Notes on Transportation into the Year 2025

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The following paper was background reading for a panel of experts who met to discuss research needs regarding the impacts of global climate change on the Nation's transportation system. It draws heavily on the first chapter of the U.S. Department of Transportation document *The Changing Face of Transportation,*[1] published in January 2001, and *Transportation in 2050.*[2] The paper assumes that global climate change is taking place, and that it will have impacts on the transportation system. The range and nature of potential effects are discussed in separate papers.

It is impossible, of course, to fully predict the timing and broad scope of changes in U.S. transportation over 25 years, or the social and economic shifts which drive them. The following projects a single scenario, among many scenarios which are possible. All of this material predated the horrific events of September 11, 2001. It is too soon to gauge what the long-term influence of those events will be on the trends depicted here.

Introduction

Table 1 provides forecasts for U.S. transportation activity to the year 2025.[3] While it is two years old, it presents an authoritative, internally consistent set of projections, and unless otherwise noted, will be the basis for all numerical activity estimates cited below. It projects that over the next 25 years, the U.S. population is likely to continue growing at an average annual rate of change of about 0.82 percent, reaching a level of 338 million by 2025. The age distribution of the population, however, will continue to change significantly. The median age has risen from 28.8 in 1975 to 35.2 in 1999, and it is expected to reach 38.0 by 2025.[4] These demographics will challenge transportation managers to maintain system safety and efficiency, in the face of a changing makeup of the workforce, the numbers of youthful versus aging drivers, and shifts in consumer preferences for products and services.

Economic projections tend to be more near-term. The Congressional Budget Office 2000 estimates suggest growth in production at a substantially faster rate than population growth—about 2.7 percent compounded annually over the next 10 years. Projected forward, we might expect Gross Domestic Product (GDP) to reach $29 trillion by 2025. In that event, per-capita GDP might well be close to 1.5 times today's level, even after adjustment for inflation.

Table 1. *U.S. Transportation Activity, 1975 – 2025.*

Forecasts Past and Future	1975 Actual	1990 Actual	2000 Estimated	2025 Forecast[13]
Transportation Context				
Population (millions)[1]	215	249	275	338
GNP (constant 1975$, billions)[2]	$1,598	$2,409	$3,049	$5,486
GNP Per Capita (1975$)[2]	$7,417	$9,675	$11,087	$16,240
GDP (constant 2000$, billions)[3]	NA	NA	$9,942	$18,258
Passenger Transportation				
Passenger-Miles (billions)[4]	2,560	3,946	5,036	8,438
Passenger-Miles Per Capita[4]	11,881	15,847	18,313	24,979
Licensed Drivers (millions)[5]	130	167	190	243
Vehicles (millions)[6]	138	193	219	262
Freight Transportation[7] (millions of Ton-Miles)	2,285,000	3,196,000	3,959,432	5,098,888
Rail	754,252	1,033,969	1,416,446	1,484,802
Water (domestic ton-miles)	565,984	833,544	763,540	NA
Water (domestic and foreign short tons)	1,695	2,164	2,453	3,429
Truck (intercity)	454,000	735,000	1,130,132	2,121,837
Air	3,470	9,064	15,904	33,925
Pipeline (hazardous liquids)	507,000	584,000	633,410	797,950
Safety[8]				
Transportation fatalities	49,214	47,248	42,600	40,300
Air Pollution[9]				
CO (millions of tons)	85.27	61.18	50.48	24.24
No_x (millions of tons)	9.45	8.51	8.66	7.98
Greenhouse gas emissions[10]	350.00	420.00	500.00	600.00
Energy[11]				
Btu[12] (trillions)	16,998	24,070	25,200	36,600

