

**2010 AND BEYOND:
A VISION OF AMERICA'S TRANSPORTATION FUTURE**

FINAL DRAFT REPORT

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CHAPTER ONE

INTRODUCTION AND OVERVIEW

BACKGROUND

The future is a topic for unending discussion and contemplation. It is not reserved for transportation alone, but is also considered by all industries, societal movements, political endeavors and virtually every other organization in our lives. We wonder what lies ahead, how it will impact us personally and professionally, if the future will bring us prosperity and comfort or challenge and concern. Only a few have not pondered the future and how their lives might be different given a certain set of circumstances.

Predicting the future is a risky proposition at best. While some elements of our lives continue forward in a linear and predictable pattern, others often change course, without warning, resulting in totally unexpected outcomes. Occasionally, the future is altered by natural events or severe weather such as earthquakes or hurricanes. Unexpected business opportunities or difficulties may alter, reap or destroy fortunes seemingly overnight. Personal tragedy, while unanticipated, may forever change one's life. Nevertheless, in spite of the risks inherent in forecasting the future, there is no shortage of individuals, including the author of this report, who take the best information available and attempt to offer a glimpse into what might lie ahead.

Great interest exists in the future of transportation in our nation. Growing population, record freight movements, safety concerns and burgeoning demands for increased mobility for people and goods all motivate a desire for change, improvement and a more effective national transportation system. What form would a future transportation system take? If the United States continues on its current course the future is predictable; further growth in congestion, tragic mortality and injury levels, and inability to compete in the global marketplace. If industry leaders and public policy makers could influence transportation's future what then would it look like? Would consumers have choice in transportation decisions? Would financial investments reflect sound business practice? And, perhaps most importantly, would transportation become a transparent element of our existence and not the current drain it is on our quality of life?

Virtually every man, woman and child is affected every day by transportation systems at the national, state and local level. Whether commuting to work on a freeway or light rail, going to school on a bus or traveling around town on errands, transportation is always present in our lives. Some would argue that a person confined to a retirement home might not depend on transportation because they never venture beyond the confines of their care

facility. On the other hand, an argument could be made that the cost of this person's food, prescriptions, or their ability to go to a physician for healthcare are all influenced by the effectiveness and efficiency of the respective system needed.

Creating a transportation system to serve our nation in the 21st Century is a daunting goal. We live in a nation where traffic congestion grows each day. Vehicle miles traveled (VMT), a standard of measure used by the highway industry, grew by approximately 80% in the past 20 years while the capacity of our nation's roads and highways increased a mere fraction of that (*1 pg. 3*). The amount of freight coming into our coastal ports increased by almost 14% from 1999 to 2000 with little improvement in the physical capacity necessary to process these goods efficiently (*2*). Transit ridership is up 24% in the last six years with investment in transit systems, for both bus and fixed guideway systems hitting record levels (*3*). Yet demand for funding in transit, as well as every other mode of passenger and freight transportation continues to outstrip available revenues by significant levels.

To do nothing is an unacceptable answer to the question of addressing our transportation crisis. Failure to take a proactive approach in attending to these massive transportation problems will do nothing more than consign us to a future of decreasing mobility and economic decline. Yet what to do, how to do it and finding sufficient money for any action are all issues that must be addressed. This report looks at the future, poses key questions and identifies major issues facing transportation leaders and policy makers. It also attempts to offer potential answers to these questions; thus placing before transportation decision and policy makers not only a picture of our nation's future transportation system but also what must be done to ensure this future is bright and full of prosperity.

PROJECT SCOPE AND OBJECTIVES

In the spring of 2003 a series of meetings were held between the American Association of State Highway and Transportation Officials (AASHTO), the American Public Transportation Association (APTA) and the Hudson Institute. The purpose was to discuss a possible study relating to the future of America's transportation system. The desired outcome was a report defining such a future. From those discussions emerged the concept of a broad based study that would research the following topics:

- Freight transportation
- Transit's role in the future
- The role of technology in addressing operational, safety, security and efficiency concerns for all transportation modes

- Transportation security
- Integrating all modes of transportation
- External influences on transportation issues

Ultimately, six research projects were conducted which serve as the basis for this report's content. Financing for these topics came from a variety of public and private sources. Three projects were funded through the National Cooperative Highway Research Program (NCHRP), one through the Transit Cooperative Research Program (TRCRP) and the rest through private funding from the Hudson Institute and its various supporters. All six projects, with research principals, organizations and funding source are as follows:

- Technology Implications for 21st Century Transportation Systems, Richard Mudge, Delcan Inc., NCHRP
- 21st Century Freight Mobility, Sergio Ostria, ICF Consulting, NCRHP
- Vision 2010, Thomas R. Warne, Tom Warne and Associates, NCHRP
- Transit Futures, Hudson Institute, Jeffery A. Parker, Jeffrey A. Parker & Associates, TCRP
- Technology and the 21st Century Vehicle, Richard Weiland, Weiland Consulting, Hudson Institute
- 21st Century Finance, Lance Grenzeback, Cambridge Systematic, Inc., Hudson Institute

In addition, the Hudson Institute used its cadre of research fellows to contribute further background into factors influencing transportation including the global economy and demographic trends. These services were principally provided by Dr. Irwin Stelzer, Director of Economic Policy Studies, and Justin Heet, a Research Fellow, at the Hudson Institute. The individual research efforts listed above were completed as stand-alone products having independent usefulness for policy makers and transportation professionals. In addition, the Hudson Institute will analyze these reports and produce their own document containing policy recommendations in the same manner they publish papers on other policy topics.

This project represents an effort to assimilate the information gathered from all the above listed sources, create a report summarizing their findings and present a composite vision of the future of transportation in our nation. As a report this document should be seen as a summary of the issues presented and readers are encouraged to seek out the individual full reports for further depth and understanding of specific issues.

There are a number of areas impacting transportation, which will not be addressed in detail in this report. As is often the case in most research projects, there is a need to draw boundaries around any study and, with some reservations, have done so for this project. Conspicuously absent are detailed discussions relating to fuel efficiency,

CO2 emissions, land use, growth and its relationship with transportation, air transportation, water borne freight with the exception of a discussion on ports and other topics related to transportation.

The document will provide AASHTO members with a look into future possibilities and will serve as a guide for policy decisions and planning. Questions addressed by this report include:

- How will our surface transportation systems be affected by the global economy?
- What should our transportation systems be like in order to optimize the national economy?
- What role will technology play in the optimal surface transportation system of the future?
- How will finance tools and mechanisms evolve to serve transportation's investment in the future?
- What impact will changing demographics and urbanization have on our future transportation systems?
- What steps must be taken to fully integrate our transportation systems according to mode?
- What must our state and local transportation systems and organizations do to manage the continued long-term growth of freight in this country?
- What will the transportation systems of our country look like when these factors interrelate in the future?

These and other critical questions serve as the basis for establishing the view of the future emerging from this research effort.

STUDY PROCEEDURE

The Hudson Institute, in collaboration with the AASHTO, APTA, and the Transportation Research Board (TRB) established a format for advancing all related research topics for this project. This included two Futures Symposia held six months apart where information from these research areas was presented and interrelationships explored. Attending the symposium were transportation officials and industry partners from both the public and private sectors who are interested in the future transportation.

As research progressed on each project, two Advisory Panel meetings were held; they were modeled after the NCHRP program, where research principals presented work to date and invited specific comments from project supporters. Ultimately, these researchers produced final reports which will be published in accordance with the practices and policies of their sponsoring organizations. Participating in both Advisory Panel meetings and the symposium were over 60 individuals, representing federal and state government, academia, and the private sector. The research results from each of these projects has now been assembled into this report to assist transportation leaders chart our nation's future course.

ORGANIZATION

This report is organized into chapters to facilitate the presentation of information. In addition to offering a description of the current state of affairs in various areas of transportation, these chapters will give insight into possible actions that would bring positive changes. Each chapter will conclude with a series of policy related questions for elected and appointed decision makers to consider.

The following is a summary of chapters and content:

Chapter 1— Introduction and Overview This chapter includes a brief overview of the current state of affairs. It offers a rationale for conducting the research and the resulting value brought to developing future policy. In addition, unique relationships between the various participating parties in this project will be outlined. The overview includes consideration of past literature and studies, and some of the factors influencing transportation and it's future.

Chapter 2— Technology Impacts This chapter considers the role technology will have in binding together all transportation modes, making them more safe, efficient and effective in providing the desired levels of services expected by American consumers.

Chapter 3— Freight and the Future The current state of freight transportation is presented in this chapter and also includes a review of trends and future conditions that will influence this economic driver.

Chapter 4— Transit in the 21st Century This chapter examines the growing role transit plays in communities across the country and how this passenger transportation mode will become an integral part of our nation's future mobility system.

Chapter 5— Transportation Finance This chapter reviews current needs and available revenue streams to meet the same. Transportation finance alternatives are delineated for both near term and long term funding.

Chapter 6--Conclusions A series of conclusions are offered concerning the research conducted for this project and the policy issues to be addressed as decision-makers chart the course of transportation into the 21st Century.

References

Bibliography

PAST STUDIES AND LITERATURE

Authors have been prolific on the subject of the future of transportation in the United States. In order to fully appreciate past studies and thought on the subject of transportation's future it is appropriate to consider a something of that which is already published. The following sections offer that sampling.

Transit

Many people agree that the transit industry is changing; returning again to become a meaningful contributor to the overall mobility of our nation. They believe there is substantial opportunity for growth into the future. One of the main issues to be addressed by the transit industry will be sustainability, which hinges on creating a variety of services with reliable and meaningful funding sources. Other issues include the needs of various groups who use transit such as the elderly and those with disabilities, as well as funding, environmental, and safety concerns. Some past researchers suggest goals for the transit industry including using new technology, improving flexibility, training employees in customer-first service, considering new ventures, expanding research and training, gaining more information about current markets, sharing information, continuing research, maintaining customer satisfaction, increasing an awareness of customer communities, and flexibility (4)(5).

In "Intercity Passenger Rail" (7) the author notes that transit has a huge opportunity for growth in the coming years. He states that in Asia and Europe intercity passenger rail is far advanced beyond that in North America, but certain challenges must be faced before a viable intercity passenger rail exists in all major metropolitan areas of North America. For example, technology needs to be developed or acquired from other countries, infrastructure must be put in place, and funding sources must be found. Although high-speed rail has a nearly unblemished record, room for safety improvements exist. There are also environmental concerns for high-speed rail including noise and vibration, and electromagnetic interference/electromagnetic field effects.

One researcher addressed the issues of marketing transit and fare collection. He found that people are motivated to use public transportation for various reasons. Marketing involves addressing these "value" issues.

Target groups must continue to be identified and customer loyalty maintained. Marketing efforts may target neighborhood transit efforts, alternative modes, clean fuels, and transit safety. He believes commuting patterns and practices will also change in the future. Suggested improvements include fare payment enhancements, use of a universal smart card, cross-industry marketing and imbedded uniform product codes (UPC) (5).

In the New Millennium, the case is made that transit must be more focused on the needs of the elderly and those with disabilities. It will be important to create Trip Chains, which make every part of the trip accessible and therefore possible. Improving transit so that it will allow access to all, including those with children, language barriers, luggage, or unfamiliarity with the local area will make transit more useable for those with disabilities as well. It will also be important to build a family of services which include accessible road and rail transit, routes near housing areas used by elderly or disabled persons, accessible taxi services, and door-to-door services. For the whole system to be accessible, it must also have equally accessible pedestrian infrastructure, terminals, stations and stops, and travel information available for those with cognitive, sensory or linguistic impairments (6).

The future practices of transportation planning are also influenced by changes that are occurring relating to transit usage in America. Future planning changes include: “renewed focus on neo-traditional development patterns,” demographics, public transit shaping development, increased multi-municipal planning and cooperation, research in new techniques, outreach plans. Future transit growth and development will also be impacted by global issues such as technology, the global economy, our aging population, economic disparity, and environmental concerns. Local issues will also affect transit and influence transit planners. These issues include: changing demographics and businesses development, technology, customer attitudes, finance, infrastructure, environment and as yet unmet needs (4).

Freight

AASHTO estimates that in 1997, 11 billion tons of freight was shipped in the United States via roads, railroads, airways, waterways and pipelines, valued at \$7 trillion (1). No future look at transportation would be complete without a thorough treatment of freight and it’s many dimensions. While the original research conducted for this project is summarized in Chapter 4 it would also be appropriate to consider here what past researchers have determined about the future of freight in our nation’s transportation system.

A change in the way information is gathered, handled, and distributed will mark one of the major changes in freight transport. Real-time data will optimize handling and movement, diminish costs, increase service, and meet

regulatory requirements. In the future, data collected by shippers and carriers would be combined with data collected by public agencies, such as weigh-in-motion, ITS-CVO (Intelligent Transportation Systems-Commercial Vehicle Operations) monitoring, travel time and volume, and would be accessible to use from a clearinghouse (8). Data must also be gathered and shared on an international level in order for freight to flow with optimal levels of efficiency (9). This data will allow freight transportation customers to make more informed decisions about alternatives and require freight transportation to meet higher standards (10). Information sharing at all steps in the manufacturing-distributing process will allow for reduction in inventories and for operation integration between companies (11).

In "Freight Transportation Planning and Logistics," (11) researchers stated that domestic and international freight demand will grow because of an increase in consumption of goods and a growth in the world economy conducive to producing goods. Freight planners will have to account for an increase in consumer service demands as well as a decrease in available infrastructure capacity. The future will require existing infrastructure to be used more efficiently and new infrastructure to be carefully developed. E-commerce will result in a decrease in shipment size and an increase in shipment frequency. Because of an increase in the complexity of global supply chains, there will be an increased use of third-party logistics providers.

One researcher states that the focus of transporting freight should be changed from containerized shipments to all multi-modal, single-bill transports. Challenges facing the system include: a lack of physical and technological growing room, demands by consumers for products which may be obtained at any time and are delivered faster and cheaper, and a lack of recognition for needed changes by the transportation industry. Both the transportation industry and regulatory officials must consider the supply chain in connection with global transport efforts and understand how competition and technology changes will affect this chain (10).

One report notes that there has been a resurgence in rail-freight transport. Small, local service is as important as national, Class 1 systems. Infrastructure, equipment improvement and updating are needed. Relationships between small carrier and Class 1 systems are varied, yet crucial. Competition from other modes, especially trucking can be challenging. The public sector affects the industry through regulatory efforts, financial assistance, safety requirements and corridor maintenance by planners (12).

Social Issues

The Federal Highway Administration estimates that 1 in 11 people are employed in transportation (1). Some studies indicate that up to 50% of transportation workers may be eligible to retire by 2010. These are the workers who have spent their careers building the current transportation system and with them will go the built up institutional knowledge of these many decades of experience. The next generation of workers will have different ideas of the ideal job and will be willing to change jobs more often. This requires a change in recruitment strategies by transportation industry leaders (13). Transit industry recruiting is also important to the future viability of that mode(7).

The social and economic impacts of transportation projects should be studied so that decisions will result in the most effective and efficient solutions for all customers. New technology should be used for impact assessment and external costs should also be evaluated. Transportation must evolve and find solutions to environmental, injury/fatality rates, and congestion concerns in order to be sustainable (14).

The changing nature of our society will surely impact transportation into the future. Past researchers have offered a number of insights into this important area to be considered by planners. The aging population will affect all aspects of life in the US including transportation. As the population grows older, population growth will occur mainly in suburbs, and in the West and South. Telecommuting is a trend that will continue into the future and will be joined by other work-from-home arrangements (15). Additionally, planners must also account for the growing trend of city-dwellers working in the suburbs, creating a reverse commute effect (16). Further detail on current work in this area will be presented later in this chapter.

Technology

Changing technology will also impact the future of transportation. New technologies will influence every aspect of transportation from safety to environmental impact to economic and social aspects. Considerable resources were expended on this project to more fully explore the influences technology will have on the future of transportation which are found in Chapter 2. However, a summary of past research is appropriate here.

Researchers are working on the technology of highways. Using nanotechnology, they have the potential to make concrete and pavement last longer as well as making steel stronger and more durable. They can also use sensors imbedded into roadways and bridges to find early signs of weakness. Sensors could also be used to alert responders to incidents on the highways and alert drivers to quickly changing weather conditions. The future may

hold highways that are able to correct cracks and potholes on their own, self-cleaning metal that doesn't corrode, automatically realigning guardrails, and bridges able to adjust their shape to wind conditions. (17).

In "Transportation in the 21st Century," researchers said that transportation would advance because of current trends in smart growth, high-speed trains, outsourcing, intelligent transportation systems, road pricing, and advancing technology in automobiles. Americans will continue to utilize motor vehicles, but will begin to make transportation choices that will relieve traffic congestion. New automobile technology will be a primary means of addressing environmental concerns. Outsourcing will increase and private-sector companies will continue to consolidate (18).

Currently, 97% of the fuel used by the transportation sector is oil. According to one researcher, that must change in the future. Alternative fuels will have specific requirements to meet before they can replace petroleum. These include sustainability, minimizing their contribution to greenhouse gas emissions on a life-cycle basis, contribution to emissions of criteria pollutants, toxicity, effect on land use and damage, cost competitiveness, and infrastructure requirements. Natural gas and electrical energy from fossil sources, ethanol or methanol from biomass, hydrogen, and electrical energy from biomass are possibilities although each has significant hurdles to overcome. Unless stringent policies are developed to implement low CO₂ fuels such as hydrogen, natural gas-derived fuels will probably see a marked increase in use in the 21st century (19).

