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The Future Isn't What It Used To Be

Changing Trends and Their Implications for Transport Planning

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Future transportation envisioned by Fred Strothman in 1900.

Abstract

This report investigates how demographic and economic trends will affect future transport demands (the amount and type of travel people would choose), and their implications. Motor vehicle travel grew steadily during the Twentieth Century but has started to peak in most developed countries. Aging population, rising fuel prices, increasing urbanization, improving travel options, increasing health and environmental concerns, and changing consumer preferences are reducing demand for automobile travel and increasing demand for alternatives. Automobile travel will not disappear, but at the margin (compared with current travel patterns) many people would prefer to drive less and rely more on walking, cycling, public transport and telework, provided they are convenient, comfortable and affordable. This paper discusses ways that transport policies and planning practices can respond to these changing demands.

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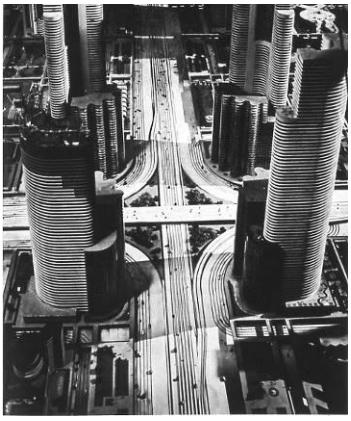


1939 Futurama

1949 ConvAIRCAR Flying Car

1958 Ford Firebird III, which included the "Autoglide" automated guidance system.

1961 Bell Rocket Belt

Introduction

According to predictions made a few decades ago, current travel should involve flying cars, jetpacks and moving sidewalks, with space transport a common occurrence (Corn 1984; Cosgrove and Orrick 2004). For example, General Motor's 1939 World's Fair *Futurama* display predicted that by the 1960s, uncongested, 100-mile-per-hour superhighways would provide seamless travel between suburban homes and towering cities in luxurious, streamlined cars. In 1961, *Weekend Magazine* predicted that by 2000, "Rocket belts will increase a man's stride to 30 feet, and bus-type helicopters will travel along crowded air skyways. There will be moving plastic-covered pavements, individual hoppicopters, and 200 mph monorail trains operating in all large cities. The family car will be soundless, vibrationless and self-propelled thermostatically. The engine will be smaller than a typewriter. Cars will travel overland on an 18 inch air cushion."[1]

The 1968 movie, *2001 A Space Odyssey*, shows commercial moon travel. The 1969 *Manhattan City Plan* stated, "It is assumed that new technology will be enlisted in this improved transportation system, including transit powered by gravity and vacuum and mechanical aids to pedestrian movement, such as moving belts or quick-access shuttle vehicles. These devices almost surely will become available by the end of the century."

Figure 1 **Segway Human Transporters**

Segway is an example of a new motorized transport mode.

Although new transport technologies grew during the Twentieth Century, including automobile,[2] airplane, and containerized freight, recent transport innovations have been more modest, and none have displaced existing modes. Segways have not replaced walking, ridehailing has not significantly reduced private automobile travel, and MagLev trains have not displaced conventional public transportation services.

Transportation professionals help create the future so it is important that we consider the overall context of long-term planning decisions. Good planning does not simply extrapolate trends, it investigate underlying factors that cause change. This report examines various demographic and economic factors that are likely to affect future travel demands, investigates evidence that travel demand is peaking, and their implications for transport planning.

[1] "Will Life Be Worth Living in 2,000 AD?" *Weekend Magazine*, 22 July 1961 (www.pixelmatic.com.au/2000).
[2] In this report, *automobile* refers to all personal motor vehicles including cars, vans, light trucks, sport utility vehicles, and even motorcycles.

Factors Affecting Travel Demands

Travel demand refers to the amount and type of travel people would consume in a particular situation, considering factors such as the quality and price of available transport options. Various factors can affect travel demands, as summarized below (Goodwin 2012; KPMG 2020; Leard, Linn and Munnings 2016). Some of these factors are well recognized in conventional travel demand analysis, but others are often overlooked or given little consideration in current planning.