[1]Population projections are taken from U.S. Department of Commerce, Bureau of the Census, Annual Projections of the Total Resident Population as of July 1: Middle Series Projections for 2000 and 2025.
[2]Forecasts for GNP are based on 1975 through 1999 data, using log linear (Holt) exponential smoothing model, parameters optimized through SAS/ETS software.
[3]Forecasts for GDP are based on 1929 through 1999 data, using damped trend exponential smoothing, parameters optimized through SAS/ETS software. NA = not available.
[4]Forecasts are based on 1990 through 1997 data, using damped trend exponential smoothing, parameters optimized through SAS/ETS software.
[5]Forecasts are based on 1949 through 1998 data, using damped trend exponential smoothing, parameters optimized through SAS/ETS software.
Forecasts for vehicles are based on 1990 through 1997 data, using double (Brown) exponential smoothing, parameters optimized through [6]SAS/ETS software.
[7]Forecasts for total ton-miles are an aggregate of the individual forecasts by mode. Forecasts for rail ton-miles are based on 1990 through 1998 data, using damped trend exponential smoothing, parameters optimized through SAS/ETS software. (The FRA, however, forecasts a two percent average annual growth rate for the 2000-2025 period. This translates into 2.4 trillion ton-miles in 2025.) Forecasts for water ton-miles are based on two forecast models: log damped trend exponential smoothing based on 1990 through 1997 data, and log simple exponential smoothing based on 1960 through 1995 data in five year increments; the two forecasts are combined with equal weights. Forecasts for truck ton-miles are based on two forecast models: linear trend based on 1990 through 1997 data, and double (Brown) exponential smoothing based on 1960 through 1995 data in five year increments; the two forecasts are combined with equal weights. Forecasts for air ton-miles are based on two forecast models: linear trend based on 1990 through 1998 data, and damped trend exponential smoothing based on 1960 through 1995 data in five year increments; the two forecasts are combined with equal weights. Forecasts for pipeline ton-miles are based on 1990 through 1997 data using log linear trend. All forecast model parameters optimized through SAS/ETS software.
[8]Forecasts are based on 1990 through 1998 data, using damped trend exponential smoothing, parameters optimized through SAS/ETS software.
[9]Forecasts for CO are based on 1985 through 1997 data, using log linear trend parameters optimized through SAS/ETS software. Forecasts for NOx are based on 1985 through 1997 data, using double (Brown) exponential smoothing, parameters optimized through SAS/ETS software. Forecasts for greenhouse gas emissions are based on expert opinion.
[10]Millions of metric tons of carbon equivalent, excluding bunker fuels.
[11]Forecasts based on 1990 through 1997 data, using double (Brown) exponential smoothing, parameters optimized through SAS/ETS software.
[12]Btu: British thermal unit.
[13]The 2025 forecasts are purely statistical. For sources of data used in these forecasts see The Changing Face of Transportation, ibid, page 1-32.

Generally speaking, as population grows, travel rises. But changes in the age distribution, geographic distribution, and even immigration also affect travel volume and patterns. Economic well-being can also slow or accelerate use of the transportation system, while changing the mix of transportation modes or trip purpose. International factors such as the globalization of the economy and population change can further impact both trade and passenger flows. Thus, demographics and economics provide an important future context for transportation decision-making by individuals, governments, and private industry.

Economic location decisions are creating large metropolitan areas around one or more urban centers and their suburbs. This pattern is particularly evident along the Nation's coastal areas. If the changes in climate occur as projections indicate, then coastal areas will need to prepare their infrastructures for higher sea levels, more frequent extreme weather events, and higher levels of accompanying storm surges. The economic losses from such storms will grow, not only because of their increased frequency and intensity, but also because the trends for these areas are higher population densities and more elaborate and expensive construction. Climate change may also bring population shifts due to shoreline flooding, changes in agricultural patterns, and increased intensity in weather-related disasters.