Another emerging technology is GIS-T (Geographical Information Systems for Transportation). "GIS-T is interconnected systems of hardware, software, data, people, organizations, and institutional arrangements for collecting, storing, analyzing, and disseminating information about areas of the earth that are used for, influenced by, or affected by transportation activity." Whereas now GIS-T is now in its infancy, as time goes on, the technological and institutional communication systems necessary for GIS-T to be a major factor will continue to grow. In many cases the technology already exists for this type of network and the challenges lie in improving the types and levels of communication between the many public and private entities that will be involved in a robust GIS-T system. In addition, it will also become more usable by the average consumer. Decisions made now about the direction GIS-T is taking will regulate the viability of this system as a force in the future (20).

Intelligent transportation systems will also be integral to the future. The goals of the Intelligent Transportation Association are: to decrease accidents by 15% and save 5,000-7,000 lives a year, protect the transportation system against natural and man-made threats, save \$20 billion a year through better management of

information and congestion, allow information to be universally available, save one billion gallons of gasoline per year and reduce emissions. These objectives can change the direction transportation takes in the future (21).

Change

One look at the future notes that the 21st century is going to be vastly different from the 20th century. Using solutions to problems that worked in the 1970's or even the 1990's will not work into the future because we are going through a major transition period. Companies of the future must be global. No matter what the industry, everyone doing business in the 21st century will function on a global level. We are also going through a period of mergers and acquisitions. In the end, three large companies usually will have a significant portion of the market share and a few niche companies will have a smaller share. Technology is increasing so rapidly that the next ten years will bring innovations allowing companies to solve problems they have not been able to in the past. The supply chain will have to become less disjointed for transportation to progress (22).

Institutions must change to account for that which is occurring in the external environment. The difference between changes in agencies and institutions that have occurred in the past and what will happen in the future is that they will have to focus on the external environment to facilitate the type and extent of their adaptation instead of the internal environment. The same types of tools will apply though: "internal restructuring, resizing, public-private partnerships, performance-based planning, and information sharing," but institutions must use these tools along with new technologies and new partnerships to progress in the 21st century (23).

In "Trends We Cannot Afford to Miss" (24) researchers predict an increase in the affluence of our society, which will affect both passenger travel and freight movement. Also, specialization will increase and demographic changes will occur, affecting the economy. Authors conclude that efforts made to improve safety, international competitiveness, operations, job access, and metropolitan capacity will have significant long-term effects on our society.

In one article, the author predicts the future of environmental law. Because of the length and complexity of rules regarding transportation plans and programs in relation to Statewide Improvement Programs (SIP), Congress and the EPA will have to simplify them to make them to allow projects to proceed more efficiently. Although the Kyoto Protocol would limit the amount of greenhouse gasses allowed in the future, there is little political support for its ratification in the United States. Mitigating methods suggested include taxation induced driving reductions and changes in land use density or developing new technologies to use non-petroleum based fuels. The authors contend

that NEPA and related laws will continue to grow in strength because of the strong environmental lobby and because congressional committees overlap on environmental issues. Confusion will reign in the area of waste management until federal laws are reformed, although clean-up costs and liability risks should continue to decrease because of state laws (25).

Three main issues are at the forefront of global transportation at the beginning of this millennium; oil dependence, air pollution, and greenhouse gas emissions. Although running out of oil is not a worry – researchers estimate the supply will last 1,500 more years – it is not economically advisable to remain dependent on oil because of the potential for continually rising costs and global instability. Carbon dioxide emissions have decreased by 25% in the last 30 years, but they must fall still further to decrease the damage to humans and the ecosystem. It will be important to implement these changes in the rest of the world. Authors call for policy changes to reduce carbon dioxide levels and use technology to improve vehicle efficiency (26).

Communications can also affect transportation. Against expectations, improved communications has not reduced travel. Three communication modes exist: face-to-face, transfer of information objects, and telecommunication. Studies differ about whether telecommunication replaces or complements travel. Future research should focus on this as well as “mobile work”, i.e., the home-based consultant. E-commerce (virtual supply chain) and teleshopping should be studied so that planners will fully understand and account for it in the future. The effects of telecommunication changes on office space and form also needs additional research (27).

Policy

Past researchers have not been bashful in focusing on the policy issues that logically emanate from any discussion of the future of transportation in our nation. They assert that these future transportation policy concerns must include economic development and future growth. Investment in transportation includes new construction as well as implementation of technology and efficiency improvements. Economic effects of these changes must be considered in developing a sustainable transportation system. Deficiencies exist in data collection and scope and must be addressed to achieve our objectives for mobility into the future. Current cost analysis functions must broaden to include a spatial perspective and economic development factors. Interaction between departments of transportation and economic development administrators is valuable and must be improved in the future for each to become more effective (28).

Through ISTEA and TEA-21, states are required to do their own multimodal planning. Agencies are expected to implement performance-based planning and measurement, including customer involvement. Asset management systems should include technology (ITS) and focus on both short and long-range goals. Financial constraints must be considered and will influence the types and numbers of projects built in the coming years. Successful multimodal planning should include goods movement, technology changes, environmental concerns, and socioeconomic equity. Different transportation groups must collaborate in new and more effective ways. Research efforts will need to be more focused and target specific areas that will result in measurable improvements to our nation's transportation system. Complex staffing issues need to be addressed or this important dimension of our future will ultimately become an impediment to fully achieving our goals and objectives for all modes of transportation (29).

This literature review provides a glimpse into the thoughts and writings of professionals who have examined key areas of our transportation future. It should not be considered as all-inclusive but rather a sampling for consideration. Many of the key policy issues facing our nation into the future will be explored in more detail in this and the following chapters.

FACTORS INFLUENCING TRANSPORTATION

Many different factors influence transportation in the United States. Some are technical in nature, such as advancements in fuel economy or the Anti-Lock Brake Systems (ABS) now found on most new automobiles. Additionally, some of these factors are not technology based yet still have significant influence--these include demographic trends or societal change. Economic events and influences impact transportation from both a domestic and an international perspective. These and other factors interact in a complex, multi-dimensional relationship encompassing the transportation system that serves our citizens on a daily basis. This chapter will explore some of these factors and how their relationships affect the national network.

Travel Patterns

How much we travel is clearly a significant measurement of what we can expect of the future. As Americans we value our mobility. Most citizens in the United States define mobility in very simple terms--Go where we want, go when we want, and go how we want. That definition of mobility, combined with a fierce desire for individual freedoms produces an ever growing pressure on our transportation network.

Vehicle miles traveled (VMT), a measure of our travel patterns, reflects an ever-increasing volume of miles traveled on an annual basis. In its Bottom Line Report, AASHTO offers the following:

“The forecasts of vehicle miles traveled (VMT) growth are derived from state and local predictions based on factors such as population, incomes, household composition, and freight trends. They indicate that growth from 2004 to 2009 will average 2.2 percent per year, or 50 percent over 20 years. To put this in perspective, VMT increased approximately 80 percent over the past 20 years to 2.75 trillion vehicle miles traveled by 2000. Even with projected growth rates lower than those of the past 20 years, highway VMT may reach 3.35 trillion by 2010” (1, pg. 3).

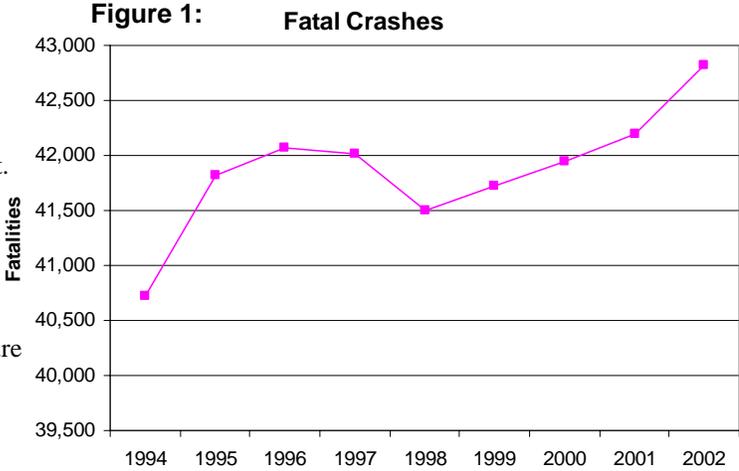
This VMT growth, even when considered conservatively, drives the need for substantive changes in capacity and operations in our future transportation system.

The growth in VMT will continue to follow past patterns unless significant societal, regulatory, technological or other changes occur. Many questions remain as to how our nation will respond to congestion and whether or not it will allow demand to continue to grow unabated. Smart Growth is a terminology assigned to a new and more efficient growth pattern in some parts of the country. In South Jordan, Utah, the Kennecott Land Company recently launched its over 4000 acre Daybreak development which is designed around a “transit oriented” approach to housing and commercial activity. Daybreak is a bold initiative designed to redefine how American communities grow and develop and is reflective of the vision of the Smart Growth movement. How aggressively will US communities embrace developments such as Daybreak remains to be seen. Never the less, this type of societal change may impact congestion and the solutions to VMT growth into the future.

Safety

Safety, without question, is the most important factor in any look at future transportation. Any solution, no matter how innovative or creative, which does not include a strong emphasis on improving system safety will be found to be without merit.

Two principal measures are used to evaluate highway safety performance. The first is total fatalities and the second is a measure of the rate of fatalities per 100 million vehicle



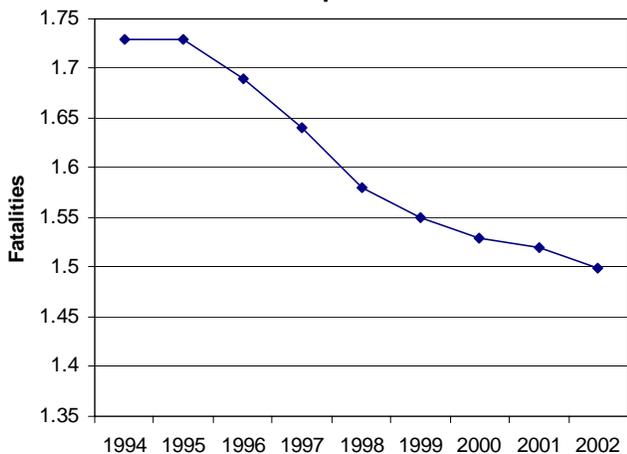
<http://www-fars.nhtsa.gov>

miles traveled (VMT). Historical trends of the number of fatalities on an annual basis are shown in Figure 1 for the years 1994 through 2002. Modest improvements have been made over the years through seat belt use, front and side air bags, greater utilization of child safety restraints and other improvements to the automobile itself. However, in spite of these improvements the total number of fatalities remains over 40,000 per year during this period.

Further, though the fatality rate, measured as one fatality per 100 million VMT, has decreased since the mid 1990's, it has now shown signs of leveling off. Figure 2 reflects this trend for the period of 1994 through 2002. This flattening of the fatality rate is additional evidence that incremental improvements in safety practices continue to be negated by how much travel is actually occurring.

It is clear that significant gains in traffic fatality reduction have occurred at different points in time due to changes in safety features added to vehicles using the transportation system. For example, increased seat belt usage, air bag deployment and other measures have aided greatly in reducing the overall rate of fatalities against the ever-increasing growth in VMT. Other safety measures such as drunk driving countermeasures, aggressive speed

Figure 2: Fatalities per 100 mil VMT



enforcement and system safety feature improvements such as improved attenuators have all offered modest assistance in this effort. In the end, however, it appears that VMT growth will continue to out pace safety improvements preventing an overall reduction in the fatality rate and the number of fatalities measured each year.

While fatalities are one dimension of safety, hundreds of thousands of injuries occur either separately

<http://www-fars.nhtsa.gov> or in connection with these crashes. The implications of injuries incident to crashes are manifold; while some can be relatively minor with the blessing of full recovery, many others involve a lifetime of disabling and devastating consequences that affect employment, family and individual functions. The high personal and societal cost can't be measured in dollars but at the same time are very real. What can be measured is the financial impact of crashes including medical care, lost wages, and rehabilitation. In 2000 the National Highway Traffic Safety Administration (NHTSA) published a costs assessment, which placed this value in excess of \$230 billion (30). To put this number in perspective, \$230 billion represents over 2% of our nation's

Gross Domestic Product (GDP) for that year. Simply said, the financial impact of crashes on the highways represents a significant drain on our economy.

No one will disagree with the fact that the traffic related deaths of over 40,000 individuals a year on our nation's highways is unacceptable. However, these questions remain:

- How does the United States break through this 40,000 fatality per year barrier?
- What will it take to make the quantum improvement in safety that should be our societal objective in this area?

Achieving safety improvements is certainly a prime objective of federal and state transportation agencies. In the United States Department of Transportation's (US DOT) 2003-2008 Strategic Plan the stated goal was to reduce the fatality rate from the current 1.5 to 1 per million VMT or by about one-third (31). While this goal is ambitious and appropriate, we should not mistakenly believe that America is the international leader in reducing fatalities. In fact, the European Union has stated their objective is to halve the annual number of fatalities by 2010 and eliminate them totally by 2020. Clearly, as a nation, the United States can and must do more to stop this terrible loss of life (32).

Congestion

The operational efficiency of the national transportation system is yet another of the issues facing transportation professionals and policy makers as they contemplate the future. Congestion is accepted as a part of our daily lives. We have become a nation that measures hours of delay and wasted fuel in billions on an annual basis. The Texas Transportation Institute (TTI) provides an annual assessment of both measures. They reported in their 2003 Urban Mobility Study of the 75 most congested areas in our nation that 5.7 billion gallons of fuel were wasted and 3.5 billion hours were lost in productivity. TTI reported the annual bill for both exceeded \$69.5 billion, which was up some \$4.5 billion over the previous year (32).

Those using the nation's highway's system are experiencing increasing levels of congestion in terms of severity and duration. Declining levels of service (LOS) and extended hours of peak congestion continue unabated across the country. As our population increases, travel patterns change and mobility requirements transition in the 21st Century our infrastructure continues to strain to serve our needs. Perhaps the most dramatic representation of why congestion continues to grow at such an unchecked rate is to examine the growth patterns of VMT and capacity. AASHTO states in its Bottom Line Report that VMT has increased some 80% in the last 20 years (1, pg.

3). When one considers that capacity is increasing at an almost indiscernible rate it is no wonder that congestion is having so much influence on overall mobility.

Congestion isn't just an urban problem without a non-urban or suburban component. In fact, inter-city congestion is an increasingly challenging problem facing transportation professionals. Often, this type of congestion occurs during periods of peak demand over weekends, in areas of high tourism activity or when events or circumstances create large movements of vehicles from one urban area to another. The US will have to address this challenge as well as the more traditional and recognized urban congestion previously referred to.

What of transit? Is our transit system impacted by these congestion levels? The answer is a resounding "yes." Where no High Occupancy Vehicle (HOV) lanes exist, a community's transit vehicles are found in the same congested circumstance that passenger cars find themselves in—slow moving traffic or an outright stand still. The operational efficiency of all transit systems are impacted by these growing levels of congestion with the exception of fixed guideway systems such as light rail or commuter rail lines.

Freight and its operational efficiency are also negatively affected by congestion. Congestion in and around ports, freight terminals and airports all contribute to the cost of transporting both domestic and foreign goods. When congestion occurs freight movements slow, become less reliable and more expensive. The same growth patterns that come from large increases in VMT on our roads and highways will ultimately become an important economic factor as the US competes in the global economy.

Demographics of the Workforce

Changing demographics is one major area of influence. Considerable research on demographic trends and workforce issues that will affect employment, societal inclinations and economic performance has been conducted by private and public entities alike. In the end, no vision of the future would be complete without a thorough examination of these other influences.

In their defining work entitled, *Workforce 2020*, the Hudson Institute explores the myriad of issues relating to demographics in our nation and their influence on our future workforce. In it they note there are four powerful trends that planners must consider in relation to the workforce and which ultimately will have an impact on demographics and transportation. They are:

- The pace of technological change in our society has never been greater
- The rest of the world matters

- America is getting older
- The US labor force continues its ethnic diversification

The challenge of transportation planners is to understand how each of these factors will influence the systems they are envisioning today and ensure that which they develop truly meets the needs of our society 20 and more years into the future.

The US labor force is becoming very diverse in its makeup and communications. The Asian and Hispanic workforce will grow faster than other segments, increasing to 6 and 14 percent respectively in the next 20 years. The African American element of our workforce will remain the same with white non-Hispanics replacing themselves and not adding to the overall increase in total workers. Most of this influx in diversity of the workforce will occur in the South and West with less impact in other parts of the country.

No one will dispute that technology is changing our lives. Yet, try as we may, our projections are often far from accurate. In the early 70's few predicted how important the personal computer would be. Fiber optic communication was still in development. Cell phones and other telecommunications devices were the stuff of science fiction books and television. Can anyone really predict what will happen when nanotechnology is fully deployed throughout the world; forever changing manufacturing activities, medical practices and other critical areas of our lives? The object of the planner is to foresee what is unseen and build a transportation system to meet the mobility needs of the future generation: no small task. Perhaps the best advice to planners is to ensure that no option is ignored; permitting the system to adjust and even rapidly "morph" as necessary in the coming years.

Hudson concludes that, "the rest of the world matters." The United States is not an island in the sea but an integral part of the global community—coordinated, related and otherwise connected to the rest of the world. A discussion of US demographics or workforce cannot be credible without incorporating elements of the global workforce and its related demographics. The US workforce of the future will be more mobile and willing to change domiciles at rates unheard of in the past century. Small and medium size businesses will outperform larger counterparts who are less nimble and able to respond to changing markets. Job volatility will be a major issue with traditional efforts to outsource causing many jobs to go overseas (*15, pp. 1-4*).