Table 1 **Factors Affecting Travel Demands**

Factor	Consideration in Conventional Analysis
Economic factors of productivity, incomes and prices	
Demographics (age, school and work status, income, physical ability)	Generally considered
Area economic activity (productivity and types of industries)	Generally considered
Fuel prices, road tolls, parking prices and vehicle fees	Fuel prices and tolls often considered, others not
Public transit fares	Generally considered
Company car policies and taxes	Only considered in special studies
Quality of available transport options	
Traffic congestion	Generally considered in traffic models
Public transport service quality	Speed considered, comfort often ignored
Walking and cycling conditions (sidewalks, bike lanes, etc.)	Only considered in special studies
Street planning and management, including complete streets policies	Only considered if they affect traffic speeds
Parking supply, management and prices	Only considered in special studies
Intercity travel conditions (road, rail and air travel)	Only considered in special studies
Mobility substitutes such as telecommunications and delivery services	Overlooked by models that extrapolate trends
Vehicle rental and sharing options	Only considered in special studies
Emerging modes (e-bikes, telework, ridehailing, delivery services)	Often overlooked
Land Use Factors	
Land use development patterns (density, mix, etc.)	Considered in integrated models
Smart growth/New urbanist/transit-oriented development practices	Considered in some integrated models
Local neighborhood retail and service quality	Considered in integrated models
Roadway connectivity	Partly considered in traffic models
Emerging social patterns and preferences	
Vehicle ownership and travel time budget saturation	Overlooked by models that extrapolate trends
Transportation demand management programs	Only considered in special studies
Changing transport preferences (declining 'love affair with the car')	Overlooked by models that extrapolate trends
Reduced youth licensure rates and vehicle travel	Overlooked by models that extrapolate trends
Health and environmental concerns	Overlooked by models that extrapolate trends

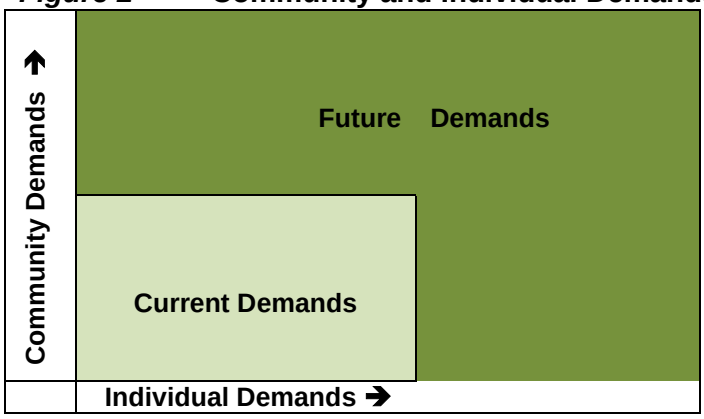
Many factors can affect how and how much people want to travel. Conventional analysis tends to overlook or undervalue many of these factors.

Many demand factors are non-linear and interactive. For example, when household increase from lower- to middle-incomes their vehicle travel tends to increase significantly, but higher incomes cause smaller growth in vehicle travel. Similarly, the impacts of automobile pricing strategies (the effects of tolls, parking fees, fuel price increases, etc.) tend to be higher in areas with better mobility options, particularly for lower-income households. Some modes tend to be complementary. For example, since most transit trips include walking links, improving walking conditions tends to increase transit demand and vice versa. All of these factors should be considered when evaluating future travel demands and the impacts of transportation system changes on future travel activity.

For public policy and planning evaluation purposes, travel demands include both *community* and *individual* perspectives. A community perspective reflects the types of travel activities that support community goals, such as reducing total traffic and parking congestion, accidents, pollution emissions. Such goals tend to increase communities' demand for resource-efficient transport options such as improved cycling, ridesharing and public transit, and for demand management strategies that encourage efficient mode use. An individual demand perspective reflects the travel activity that individual travelers or households will choose given available travel options. For example, aging population, rising fuel prices and increasing health concerns tend to increase demand for walking, cycling, ridesharing and public transit.