Priorities

It is impossible to predict how the top priorities for the Nation's transportation system will change over the next 25 years but they will likely be close to those of today: safety, transportation security, congestion relief, environmental protection, energy usage, globalization, and more rapid deployment of new technology. These concerns will be addressed through experimentation in innovative solutions, creative management and planning, developing technologies such as Intelligent Transportation Systems (ITS), and new strategies for capital investment and financing. Although the transportation system could take may future forms, all improvements will be designed to improve access and ensure the free flow of goods and people within and among all of the various modes of transportation, and to allow people to be even more productive with their time, to experience new things, and to always be connected.

Safety

Reductions in highway accidents have come from improvements in road and motor vehicle design, increased seat belt use, enactment and enforcement of drunk driving laws, improvements at rail grade crossings, and public awareness campaigns. Additional gains are expected from advances in roadway designs, in-vehicle technologies (particularly wide-spread deployment of collision avoidance systems), technology-enhanced traffic law enforcement, further pedestrian/cyclist separation, and advances in trauma response and medical treatment after crashes.

Aggressive safety programs are ongoing in other modes as well. NASA and FAA are engaged in a joint program with the goals of reducing the aircraft accident rate by a factor of 5 by 2010, and by a factor of 10 by 2025. Rail operation will benefit from wide use of advanced train control systems, along with improved locomotive and rail passenger car safety standards. Recreational boating and marine safety programs, and improvements in the general safety of vessels (e.g., structural safety, fire protection) will retain their importance, even with the Coast Guard moving to the newly formed Department of Homeland Security.

While it is impossible to forecast the results of continued high priority safety programs, the projections of Table 1 indicate that fatalities could be expected to decrease to about 40,300 per year by 2025, even with passenger miles increasing by 68 percent over 2000. Technology, innovation, and leadership will be the keys to major safety advances in the future. The safety implications of potential climate change are presently poorly understood, and need to be identified and quantified so that the Nation can begin to develop safety countermeasures that will forestall its negative effects.

Transportation Security

On September 11th, 2001, an attack by a determined and remorseless enemy brought us to realize the vulnerability of our transportation system. As a result, changes will be made in all modes, to meet the significant security challenges facing the transportation system, beginning with terrorism, and the introduction of weapons of mass destruction, but also including smuggling of people and illegal drugs, and protection of natural resources. Working closely with the Department of Homeland Security, Secretary Mineta intends to assure that these investments in new infrastructure and technologies made to enhance security also will improve system efficiency. As the impacts of climate change on transportation become understood and identified, and possible measures to mitigate them are catalogued, the changes made to respond to security needs may offer concurrent opportunities to respond to climate change.

Congestion

Addressing problems related to congestion will be a major challenge over the next 25-year period. Highway vehicle-miles traveled exceeded 2.6 trillion per year in 2000 and continue to grow. Transit ridership reached 9 billion in 1999, the highest in 40 years. Commercial airports handled more than 8.5 million flights, nearly double the number of flights handled in the mid 1970s. By 1999, U.S. domestic revenue passenger-miles had climbed to 473 billion and will continue to increase.

With economic growth will come increasing demand for transportation services, exacerbating present capacity constraints. In the surface modes, we cannot build ourselves out of this situation. Population presence and the existing built environment limits our ability to construct enough lanes or roads in most places where capacity is needed. Given the large footprint of the current urban infrastructure, relatively little ground level addition will be possible, without greatly increased expense. Possible alternatives by 2025 include: going underground for expanded subway systems to carry people and goods, multi-tier roadways, building new guideways above ground over existing rights-of-way for rapid rail, or better exploitation of existing infrastucture through new practices and technology.

No matter what the form of infrastructure, new or existing, the long-range transportation planning process should now consider the anticipated effects of climate change, potentially building-in more resilience to climate variability while recognizing that there will be different impacts in different areas. Increased temperature loading on construction materials, higher likelihood of extreme weather events and the destruction and flooding that accompanies them, the possible collapse of perma-frost based structures, land erosion and subsidence, impacts of sea level rise on our ports and in coastal areas, and water level changes in the Great Lakes will all pose significant challenges for transportation officials.