It's no secret that America is getting older. The Baby Boom brought many millions of our citizens into the world between the years of 1945 and 1965. By 2010 the first of the Baby Boomers will begin to retire, leading to a 20% segment of the US population being over 65 years of age by the year 2020 (*15, pp. 5*). These aging citizens

will affect the labor market, the economy, political issues and society as a whole. Medical advances will allow this group to work and play longer in life spawning new and different trends to accommodate this emerging lifestyle of the “healthy and active senior.” Our aging society will stay in the workforce longer, recreate differently and in general be unlike any former group of retirees.

Transportation must accommodate this important segment of our society, their living habits and their quest for quality of life. In the end, technology may also influence how much longer they are able to retain their driver’s licenses and safely operate a vehicle. Those who choose not to drive, but who are still healthy enough to get out and about will also put different demands on our nation’s transit systems. The whole array of transportation services from automobiles, to transit, to ship and air will slowly evolve in response to what will be a more affluent, demanding and active group of consumers.

Distribution of population will influence how transportation will operate and provide mobility in the 21st Century. Shifts from the Northeast to the Southwest are well known and expected. The depopulation of rural states like South Dakota and the general depopulation of rural America to urban areas will also occur. Eastern seaboard states will experience different transportation impacts due to demographics than their west coast counterparts. Thus, one solution truly isn’t going to fit every challenge that lies ahead.

The US Census Bureau finds the practice of predicting population growth patterns challenging at best. Assumptions about fertility rates and mortality rates have been rather stable and predictable. What has also been challenging is that the unexpected levels of immigration don’t fit the traditional models for forecasting population change. The Hudson Institute notes that increasing immigration has been a pattern for US population growth for over 20 years. For example, in 1980 the net migration into the US was 500,000. Ten years later it had grown to 650,000. By the year 2000 it had increased to 1.5 million. Hudson predicts that by the year 2050 the majority of our population growth will be from immigration and not from organic growth (33).

All told, demographics and the changing workforce will create change in significant ways. Transportation planners and policy makers would be wise to account for these changes as they prepare for the future.

The Global Economy

How will the global economy impact our 21st Century transportation system? This question is fundamental to addressing the future in a responsible way. In 1999 Thomas L. Friedman, Foreign Affairs correspondent for The New York Times, wrote a telling book on the global economy entitled, “The Lexus and the Olive Tree.” In it he

expounds on the impact the global economy is having on the US and nations throughout the world. He summarizes as follows:

“Globalization is not just a phenomenon and not just a passing trend. It is the international system that replaced the Cold War system. Globalization is the integration of capital, technology, and information across national borders, in a way that is creating a single global market and, to some degree, a global village.

You cannot understand the morning news or know where to invest your money or think about where the world is going unless you appreciate this new system, which is influencing the domestic policies and international relations of virtually every country in the world today” (34).

Manufacturing has long looked to overseas markets for more economical production activities. For years, white-collar employees in US companies felt assured that their positions were not at risk. Today, with software, engineering and a myriad of other non-blue collar positions being outsourced to Asia and the Near East, these workers are facing as much risk as any other segment of the workforce.

For years, Wal-Mart touted their “Made in America” origins for the products they sold. In 2003 even they have succumbed to the need to provide goods at the lowest possible price--generally manufactured overseas. In an article published by the Washington Post this point is driven home with finality. In it Wal-Mart reported that their imports from China exceeded \$15 billion in 2003--placing it at number five in the list of China’s largest trading partners, ahead of France and Britain (35).

The US consumer is now caught in a conundrum of economic policy and customer choice. Will they choose lower prices, which are often provided by offshore labor or will they be willing to pay a little more for domestically provided products? In spite of their feelings towards protecting domestic labor, the trend appears to be towards a choice for lower prices as evidenced by the fact that Wal-Mart is America’s largest retailer with sales of more than \$245 billion a year (34). One of the key differentiators will be the available transportation system and how it will be used by consumers and retailers. Transportation can serve to reduce the marginal cost of goods. Improved transportation systems, borne out of transportation policies and improved efficiencies can and will have an impact on the price competitiveness of goods manufactured and sold in the US.

Irwin Stelzer, a Director, Economic Policy Studies with the Hudson Institute and a noted economist here in the United States and in Britain, offers many insightful thoughts on the global economy. He stated that our 21st Century transportation system will be impacted by five principal policy areas. They are:

- Macroeconomic and microeconomic policy-the mixture of monetary, fiscal and policies that impact economic growth and the wealth of nations
- Individualism vs. collectivism-a measure of individual freedoms and how they are leveraged by citizens in their personal, professional and social pursuits
- Tax policy-The power not to tax is the power to stimulate. The future of our nation's transportation network will be determined by how we employ the power to tax
- Homeland security and defense policy-increasing security results in additional costs for every transportation system in the world. How these two, security and defense, interact in the future will have a major impact on our nation's economic vitality and transportation system
- Environmental policy-how nations react to environmental policy will impact transportation systems in the future. In addition, what environmental objectives will be reached at the expense of safety objectives?

He concludes with the following statement: "In the battle over transport policy, politics will trump economics. Prices that internalize the social costs and benefits of various modes of transport will remain of interest to economists and think tanks, but prove of little interest to politicians more interested in creating construction jobs, responding to ... lobbyists, preserving uneconomic air and rail service to small communities in their states and districts, catering to the not-in-my-back-yard crowd that abhors airports, and otherwise responding to political, rather than economic pressures." (36)

Perhaps one of the most vivid reminders of the global economy and its influence on the US business market is the steel crisis of 2004 where demand for steel in China is affecting price and availability in the US. Engineering News Record reported in its March 22, 2004 issue that prices for scrap steel had increased by 20-60% in the first quarter of this year due to the huge demands placed on the market by work in China (37). Ten years ago who would have thought that rebar prices in Duluth would be influenced by projects in mainland China. Today it is a reality of the global economy.

The global economy is real and without borders. It makes a "call center" in India providing services to clients in America possible. Software engineers write code for clients thousands of miles away. Jobs of all types are at risk. Transportation systems become facilitators as well as elements of this global economy. Transportation

planners and policy makers can't deliver on the future without an appreciation for this important part of the overall picture of our nation and world.

Many factors will force decisions about our 21st Century transportation system. Safety, congestion, demographics and the global economy are just a sampling of those factors that must be considered when making strategic transportation decisions. There will be many routes and directions to choose from in determining our future system. Transportation leaders would do well to choose wisely.

TRANSPORTATION SECURITY

Transportation security is a high priority element of the 21st Century transportation system as a consequence of the changing environment in our world today. Even before the tragic events of 9/11, transportation systems were vulnerable to terrorist events as evidenced by repeated terrorist activity in Israel as well as the nerve agent attack a number of years ago in a Japanese subway. In spite of these past occurrences, transportation security in the United States prior to 9/11 was largely focused on modest efforts in the airline industry and general security measures at ports and other freight terminals. Today much has changed, requiring professionals and policy makers to view their future through the "security lens," in order to have a full vision of the 21st Century transportation system.

The Threat

The threat to transportation security is rooted in the airline hijackings of the sixties with spectacular and tragic incidents occurring over a number of years and involving various perpetrators with and without political motives. Implementing modest counter-measures in airport terminals as well as deploying sky marshals mostly eliminated hijacking as an issue. However, in the ensuing thirty years, isolated incidents served to remind us of our vulnerabilities. The downing of Pan Am Flight 103 in Lockerbie, Scotland was foreign-generated with direct transportation links. Others, like the bombing of the Murrah Federal Building in Oklahoma City in 1995 originated domestically and had a transportation connection solely as a function of weapons conveyance.

Today, the array of threats to be considered by transportation professionals is much more complex and multi-dimensional. Origins may be foreign or domestic. Perpetrators may live here in the US or enter temporarily for the purpose of causing harm. Virtually any mode of transportation is a possible target as are citizens of every walk of life.

A variety of threats must be considered when designing and operating the 21st Century transportation system. In the recent years much media attention has been given to weapons of mass destruction (WMD). Certainly, from a national security standpoint, WMD must be dealt with and considered. However, the March 11, 2004 train bombings in Madrid, Spain revealed a new dimension to the linkage between terrorism and transportation. This incident illustrates how a series of bombs, carefully coordinated in areas where large numbers of citizens have congregated, can also result in a high loss of life, cause psychological turmoil and ultimately sway political processes. Thus, security in the 21st Century must address events both large and small.

The types of threats for causing harm are now varied and further complicate the transportation security issue for a transportation professional and policy maker alike. These include:

- Nuclear-including dirty bombs
- Biological
- Chemical

Each of these poses a threat to the safe conveyance of persons or goods on our nation's transportation system.

Transportation Vulnerabilities

Transportation systems are particularly vulnerable targets. In 2002, the National Academies of Science published a report entitled, "Making the Nation Safer, The Role of Science and Technology in Countering Terrorism." This comprehensive work considered a wide array of homeland security measures including those particularly relevant to transportation. In this report it is noted that transportation systems are vulnerable due to some of their inherent characteristics. Those listed are:

Openness and Accessibility-most systems are designed to be efficient, easily accessed by users and in many ways unrestricted. Even airport ticketing and baggage claim areas are still open to the public. Transit facilities and highways are also notably open and easily accessed by user and perpetrator alike.

Extent and Ubiquity-Transportation assets tend to be characterized by their high numbers. With almost 600,000 bridges, a 160,000 mile National Highway System (NHS), a freight-rail network of over 300,000 miles and 10,000 miles of commuter and urban rail systems, the size and extent of the overall network is a major vulnerability.

Emphasis on efficiency and competitiveness-the emphasis we place on being price and performance competitive in the services we render and receive impacts security measures in a number of ways. The foremost one is the

pressure to move consumers through the system with as little delay as possible while balancing the impediments inherent in a competent security system.

Diversity of owners, operators, users and overseers-in nations that have nationalized transportation modes and networks the coordination activities that are part of a transportation security system are eminently easier to implement as opposed to the diverse nature of the US system. Coordinating security practices among a variety of public and private sector entities is always challenging.

Entwinement in society and the global economy-our economy and way of life are inseparable from transportation. Whether commuting, shipping, recreating or engaging in any other activity, almost every element of our daily lives is influenced by transportation. Our vulnerabilities are many and the potential consequences significant. For these reasons, transportation security is a major issue with no singular solution (38).

In examining specific vulnerabilities each mode has it's own. Not all components would have the same levels of exposure or consequences stemming from a violent event. A brief listing is provided below:

Air

- Aircraft
- Terminals
- Freight operations

Ports

- Ships
- Cargo containers
- Transfer facilities
- Intermodal terminals

Highways

- Bridges
- Lifeline facilities
- Tunnels

Pipelines

- Terminals
- Pipelines

- Valves
- Booster stations

Transit

- Vehicles
- Terminals
- Underground stations

The depth and breadth of the challenge may seem overwhelming given the array of transportation elements listed above. However, transportation professionals and policy makers must aggressively plan and execute security measures appropriate to the feature and threat level.

The Response

Transportation security involves identifying risks and managing them in the context of the operational requirements of the network in question. It takes many forms. Transportation security includes protection of cargo and its conveyance systems, of passengers in automobiles and on transit systems, of the infrastructure itself, and of course adjacent people and facilities, which might be in danger from a security event involving transportation. Each has its own set of vulnerabilities and requirements for ensuring security.

In the wake of 9/11 the US response to the threats to transportation security were heavily focused on the airline industry and passenger travel. Heightened security measures were immediately implemented and have continued to evolve in sophistication and practice. The US DOT established the Transportation Security Administration (TSA) to staff and manage this key element of our nation's domestic defense. Eventually, TSA was consolidated into the Department of Homeland Security (DHS) along with other federal agencies focused on various elements of national security. In addition, the Patriot Act passed by Congress, combined with many other state and federal actions to provide greater protection for our infrastructure and citizens.

In the war on terrorism there is no place for complacency. Yet, with extensive security measures in place in the airline industry, attention is now turning to other transportation modes. Transit operators have long felt exposed to the threat of terrorism. The Madrid bombings brought this mode to the forefront of the discussion on transportation security. In addition, other modes including freight, inland waterways, ports, and other critical transportation links are being scrutinized.

In the 21st Century, transportation planners will have to add additional elements to the normal process for planning and delivering projects to their customers. These elements include a comprehensive process of risk analysis and management based on specific project needs and issues. There are four steps in managing risk; they are:

- Identification of risk elements or features
- Assessment of risk levels including human and infrastructure exposure
- Identification of mitigation strategies
- Implementation of mitigation measures

This report is not intended to provide detailed tools for addressing each of these elements of risk but to identify this process as a new requirement for our nation's 21st Century transportation system.

Funding

Many believe future funding will be earmarked for security at state transportation agencies for a variety of purposes. These individuals originally saw this heightened interest in security as a possible means for expanding infrastructure beyond what traditional funding sources would provide. Unfortunately, indications are that any funding directed to state DOT's will probably be focused on specific security measures and not for meeting infrastructure needs and not on capacity expansion. Several examples are appropriate to illustrate this point.

During the 2002 Winter Olympic Games in Salt Lake City, Utah, a heavy emphasis was placed on security for this post 9/11 event. Congress provided federal funds to assist federal, state and local law enforcement agencies in meeting the security needs of the games. The Utah Department of Transportation (UDOT) worked hand in hand with these agencies and provided a important dimension to the overall efforts to thwart potential terrorist events. Pertinent to this discussion is the fact that virtually all efforts and resources employed by the Utah DOT were staffed and funded using existing appropriations from the legislature with no additional funding with security origins going to the agency or its infrastructure.

In the wake of the Madrid bombings many have had raised expectations that the transit industry will experience a funding windfall to assist with security, critical capacity requirements and operational needs. To be sure, transit properties seem poised to receive funding to address these marked security needs. However, every indication is that funding received will be strictly a reimbursement of expenses incurred and not a contribution to system expansion or enhancement. To date, funding for port security measures has also followed this pattern of

attending to the newly implemented systems and not on the capacity concerns which impact freight operations on a daily basis.

Transportation leaders should move cautiously on the matter of funding and security. It would be ill advised to say state transportation agencies, transit properties or port authorities would never receive funding under the auspices of transportation security. Nor should efforts to secure funding be curtailed. However, two points seem clear. First, transportation security funding, if provided at all, will probably be reimbursement funds based on expenditures already made or anticipated by the agency or operator. Second, substantial infusions of funding for capacity purposes will not be a goal of federally provided transportation security funds.

The security issues surrounding our transportation systems are significant and must be addressed. This is a dynamic area for transportation professionals and policy makers alike to consider thoughtfully. It will not go away but rather must become an integral part of all planning and operational consideration for transportation policy makers into the future.

THE FUTURE

As stated at the beginning of this chapter the future is complex and predicting it is a daunting task. This brief review of past research efforts and their recommendations as well as the summary of many of the influencing factors on transportation makes the task seem even more challenging. Facing these challenges and addressing these complex and multi-dimensional issues is not optional for elected officials or transportation leaders. How they are addressed, what policies are implemented and how a myriad of substantial and smaller issues are considered into the future will determine the nature of our nation's 21st Century transportation system.

CHAPTER TWO TECHNOLOGY AND THE 21ST CENTURY

“Technology will play a key role in the future of our transportation systems.” This statement has been made for at least two decades, yet somehow the impact of technology on our transportation systems has been limited at best. In the ‘90’s transportation leaders dreamed of a fully integrated system that included all modes operating seamlessly-- using available technology. While we have made some progress that dream is mostly unrealized.

Unfortunately our vision of technology is sometimes constrained by the external influences that will be discussed in this chapter. It is also hampered by our own lack of vision. The world is full of examples such as the microchip, personal computer and others where even learned individuals couldn’t see far enough to gauge their true impact. To give credit to state DOT’s, they face many other issues everyday which distract them from advancing technology’s role in their state transportation system.

In some regards the industry has been limited by its own accomplishments in further implementing technology. Many states have deployed Intelligent Transportation Systems (ITS) in urban areas. These systems take the form of loop detectors, cameras, variable message signs (VMS), operations centers and signal coordination systems. While these systems are providing value to state DOT’s and their customers, cases exist where the officials who make strategic transportation decisions believe that a few cameras, a handful of VMS and an operations center with a video wall represents the pinnacle of technology application. Our vision of the 21st Century transportation system indicates that these elements, while valuable, are simply precursors to what can and should be technology’s role in operating multi-modal transportation systems in the states.

To consider technology’s role one must discuss two different perspectives. First is how technology will impact the vehicle itself. Whether an automobile carrying a family through their daily routine; a high speed efficient transit system providing vital mobility functions for an urban area; or a freight system composed of over-the-road trucks--all would be affected by available on-board systems technology. Second, technology will play a role in the future as an infrastructure element itself—gathering information from a variety of sources, communicating information to vehicles, and synthesizing key data to assist the state DOT in improving the operational efficiency of key elements of their system. It is this combination of in-vehicle and infrastructure application of technology that will be the answer to advancing our industry’s safety goals and operational objectives.

This chapter presents a summary of the technology implications for 21st Century transportation systems. As the Hudson project progressed, it became evident that a single research effort would not capture the effect of

technology on our nation's mobility. To bridge the gap, two projects were designed to address this multi-dimensional issue. As mentioned in Chapter 1, the two projects were:

- Technology Implications for 21st Century Transportation Systems, Dr. Richard Mudge, Delcan Inc
- Technology and the 21st Century Vehicle, Richard Weiland, Weiland Consulting

Much of the information in the reports from these two research projects as well as how it might be combined into an integrated technology environment for our nation's transportation system is presented. In addition, this chapter shows a vision of how combining infrastructure and in-vehicle systems can operate together to provide a high mobility level in the 21st Century.