Both of these perspectives should be considered when evaluating transport demands. This is important because these two perspectives have multiplicative effects: if both community and individual demands for an alternative mode doubles, total demands quadruple since the community wants people to use those modes and more individuals are willing to use them. As a result, a combination of trends, such as aging population, rising fuel prices, urbanization, increasing health and environmental concerns can greatly increase walking, cycling, ridesharing and public transit demand, since it increases both the value to communities of increased use of these modes, and travelers willingness to use them.

Figure 2 **Community and Individual Demands for an Alternative Mode**



Demand can reflect both individual consumers' and community perspectives. If both individual and community demands for travel by a mode doubles, total demand quadruples since both individuals and their communities perceive more value from increased use of that option.

For example, you might want walking, cycling, ridesharing and public transit improvements in your community, in part because you want other travelers to use these modes in order to reduce congestion, accident and pollution costs you bear (an external benefit), and partly because you want to use those modes yourself. This can help create a self-reinforcing cycle of improved travel options, increased use of non-automobile modes, more social acceptance of alternative modes, and more support for their improvements.

As a result, demographic and economic trends that increase demand for non-automobile modes can have significant synergistic effects (their combined impacts are much larger than the sum of their individual impacts), and modest changes often research a tipping point beyond which their impacts are large (Hidalgo and Zeng 2013; ITF 2021; Johnson 2021).

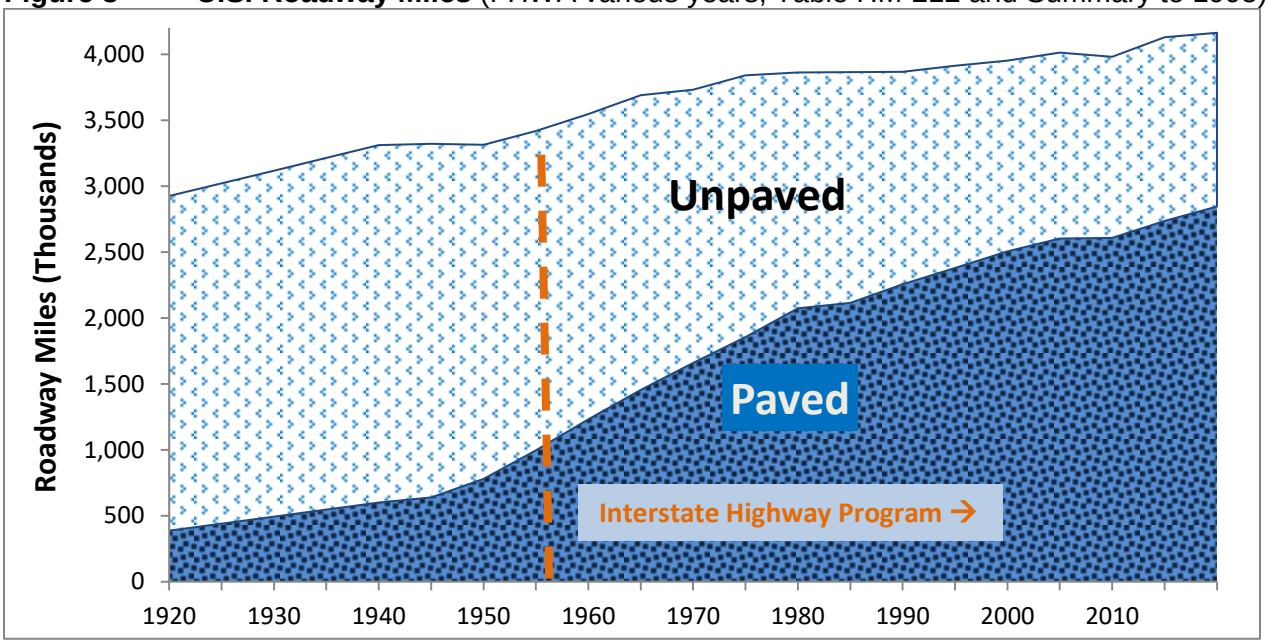
Twentieth Century Transport Trends

This section summarizes how transportation infrastructure, vehicle ownership and use developed during the Twentieth Century. Also see DfT (2015), ITF (2013), NCHRP (2014) and USDOT (2015).

