Defining the Future: Transportation Challenges for the Twenty-First Century

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My task is to provide a brief summary of the key characteristics of the future as outlined in some of the recent studies and reports that seek to define where we are, where we are going, and how we should get there.

The process that has been used to develop plans and proposals for the future of U.S. transportation comprises three distinct steps. The first deals with determining trends in our society that will influence the travel requirements of the nation; the second seeks to understand and define the nature of transportation problems as seen by the users and providers of the system; and the third attempts to formulate a program of transportation improvements that responds to these societal changes and needs.

In this paper I attempt to summarize key elements of what has been said in each of these three areas, as they are intertwined in our effort to define the future. We must know what the trends are, be aware of the shortfalls that exist in our present systems, and then decide what to do about it.

Let me illustrate with an example. The fact that our population is aging is accepted as true because we can accurately forecast demographic trends. Our surveys also indicate that many seniors drive and that the numbers are on the increase, but traffic signs, markings, and the like are not designed for them. As users of the highway they are at greater risk than others. There are many possible alternatives, and the ultimate outcome will depend on our ability to define and implement those that are feasible and cost effective.

TRENDS

To begin, let us look at the future from the viewpoint of trends in society that will influence travel requirements for the next 30 years. I recommend three reports that contain considerable documentation and analysis of the most relevant characteristics that help to define our nation in the future. These are TRB Special Report 220: A Look Ahead: Year 2020 (1); FHWA Interim Report America's Challenge for Highway Transportation in the 21st Century (2); and American Public Transit Association (APTA) Interim Summary Report Transit 2000 (3). Let us review some findings of these reports.

The TRB report examined future trends in terms of economic growth and vitality, demographics and lifestyle, energy and environment, patterns of future development, commercial freight transportation, personal mobility, new technology and communications, and resources and institutional arrangements.

The FHWA Interim Report identified five key variables that affect future highway activity. These are demographic and economic forces, energy, technology, and the environment.

The APTA report identified the most significant of the forces and factors that will influence the transit environment to be congestion and auto dominance, suburban growth and development, threats to the environment, and threats to energy independence.

A careful reading of these reports shows a considerable amount of overlap and duplication, which I would interpret as agreement regarding some basic emerging trends. We do appear to be "singing from the same hymnbook" as far as what we think future demands may look like. What we do about it is, of course, another matter. To avoid saying the same things over and over, I have selected several of the key issues and summarized these from one or another report.

Demographic and Economic Forces

The FHWA report (2, p. 19) states:

Demographic and economic forces will play a primary role in shaping transportation demand over the next 30 years. Although population growth will continue to be slow, total population will still increase by 47 million persons between 1990 and 2020, an increase of nearly 20 percent. While this is roughly one-half the percentage increase in population that occurred over the past 30 years, population increase will continue to be an important, though declining, source of transportation demand through the year 2020.

More important than changes in total population will be changes in the characteristics of the population. Of particular importance will be the maturation of the baby-boom generation. The baby-boom generation will be middle aged in the 1990s, providing an experienced and productive labor force to stimulate economic growth. At the same time, the cohort following the baby-boom generation will be significantly smaller in number, creating the potential for severe labor shortages in entry-level age categories. Lack of growth in the younger age categories and the accompanying slowdown in creation of new households can be expected to influence consumer expenditure patterns, with the strong potential for slower growth in expenditures for housing and durable goods, such as automobiles.

Interregional migration and changing urban settlement patterns will also exert important influences on future transportation demand. The West and the South will continue to be the growth leaders, attracting population from other regions.
and from outside the United States, though regional growth disparities are expected to gradually diminish over the next three decades. Concentration of growth in the largest metropolitan areas is expected to continue, and an increasing number of suburb-to-suburb trips, center city-to-suburb trips, and intrasuburban trips are likely to characterize the future pattern of travel within metropolitan areas. The density of suburban residential development is likely to increase as apartments and townhouses account for a rising share of new housing construction in response to higher land and energy costs and declining average household size.

The trend toward increased globalization of all domestic economies is most likely to continue into the foreseeable future. This trend may affect the total demand for freight transportation, and it will certainly alter the pattern of commodity movements that formerly moved between domestic origins and destinations and now move across the international border. The newly industrialized countries, or the countries of the third world, may become an increasingly important market for U.S. consumer goods in the 21st Century. Globalization of the economy has also fostered international movements of passengers for business and personal travel. The impact of such travel is generally not noticed beyond border areas, but is growing in importance to transportation and economic development planners.