TECHNOLOGY OBJECTIVES

Technology implementation for its own sake is not the view expressed in this report, nor is it that of Weiland or Mudge in their separate efforts. The underlying objectives of advancing technology into all types of vehicles and the transportation infrastructure are really two-fold:

- Improve safety performance
- Improve operational efficiency

While other sub-objectives would be achieved through technology implementation, these two goals serve as principal drivers in the significant effort required to deploy a multi-dimensional technology system.

TEHCNOLOGY AND THE 21ST CENTURY VEHICLE

There is no question that technology and its deployment in vehicles of all types will significantly influence our country's transportation future. It will be felt in both safety performance and by those focused on the total system and its operational effectiveness. Additionally, the technology discussion in the 21st Century vehicle transcends just the passenger automobile to encompass all types of passenger and freight conveyances, including transit and motor carrier. Certainly the data gathered, information shared, operational improvements and other benefits accrued from new technology installed and functioning in vehicles has value across all points of view.

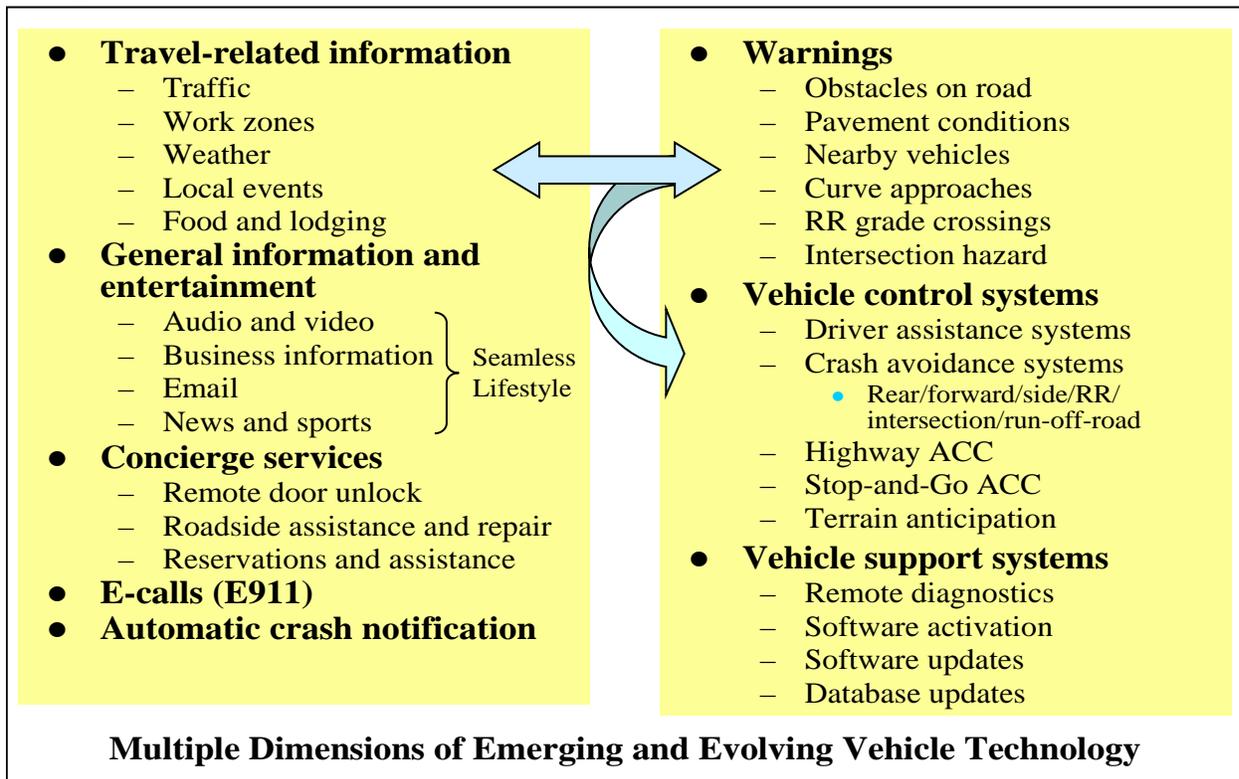
Safety Systems

The role of in-vehicle technology is really two-fold. The first relates to safety and the second focuses on information and entertainment. The insertion of technology into all previously mentioned modes fills both roles simultaneously. For example, a consumer is less likely to pay a premium for a sophisticated system that communicates safety related information to and from their vehicle unless they derive benefit in information or value

unrelated to safety. On the other hand, entertainment on its own doesn't provide traction towards improving safety. Thus, transportation professionals must see technology deployment as a system with a broad range of benefits and not as specific functions.

In his report entitled, Technology and the 21st Century Vehicle, Weiland summarizes the multiplicity of benefits and interrelated systems that would be part of this future vehicle. Figure 3 from his report indicates the depth and breadth of these systems.

Figure: 3



These clear relationships help delineate the strategies required to fully exploit technology in the future.

Considerations of safety systems stemming from in-vehicle technologies, reveals that they influence multiple levels of actual vehicle operation. One extreme would be a fully automated system where the driver exercises virtually no control over the vehicle's operation; all elements of destination, speed, braking, steering and other performance elements are totally controlled by on-board technologies. The other extreme would be current vehicle configurations where the driver has virtually total control over all these elements with the exception of some current systems such as the Anti-lock Braking Systems (ABS) and independent traction control. More likely in the near-term, the 21st Century vehicle will be in between these two while tending towards the former.

A principal safety objective for technology in future vehicles will be crash prevention. Achievement of this end may manifest in a number of ways depending on the level of control a vehicle operator will relinquish to achieve a higher level of safety. This is a key point—an operator’s perception that the automated system will actually perform more reliably and effectively than they themselves would in a given situation. This control issue transcends technology because even today, most of what is discussed in this report is already possible. Public confidence in technology’s performance may be one of the material limiting factors to be overcome in this move to further improve future vehicles.

The concept of crash prevention is important because fatalities, injuries and property damage statistics can be reduced or eliminated all together by, obviously, preventing crashes in the first place. A continuum exists in the discussion of crash prevention—one likely to mirror the implementation of technology in future vehicles. On one end of this continuum is a system providing basic roadway and environmental information, for example, by notifying the driver that a curve is ahead or that ice has formed on a bridge just up the road. The driver could process this information along with his own sensory input and decide on the proper action.

The second level of crash prevention would include the environmental information just mentioned, add to it information based on input from the roadway and the vehicle, and then generate a warning to the driver. In this situation the information about the curve or icy bridge would be combined with current performance statistics of the automobile such as the speed of travel and tire tread condition. The operator could then hear a warning that action should be taken to avoid a crash given the current environmental and operational circumstances surrounding the vehicle. A further iteration of this system would have the warnings offered as a function of the driver’s skill level. For example, if the driver was a newly licensed teenager and thus not skilled in icy conditions, the warnings would be modified accordingly. Such a system would also react to other physiological or age related situations as appropriate.

The final level of crash avoidance is reached when elements of the previously described systems are combined with automated vehicle functions, which allow the system to take over operating the vehicle to prevent a crash from occurring. In this case all the above might occur, but if the operator continues without heeding data inputs and audible warnings and a crash is still imminent then the system takes over and provides automatic braking or other action to prevent the crash. Obviously, this level of crash avoidance requires a high level of confidence in the system on the operator’s part.

Detractors may argue that this kind of crash avoidance system is not only too far into the future but also not possible. In fact, both Toyota and Honda have developed what they term “crashless” vehicles and are prepared to deploy them in markets outside the US. Future sales here will largely depend on a number of non-technological issues to be described later in this report.

Information/Entertainment Systems

The second area where technology will provide value to the operator can be categorized as information or entertainment. These systems may seem superfluous when compared to benefits derived from safety related systems, but they are directly related to technology penetration and user acceptance.

Information takes many forms and will continue to evolve over time. Some of the current or near-term provided information types include:

- Dining
- Shopping/commercial
- Navigation
- Service availability
- Email
- Telephone service
- News (current events, sports, business information)
- Teleconferencing
- Internet
- Vehicle services

Weiland suggests that these types of systems create an in-vehicle environment, which allows the vehicle to become a lifestyle extension of the operator and passengers rather than an interruption in the flow of life’s daily events.

Customization will create even more desirable effects as these types of information or entertainment become part of the in-vehicle experience throughout the fleet.

Some of these systems already have a place in vehicles today. For example, some transit systems provide Internet connectivity; also navigation products and services are available on many passenger vehicles. However, in contemplating the 21st Century vehicle, there is no question that current systems are simply precursors that are suggestive of the future. By then these systems will be interactive in function and operation. For example, Internet

connectivity, combined with navigation arrays and driver information systems would allow an operator to drive directly to a restaurant or medical facility based on the interests or needs specific to a driver or occupant of a particular vehicle. Interaction by these individual systems will allow transportation technology to improve in value, application and utility.

Finally, interconnecting individual vehicles is a crucial component of technology use in the 21st Century. Vehicles, whether automobile or transit, functioning as individual units with sophisticated technology systems will benefit their occupants. However, to the extent that they communicate and share information with one another, the technology benefits are raised to new levels of safety and operational value. For example, if a vehicle registers slick pavement conditions, it might communicate that information to other vehicles in the area so that as they approach that same location their operators or technology systems can react accordingly. Or, if quick braking is necessary to avoid an unexpected hazard such as an object in the road or a pedestrian crossing the highway, this can also be shared with other vehicles and preventive action taken.

This higher level of communication creates a host of issues relating to architecture, communications, reliability, and technology use that will be discussed later in this chapter. While these elements may comprise a list seemingly overwhelming to the transportation professional, one non-technology issue may be the most challenging of all--individual privacy. Overcoming the concerns citizens will have about relating information from their vehicle and its performance to unknown third parties may be the most difficult obstacle to achieving this added benefit in the 21st Century vehicle.

TECHNOLOGY AND TRANSPORTATION INFRASTRUCTURE

The second area where technology will have a significant impact on transportation is its deployment as part of the infrastructure itself. Thoughtful consideration of technology's future role leads one to realize that safety and operational objectives can only be partially met if the total focus is on the vehicle and none is on the "hard" elements of transportation such as bridges, pavements, parking facilities, and other features of our highways.

Dr. Richard Mudge of Delcan Inc. prepared a report entitled, "Technology Implications for 21st Century Transportation Systems" which articulates this important relationship between technology, infrastructure and the operational benefits derived from combining them. Mudge suggests that three key opportunities arise from a fully deployed relationship between technology and the "hard" infrastructure. He offers the following in his report:

1. **More business like management.** These data will provide DOT's with the real-time information they need in order to manage their system using direct measures of the quality of service their customers receive. Of course, most private business already operates with this advantage. This has implications for operations, planning, design, and how agencies interact with some of their customers (for example, see item three below).
2. **Performance based pricing.** Real-time information about the quality of service on all significant roads (and transit lines) will open the door to large-scale use of performance based pricing. That is, travelers can be told the travel times to expect – and how much they will pay to receive a certain level of service. This approach will encourage more effective use of our limited capacity. It differs in concept from most congestion pricing schemes and differs in scale from HOT lanes. (High Occupancy Toll lanes offering access to paying customers.) This would be similar to checking an airline flight's on-time performance before booking a reservation.
3. **Improve link with economy.** Today's economy depends on reliability and predictability – also true of course for much of our non-work travel. Real-time information about the quality of service on all roads can be a powerful economic tool for a world that assumes everything is part of a supply chain. Transportation agencies can now develop a different business model; one that involves an active partnership with private industry, rather than making the necessary physical improvements and then hoping that industry responds positively. By integrating travel information, predicted travel times, and a performance-based system of rewards, highway and transit services could be coordinated to match the needs of today's businesses, with business shifting how they use the network in order to improve its efficiency (*39, pg. 1*).

Mudge clearly sees the value of technology not only in operating the transportation system more efficiently but also in its role in linking it to funding, intermodal performance and making transportation a more powerful element of our nation's ability to compete in the global economy.

Advancing the integration of technology into our transportation infrastructure must be something more than additional cameras or more variable message signs on our roads. To be sure, these components benefit users and transportation systems operators today and will continue to provide value. However, a view of technology in our nation's future transportation system is one that builds on these features and advances them to new levels of operational value.

Vehicle Infrastructure Integration (VII) is a direct attempt by the Federal Highway Administration, the AASHTO and a variety of private sector partners to advance the integration of technology into this system of

vehicles and “hard” elements on the roadway. The applications of such a system seem almost endless as one considers the full array of possibilities. Table 1, from Mudge’s report gives the reader a sampling of the kinds of interactions possible under a VII environment (39, pg. 7).

Table 1: Potential Applications of a System-wide VII Type Solution

Infrastructure-to-Vehicle	Vehicle-to-Infrastructure	Vehicle-to-Vehicle
Intersection Collision Warning	Post-Crash Warning	Vehicle-Based Road Condition Warning
In-Vehicle Signage	SOS Service	Post-Crash Warning
Road Condition Warning	Stop Sign Movement Assistance	Blind Merge Warning
Stop Sign Warning	Floating Vehicle Data	Adaptive Cruise Control
Adaptive Headlight Aiming	Intelligent On-Ramp Metering	Wrong-Way Driver Warning
Curve Speed Warning	Intelligent Traffic Lights	Blind Spot Warning
Dynamic Navigation	Electronic Toll Collection	Instant Messaging
Rail Collision Warning	Emergency Vehicle Signal Preemption	Vehicle-Based Road Feature Notification
Low Bridge Warning	Remote Diagnostics/Repair Warning	Visibility Enhancer
Work Zone Warning	Air Quality Warning	Lane Change Assistant

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e is strictly illustrative of the possibilities available when a fully mature VII environment is in place.

The full deployment of the VII concept depends on a number of factors and the desire of those in the transportation community to overcome the barriers that will be presented later in this chapter. There will certainly be a strong public-private partnership with levels of cooperation, coordination and collaboration relatively unknown today. These public-private partnerships will include, but will not be limited to the following:

- State Departments of Transportation (DOT)
- US Department of Transportation
- Motor carriers
- Automobile manufacturers
- Telecommunications providers
- On-board equipment manufacturers
- Commercial service industry participants
- State law enforcement agencies

- Local law enforcement agencies

Mudge notes that as technology is deployed throughout the transportation network in a VII environment many of the changes will have consequences in five important areas of transportation service delivery. They are:

- Management and operations
- Planning
- Design
- Economic links
- Finance

Each of these will be explored briefly below:

Management and operations will improve through greater system reliability and by offering a system that performs closer to consumer expectations. The emphasis will be on addressing recurring congestion, providing enhanced feedback to the consumer and in improving the safety and efficiency of the transportation network.

Planning will change as the system performs more efficiently through the deployment of technology in vehicles and the infrastructure itself. On-board systems will allow travelers to more efficiently select routes based on real-time system feedback thus modifying travel-demand models and other planning tools. Design elements will be affected as technology allows vehicles of all types to travel in ways not possible today due to the lack of predictability infused by the “human” element of our operators. With technology filling a more significant role in this new environmental capacity, roadway geometrics will be modified and safety features improved.

This new advanced environment will create significant links between system operations and the economy. Goods will move more efficiently. People will waste less time stuck in traffic or avoid the experience altogether. The links between system performance and cost of service will become more pronounced as users exercise informed choices about how they use the transportation network, which mode is selected and the timing and value of the anticipated trip. Consumer choice will become a powerful element of this future system. In some ways, the economic impacts and strong financial links will be the most practical and fundamental attributes of the 21st Century transportation system (*39, pg. 8-10*).

New models for sharing cost of services and new paradigms of performance accountability will also be attributes of this new transportation environment where technology plays such a significant role. Today, failure of the system impacts users in a negative way but there is very little real or immediate consequence to service

providers. In the normal commercial/consumer relationship a customer who is dissatisfied with the service level they receive from a vendor or provider can choose to go somewhere else for that service on subsequent occasions. In the case of our transportation system, few such opportunities exist. Missing a meeting, being late to a child's sporting event or even losing precious discretionary time due to repeated congestion has no consequence to the service provider nor is there any retribution by the consumer. The vision of technology's role in the future is that service levels, financial contribution on the part of consumers and services given and received will be interrelated with new and profound elements of accountability and performance as attributes of this system. Consumers will choose transportation options based on promised performance and will make decisions with full knowledge of their financial consequences. It will be a system where technology and performance combine to positively enhance how transportation impacts our quality of life.

BARRIERS TO THIS VISION

The challenges awaiting transportation professionals and policy-makers in deploying these previously mentioned advances are not all technological. The majority of the challenges awaiting those implementing these improvements come in the form of organizational, cultural, or in some cases legislative agents. Perhaps if they were strictly technology oriented these challenges would be easier to surpass; but however difficult they are, we must overcome them in order to achieve this vision of transportation in the 21st Century.

While many institutional, technological and policy related issues are barriers to this vision of transportation, only the most significant will be presented here:

- Safety
- Privacy and Security
- Data ownership
- Enforcement
- Liability
- Anti-trust and economic regulation
- Public-private partnerships
- Telecommunications
- Corporate culture

The extent of these barriers and the importance of defining and addressing them will be briefly presented below.

Safety-the US will have to be more willing to address the fatality rate and employ the kinds of resources, make the cultural and regulatory changes necessary and expend the funding required to make the quantum leap in transportation safety that ought to be the primary objective of the 21st Century transportation system.

Privacy and Security-US citizens value their right to privacy and eschew invasions of the same. As data is collected, shared and managed to enhance system performance and safety, consumers will have to be assured that specific data collected about their movements, operator performance and other unique and personal attributes of their transportation experience are guarded and their privacy respected. In this new age of terrorism, security of data of all types will be fundamental to public confidence and national security.

