportunities presented by the emerging technology in information systems, automation and tele communications. A concerted effort in this area by government, private industries and universities can make a significant impact on productivity and performance of transportation systems.

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