Energy

According to FHWA (2, p. 24),

Forecasts by the Department of Energy and others reflect a general agreement that the transportation sector's consumption of energy will continue to grow throughout the remainder of this century, and into the next, though growth rates are likely to be lower than those experienced in the past. Improvements in fuel efficiency are expected to largely offset increases in travel demand.

Although improvements in fuel efficiency have made an important contribution to energy conservation in transportation, the overwhelming reliance on petroleum for meeting the demands of the transportation sector is expected to continue into the foreseeable future. As pointed out in a recent report by the U.S. Department of Energy (4),

Pushing fuel economy farther and faster could help (reduce transportation's demand for oil), but not much. None of the efficiency improvements envisioned would affect the continuing 97 percent dependence of the transportation sector on oil-based fuels, factors that affect the future supply and demand for petroleum will be important determinants of the future price and availability of personal and commercial transportation services.

Environment

The FHWA report (2, p. 32) notes:

As a major consumer of petroleum, the motor vehicle, or, more specifically, the gasoline-powered internal combustion engine, is a major contributor to urban air pollution problems. This knowledge, and growing concern about the degradation of air quality in urban areas, has resulted in a succession of federal laws designed to limit air pollution from motor vehicle sources. The Clean Air Act Amendments of 1970 and 1977 shaped major national programs designed to control stationary and mobile sources of air pollution. These programs included requirements for the development of emission control devices that dramatically altered the emission characteristics of motor vehicles, and requirements for development of plans by the states to assure the attainment of National Ambient Air Quality Standards.

Over the past several years, public demands and government regulations have spurred the development of much less polluting automobiles than were previously produced. In 1970, the average car emitted 85 grams of carbon monoxide per mile, compared to the current level of about 30 grams per mile. Carbon monoxide emissions are expected to drop another 50 percent by 2000. Efforts to improve the fuel efficiency of automobiles have contributed to a substantial reduction in the average fuel consumption per mile of travel, although much of the efficiency-related reduction in fuel consumption has been offset by increases in travel. Efforts to shift automobiles from petroleum consumption to consumption of alternative fuels have also been promoted as a means of reducing air pollution, although the least-polluting method of producing methanol, the most viable of the fuel alternatives, results in emissions of "greenhouse" gases that are comparable to gasoline combustion.

Life on earth is dependent upon a variety of atmospheric gases, such as carbon dioxide, nitrous oxide, chlorofluorocarbons, methane, and ozone. These gases are critical to the earth's climate because they trap infrared radiation reflected from the earth's climate surface, thereby raising the temperature of the planet. Because the clear atmospheric gases permit radiant light to pass through, while trapping the reflected heat in a manner similar to the glass panes of a greenhouse, these gases are commonly referred to as "greenhouse" gases. The warming effect they have on the earth's climate is called the "greenhouse effect."

Since the time of the industrial revolution, when the world's economies began to base their prosperity on the burning of fossil fuels, and settlement of forest lands and prairies began to remove the plant life that was part of a natural cycle of carbon absorption, the waste products produced by the burning of fossil fuels have produced a dramatic increase in the volume of greenhouse gases. Atmospheric scientists and climatologists are convinced that the volume of greenhouse gases will continue to rise during the next century, and will result in a worldwide increase of from 4 to 15 degrees Fahrenheit, unless immediate steps are taken to conserve energy, develop alternative fuels that do not contribute to the greenhouse effect, and reestablish forest cover. Many experts feel, however, that there is a low probability that these remedial measures will be undertaken in time, or to a sufficient degree, to forestall the greenhouse effect. Many believe that even if Draconian measures are taken to reduce the volume of greenhouse gases to the best that they can do is to delay global warming, and, perhaps, keep the temperature rise at the low end of the range of possibilities.