Data Ownership-Today the lines between public and private ownership of data are relatively well defined. Too little sharing is done because of existing paradigms that affect public-private partnerships. A new age of openness will have to emerge where public agencies are less concerned about private entities gaining an economic advantage through the use of publicly obtained data and more interested in system performance improvements resulting from sharing their information with the private sector. This new age will see public and private entities recognizing that free and open sharing of all data is key to both groups then delivering the services they desire to their customers. Data ownership will become a transparent element of this new transportation system and organizations will come to realize that raw data itself isn't important but how entities use that data to provide products and services to their customers.

Enforcement-In Europe, technology is used for enforcement purposes such as fining speeding violators on the highways in the Netherlands. It is clear that US citizens see the use of technology for such purposes as an intrusion on their privacy and are not likely to agree to its use in this way. On the other hand, other enforcement issues may be agreeable to the American public. For example, systems are currently in place where motor carrier credentials are examined and validated at ports of entry across our country. Expansion of these systems would further improve safety and enhance revenue collections. Past experience shows that the public will tolerate technology enforcement practices with a clear connection to their personal safety. Other enforcement issues will arise and policy makers will need to assess the public's tolerance to their implementation.

Liability-Technology continues to proliferate more aggressively outside the United States due to the significant liability issues these systems hold for installers and product and service providers. The litigious nature of our society and the lack of tort reform in our legal system are major impediments to the deployment of already available

technology. The crashless vehicles currently ready for deployment by Honda and Toyota will likely remain off the US market until these companies feel their economic viability won't be put at risk due to liabilities incurred. In addition, liability issues will also drive requirements for backup systems and redundancies, which provide the system reliability consumers will come to expect.

Anti-trust and economic regulation-Current regulations provide significant consumer protections relating to the relationships between manufacturers and product suppliers and how they might influence price and equipment availability. Past experience has shown the need for such public protection. However, in the new environment of technology deployment new paradigms of cooperation and partnerships may emerge, requiring modifications to current practices. For example, prohibitions against sole source arrangements, single forms of system architecture, and other activities heretofore considered anti-trust issues, would now be encouraged as efficient and appropriate. However, this environment will have to provide the consumer with new means of price protection previously afforded through the anti-trust laws currently in place.

Public-Private Partnerships-Current regulations have established strict boundaries between public and private entities as they do business in the transportation arena. These regulations serve to protect the public's interest and money and evolved over time as reactions to detrimental practices. While inefficient, this separation has been valued by the public and the inefficiencies accepted as the cost of this protection. The 21st Century transportation system will require new relationships between the public and private sectors which will be much more open and efficient. For example, it may be in the public's interest to sole source some major element of the VII system. However, in exchange for this ability to form a new and potentially lucrative relationship, policies must be in place to ensure continued public protection.

Telecommunications-Fundamental to technology deployment will be the use of telecommunications. The full array of telecommunications issues needs to be examined including security, bandwidth, system architecture, providers, specific technologies and others.

Corporate Culture-Perhaps one of the most challenging barriers to future implementation of technology will be the basic culture, organizational issues, and traditions found in both public and private entities. Organizations that hoard data, refuse to cooperate with other entities, operate in secrecy and otherwise don't participate in this new and open environment will not only slow their own success but will also detract from progress in the broader application of the concepts discussed in this chapter.

This final barrier, corporate culture, may deserve further emphasis. All are familiar with the history of the MS-DOS, and Apple's PRODOS and Apple DOS operating systems; and how the former chose to be an open system and the latter chose to remain closed to producers of related products. The first flourished and became the de facto standard of the industry. The second has never gained more than a fraction of the market share. In addition, owners of BETA format videocassette tapes will long remember the early formats--BETA and VHS. BETA was thought by many to be technologically superior to VHS. Yet, through a series of strategic mistakes by those who promoted the BETA format, VHS has been the standard for video recording and playback devices. The lessons learned from these two examples are important for the future of technology in the 21st Century transportation. Public and private entities alike should resolve to not repeat these kinds of mistakes.

The future of our transportation system is based in technology found in vehicles of all types and integral to the infrastructure. Barriers must be overcome to take full advantage of these systems. The extent of our success in achieving safety and operational objectives may hinge on our ability to leverage technology in both the vehicle and as part of the system infrastructure.

TECHNOLOGY POLICY ISSUES

As policy makers and transportation leaders consider the future and how technology will impact our society a number of additional questions or issues are suitable for consideration. They are:

- What public/private institutional barriers must be eliminated to properly leverage technology?
- What is the appropriate role for government, if any, in promoting these and other technologies?
- What legislative changes must be pursued to mitigate the current tort liability environment?
- How can the current VII effort be expanded and made more even more meaningful?
- What can be done to accelerate the implementation of new technologies?
- How can technology be used to integrate the various transportation modes?
- How can the issue of personal privacy be addressed?

THE FUTURE

Technology will be a key ingredient in the 21st Century transportation system. This system will include vehicles that use technology to create and sustain important safety features and thus reduce the occurrence and consequential effects of crashes. These safety systems will transcend the individual vehicle and be an interactive "system" where all vehicles communicate, share information, respond to one another and the infrastructure around

them. It is a future where its users relinquish certain elements of control for a proven and substantial gain in safety and mobility. Technology will influence funding in a significant way. Collection of revenue, assessment of impacts, land use planning as well as intermodal planning and operations will all interact in the future resulting in safer and more efficient transportation systems. Change in the transportation world of the 21st Century will be driven by rapid and creative deployment of technology in all aspects of the system and all modes.

CHAPTER THREE

FREIGHT MOBILITY

Many motorists face congested roads and highways on a daily basis. Accident statistics are nearly overwhelming in their personal and societal impact. The rising cost of consumer goods is also a concern to many. Strategies to address these issues are discussed by transportation professionals and elected officials across the country and yet, one element of our system that is often overlooked is freight. Freight transportation is a vital element of our nation's transportation system; ultimately, it should affect virtually every decision or discussion on the subject.

As the United States continues to play a significant role in the global economy, maintaining that role will, in many ways, be defined by the effectiveness of our freight transportation system. If the US is unable to efficiently move domestic products both within its borders and worldwide, economic consequences will be felt for many years. Movement of both domestic and foreign manufactured goods through our nation's freight system will impact not only our economy but also that of our important trading partners.

One problem is that freight is sometimes viewed as a singular element of our transportation system. For many citizens, freight transport is represented by over-the-road trucks. That is all they see or understand regarding freight and its movement. However, freight transportation is a multi-dimensional system consisting of a complex network of activities and functions, which work together in moving goods from point A to point B. The conveyance of a simple product may involve multiple freight modes and a number of transfers as it journeys from point of manufacture to point of consumption.

This chapter will consider the following freight modes in analyzing current and future freight issues:

- Motor carrier
- Rail
- Ports
- Inland waterways
- Air

Sergio Ostria of ICF Consulting completed the report entitled, 21st Century Freight Mobility for the National Cooperative Highway Research Program (NCHRP), which serves as the basis for this chapter's content.

FREIGHT TODAY AND INTO THE FUTURE

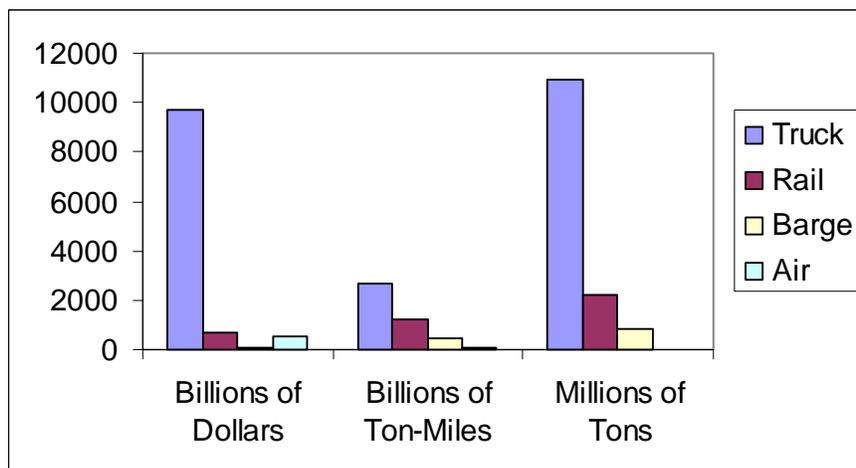
Freight can be viewed as a closed system; products will either move by truck, barge, rail, ship or air; those are the only choices. For most shippers the decision to use one mode over another is a matter of economics and timing. If a particular mode provides the desired level of service in terms of timely delivery and reliability and is the lowest cost option, it will likely be selected. Congestion, efficiency, and other elements also influence this decision. One trend seems to be certain--when shifting between modes the default mode for when all others fail is trucking. This default condition results in furthering the impact of freight transport on the highways. Thus, the importance of our nation's rail system and its continued viability is of great interest to the highway community.

Analyzing the current state of freight transportation reveals a complex, network facing many challenges. In 2003 AASHTO produced the Freight-Rail Bottom Line Report. It reviews the contribution of different modes of freight transport using three performance measures:

- Billions of Dollars
- Billions of Ton-Miles
- Millions of Tons

This information is summarized in Figure 4. Note that the trucking components for the year 2000 values are significantly higher than the other modes or even the aggregate of the other modes. This reflects the major part the trucking industry plays in the overall picture of domestic freight transport. One would correctly surmise from this information that substantive improvements in trucking industry operations will affect a large proportion of our nation's freight.

Figure 4: U.S. Domestic Freight Movement (2000)



Source: AASHTO, Freight-Rail Bottom Line Report

In spite of the essential contributions of the trucking industry, our nation has its roots in rail and will continue to rely on rail for a substantial role in transporting goods throughout the country. Currently Class I railroads comprise over 100,000 miles of track throughout the

United States. Regional and shoreline railroads account for another 30,000 miles. (40, pp. 33) Again, though rail freight transport isn't nearly as prominent as the motor carrier industry's contribution to our economy, it is still a crucial element in the overall freight mobility picture. The significant reduction or elimination of rail freight movements as a viable alternative would have a devastating impact on the transportation network serving both passengers and goods.

The rail industry has seen marked upheaval in the last twenty years as it has gone through mergers and acquisitions, struggled to compete with the trucking industry, and continued operations with an infrastructure that is decaying due to lack of investment. This process of change is likely to continue as the railroads achieve equilibrium in the US economy. However, many factors will influence the future of our nation's railroads. Though rail carries a smaller portion of the total tons of freight transported in our country than trucks do, that contribution is substantial.

While air and barge freight movement are not major players in the amount of tonnage transported, these key modes are still an integral part of the domestic freight delivery system. In certain markets, these are the primary modes of transport. The lack of infrastructure to support both is becoming a major hindrance to continued growth and vitality in their respective areas.

IMPEDIMENTS TO EFFICIENT FREIGHT TRANSPORT

When examining the condition of freight transport a series of obstacles emerge that must be overcome in order for freight to continue its positive role in our economy. Much like a "governor" controls the speed of an engine, failure to address these systemic issues may ultimately cause freight to be a "governor" on our economy.

Congestion on our nation's highways is the most critical inhibitor of efficient freight movement today. The Texas Transportation Institute publishes a report each year about the most congested cities in our nation. A review finds that these cities are located adjacent to virtually every major inland and coastal port. Discussions about congestion often focus on the gallons of fuel wasted due to delay or the hours of lost time experienced by vehicle occupants. While motorists sit idle on congested roads, so do the motor carriers who transport goods into or out of these cities. Idle trucks and tractor-trailers caught in traffic translate into increased costs of goods and loss of productivity of this critical transportation element.

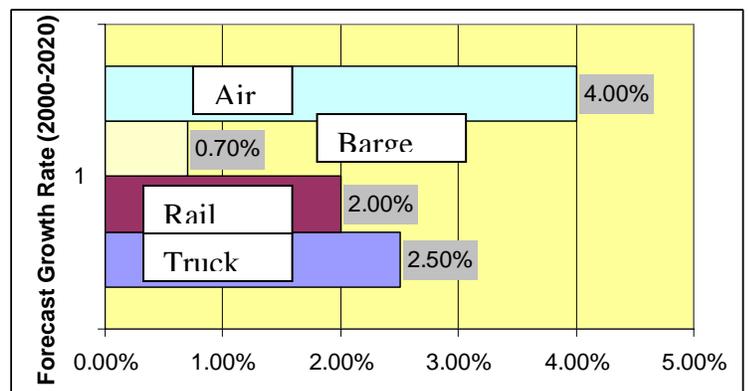
The lack of capacity on crowded highways isn't the only source of congestion in the freight industry. The effectiveness of freight transfer points is another area where congestion is a major issue. No product movement occurs without at least two transfers. At minimum a loading process takes place at the manufacturing plant and an

unloading activity occurs at the final consumption point. Sometimes moving goods between modes requires additional points of transfer. For example, goods arriving via air-freight must still be loaded on a truck for the “final mile” portion of their trip. Containers shipped from overseas may be transferred several times as they are loaded onto a container vessel at the port of origin, unloaded at a US port, placed on a tractor trailer or piggy-back rail car, then transported to their final destination. Each of these transfers or “hand offs” of the freight product represents potential inefficiency in the freight system. Lack of capacity to handle the volume at these transfer points results in congestion on both sides of the transfers.

Infrastructure investments, or the lack thereof must be considered one of the salient points affecting the productiveness of our nation’s freight transportation system. However, most think only of highways when discussing infrastructure. True, improving the congested conditions of our highways will directly impact freight efficiency and cost effectiveness. However, further efficiency gains are available, and necessary if public and private funds are to be funneled into our freight-rail system. In AASHTO’s Freight-Rail Bottom Line Report there is clear evidence of the need to invest in the rail-freight system. This insightful report delivers a sobering perspective in the statement: “Total domestic and international freight tonnage will increase by 67% by 2020. At current investment levels, the railroad industry would have difficulty absorbing its share of this growth.” (33, pp. 45)

One of the challenges facing transportation leaders as they consider investing in the rail side of the transportation equation is the fact that most freight rail infrastructure in the US is privately owned. Thus to invest significant public monies into this privately owned and operated system becomes a major policy issue with many nuances and ramifications. Invest we must. How and when it will occur and with what dollars remains the question for the future.

**Figure 5:
A Plausible Annual Growth Scenario (2000 to 2020 in Ton-Miles)**



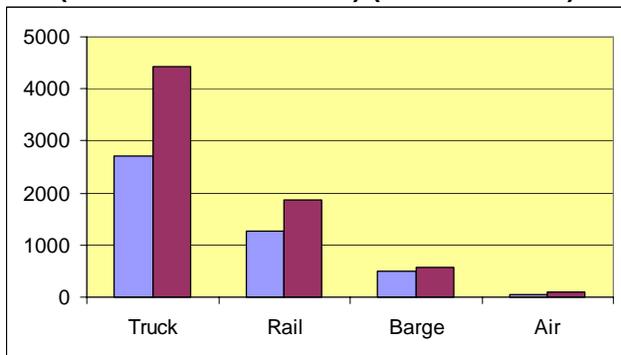
LOOKING AHEAD

What does the future hold for freight in the United States? Intuitively one would expect substantial continued growth. The projected growth rates among the modes are pertinent in this discussion. Research performed by Sergio Ostria in his 21st Century Freight Mobility report allows a glimpse into how freight movements will change in the future. Figure 5 reflects plausible growth rates for each mode from 2000 to 2020 (2). These annual rates reflect how each mode may change. While they are clearly conservative projections, it is apparent that

even more modest growth rates will affect our transportation system well into the future. It is safe to say that the current level of investment in any of the modes is not high enough to handle even a fraction of this growth level.

Figure 6:

What do these forecasts mean? (Billions of Ton-Miles) (2000 vs. 2020)



How does this increased volume translate into consequences for the national transportation system? Figure 6 shows forecasts for each mode and

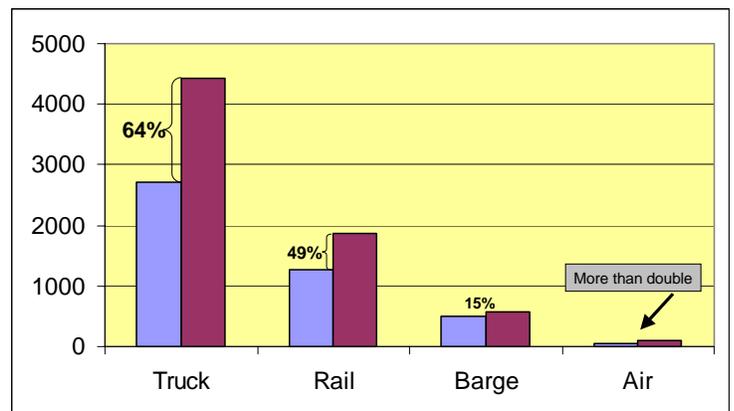
how their respective Ton-Miles will change between 2000 and 2020 (2). The results and impacts of this growth will be determined by transportation policy makers as they determine the nature and amount of future investment in freight infrastructure.

Figure 7 is a reflection of how freight tonnage will change as a percent of growth. Many factors will influence freight growth and how the different modes contribute to the total freight transportation picture. Ostria lists two principal reasons for such material predictions of freight growth. They are:

- Growth in economic output and increased dependence on imports
- Technology

As each of these areas mature, further increases in freight movements and changes in how freight interacts as a transportation element will occur. (2, pp. 10)

Figure 7: What do these forecasts mean? (Billions of Ton-Miles) (2000 vs. 2020)



No discussion of the future would be complete without an exhaustive look at every freight mode. Investment is the nucleus of future growth; failure to invest will mean long-term negative results in the economy, quality of life and will cause further decline in our transportation systems. The challenge for transportation professionals and policy makers is to determine how, where, and when to invest so as to avoid a catastrophic outcome for freight efficiency in the 21st Century.