Transportation Infrastructure

At the start of the Twentieth Century most roads were unpaved. Roadway mileage and quality increased tremendously during the Century, culminating in the Interstate Highway System. Since that system was virtually completed in the 1980s there has been little roadway expansion, as indicated in Figure 3. Similar patterns occurred in other developed countries.

Figure 3 U.S. Roadway Miles (FHWA various years, Table HM-212 and Summary to 1995)



During the last century most roads were paved. Starting in 1956, the U.S. Interstate Highway program developed a network of high-speed highways that significantly increased vehicle travel speeds.

Railroad mileage increased during the first half of the Twentieth Century and declined during the second half, but the decline has stopped, and Class 1 track mileage increased slightly between 2000 and 2002. Many major rail lines and terminals are now being upgraded to accommodate more rail traffic and container volume.

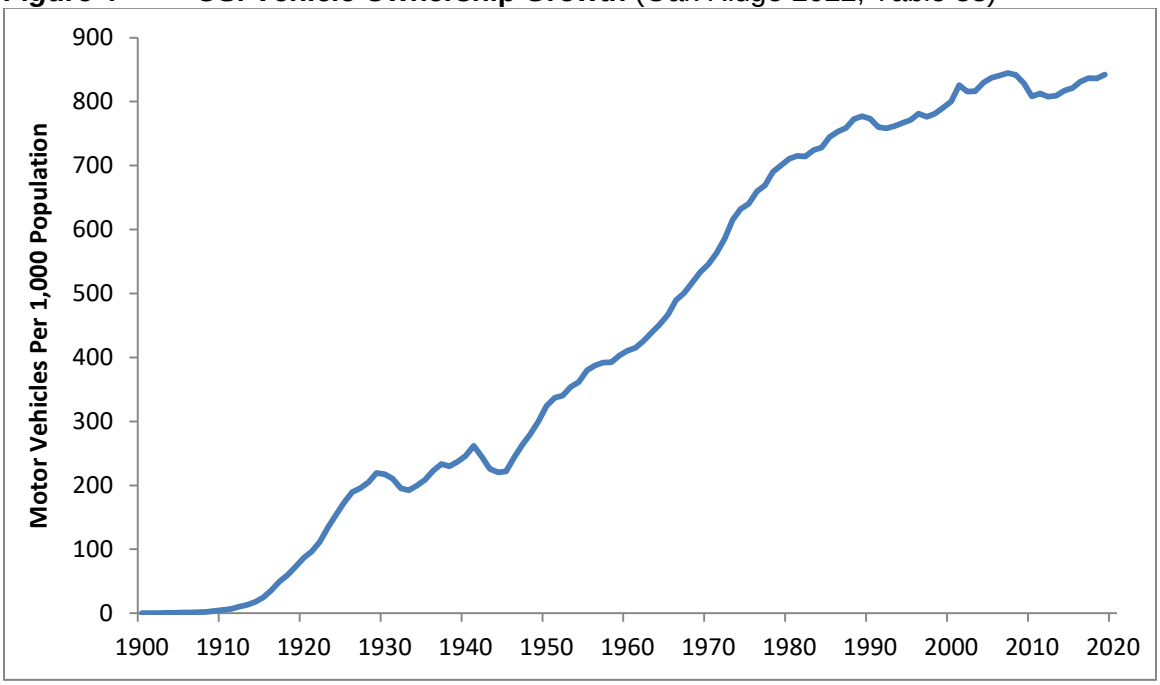
Airport and port infrastructure also expanded significantly during much of the Twentieth Century. Some expansion continues, particularly at major transfer hubs, but much of demand growth is being accommodated by incremental improvements and better management of existing facilities. Some airports and ports are inefficiently oversized.