Congestion and Auto Dominance

The APTA Transil 2000 (3, p. 13) report agrees with others regarding trends in auto usage, stating:

No doubt exists that the private automobile will remain the central means of mobility in the coming years. Doubt does exist however, over whether or not the current level of reliance on single-occupancy, private vehicle use can or should be sustained indefinitely, and what the consequences may be. This is a central question for the decades ahead in light of the following: Increasing congestion and delay are now a common feature of urban travel; Household auto ownership is expected to increase past the point where, on average, an automobile will be available for every employed person; Congestion will increase more than 400% over the next 20 years on the nation's freeway systems and over 200% on nonfreeways, according to the Federal Highway Administration, in areas under one million population, freeway congestion will increase over 1000%; Total travel is expected to increase a minimum of between 1-2% annually adding to the current roadway system over the next 32 years the same amount of new traffic that has been
added in the last 32 years; actual growth in travel demand could be twice this conservative estimate.

The implications are clear. Auto availability will continue to increase, but the cost and convenience of auto travel will deteriorate significantly in an increasing number of areas.

Suburbanization Growth and Development

The APTA report echoes the findings of others with regard to the changing pattern of land use expected in the future. The report (3, p. 15) asserts:

Rapid suburbanization of jobs and housing in recent decades has resulted in highly scattered trip-making. The patterns and nature of this explosive growth in travel has overwhelmed street and roadway capacity and in many instances cannot be accommodated economically by traditional transit services. The suburban phenomenon is characterized by typical low density development, a patchwork of buildings and land uses on specific sites, the absence of effective coordination of land use with transportation and other infrastructure investments, and an imbalance between the location of jobs and housing.

Typical suburban densities in most areas are 25 times lower than in our downtowns, and while it is true that the explosion in suburban growth is expected to continue into the next century, the problem is more complex.

Overlaying the low-density development pattern is the emergence of major multi-use centers and "urban villages" that, in many cases, are approaching the densities of typical downtowns. In addition, the traditional form of suburban development is being subtly altered by a number of factors including congestion and limited access, mounting labor shortages, changes in tax laws that spurred recent suburban office growth and by environmental concerns.

Suburban labor force shortages, the strong growth of service industries in central cities, and other factors indicate that an increasing premium may be placed on employment locations that are accessible from throughout a metropolitan region, influencing further growth in central city and CBD areas where services, infrastructure and amenities already exist. The suburban phenomenon is not as simple as it first appears, but requires the continued attention of public transportation experts.

Economic Growth and Vitality

The TRB 2020 Conference focused on a broad range of issues that may influence the incentive for additional investment in transportation facilities. In addition to those cited earlier, the impact of investment in infrastructure was considered as it relates to the overall economy. The report (1, p. 6) stated:

A 2.6 percent growth rate in the gross national product (GNP) is forecast for 2020 in terms of labor force and productivity. However, to sustain the current U.S. standard of living, the level of economic activity needs to be 3.5 percent. In order to close the gap, increased rates of capital investment are needed by both the private and public sectors.

Higher rates of capital investment are key to future growth of productivity and income for the nation. Investment in transportation has certainly contributed to this country's growth during the first three-fourths of the 20th Century. Such investment has declined as a portion of the GNP and as related to the increase in vehicle miles traveled. Additional transportation investment is necessary, in a form that will yield improved productivity from more efficient technology.

Commercial Freight Transportation

The TRB 2020 Conference attempted to describe the environment for commercial transportation in the future. Many unknowns exist, however. The report (1, p. 11) noted:

Although the GNP will grow more slowly than in the recent past, industrial production is expected to increase, and thus demand for rail and motor carrier transportation services should expand. A major unknown is understanding how rail-truck competition will be resolved during this period. Changes in governmental policies may influence the competitive environment. Policy areas in which such changes have occurred or may occur include regulation, abolition of the Interstate Commerce Commission, truck access to the interstate system, size and weight laws, use of twin trailer trucks, urban truck bans, new sections of the interstate, and the quality of the highway system.

The rail and trucking industries have changed dramatically because of the recent deregulated environment. In the 1950's rail car was the standard mode for transporting manufactured products. The construction of the interstate highway system and deregulation underlied the shift from rail to truck, which is the major competitive change affecting the freight industry. Intermodal transportation represents the cutting edge of rail-truck competition and consequently the hope for future growth of earnings for the rail industry. New intermodal technology such as the RoadRaileR could revitalize a portion of the rail market. Although the past has shown slow growth in the industry and movement has been from rail to truck, these trends could be reversed as demand increases and competition grows.