Freight investments should come in several forms. Some affect one mode directly while others result in overall transportation system improvement with freight receiving its share. The list of needed investment opportunities includes:

- Improving safety conditions on roads and highways
- Reducing highway congestion in urban areas
- Reducing highway congestion in rural areas with significant freight movements
- Improving port facilities to accommodate greater volumes of ship borne freight
- Improving port transfer facilities to speed up transferring ship borne freight to rail and highway conveyances
- Improving other terminal facilities for transfer of domestic freight including truck to rail and rail to truck
- Improving rail infrastructure

Each area represents a major need in the quest for greater efficiency in freight movement.

Rail deserves particular attention in this discussion. The AASHTO Freight-Rail Bottom Line Report is clear in articulating that rail investment is crucial to the future of freight. It states that freight investment needs through 2020 including the funds required to accommodate repair, maintenance and improved operations would be in the \$7.5-8.5 billion per year range. (40, pp. 4). These revenues would have to come from new sources and not from the railroads or borrowing.

One may wonder why AASHTO is so concerned with freight-rail movements and improvements to the rail network. The answer is this: If the United States fails to invest in rail infrastructure, it's ability to fill a crucial role in goods movement in our country will be severely restricted. To the extent rail cannot perform, those shipping goods will choose alternative modes. The alternative of choice is the motor carrier industry, which would put even more strain on the road and highway system. The increase in motor carrier VMT would be staggering.

The discussion of investment in our nation's freight transportation system has an element of uncertainty that cannot be ignored. That is: if substantial investment is made, what will the diversion from our highways be? Can our nation's rail companies operated efficiently enough to take advantage of new capacity incident to this investment or will it remain unused to to their inability to operate it? Can our rail network really be competitive with the "just in time" delivery methods of the motor carrier industry? Who can predict the answers to these questions? In the end, these and other issues will have to be addressed as policy leaders move the increase the investment in our nation's rail system.

Envisioning 21st Century transportation system includes an effective freight component. It includes operational improvements to all freight transport modes including highway, rail, barge, ship, air, and port. The vision shows that funding should be appropriately allocated to ensure that terminals are as well funded and improved as the linear networks are. This view also includes increased technology deployment to further enhance freight movement. Achieving this vision will determine how the US fares in the future global economy and may be the most important investment decision made in the transportation arena.

FREIGHT POLICY ISSUES

As decision-makers think about the future role of freight and how to make it more efficient, a number of key policy issues ought to be considered. They are as follows:

- What revenue sources are available today?
- What new revenue sources need to be established?
- Who will administer the funding generated by these "freight" related revenues?
- Who will prioritize the projects against which this "freight" related revenue will be appropriated?
- Is this a national, regional or state issue or all of the above?
- How will investments in rail occur-- private funds, public monies or some combination?
- What is the role of the state DOT and/or federal government (USDOT) in managing and administrating freight movement?
- How should coordination between port authorities, airport authorities and other third parties together with state and federal agencies work to create a seamless freight transportation network?
- How can the national freight system be maximized to accommodate further growth while limiting capital improvements?

- If public monies are invested in our nation's privately owned rail network what will the concession be that will be required of the railroads and will they be willing to receive these funds with those conditions?

THE FUTURE

The future of our nation's mobility is absolutely and inseparably connected to how the issue of freight transportation is addressed. Properly implemented, freight systems will not be ignored but enhanced because an effective and efficient freight system will not only impact goods movement but also improve the overall mobility of passenger systems. The future freight system will be smoother in its operations. Modal transfers will be efficient and transparent to the processing of freight. More importantly, these modal transfers will no longer play a major role in the marginal cost of freight movement but rather make the use of multiple modes an enhancement rather than a financial detractor. Domestic freight will be a competitive element of the overall system of goods movement allowing the United States to continue to be a strong player in the global market. Funding sources will be established that will provide sustainability to our nation's public and private freight systems.

CHAPTER FOUR

TRANSIT IN THE 21ST CENTURY

The history of transit usage in the United States can best be described as cyclical. From 1900 until the beginning of the Great Depression in 1929, ridership grew steadily. During the decade of the depression years, poor economic conditions, unemployment and differing travel patterns resulted in a decrease in overall usage. As a consequence of World War II American society was forced to substantially change its travel patterns. Fuel rationing, among other things, created an environment for increased transit usage with peak ridership experienced in 1946 at 23.4 billion trips on trains, buses, and trolleys.

Another cycle began after World War II when fuel prices dropped, post-war suburban sprawl took hold, cross-country travel was romanticized by Route 66, and a new Interstate Highway system was born. However, within 15 years of the end of World War II, ridership dropped from a high of 23.4 billion trips to 9.3 billion in 1960 and a low of 7.3 billion in 1972. Since that time, ridership has again increased to 9.7 billion trips in 2001. The indications are that trend will continue and that transit ridership will continue to grow in the future (3).

TRANSIT TODAY

Transit usage continues to expand as systems around the country mature and new investments take hold. The ridership numbers reported in 2001 at 9.7 billion trips represents a 3% increase over the previous year with a net increase of 24% for the last six years (3). Several factors are behind this growth in transit usage:

First--Choice. Consumers are exercising freedom of choice and using transit in lieu of other transportation modes. This choice allows stress-free travel to and from work or other destinations on safe, clean, and reliable public transportation.

Second--Availability. With increasing investment and property upgrades in transit systems within many communities, users are finding a greater range and convenience in service which influences their choice of mode.

Third—Environment. More and more riders are using transit as a way to help both community and environment as we become more conscious about health, quality of life, and environmental issues.

Transit service is provided by approximately 6000 public transportation agencies representing every state, cities like New York and Chicago, and towns, down to very small townships or rural counties. These agencies operate a variety of modes including buses, commuter rail, light rail, bus rapid transit, subways and others. It is a complex network often taken for granted until it is not available.

TRANSIT FUNDING

Transit system growth is a function of funding availability. Requests for federal funds are at record levels as more and more communities seek to build new systems or expand existing networks. The Transportation Equity Act for the 21st Century (TEA-21) provided a significant boost to overall transit funding with a 2003 level of \$7.2 billion (3). But federal funding paints only part of the transit investment picture. Local and state funds have become a principal source for the needed monies to meet the requirements of transit properties across the country.

In his *Transit Futures-2010 and Beyond* report, Jeffery A. Parker noted the disparity between the level of federal investment in transit and that of local or state government. He expresses concern about this growing gap and its public policy implications. Figure 8 reflects the data upon which Parker bases his concern.

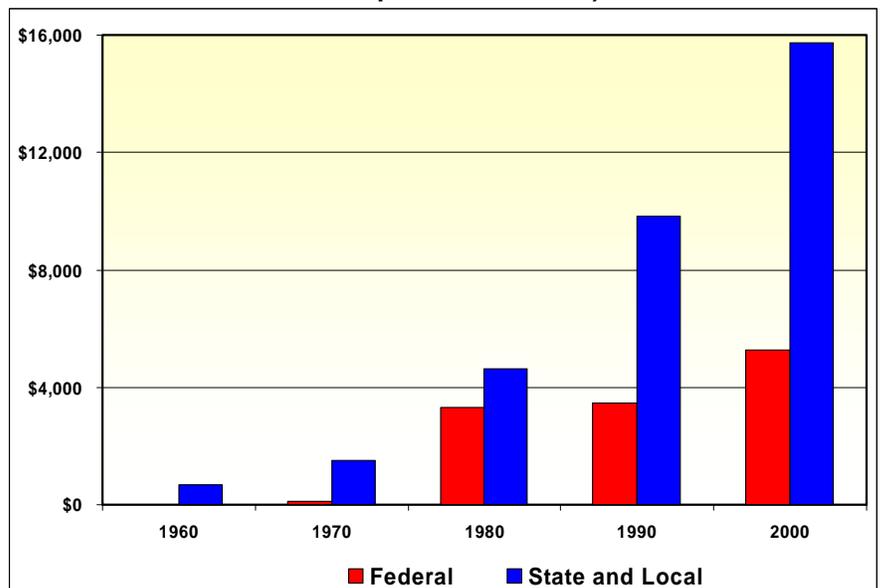
Funds from local sources come one of

the following:

- Indirect User Fees (Fuel tax share)
- Specialized Taxes
- General Taxes

In its report for the Hudson Institute, Cambridge Systematics provided the relative values for each of these sources as follows, in Table 2:

Figure 8: Funding Levels for Public Transportation (millions of year-of-expenditure dollars)



Source: *Transit Futures – 2010 and Beyond*

Table 2: Current Annual Revenues (billions 2000 constant dollars)

Funding Sources	Highway	Transit	Passenger Rail	Freight Rail*
Direct User Fees	\$5.4	\$8.1	\$1.3	\$0
Indirect User Fees	\$75.6**	\$5.8	\$0.0	\$0.180
Specialized Taxes	\$11.7	\$14.3	\$0.8	\$0
General Taxes	\$24.8	\$6.1	\$0.1	~\$0.015

*Public sector only **Less revenue allocated to transit and rail
Source: Cambridge Systematics

Transit officials face many constraints as they seek additional funding. Fare box revenues have upper limits and increasing the basic fare in communities is challenging. The portion of the federal fuel tax that goes to transit is fixed in law with increases coming only with a commensurate increase in fuel consumption or the fuel tax. Specialized and general taxes represent efforts by states and local communities to tap their own scarce resources to find sufficient money beyond federal funds and the fare box. Those familiar with sales tax initiatives and other local funding sources will understand the challenge of increasing these revenue streams sufficiently to achieve desired funding levels.

Failure to adequately invest in infrastructure is not only a problem in building and maintaining highways. Under-investment in transit has caused critical needs to be unmet year after year. In its Bottom Line Report, AASHTO notes that to maintain the current system would require an investment of almost \$19 billion per year from 2004 through 2009 assuming a ridership growth rate of 1.6% per year. Contrasting this need with the current funding level of \$9.5 billion makes it clear that transit maintenance is in a downward spiral that will reduce available service levels when riders are demanding increases. (*1*, pp. 2)

Truthfully, the funding discussion shouldn't focus on the basic cost to maintain the system. A system that is an integral part of our overall transportation network is an investment, and simple maintenance should not be a long-term management strategy. The same AASHTO report indicates that "an annual capital investment of \$43.9 billion will be required to improve the current physical condition and service performance of the nation's transit system...", assuming a 3.5 % growth rate of ridership. (*1*, pp. 2) This ridership growth rate is more in line with actual experience as opposed to the 1.6% level mentioned in the previous paragraph. In summary, a critical need exists for additional transit funding with only limited funding sources available.

Transit projects are criticized for their highly subsidized nature and the fact that they are not self-sustaining through fares. It is true that no transit agency is able to meet all of its financial obligations through the fare box. It is also true that state and local funding sources must pay the difference in operating costs less the amount collected from riders. However, to say that transit is a subsidized mode of travel and highways are not is false. Roads and highways are also heavily supported through fuel tax revenues, sales taxes, user fees and other general revenue. Finding a balance between available funding, modal requirements and transit/highway interrelationships will be influential in solving financial issues for both modes. Any analysis must include methods of procuring a substantial increase in available funding for transit properties to maintain, improve and even expand their systems.

21st CENTURY TRANSIT

Transit's future will be defined by two specific elements—money and mobility. Previously, the need to change the level of investment in our transit systems was mentioned. There is a related need to integrate transit systems into the national transportation network through a new vision of mobility.

A sense of future demand for transit service may be gained from a review of the status of requests to the federal New Starts program. AASHTO reports that currently 78 projects in 26 states and the District of Columbia are included in the New Starts program—projects which have moved beyond the initial study stage. These projects carry an estimated aggregate value of \$47 billion. In addition, over 150 other projects across the country are in the preliminary study stage; the majority of which will ultimately vie for funding through the New Starts program. (1, pp. 42) The 78 projects currently in the pipeline for New Starts funding represents years of available federal money. This makes prospects for the other 150 projects bleak unless transit funding improves substantially. Clearly, finding a way to enhance the revenue streams available to transit properties across the country must be a principal goal for achieving the vision of transit in the 21st Century.

Perhaps the most exciting prospect in transit arises from a concept called “Mobility Management.” Mobility management is an emerging idea that reflects a possible vision of our future transportation system. This is an idea whose time has come and one which will hopefully create the environment where transit again provides a substantive contribution to mobility.

Mobility management is about a system of modes, operating as a seamless unit, where transportation decisions are made by consumers based on travel time, cost, routing, schedule and convenience. The environment is totally integrated so that travelers can make choices based on performance and reliability and not by chance.

Perhaps the best way to describe such a vision of transportation is through an example. This hypothetical situation will serve as an illustration only: The future finds our hypothetical traveler preparing to leave for work. Through in-home technology that is linked to an array of public and private transportation related systems, the customer is apprised of current travel conditions on the corridors leading from home to his employment. These alternatives might include one or more transit options, private automobile, a taxi or even a rideshare opportunity. Our traveler would choose a conveyance based on schedule, price, reliability and a variety of other factors. It is a decision-making process using accurate information as opposed to the random environment we usually travel in today.

Once the traveler has selected a travel mode he begins the journey. In this example, he chooses to use his private automobile. However, on his way to the office our traveler finds that freeway conditions have changed due to an accident. The automatically updated arrival time display on his dashboard shows a potentially late arrival for an important appointment. At this moment the driver scans his on-board system for alternatives, which are constantly being updated via the visual display in his vehicle. He chooses a light rail line adjacent to the freeway as his alternative and moves immediately to the station for an easy transfer and ride to his office. He makes his appointment with minutes to spare.

Our traveler happens to be leaving town on a business trip this evening. So, after work he steps to the curb and hails a taxi to the airport. When entering the cab, his frequent flier credentials are read through a wireless device in the vehicle's on-board system; it automatically tells the driver which airline, flight time, that the flight is on time and gives the driver a series of routing choices. When they arrive, our traveler disembarks but doesn't pay for his fare. The reason is because of the integrated transportation system characterized by the mobility management concept. In this future vision all systems are interconnected and the plane ticket cost includes the fare for transport to the airport. Tonight, when the cabbie completes his/her shift, the fare will be added to his/her daily wage from the airline's account and each party will have reconciled their respective financial positions without a second thought.

This example may seem simplistic but it is important to understand that this is a vision of the future for transportation. It includes a major role for transit when it is integrated into the mobility management approach to our transportation system. It is one that system users will come to expect sooner than later.

TRANSIT POLICY ISSUES

A series of policy related questions or issues is worth of consideration by policy makers and transportation leader alike as they consider the future of transit and the mobility management concept in the 21st Century transportation system. They are:

- What is transit's role in the 21st Century transportation system?
- How will transit function as a meaningful partner in the transport of people?
- What influence will increasing ridership have on the movement of freight?
- How will transportation leaders create a seamless system where choice, price and mobility influence consumer decisions?
- How can technology be deployed more rapidly in transit operations?
- How can more revenue be derived to assist in advancing transit projects across the country?
- What can be done through education, pricing, scheduling, routing or other means to increase transit ridership?
- What are the major impediments to the mobility management concept?
- What new relationships, public and private, must be forged to make mobility management a reality?

THE FUTURE

There is no question that transit will play a key role in the future of our nation's transportation system. That future will include a transit system that compliments all other modes, that is integral in the planning and implementation of future infrastructure projects. The future includes a full implementation of mobility management with consumers making choices based on cost, time and ease of use. Transit systems will take full advantage of technology and will offer efficient means for travelers to move from one point to another and from one mode to another. Transit funding will also see a significant transition from its current "second tiered" role to one where there are sustainable and meaningful monies available to provide for the transit needs of our society. In many ways, the vision of our nation's transportation system will be influenced by how effectively transit is incorporated into that future.

CHAPTER FIVE

21ST CENTURY TRANSPORTATION FINANCE

Perhaps the most important factor in determining what the vision of our transportation future will be is finance. Where does the money come from to pay for the maintenance, capacity improvements and operational aspects of our future transportation system? Ideas are powerful. Vision is wonderful. It can be a future where technology and transportation are joined in a seamless system offering safety and lifestyle value to our everyday pursuits. All of the concepts presented in this report lead us to a future mobility that would ensure America's role in the global economy and provide us with transportation choices to not only preserve but also enhance our quality of life. However, none of this will be possible without financial support. In short, bringing to life the vision of the year 2010 and beyond for transportation will depend on our nation's ability and willingness to invest in all of its transportation modes.

THE NEEDS

Transportation finance needs have been carefully documented and published by a number of organizations. These were used as resource materials for this chapter. In addition, the previously mentioned 21st Century Finance report prepared by Cambridge Systematics, Inc. provided powerful insights into the current financial picture as well as provided recommendations for our future. Their work will serve as the basis for this chapter.

Both the US Department of Transportation (US DOT) and AASHTO have reported key values for the needs of our nation's highway system. They are presented in two reports: the first, by the US DOT, Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA) is entitled, "2002 Status of the Nation's Highways, Bridges, and Transit: Condition and Performance, Report to Congress" which is often referred to as the FHWA C&P Report (42). The second, published by AASHTO is entitled, "The Bottom Line" which was published in 2002 (1).

A picture of our national transportation finance needs is clearly and explicitly presented in both reports. While the values presented in both documents vary from one another due to differing assumptions they still present a clear message about the current finance situation in transportation today. The following is a summary:

FHWA Condition and Performance Report

Cost to Maintain-The required investment to maintain the current highway system is \$76 million in constant 2002 dollars. Other non-capital costs such as maintenance and operations add an additional \$63 billion in

the year 2000. These expenses are estimated to grow at a rate of 1.6 percent annually. Thus, the FHWA estimates the total amount for the “cost to maintain” to be in 2000 is \$139 billion, which will grow to \$170 billion per year by 2025.