Options that can reduce congestion and the demand for transportation may receive higher priority for development, such as telecommuting, alternative work schedules, peak period pricing and various user fees. Information technology offers a variety of scenarios for congestion relief. Improved communications providing virtual reality phones could let us feel closer to business associates and friends, reducing the need for face-to-face contact and with no need for geographic proximity. This could mean higher dispersion, however, increasing freight distances, and with uncertain outcomes as to personal travel.

Passenger Travel – By 2025, travelers will have widespread, real-time access— any time, any place—to information of all types, such as transportation availability, geographic location, and operating conditions over various segments of a trip. Using a range of media, they will be able to request demand-responsive services from any location. Transportation will have more of a customer orientation, and provide relatively seamless intermodal trips. In absolute terms, passenger-miles of travel will increase faster than the growth in travel experienced during the 1990s—from 5 trillion miles in 2000 to 8.4 trillion in 2025, provided that capacity issues can be adequately addressed. A corresponding rise in global travel is also expected.

Even before the events of September 11, 2001, **aviation** was beset with capacity problems and significant public concern about flight delays and cancellations. Technology to address weather-related delays and modernization of the nation's air traffic control system will be part of the solution. Continued investment in airport capacity will still be necessary, with forecast demand exceeding capacity in a substantial number of airports, presenting a major constraint on growth.

Today's market share of **transit**—and its capacity in some geographic areas—is small, and may be only a small part of the solution. Although transit ridership has been recently growing at a rate faster than automobile travel in some urban areas, its impact has been limited. As congestion continues to grow, as the frequency and convenience of service improves, and as residential and commercial development decisions become better integrated with transportation decisions, more of its benefits will accrue, even to non-users. In addition, its role in maintaining mobility in metropolitan areas may gain in importance and with it the economic vitality of these areas may hang in the balance.

Congestion on **highways** will also be addressed through capacity expansion or a variety of demand management policies and technological innovations. Peak period access pricing may gain in prominence and could help to spread the flow of travelers through choke-points throughout the day. New transponder technology will collect tolls without the need to stop, and efficiently distribute the revenues to all stakeholders. Metropolitan areas across the country are actively deploying Integrated ITS Infrastructure to improve the capacity of the highway system. The tools necessary to advance telecommuting are available, but it is impossible to predict at this point what it's impact will be on the trends shown in Table 1.

The interest in high-speed, **rail**-based ground transportation, heralded by the unveiling of *Acela*, Amtrak's new high-speed train service (with speeds reaching150 mph) in the Northeast Corridor, may continue to grow. By 2025 other corridors in the nation may have high-speed train service, but there are many barriers to overcome before rail provides intercity travel times that will rival those of air travel.

Increased use of **waterborne** systems could address congestion in certain metropolitan areas like San Francisco, New York City, and Seattle. Ferries traveling up to 50 knots using conventional engines can mitigate traffic, but will require auxiliary technologies to control their emissions.

There will be greater concern for the safe mobility of those over 65, who will make up almost one-sixth of the population by 2025. New technologies will be employed to keep them driving safely longer, balanced by additional, more user-friendly, mobility options.

While traveling in the future will be different, the basic modes we use are unlikely to change. What will change are the characteristics of these systems, how we use them (e.g., the growing trend for shared ownership and use of cars), and how we construct our daily routines. As noted above, technology, and the prospect for increased affluence will help enhance the quality of the transportation experience.

Freight - The next 25 years will be a challenging time for all sectors of the freight community. Congestion and capacity issues are already apparent in every mode, with much of the transportation infrastructure requiring modernization. Workforce shortages are projected. At the same time, e-commerce and increasing globalization of the economy will increase transportation demand, requiring both more system capacity and greater reliability. Buyers will enjoy a close consumer-factory relationship where they can instantly customize their ordered products electronically and have them shipped directly from the factory. The freight system must accommodate an increase in

GDP likely to grow by 84 percent, in 2000 dollars, and that is projected to grow to just over 5 billion ton-miles by 2025—a 29 percent increase. But there may be shifts in how freight is moved and how freight transportation is managed.

