Applications of Advanced Technologies in Transportation: Lessons Learned and Future Directions

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Abstract

This panel session will address the current status of ITS and related programs, as well as experiences gained in the first decade of their deployment and will examine what lies ahead in terms of advanced technology applications in meeting ever increasing demand for mobility, security, and sustainability.

Introduction

The rapid pace of motorization and urbanization is a worldwide phenomenon. The urban population is increasing at a much faster rate than the total population, while the growth in automobile use is soaring compared to the automobile fleet growth. What is of concern is that these trends are much more pronounced in low and moderate-income countries (World Bank, 1996). In fact, most of the megacities are now located in the developing world where rapid motorization coupled with inadequate infrastructure are creating severe transportation and quality-of-life problems.

In the past decade, most industrialized countries have undertaken the deployment of emerging information and communication technologies with the hope of finding viable and practical options for meeting burgeoning travel demands. The basic lesson learned is that these technologies, as they have been deployed so far, are primarily oriented to improving traffic operations and are basically short-term solutions. Also, these technologies are mostly irrelevant to a great majority of developing countries (Sinha, 2003).

In order for us to harness the real potential of information and communication technologies in achieving sustainable transportation, we must go beyond short-term solutions of traffic operations and look for long-term modifications of travel behavior. We need to use technologies to link landuse-transportation systems to appropriate pricing mechanisms (Sinha, 2000). Only when we can effectively deploy electronic

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road pricing and provide wide and easily accessible opportunities for work, shopping, and entertainment through the Internet, will we succeed in tapping the limitless potential of technologies in shaping our urban areas and making transportation systems sustainable in the long-term.

Costs and Benefits of Advanced Technologies for Transportation

Transportation engineers are always seeking cost effective technology opportunities [Hendrickson 2004]. The costs of advanced technologies include new equipment and software, but also risks of failure and disruption of existing habits. Nevertheless, advanced technologies can be critical in achieving social goals, such as improved operations, enhanced safety and reduced environmental impact. As more demands are placed on our transportation systems, there should be a world wide effort to introduce cost effective advanced technologies.

Intelligent transportation systems (ITS) are a good example of new technologies that can be beneficial. Potential benefits include improvements in safety, mobility, system capacity, customer satisfaction, productivity, energy use and environmental impact (Miretek 2003). For example, an electronic fare payment system in Ventura CA had costs of less than $2 million, but increased revenues by roughly $15 million through reduced fare evasion and administrative costs.

The largest impediments to the introduction of advanced technologies are the lack of incentives for innovation and the diffused nature of benefits. Many public agencies are concerned with system operation rather than system improvement. For example, small municipal traffic departments may expend all their resources on repairing broken signals, neglecting systematic opportunities for improvements. Roadway networks are controlled by numerous agencies, each with their own set of priorities, making large changes in the network operation difficult. In the absence of market incentives, local leadership may be essential to accomplish change.

Traffic Management and Congestion Pricing

Three examples of significant penetration by ITS technologies into urban traffic management warrant consideration:
1. Surveillance and area-wide control of traffic, including rapid incident response.
2. GPS-based tracking of buses and other service vehicles with feedback to traveler information services.
3. Expansion of congestion-related road pricing.

There is nothing really new about these ideas. What is noteworthy at this point in time is the extent they have come into widespread use, both in major urban areas and in smaller communities.

Urban traffic management centers (TMCs) have existed for about thirty years. Several states such as Illinois, Minnesota, New York, Texas and California have been
leaders in expanding TMC services and deploying related technologies. In California, all TMC's have recently been linked together into a comprehensive statewide system employing compatible data systems and protocols for interagency cooperation, in part responding to homeland security imperatives. TMCs exist in all major urban areas and at several rural locations to deal with recurrent recreational traffic peaks and any emergencies that arise.

GPS-based traveler information systems for transit have been used for years by major transit properties, as well as in other fleet operations. These systems are now appearing in low volume settings where enhancement of public transport modes has typically received fairly little attention. Electronic bus status signs are found in the recreational community of Vail, CO. Also, the California Dept. of Transportation has recently supported the development of an open architecture, public sector transit information system (EDAPTS) suitable for deployment in small and medium size communities (Sullivan et al., 2002).