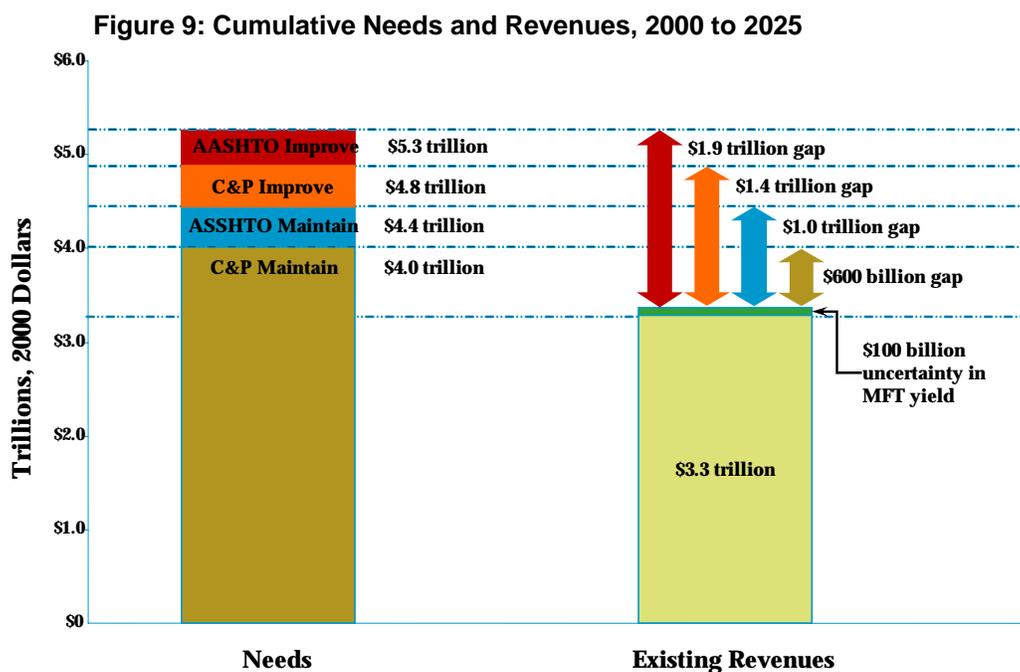
Cost to Improve-In 2002 constant dollars the FHWA estimates that to maintain the system and make the capital highway improvements necessary on our nation’s highways it would take \$107 billion per year. When added to the previously mentioned O&M costs the total requirements under the “cost to improve” scenario goes from \$170 billion in 2000 to \$186 billion in 2025. (43, pp. 4)

AASHTO Bottom Line Report

Cost to Maintain-In its assessment of needs AASHTO determined that the minimum amount needed to maintain the current status of our highway network was \$92 billion in 2000 constant dollars. Adding in O&M costs brings the total to \$155 billion in 2000 and \$186 billion in 2025 as the annual amounts needed to maintain the system. These values vary somewhat from the FHWA C&P Report due to some differing assumptions.

Cost to Improve-AASHTO estimates the dollars needed to not only maintain the system but also make required improvements for the future would be \$125.6 billion annually in 2002 constant dollars. Add to this amount O&M costs and the totals grow from \$189 billion in 2000 to \$220 billion in 2025 as the annual needs under the Cost to Improve scenario. (43, pg. 4)

In their report Cambridge Systematics presents a clear picture of the gap between funding and the needs articulated above. Figure 9 from their report depicts this gap graphically.



Source: Cambridge Systematics based on FHWA and AASHTO data

Note that the funding shortfall under even the most conservative scenario over this 25-year period is approximately \$600 billion with the gap depicted by AASHTO’s estimate of the Cost to Improve reaching almost \$2 trillion by the year 2025. It is a sobering picture of the future when one considers our current state of needs versus the revenues available to meet those needs.

In addition, the cumulative needs expressed in this report and the work conducted by Cambridge Systematics is for roadway improvements and system maintenance only. Other advances, such as implementation of aggressive technology solutions discussed elsewhere in this report are not expressly included in these cost estimates and should not be assumed to be addressed.

Transit

The funding shortfalls for transit projects are no less significant. Cambridge summarized the Conditions and Performance Report and the AASHTO Bottom Line Report regarding transit needs. They offer the following observations:

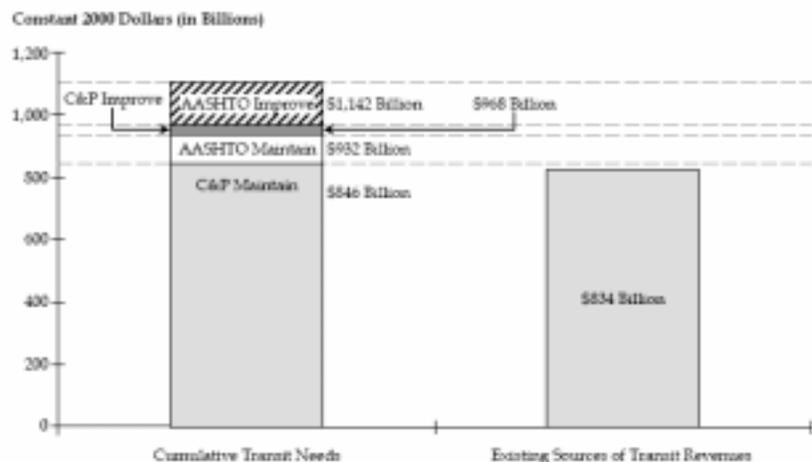
“Need to Maintain” Estimates

- FHWA Condition and Performance (C&P) Cost to Maintain-The FHWA C&P Report to Congress estimates the minimum amount of capital investment needed to maintain the nation’s transit systems at \$35 billion annually, increasing to \$45 billion in 2025, driven by population and economic growth.
- AASHTO Cost to Maintain-AASHTO’s Bottom Line Report, using slightly different analytical assumptions, estimates

the minimum amount of capital investment needed to maintain the transit system at \$39 billion annually, increasing to \$49 billion in 2025.”

Both reports also focus on the need to improve transit systems into the future and offer the following:

Figure 10: Cumulative Transit Needs Compared to Cumulative Transit Revenues, 2005-2025. Base Case Forecasts



Source: Cambridge Systematics based on FHWA and AASHTO data.

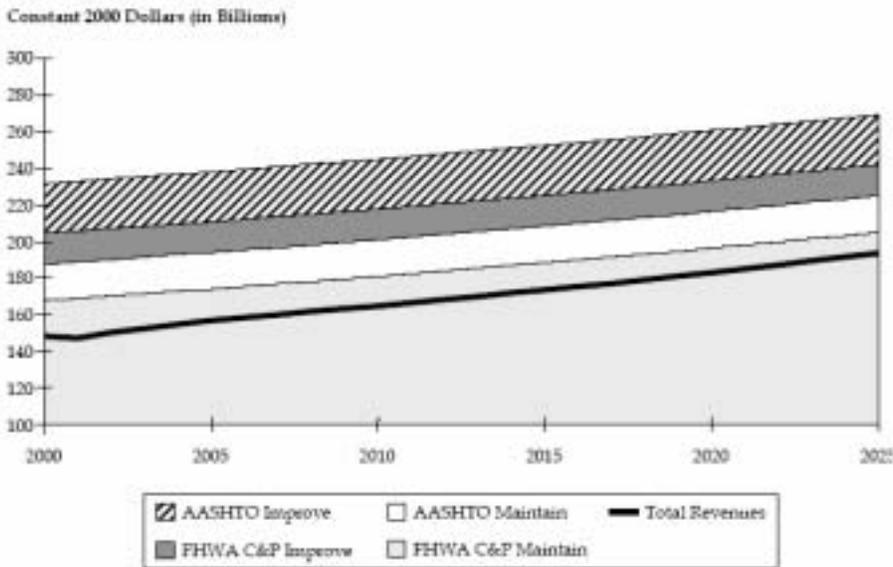
C&P Cost to Improve-\$41 billion in 2000 rising to \$50 billion in 2025.

Bottom Line Report-\$49 billion in 2000 rising to \$59 billion in 2025.

In its analysis Cambridge offered a graphical reflection of these realities and this has been included in this report as Figure 10.

The discussion of transportation finance must be viewed with both highways and transit in mind. Revenue solutions for one cannot be practically advanced for one without the other. Thus, an understanding of the

Figure 11: Annual Highway and Transit Needs Compared to Annual Highway and Transit Revenues, 2000-2025
Base Case Forecasts



Source: Cambridge Systematics based on FHWA and AASHTO data.

FUTURE TRANSPORTATION FINANCE OPTIONS

In determining the nature of our 21st Century transportation system leaders and policy makers need to look towards two distinct and important horizons. The first is a period of time encompassing the next 10 or 12 years taking the industry to about 2015 or through approximately two more reauthorization cycles. During this timeframe many of the changes anticipated in technology, fuel types, vehicle types and other determining factors surrounding transportation finance will remain relatively constant. There will be changes and we will evolve in the areas of policy, technology and societal agendas, but there is a sense that our basic structure and tools for transportation finance won't change drastically in this short-term window.

cumulative needs for both modes is critical to advancing future finance strategies.

Cambridge summarized these multi-modal needs in their report which has been included here as Figure 11. It is sobering to note that the combined gap, based on AASHTO's Bottom Line Report reaches \$1.6 trillion between 2005 and 2025.

In addition to this glimpse of the future there is another that looks beyond 2015 and what lies ahead. This vision is driven by substantive changes in technology, fuel types and their consumption, societal change and policy evolution. It is different from the conditions before 2015. Our discussion of transportation finance is therefore divided into two parts--Near Term and Long-Term.

Near Term Financing Options

Near-Term improvements in finance rely on many of the strategies already known to transportation professionals around the country. They include the following:

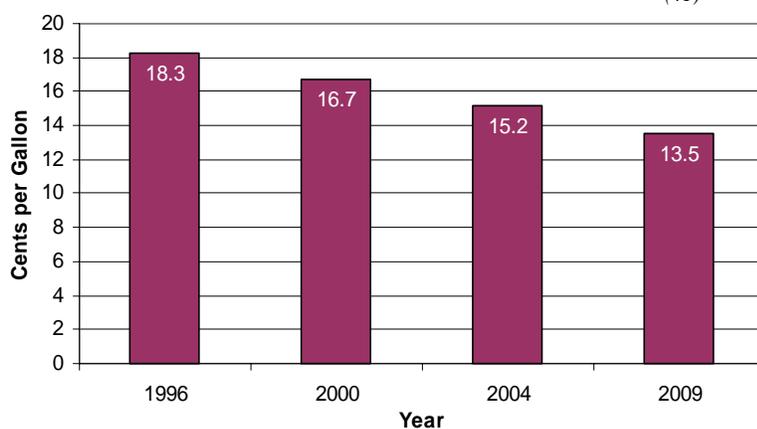
Indexing Motor Fuel Taxes (MFT)

It has long been recognized that the lack of elasticity of the motor fuel tax is its main detractor as a revenue source. As the cost of other goods and services increases and inflation occurs the fixed rate of the motor fuel tax decreases in real value over time. In fact, the buying power of a new fuel tax increase begins to decline from the day it goes into effect much as a new car falls in value the moment it is driven off the showroom floor. Figure 12 from AASHTO's TEA-21 Reauthorization Recommendations reflects this erosion over the period from 1996 through 2009, a decline of 26% in ten years (44, 5).

To counter this effect AASHTO and others have advanced proposals that would apply an indexing factor to the motor fuel tax in order to provide a means for it to adjust with inflation and retain some of its original buying power. Several proposals exist for indexing the MFT at the federal level but none has been adopted formally into law.

In their report Cambridge Systematics provides a clear assessment of indexing the MFT and how it would impact the ability to fill the "gap" in transportation funding previously discussed. Their analysis shows that indexing the motor fuel tax to the Consumer Price Index (CPI) would result in an increase in revenues from 2000-2025 in an amount of approximately \$301 billion. Figure 13 shows the Cambridge's reflection of the impact this

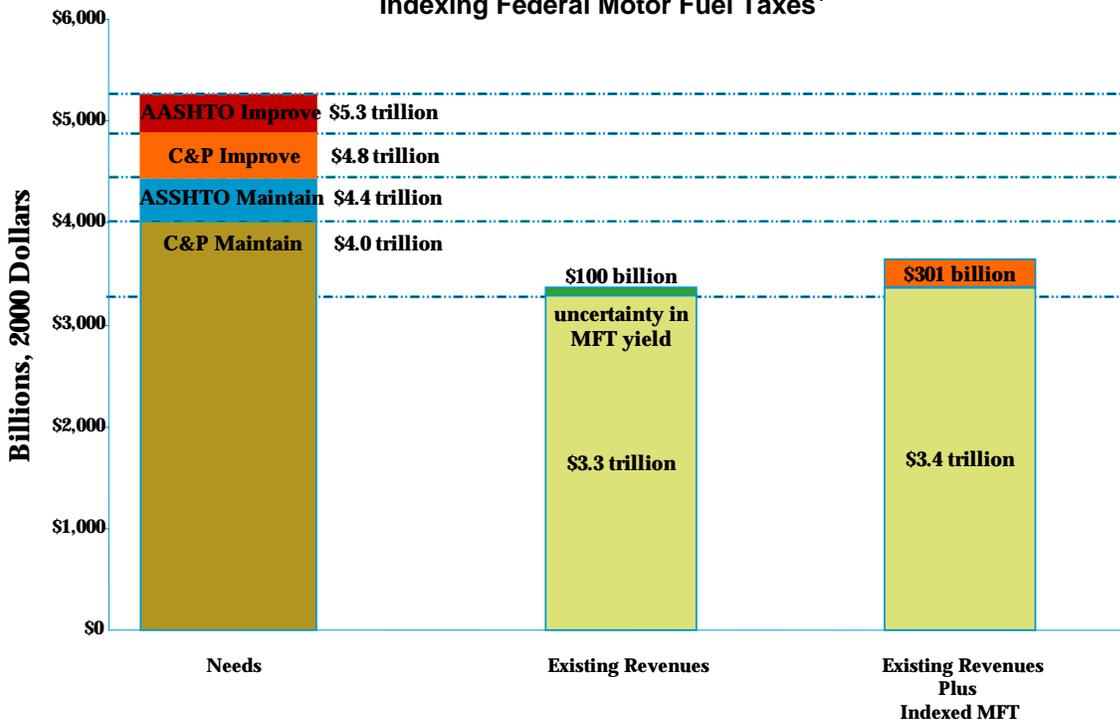
Figure 12:
Erosion of the Purchasing Power of the Federal Excise Tax on Gasoline Due to Inflation (41)



Source: AASHTO

would have on meeting the transportation needs presented in both the FHWA C&P Report as well as AASHTO's Bottom Line Report. These estimates include some modifications due to anticipated future fuel efficiencies.

Figure 13: Cumulative Needs and Revenues: Indexing Federal Motor Fuel Taxes¹



1. Assumes MFT would be adjusted in 2005 for retroactive indexing back to 1995, thus in effect adding 5 cents to the 2005 price. The n the MFT would be indexed annually based on CPI and forecast by the Office of Management and Budget.

Source: Cambridge Systematics, Inc.

Expanding the Use of Toll Facilities and HOT Lanes

A growing area of interest in the transportation finance arena is the expansion of toll facility use and the implementation of High Occupancy Toll (HOT) Lanes on other corridors. Toll facilities are well known with many successful applications in places like Chicago and the New England states as well as other facilities across the country. Additional toll facilities are possible with changes in federal law and actions by state and local policy makers. These opportunities are limited by several factors: First, is there sufficient traffic to generate tolls in large enough volumes to finance operations and maintenance (O&M) and capital needs. Second, what is the price elasticity for the facility in question? Is the driver going to experience sufficient travel time improvement over another “free” facility to justify paying a toll? Third, what other operational impacts would establishing a toll facility have on the rest of the local network? Actually the opportunities are limited and those looking to the future

should not see this as the only answer to the current transportation finance dilemma. The encouraging element of this option is the many public-private ventures being discussed today may find finance solutions in some form of a toll road or highway.

The concept of HOT lanes has emerged in recent years as an option worthy of consideration. The SR 91 experience in southern California has provided evidence that people are willing to pay for better service in the form of a lane that will allow them to avoid other congested general purpose lanes. Transportation leaders and policy makers are seeing HOT lanes as one part of the solution for addressing the state of finance in transportation. This is an important concept in contemplating the future of transportation in our country. The public, users of the network, appear to be more and more willing to pay for performance based on a desire for higher levels of service.

Understanding that increasing toll facilities and implementing HOT lanes will have limited application, Cambridge Systematics estimated that these two funding sources would provide an additional \$67 billion through 2025. This still would leave a cumulative funding gap of \$501 billion over the 25-year period in question. (43, pg. 8) Further opportunities for expansion of toll facilities would appear if Congress would reduce their long-standing prohibition of tolling the Interstate Highway System.