During the first two-thirds of the Twentieth Century public transit ridership service declined due to a spiral of declining investment, service quality and ridership, but this has been reversed as many cities reinvest in transit infrastructure and implement policies that increase service quality and encourage ridership. For example, between 1995 and 2002 bus route miles increased about 20% and rail transit track mileage by about 40%.

Vehicle Ownership

In the U.S., per capita motor vehicle ownership grew during the Twentieth Century but peaked at 0.79 vehicles per capita in 2007 as illustrated in Figure 4. This is significantly higher than most peer countries.

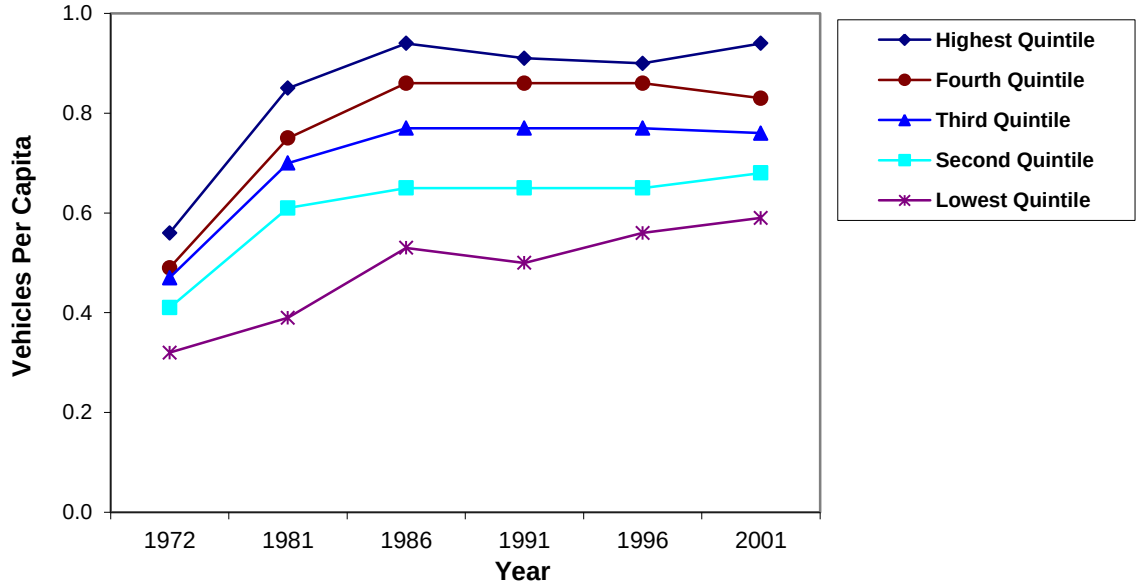
Figure 4 **US. Vehicle Ownership Growth** (Oak Ridge 2022, Table 38)



Per capita vehicle ownership grew during most of the Twentieth Century but peaked in 2007.

Figure 5 illustrates per capita automobile ownership trends by income class from 1973 to 2001.

Figure 5 **Vehicles Per Capita By Income Class** (BLS, Various Years)