There will be a continuation in the trend to a high volume of smaller shipments to satisfy low or no inventory production and distribution requirements and express package delivery. Highly integrated freight transportation companies will provide full logistics/transportation services using multiple modes.

Trucks will continue to dominate the freight transportation market, and their share of the primary shipment tonnage transported in the United States is expected to remain relatively constant for at least the next 10 years even as total volumes increase. There will be continuing efforts to address empty backhauls and unnecessary stops using information technology. Nevertheless, increasing truck traffic will become even more of a source of congestion along the Interstate and urban arterials.

Domestic **water** freight movement is expected to increase moderately over the next quarter century; foreign waterborne commerce is expected to double. A significant increase in international freight movement will require much larger ships, deeper channels, and high-capacity efficient intermodal cargo-handling ports. As these ports are improved, they can also incorporate measures to mitigate the expected effects of climate change.

Air cargo growth is expected at a pace even greater than today's because of e-commerce and globalization. Larger aircraft, both dedicated freighters and passenger aircraft with excess storage capacity, are expected to accommodate the growth in freight demand.

Estimates of growth in **rail** ton-miles vary considerably, with the most robust estimate putting the average at 2 percent per year between 2000 and 2025.

Pipeline movements are projected to grow by over 25% through the period.

The Environment

It will become increasingly challenging to balance the need for greater mobility with the need to protect the environment. Projected growth in the population and the economy, along with the associated increases in travel and shipping, might easily offset the gains that might be achieved by greater choices in transportation, improved land use patterns, reformulated fuels, or greater capture of pollutants. Today, 39 percent of the U.S. population lives in a "nonattainment" area—not meeting National Ambient Air Quality Standards—for one or more of six criteria pollutants. Ground-level ozone, in particular, remains an important problem for most people in these areas.[5]

Tailpipe emissions of criteria pollutants from automobiles have already diminished substantially due to Clean Air Act standards, and their continued reduction is anticipated through 2025. They will continue to improve for trucks of all sizes as the new Tier II[6] and heavy-duty diesel regulations[7] take effect. As long as light duty vehicles are fossil-fuel dependent however, actual reductions in greenhouse gas (GHG) emissions appear to be limited, although new efficiencies introduced into the conventional power train have the potential to improve fuel economy by 20-40 percent or even more over the coming years.[8] While we look to fuel cell and hybrid vehicles to offer even sharper declines, the full pace of deployment of such vehicles into the fleet by 2025 will be limited by the major national investment in making fossil fuel powered engines and the long lead time necessary to introduce new technologies into manufacturers' product lines.

In 2000, transportation produced nearly 1900 teragrams (1 Tg = 1 million metric tons) of greenhouse gases per year. Table 2 shows the growth in these emissions over the past decade, and the proportion of total national greenhouse gases they represent. Figure 1 shows how they were distributed among the modes over that period. Table 1 indicates that greenhouse gas emissions are projected to grow 20 percent by 2025.

Emissions from airports and aircraft will become a greater concern as air travel increases. New aircraft meeting international noise and emissions standards will result in even quieter aircraft by 2025. Most of the world's current commercial aircraft, however, still will be operating 20 years from now. Increased use of cleaner ground support equipment and other steps to reduce airport-related emissions are likely to be in place. New communications, navigation, surveillance, and air traffic management procedures will allow optimization of all phases of flight – from planning and surface operations to enroute flight paths with resultant fuel savings and environmental benefits.

Large oil spills into U.S. waters are becoming less common and a response regime is in place to minimize impacts. Eventually, shifts in automotive design away from fossil fuels could break the pattern of both U.S. reliance on foreign oil and the associated pollution risks of moving that oil.

Efforts to control and reduce the introduction of invasive species in the transport sector will make progress, but this emerging concern is likely to continue to be an issue.