New business organizations that may evolve to handle freight constitute a separate issue, and changes are already taking place. For example, short-line railroads have emerged since deregulation. The larger railroads have spun off low-density lines into separate businesses that have reduced their labor costs and adjusted their overall cost structures. "Total" transportation companies that might arise to utilize both rail and motor carrier modes are certainly on the horizon, but even these will have to decide how intensively to use each mode.

New Technology and Communications

Underlying all of the forecasts is the expectation that new technology and communications will play an important role in the future. The FHWA report identifies five specific areas where technological development may have a significant impact on the future of highway transportation. These are automobile, motor truck, traffic controls, telecommunications and computers, and highway materials and construction. The TRB 2020 report (1, p. 12) identifies similar areas and states:

Because the computer-control revolution is just beginning, one can only guess at its effects, but the pace of such change will quicken. Industrial plants can be much smaller. Factories can be located wherever there is good transportation, even in places that are not yet cities. Freight movements will be diverse and time-sensitive. Although these changes appear to favor trucking, new technology, such as the "carless piggyback" or RoadRaileR, and logistics control systems will help the railroads to compete.

It is unlikely that many more expressways will be built to reduce congestion. There will be a trend toward working at home, but transportation will not be affected significantly by this trend in the near future. Half-width vehicles have been developed that could increase the throughput on existing highways, and electronic guidance systems will help drivers locate new destinations. In the discussion of automatic vehicle control (AVC) and similar vehicle guidance systems, it was concluded that obstacles to their development are more institutional than technological. Improved traffic signal systems have been developed to increase speed of traffic flow and reduce the time and fuel involved in travel.

Improvements in vehicle technology are also anticipated. Fuel economy gains will continue and new materials that reduce the weight of the car may be used, although this could increase the price of the car by more than the savings in fuel costs. However, the cost of these materials will decrease with time and experience, and new materials will be widely used by 2020.
The internal combustion engine is approaching theoretical propulsion efficiency limits, and it will be difficult to obtain further improvements. Fuel cells, a potential replacement for the battery, use an electrochemical process, but low-cost catalysts are needed to make them economically feasible.

PROBLEMS

The second phase of the future's process is identifying the current state of transportation services and the critical needs as defined by those who use, operate, and are responsible for system delivery. Scattered throughout the reports cited earlier are proposals for how both transit and highway should position themselves for the future. Another report however, takes a "grass roots" approach and summarizes the findings from 65 public forums held around the country between August 1987 and May 1988. More than 2,300 individuals testified at these forums, representing 49 states and the District of Columbia. As was expected, numerous specific proposals were received, many dealing with short-term concerns. The major items, listed by urban or rural location, are remarkably similar to those identified in FHWA, APTA, and TRB reports. They indicate a recognition of the problem and the need for the private sector and government to respond.

Major Concerns of Transportation Users: Urban

- Transportation facilities in the larger urban areas are heavily congested, and congestion is likely to increase in the future. This trend is adversely affecting commerce, and stimulating further suburban spread.
- Population growth has been heaviest in outer suburban communities, which is changing the nature and direction of transportation demands. The once dominant suburb-to-city center commute is now only the third largest movement.
- The physical condition of transportation facilities—especially expressways, city streets, and transit—is deteriorating. There is a universal desire that the essential service provided by urban Interstate highways be properly protected.
- Needed new and expanded facilities, whether highway, transit, or rail, are not being provided in time.
- The future U.S. population will be older than today's; thus, transportation issues will be different.
- Transportation investments will be needed to rejuvenate portions of older urban areas.
- Traffic engineering improvements (signals, signs, markings, parking, high-occupancy vehicle lanes, turning lanes, etc.) should get more attention.
- Private and governmental organizations must cooperate more to further reduce the extent of single-passenger commuting.
- Deliveries of goods and supplies to urban commercial establishments is becoming more difficult, particularly as the "just-in-time" delivery concept spreads.
- Traffic congestion is adding to the costs of transportation service, creating another impediment to national economic health.
- Access to airports and waterports must be improved.
- Long-term availability of domestic petroleum products is a worry. Conservation, alternative fuel development, complete exploration of domestic sources, and options to the single-occupant automobile are called for.
- The transportation planning process must be improved, and better coordinated with land development schedules.
- Environmental goals, particularly for clean air, are a continuing concern.
- The federal government appears to be neglecting urban transportation issues, as funding of all programs has been reduced and funding for one mode has been forced to compete with another.