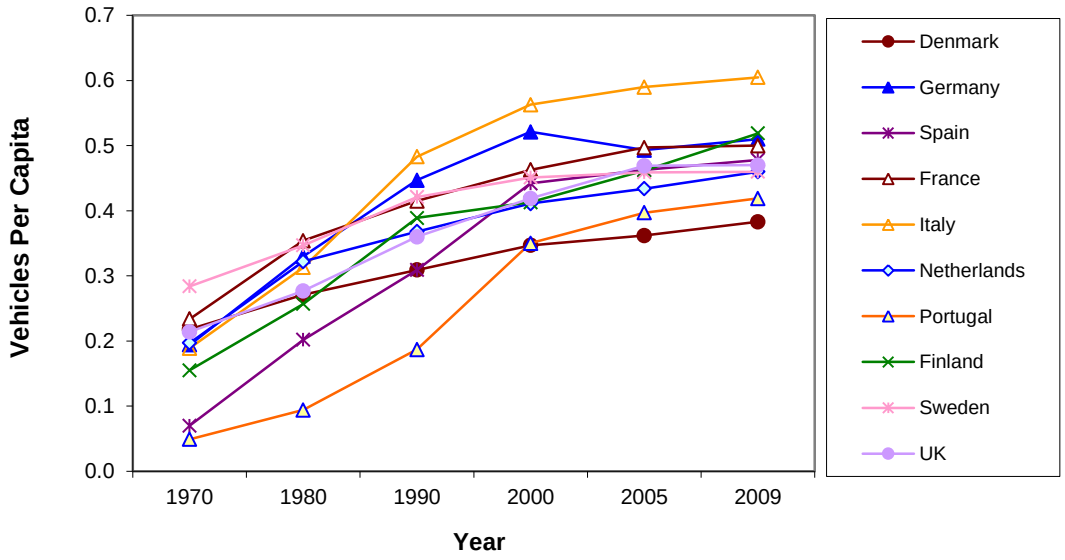
Vehicle ownership rates grew for all income classes until about 1985, but subsequently leveled off.

The period of vehicle ownership growth coincided with Baby Boomer's peak driving years, significant growth in women employment rates, rising wages, low fuel prices, cheap credit and suburbanization.[3] Most of these factors have peaked and many are now reversing. Market experts predict that demographic and economic trends will reduce the U.S. vehicle fleet size (Schwartz 2015). Rubin and Grauman (2009) explain,

> "Both vehicles per licensed driver and vehicles per household have seen steady, almost uninterrupted growth since the last OPEC oil shock nearly thirty years ago. But both are likely to deteriorate markedly over the next five years, reversing the trend growth in vehicle ownership seen over much of the post-OPEC shock period. This fundamental change in the number of vehicles on American roads will be accomplished not only in the short-run by the broad deleveraging of consumer credit, but also by the prospect of consumers paying last Memorial Day weekend gasoline prices ($4/gal) once economic growth gets back on track.

International data, illustrated in Figure 6, indicates that vehicle ownership growth rates started to decline after 1990 in most wealthy countries such as Denmark, Germany, France, Italy, Finland, Sweden and the U.K., and appear likely to level off at a point lower than the U.S. peak of 0.75 vehicles per capita. Millard-Ball and Schipper (2010) and Newman and Kenworthy (2011) found similar patterns in other industrialized countries (Australia, Canada, various European countries, and the U.S.).

Figure 6 **International Vehicle Ownership** (EC 2010)



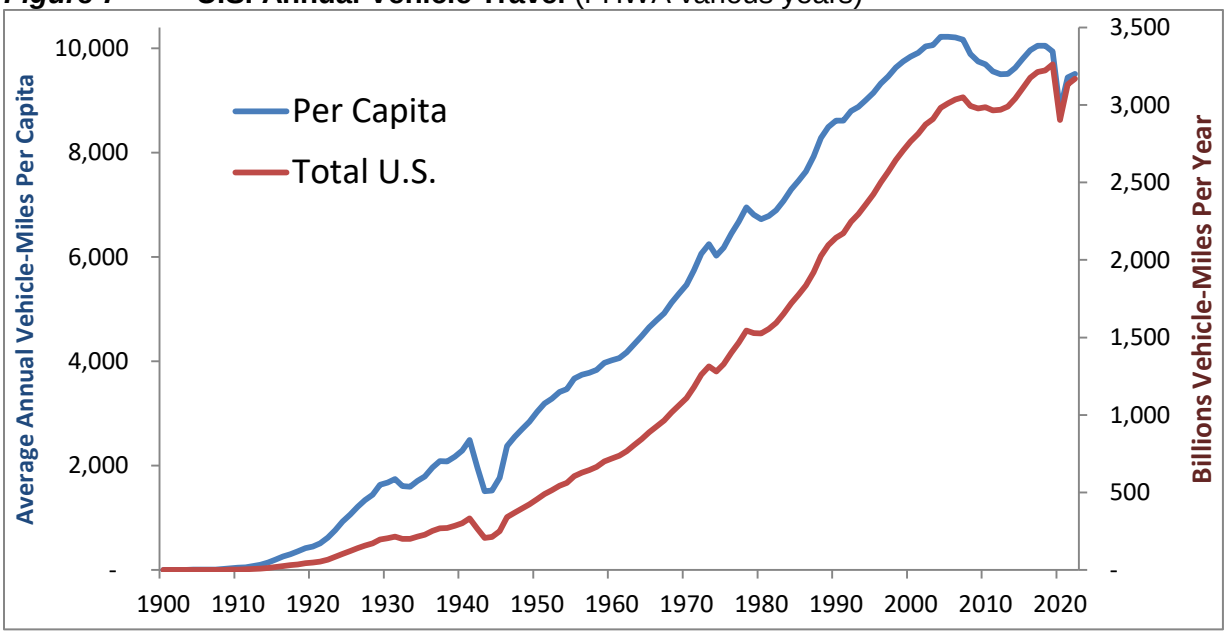
Vehicle ownership grew in most European countries between 1970 and 2000, but is peaking.