Dispersed, auto- and truck-dependent development patterns, often referred to as urban sprawl, can increase costs of providing community services and increase congestion, pollution, and consumption of natural resources. Zoning and land-use patterns that put needed day-to-day services close to each other, and support a range of transportation choices (e.g., communities that encourage less auto dependence, and use of transit, walking, bicycling, and small motorized personal vehicles) will begin to address these concerns, but will take many years to develop.

Table 2. *U.S. transportation sector greenhouse gas emissions by gas (Tg CO2 Eq.) and percent of U.S. total (2002).*** [9]

	1990	1995	2000	% of U.S. Total (2000)
Transportation Total	1,530.5	1,655.1	1,879.7	26.80%
Direct Emissions	1,527.7	1,652.4	1,877.0	26.80%
CO2	1,471.8	1,579.4	1,789.5	25.60%
CH4	4.9	4.8	4.4	0.10%
N2O	50.9	60.4	58.3	0.80%
HFCs	7.9	11.8	24.8	0.40%
Electricity-Related	2.8	2.6	2.8	N.A.

** Estimates are in units of teragrams of carbon dioxide equivalents (Tg CO_2 Eq.), which weight each gas by its Global Warming Potential, or GWP value.

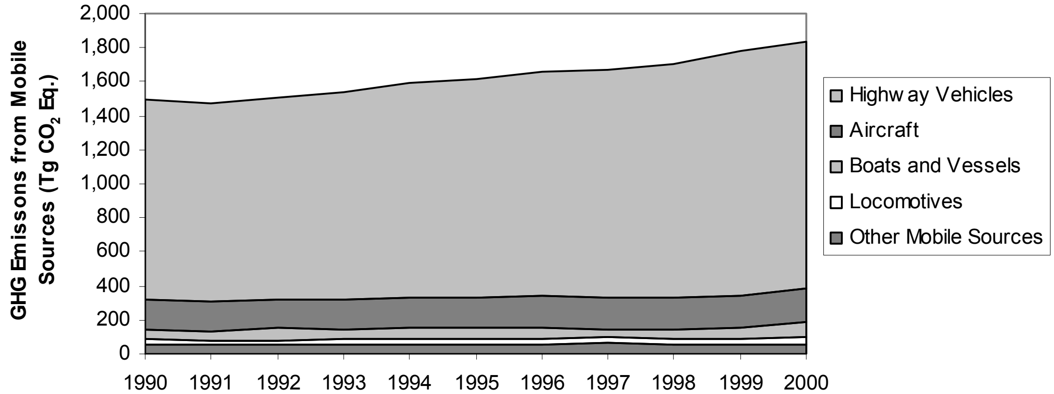

Figure 1. *Greenhouse gas emissions from mobile sources by mode (Tg CO_2 Equivalent). Highway vehicles generate the majority of emissions, with aircraft the next largest contributor.*[10]

In addition, there is growing recognition that transportation planning is not only about transportation, but also about the critical role it plays in all domestic sectors to meet the goals of other social policies. Besides its well defined role in energy policy, trade, and economic development, future planners will more systematically incorporate transportation considerations into their work in the areas of housing, land use, tax policy, health, aging, and homeland security.

Energy Usage

Detailed projections of domestic energy use are available from the Department of Energy only to 2020, as may be seen in Table 3. It projects that transportation energy use will rise from 27 trillion Btu per year to over 39 trillion Btu in 2020, a 44 percent increase. Over the next quarter century, transportation energy growth will continue to be dominated by the burning of gasoline and diesel fuels. There will be no shortage of such fuels, as long as people are willing to pay $30-35 per barrel for oil or its equivalent, which we willingly did in the past.