Major Concerns of Transportation Users: Rural

- The Interstate Highway System is the backbone of long-distance service, but many segments are outdated and newly developed areas are not well served. High-quality access routes to the Interstate system are a major need in many states.
- Major farm-to-market roads are deteriorating under heavier use because of rail branch line abandonments.
- Rural shippers often find no competition between railroads and trucking.
- Local rural governments have difficulty in meeting needs for bridge replacement and other relatively high cost capital investments.
- An aging rural population will need better public transit.
- Transportation development must respect the character of the area traversed and protect it.
- Road access to national parks, forests, and Indian reservations is getting worse. The economic importance of tourism and recreational driving demands greater attention to improving scenic driving opportunities.
- New road facilities are needed to serve expanding recreational and economic developments needs. Cities must be better connected with growth centers and resort areas.
- A network of scenic byways is needed in every state to serve tourists and recreational travelers.
- Rural transportation safety is a concern.
- The federal government appears to be neglecting rural transportation because of competing budgetary pressures.

PROGRAMS

The final element in the future's process consists of defining a strategy and a program that responds to the societal changes and needs that have been identified, and then proceeding with their implementation.

It is not my role here to describe the various programs that have been developed by APTA, AASHTO, FHWA, and others, as these will be scrutinized by public officials and political leaders, who eventually must decide (2,3,6,7). Then the actions taken will serve to incrementally add to our nation's extensive transportation system, either by rehabilitation or adding new capacity. I would, however, like to identify several basic viewpoints that are relevant for us to consider as we move into this new century of transportation.

Three individuals who have written perceptively on this topic are Peter Koltnow, Tom Larson, and Daniel Brand. Each presents thoughts worthy of consideration, that should be included in the process of identifying alternatives and recommending action.
Koltnow (8) makes the point that we should not be timid or pessimistic in our expectations of the future. He illustrates this by citing the many changes that have occurred in the past 30 years, many which were unanticipated, and claims that we have responded to these challenges remarkably well. He lists tasks for the next three decades, including new capacity in the suburbs, retrofitting of safety features, substantial miles of new roads, modern traffic control, and new communications and guidance systems. He states, “None of these measures will gain necessary support without leadership. If those responsible are shortsighted or out of touch, they forfeit their right to direct the next generation of transportation progress.”

Tom Larson (9) reminds us that three elements are necessary if we are to effectively deliver new transportation services. In addition to a vision of the future, we require an “authorizing environment” (i.e., support of the people for our new product) and an organizational capacity to deliver that product. Without these three in place, we are likely to be unsuccessful with new ideas. This approach suggests “incremental change” which he believes in, “but with enough excitement and challenge to keep us enthused and regain and maintain public support for something we all know to be useful to our society.”

Dan Brand in his excellent summary of the TRB 2020 Conference (1, p. 22), described the three stages of innovation to buttress his call for automation as a direction for the 21st century:

The first stage of innovation typically occurs when an invention performs an existing function better than before. The early motor was faster and pulled more weight on dry roads than the horse, but its function was the same as that of the horse.

In the second stage of innovation, the invention has been improved and new uses have been found for it. In the case of the motor car, self-starters were developed, vehicles were adapted to move goods as well as people, and chauffeurs were added to create the motor bus.

In the third stage of innovation, the structure of the surrounding system, in this case the city, adapts so that the innovation performs a new function better than before. Computers are well suited to enhance or take over part or all of the existing guidance and control functions now performed by humans. Automated highways, or more logically, automated guideways of an intermediate-stage dual-mode system, could well be the next transportation engine that drives the economy. Transportation speeds and throughput could be markedly increased. The market for microprocessors in this application would certainly dwarf the few million personal computers now in use.

Are we on track for developing the transportation engine for economic growth in the year 2000? Brand thinks we probably are, “Transportation should get on board and try to drive this development in the public interest.”

“We can only wonder and speculate on what the second and third stages of innovation would or will be—the new uses for the innovation, and how the structure of the surrounding system would adapt.” Brand demurs and does not speculate further. Analogies has carried us to the point where automation as a research direction appears as an eminently logical response to the nature and level of demand for future highway and public transit services. The rest is left for history.

So there you have it. We have made great strides in defining those factors that will govern our future. What the future will turn out to be, however, will depend on our actions, vision, and leadership as we seek to develop a new program of transportation suitable for the needs of a new century.

REFERENCES