As throughout the world, policy makers in the U.S. have for many years shown an interest in applying congestion-related pricing to crowded roadways. About 1990, after decades of effort, landmark legislation in the form of California Assembly Bill (AB) 680 and the federal “Intermodal Surface Transportation Efficiency Act (ISTEA)” finally led to implementing a number of creative road pricing projects, from which we continue to learn valuable lessons (Berg et al., 1999). There are nine innovative pricing projects currently operational in the United States, and approximately six more under construction or in final planning. A common feature of all the U.S. projects is that pricing (the toll) varies with the time of day, in order to encourage traffic to shift from congested periods, and in some cases to high occupancy vehicles. Both due to the voluntary nature of participation and the desire to enhance public acceptance, these initiatives are called “value pricing.” Full project descriptions can be found on the national Value Pricing Website (Univ. of Minn., 2002).

The existing U.S. value pricing projects were developed and are managed by three state DOT’s (Florida, New Jersey, and Texas), three regional government agencies, and one private company (the private operation, SR 91, has since been taken over by a regional government agency). Pricing rules vary widely, with peak/off-peak differentials ranging from as little as 7-9% (New Jersey Turnpike and San Joaquin Hills Corridor) to a factor of five (SR 91 and I-15). Toll structure complexity also varies widely, from the 17-tier structure of SR 91 through traffic-activated dynamic pricing on 1-15 to simple two-tier structures at most other facilities. In about half the projects, toll discounts are linked to operators’ efforts to increase use of electronic toll collection technologies.

All in all, it appears that positive experience with Value Pricing has set the stage for more deployment of innovative road pricing and its supporting technologies in years to come. Evaluation studies for past projects have documented valuable
lessons that show under what circumstances creative pricing is most likely to be successful (Sullivan, 2002).

ITS Technology Applications in Security

In recent years the need for the protection of transportation infrastructure has become critical. This need is not only in relations to natural disasters, such as earthquakes or floods, but also in response to manmade disasters. There are numerous possible applications of ITS technologies in transportation security, primarily focused on sensing, monitoring and communications. There is a wide range of applications that are currently being considered for many aspects of infrastructure hardening, evacuation operations and training exercises and drills. The need to integrate these applications to enable global approaches to transportation security presents both opportunities and challenges for policymakers and engineers alike.

What Lies in the Future?

Attempting to predict the future in advanced technology applications in transportation is one of the more challenging assignments. Regardless of how optimistic or bold our thinking, we will certainly under-estimate what a generation or two will bring. The best way to begin, however, is to note some of the past accomplishments in the field, and then make an attempt at predicting where we may be in twenty years.

When considering the advancement of technology in any field, including of course transportation, it is much easier to look back than ahead. Only about three decades ago technology had an entirely different meaning – it was a slide rule, a surveyor’s chain and transit, and at its most elegant, a room-sized IBM 360 computer complete with punch card readers.

We were all first hand eye witnesses of the revolution: The little electronic calculator that cost $795, the Apple computer, the IBM PC AT with a 10 meg hard drive, Windows, NT, XP, the multi-gig hard drive, the three-gig processor, graphics better than Hollywood – and that is only computing for the desktop. We have also witnessed the revolution brought on by GPS, transponders, wireless internet, ITS, and so on. Today there are single engine airplanes that have better communication and navigation capabilities than commercial airliners did ten years earlier.

Each advance has impacted transportation in some way, in terms of planning and design, data acquisition and management, communications, billing, tracking, field applications in surveying or construction, etc. It has all happened on our watch. However, the basics of transportation have not changed that dramatically. We still use diesel and electric trains moving on steel tracks, diesel and gas powered trucks, buses and autos moving on concrete and asphalt highways, and jet powered airplanes taking off and landing on concrete runways the same way they did fifty years ago.
The future will bring big changes in transportation; this is certain. What will they be? The easy answer is more of the same. There is one absolute: Advances in computing will fuel these changes. In point of fact, they will either mirror or follow computing power surges. Freight will still be moved by trucks and trains, and people will still be moved by cars, trains, and planes, but with more efficiency.

The biggest change perhaps will be with the interface between transportation and communication. The need for white collar jobs to be focused at specific locations and times is already diminished. In a generation, nearly all work in many professions will take place anywhere in the world at anytime. The need to cater to commuters as a priority in transportation delivery therefore will be at the bottom of the list. Office infrastructure and related services will be in great excess as electronic and virtual transportation is the norm in the professions. This in turn will create a greater emphasis on goods movement in the current transportation inventory, and in the advances brought on by technology.

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