New powertrain designs, such as hybrid electric and fuel cells, will become more common. As noted above, these new vehicle designs will be introduced slowly into the fleet, and take more years before their sales volumes comprise a significant portion of new vehicle sales. Because it will take nearly a decade for such vehicles to capture a significant share of the total U.S. vehicle fleet, their effect on transportation energy use may only begin to make an impact by 2025. Policies such as tax incentives may be employed to accelerate the deployment of electric hybrids and fuel cell vehicles into the fleet.

Globalization

Several references above alluded to the growing globalization phenomenon, as more countries become linked by advanced information technologies, transnational enterprises, integrated financial markets, and growing international goods movement. Globalization will influence much of what we buy in the future. Most changes in transportation will occur outside the United States, requiring new capital for infrastructure investment in developing countries. As globalization spreads, average per-capita income of countries around the world will become closer. International transportation will now require new levels of security to combat terrorism, along with the enforcement of safety codes, environmental standards, and other forms of standardization required to facilitate transborder commerce.

Technology

It is often the case that we see great potential gains in efficiency or functionality from developing technology, but a marked lag in its deployment, so there will be continuing impetus for reducing the time from development to marketplace. Civil use of the Global Positioning System (GPS) will provide the basic infrastructure for a continuing and substantial improvement in the safety and efficiency of our national air, surface, and marine systems. ITS is being widely deployed to improve the mobility and safety of our surface transportation systems. Technologies such as ramp meters, electronic surveillance, signal synchronization and preemption; advanced weather and road condition information; computer-aided dispatch systems; commercial vehicle technologies[11]; and a host of infrastructure innovations promise to reduce congestion, improve efficiency, and make travel safer. While all of these benefits are expected as we increase the deployment of GPS and ITS, some of these gains will be offset by the expected growth in highway travel by 2025.

Advances in materials will introduce new efficiencies by 2025 at every point of manufacture and construction. Nanotechnology and carbon fiber construction will enable light but very strong automobile and aircraft designs, with commensurate safety and fuel benefits. The same technology will likely spawn a new generation of rigid air ships for both passenger and freight transportation.

The current trend of embedding new technologies into the operations and management of the transportation systems will continue and probably accelerate over the next 25 years, facilitated by the continuing evolution of computers and communication components and networks. This technology will play a prominent role in enabling sophisticated administration and operations of transportation services in an era of constrained expansion of physical infrastructure. The management of transportation systems will become highly automated and increasingly real-time, to the point where many aspects of it may seem to occur in the absence of human intervention. Real time pricing of transportation facilities will increase efficiency, reduce congestion delays and provide for innovative pricing policies.

Conclusion

Many would rate our transportation system as the best in the world, considering the long trip distances we take for granted, our safety measures in place, the low costs of the delivery of our goods, or the reliability that allows manufacturers to organize production around just-in-time inventory systems. But it is also a system under severe stress in some areas, due to congestion, increasing demands for travel and freight movement, and additional environmental and social requirements. The upward trends in population, and growth in national and international economic activity will exacerbate this, and it may well be that all we can do is maintain the level of service now provided. Technology of all kinds will offer relief, but it is impossible to predict the forms it will take, and how they will transform our society. The transportation system is massive, and its planning, construction and use cycles endure over many decades. It is difficult to project the full extent to which potential climate effects (e.g., more frequent violent storms, flooding) could bring additional stresses. At this juncture, nevertheless, we must initiate the research that will provide a scientific basis for informing our State and local partners, our managers, and our long-range planners, on what future investments would be most cost effective in responding to these effects.