Tax Credit Bonds

The third area of short-term finance solutions is found in the concept of Tax Credit Bonds. AASHTO has developed and proposed to Congress and the United States Department of Transportation (US DOT) a finance approach that would expand on existing revenues and provide a one-time infusion of needed funds for capital improvements to the nation's highway system. In their report, Cambridge Systematics summarizes the AASHTO proposal as follows:

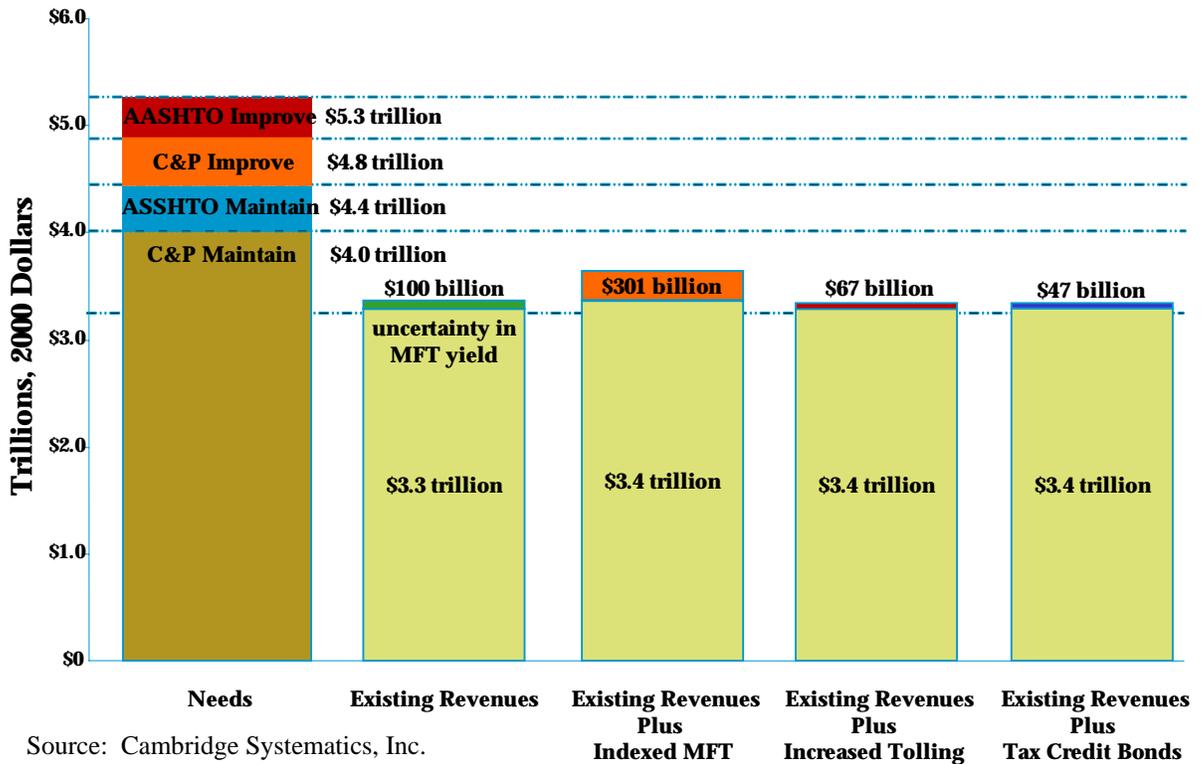
“AASHTO has proposed issuance of tax credit bonds to expand the amount of revenue available to the surface transportation program in the near- to mid-term. AASHTO's proposal envisions sale of up to \$80 billion of tax-credit bonds. About \$20 billion of the proceeds would be set aside and invested in a sinking fund to pay back the principal of the bonds, leaving \$60 billion of revenue for investment in transportation projects. The cost of the tax credits, estimated at a total of \$47 billion over the course of the program, are assumed to come from the general fund, not from transportation revenues, thus bring new revenues to transportation.

The revenues from tax-credit bonds will be a one-time infusion of general revenues and that the \$60 billion will be spent out over a 10-year period from 2005 to 2015. The revenue from tax-credit bonding would increase annual highway revenues by from about \$13 to \$26 billion per year

over 10-year period. The revenues would not be sufficient to close the gap between annual revenues and annual “need to maintain” expenditures, nor would tax-credit bonding generate sufficient annual revenues to achieve the “need to improve” levels. The cumulative revenues generated by tax-credit bonding will total to an additional \$47 billion over current revenues, but leave a cumulative unfunded gap of \$521 billion to accumulate over the 25-year period.” (43, pg. 8)

A look at the impact these three strategies would have on filling the transportation finance gap is provided in Figure 14, which was developed by the authors of the Cambridge Systematics report. The cumulative impact of all three, if implemented immediately, do not even achieve the lowest assumptions found in the FHWA C&P Report for maintaining status quo.

Figure 14: Cumulative Needs and Three Options for Increasing Mid-Term Revenues



In addition to these three strategies many members of Congress, the transportation industry and others feel strongly that the basic level of the federal fuel tax must be adjusted substantially to accommodate our nation’s growing needs. Currently, a penny of additional motor fuel tax will raise approximately \$ 1.9 billion for the Highway Trust Fund (HTF). (44, pg. 6) Various proposals have been made to raise the motor fuel tax to help fill the

gap as a near-term strategy. This would clearly be a major contributor in filling the critical shortfall discussed in this chapter.

Some would suggest that current and proposed innovative finance solutions are the answer to the documented needs. Programs established by Congress and managed by US DOT offer some options for public agencies to advance projects ahead of their normally possible schedules. These include the expansion of both the Transportation Infrastructure Finance and Innovation Act (TIFIA) loan program and Grant Anticipation Revenue Vehicle (GARVEE) bonds. Each provides a means to expand the available funds for transportation projects through the use of additional debt financing. There is some value derived from the TIFIA approach due to the increased ability of the private sector to provide project financing and secure favorable terms for their role in financing the project.

Among the other near term strategies available are the leveraging of public-private partnerships, and fully exploiting the revenues generated by adjacent properties due to transportation improvements. Such initiatives are currently hampered by federal and state regulation and by the lack of clear business models to follow. Opportunities in these and other concepts exist but much needs to be done to bring them to the point where they contribute to the financial well being of our nation's transportation system.

The most important point to make in the discussion of near-term finance options for transportation is the need for "net new revenue." This concept is sometimes lost in the discussion of finance tools for the future. The TIFIA and GARVEE programs are good. But they, along with many of the other proposals on the table, don't represent "net new revenue." That is not to say debt financing is a bad thing in the near-term transportation finance picture. Well thought out and deliberate use of debt financing is a wise and justified action for many capital improvement projects. However, debt financing cannot be used as a substitute for new money to fill the gap depicted in the figures found in this chapter.

Long Term Finance Options

Looking to the future transportation leaders and policy makers will realize that solutions for their financial needs will be different as technologies improve, consumers change and other factors about our lives are modified. It is challenging to see into the future and predict what should be done with finance issues while we are struggling with the present, but we must do so. The impetus is clear--if the finance tools are to be fully functional in the 2015-

2020 timeframe, the time to begin the methodical transition is now. Thus, it is important to understand the long term future so that actions taken in the short term will ensure the financial viability of our 21st Century system.

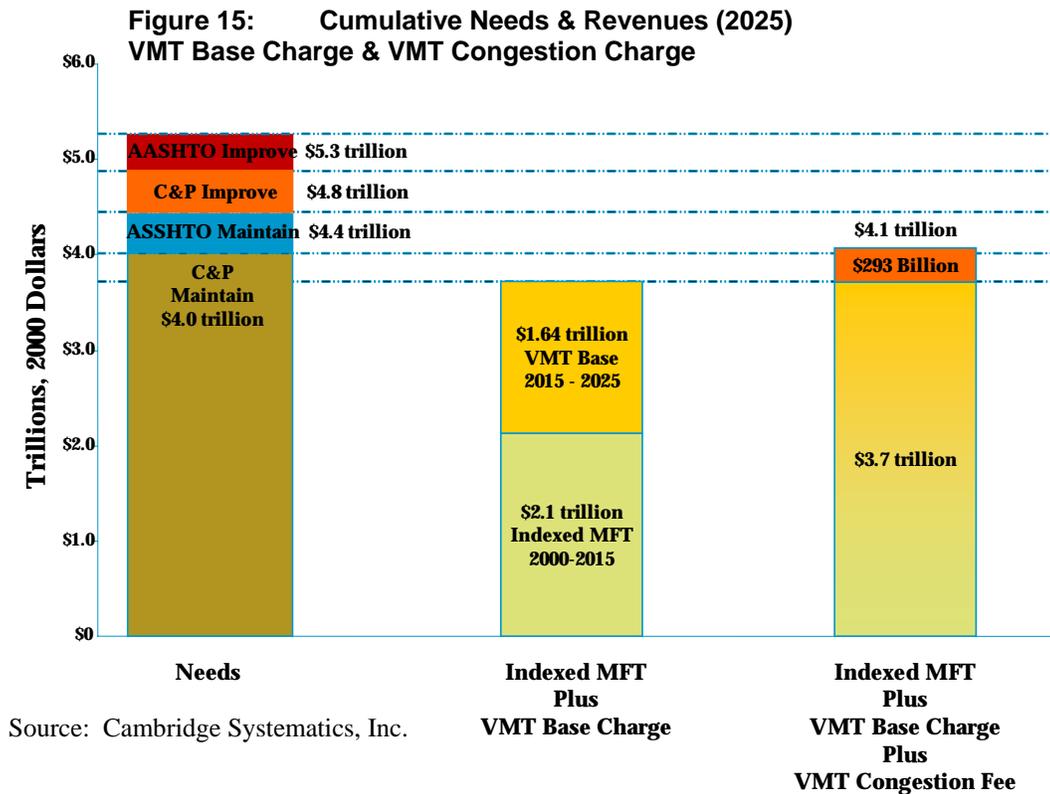
What does the future hold for current financing tools? This question drives the thinking behind ensuring that needed funds are available well past the 2010 or 2015 horizon. Certainly, toll roads will probably still be a viable and important element of our finance system. HOT lanes will also be a part of that mix of revenue tools. Sales and general use taxes and other means will likely continue being used. However, today's principal revenue source, the motor fuel tax, is probably the tool most in question in the 2015 and beyond timeframe. How does increasing fuel efficiency impact revenues collected from the MFT? Is there a possibility that the MFT will be virtually eliminated due to some other technology taking its place such as hydrogen fuel cells or hybrid vehicles? If the MFT goes away as a viable source of funding, what will fill its role? In the end the 2000-2025 needs presented earlier in this chapter won't go away. The challenge for transportation leaders and policy makers is to ensure that long-term solutions are available when needed.

All indications are that the US will eventually have to address the declining value of the motor fuel tax as a revenue stream for transportation projects. Whether the cause is much better fuel efficiency or the pervasive deployment of hybrid vehicles, options should be considered as alternatives to the traditional fuel tax. One of the possible alternatives would be the use of a mileage-based system to generate funds for transportation. Such a system, based on the Vehicle Miles Traveled (VMT) would probably replace the MFT as the principal funding method.

While many details would have to be developed, the basic concept is that users would be assessed a fee for the miles they travel as a reflection of their impact on the transportation system. The analysis provided by Cambridge Systematics in their report for the Hudson Institute shows that both a base rate for normal travel could be applied to each vehicle.

Cambridge suggests that a VMT based rate could be applied to the total vehicle-miles of travel accrued by each vehicle each year. Per the Bureau of Labor and Department of Energy the average vehicle owner spent \$6,990 to own and operate a car 11,976 miles in 2000, the equivalent of \$0.58 per mile. Of this amount, about \$0.11 per mile was spent on fuel and oil and \$0.019 per mile on Federal and state motor fuel taxes. If VMT base-fee revenues were used to replace motor fuel tax revenues in 2015—a revenue neutral swap—the VMT base rate would about 1.89 cents per VMT.” (43, pg. 4-3)

Cambridge Systematics also suggests that such a VMT based system could include an additional congestion fee assessed on miles traveled in particularly congested corridors. This fee could raise the total per mile amount to \$.20. Figure 15 from their report reflects the impact this VMT based system would have on the available transportation revenues in addition to an indexed motor fuel tax through the year 2015. (43, pg. 10-11)



Of note is the fact that these finance tools bring the possible totals to \$4.1 trillion leaving a gap of \$1.2 trillion between now and 2025.

Other Measures

In addition to finance strategies transportation agencies will also need to offer their customers greater efficiencies in their daily work. Improving the basic business practices of a transit property or a state DOT are activities that most, if not all, are engaged in today. Streamlining activities, realigning personnel and other resources, eliminating extraneous work and other measures are netting these agencies important cost savings. While these efforts are noteworthy and necessary, they net relatively small returns in comparison to the revenue needs that exist across the country. Policy makers should not believe that they can avoid hard decisions on the revenue side of this discussion by suggesting that shortfalls can be overcome through greater efficiency in government. The

numbers just don't add up nor is the public willing to sacrifice the level of service they receive from their governmental agencies to achieve the kinds of monetary savings that would even begin to contribute to the overall shortfall.

Another area worth mentioning in this discussion of finance and revenue is asset management. Asset management has emerged as a strategy for public agencies to wisely and thoughtfully ensure that all their resources are being utilized to their highest and best value. It is a proactive approach to every element of the agency's assets from rolling stock in a transit agency to signs and culverts at state DOT. Some public agencies have turned to the private sector to achieve their desired objectives in the area of asset management. All told, the deliberate use of this management strategy appears to be an important element of the future of these transportation agencies. However, as was stated in the previous paragraph, asset management should not be seen as a substitute for "net new revenue" for our nation's transportation systems.

Financing the critical needs of our 21st Century transportation system will be the keystone of everything discussed in this vision of the future report. Transportation planners can plan. Policy makers can further highway bill after highway bill. They can tinker around the edges of transportation finance and make modest changes and improvements. Still, a huge gap remains and it won't be filled with such small changes. The gap represents real needs--not "nice to have" improvements. The near term options presented in this chapter are only part of the answer. The long-term option of a VMT based system is also only part of the solution. Even with full implementation of all of these finance options our leaders must still find a trillion dollars between now and 2025. Our vision of the future will depend on how well transportation leaders and policy makers meet this challenge.

FINANCE POLICY ISSUES

Policy questions and issues relating to transportation finance are numerous. Some are offered as follows:

- What finance systems must be put in place to accommodate ports and their needed improvements?
- How can current and future finance tools ensure the vision of mobility management?
- How can financing tools be used to more fully integrate the differing and extensive needs of each of the modes?
- What revenue streams have yet to be tapped?
- Are there any financing models from other countries that might be transferable to the United States?
- Would a governance change make transportation finance more cost effective?

- How can the private sector be enticed to engage more fully in transportation finance?
- What can be done to finance regulations that would further enhance transportation finance options?
- Will efficiencies be gained by changing the current financing options available to the states?
- How can financing be generated to make the freight industry more cost effective?
- Are there investments in infrastructure that will generate revenues and render systems self-sufficient?
- What are the policy, regulatory, cultural and organizational issues impeding new and innovative transportation finance initiatives?
- How can asset management assist activities assist in filling the funding gap?
- What more can be done with asset management to ensure policy makers guarantee sufficient funding for transportation needs?
- What is the future of the motor fuel tax as fuel efficiency increases and gasoline consumption diminishes?

THE FUTURE

The ideal future of transportation finance would include sufficient revenue to address the needs of our nation's transportation system for all modes. It would provide choice of price for the consumer and stable revenue for public agencies to operate, maintain and improve their systems based on the changing demands of the people they serve. It is a system that more closely reflects the user's impact on the network and where that individual pays their fair share of their consumption of the facility. Thus, costs and benefits are more closely aligned than they are today. This vision is ambitious by any measure. But, it appears to be where the public wants to be. Thus, the challenge for transportation leaders and public policy makers is to take the necessary steps to ensure the reality of this vision.

CHAPTER SIX

CONCLUSIONS

Transportation will continue to have a major influence on our daily lives in the years to come. It will determine our mobility, affect our professional lives; or it may persuade us to live in a certain community or part of the country, or it may control how we allocate our precious discretionary time. As a nation this future system will be a significant factor in how competitive the United States is in the global economy and in the vitality of our domestic business environment. Transportation will be just as important in the future as it has been at any point in our history.

The challenges that lie ahead may seem overwhelming. Congestion is growing at alarming rates with vehicle-miles-traveled projected to increase by 50 percent in the next 20 years. Mortality on our nation's highways is still at an unacceptable level consistently exceeding 40,000 per year. Inefficiencies are too common as freight moves around the country with the prospects of higher levels being experience as freight tonnage is projected to grow by 67% by 2020. The different modes still don't work well together as parts of the transportation "wheel". The funding gap seems to grow on a daily basis. Even conservative estimates peg the gap between needs and funding at values in excess of \$1.5 trillion between now and 2025. Sometimes it seems that we are impossibly far away from the vision of the 21st Century transportation system as presented in the last eight chapters.

In the next few years transportation leaders and policy makers have to make some of the most important decisions that have ever faced the industry. The good news is that these issues have been thoughtfully considered by the publications and documents referred to in this report and in others not presented. The research performed as a consequence of this joint Hudson, AASHTO, APTA, and TRB effort has provided even more insight into appropriate solutions.

The network we know today will be substantially different than the one that will serve this nation in the future. Solutions won't be easy. They will require new public-private relationships never before used in the transportation community. Technology will need to be deployed and accepted at a faster pace than ever. All modes must unite into a seamless transportation system. Laws will have to be changed, procedures modified, and major new funding sources will have to be developed in ways unknown at this time. Failure to take on the "hard" issues like tort reform, public-private partnerships, and other thorny and complex issues will impede the realization of this vision.

Leaders throughout the country representing all elements of the transportation community are engaged in deliberate and thoughtful activities relating to the future. The level of sophistication found in these agencies, groups, associations and companies is at its highest level ever. They understand the economics of our transportation system. These leaders are well schooled in many of the areas discussed in this report. They have taken the time to gather the facts and understand the issues.

The time to act is now. None of the conditions described in this report will improve over time in the absence of action. Public policy makers and transportation leaders alike must step up and move our nation to this vision of our transportation future.

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