***Table 3.** Transportation sector energy use by mode (Trillion Btu).*[12]

	2000	2005	2010	2015	2020	Annual Growth rate 2000-2020
Highway						
Light-Duty Vehicles	14,971	16,743	18,485	20,072	21,367	1.80%
Automobiles	8,641	8,639	8,763	9,065	9,387	0.40%
Light Trucks	6,305	8,079	9,697	10,981	11,953	3.30%
Motorcycles	25	25	25	26	27	0.40%
Commercial Light Trucks (1)	638	686	772	849	914	1.80%
Buses	182	191	200	204	203	0.60%
Transit	87	92	96	97	97	0.60%
Intercity	23	25	26	26	26	0.60%
School	71	75	79	80	80	0.60%
Freight Trucks (2)	4,523	5,212	5,936	6,598	7,099	2.30%
Medium (1000-26000 pounds)	758	805	872	976	1,095	1.90%
Large (> 26000 pounds)	3,766	4,407	5,064	5,621	6,004	2.40%
Non-Highway						
Air (3)	3,113	3,347	3,913	4,571	5,287	2.70%
General Aviation	189	200	226	258	292	2.20%
Domestic Air Carriers	1,812	1,940	2,170	2,426	2,677	2.00%
International Air Carriers	670	731	827	936	1,038	2.20%
Freight Carriers	443	476	689	951	1,280	5.50%
Water (4)	1,713	1,665	1,706	1,756	1,801	0.20%
Freight	1,401	1,342	1,368	1,401	1,430	0.10%
Domestic Shipping	302	321	340	364	383	1.20%
International Shipping	1,099	1,020	1,028	1,037	1,047	-0.20%
Recreational Boats	312	323	338	355	371	0.90%
Rail	585	635	664	691	718	1.00%
Freight	506	547	569	587	605	0.90%
Passenger	79	87	96	105	114	1.90%
Intercity	20	23	25	27	30	1.90%
Transit	44	49	54	59	64	1.80%
Commuter	14	16	17	19	21	1.90%
Lubricants	180	207	222	237	250	1.70%
Pipeline Fuel Natural Gas	792	796	860	950	1,019	1.30%
Military Use	620	701	732	749	758	1.00%
Aviation	509	576	601	616	623	1.00%
Residual Fuel Use	18	20	21	22	22	0.90%
Distillate Fuel Use	93	105	110	112	114	1.00%
Total	27,317	30,182	33,490	36,676	39,416	1.90%

Notes:

(1) Commercial light trucks from 8,500 to 10,000 pounds.

(2) Does not include commercial bus and military use.

(3) Does not include military jet fuel use.

(4) Does not include military residual oil.

Totals may not equal sum of components due to independent rounding.

[1] The Changing Face of Transportation, U.S. Department of Transportation, Bureau of Transportation Statistics, BTS00-007, Washington, D.C.
[2] Safford, Mark A., Transportation in 2050, John A. Volpe Transportation System Center, Cambridge, MA, unpublished draft, 3/7/02.
[3] The Changing Face of Transportation, *ibid.*
[4] U.S. Bureau of the Census, Census 1999.
[5] EPA, National Air Quality 2001 Status and Trends, http://www.epa.gov/air/aqtrnd01/gndozone.html.
[6] EPA Fact Sheet:, *EPA's Program for Cleaner Vehicles and Cleaner Gasoline*, (EPA420-F-99-*051,* December 1999), http://www.epa.gov/otaq/tr2home.htm
[7] EPA*, Nonconformance Penalties for 2004 and later Model Year Emission Standards for Heavy-duty Diesel Engines and Heavy-duty Diesel Vehicles*, August 1, 2002, http://www.epa.gov/otaq/hd-hwy.htm#regs.
[8] National Research Council*, Effectiveness and Impact of Corporate Average Fuel economy (CAFE) Standards*, July 31, 2001.
[9] U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990 – 2000, April 15, 2002.
[10] EPA Inventory, *ibid.*
[11] Commercial vehicle operations will be enhanced through such services as weigh-in-motion, automated vehicle identification, credential verification from multiple jurisdictions (including border crossings) and on-board and roadside vehicle safety inspection and monitoring. Measures to improve surveillance of potentially dangerous cargos could also improve tracking and dispatching functions for freight carriers generally, resulting in more direct routing and reduction of idling and traffic delays.
[12] U.S. DOE EIA, Annual Energy Outlook 2002, Supplemental Table 33.

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