[3] For more analysis of factors that contributed to vehicle travel demand growth from the 1960s through the 1990s see National Personal Transportation Survey analysis by Pisarski (1992) and Puentes 2012.

Vehicle Travel

Motor vehicle travel grew during the Twentieth Century but peaked early in the Twenty First Century in most developed countries (DfT 2015; ITF 2013; Pyper 2012). The U.S. peaked at about 10,000 annual vehicle-miles in 2006 and subsequently declined, as illustrated in Figure 7. New Zealand and Canada peaked about the same time at lower levels (Denne and Wright 2016; Shenstone-Harris 2016). These peaks predated the 2008 fuel price spike, reflecting fundamental demand shifts (Silver 2009; Millard-Ball and Schipper 2010; Metz 2010; Sivak 2013-2018). Vehicle travel grew during 2014-2019, a period of declining fuel prices, but stayed below the peak.

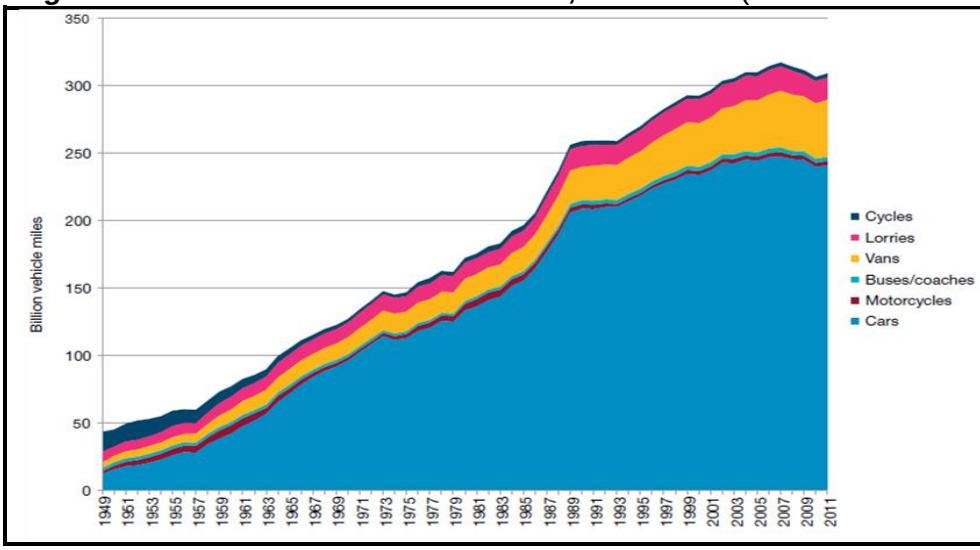
Figure 7 **U.S. Annual Vehicle Travel** (FHWA various years)



Per capita US vehicle travel grew steadily during the Twentieth Century but subsequently peaked. It has largely recovered from the Covid pandemic decline but is still significantly lower than in 2006.

Figures 9 and 10 illustrate similar patterns in Great Britain and European countries.

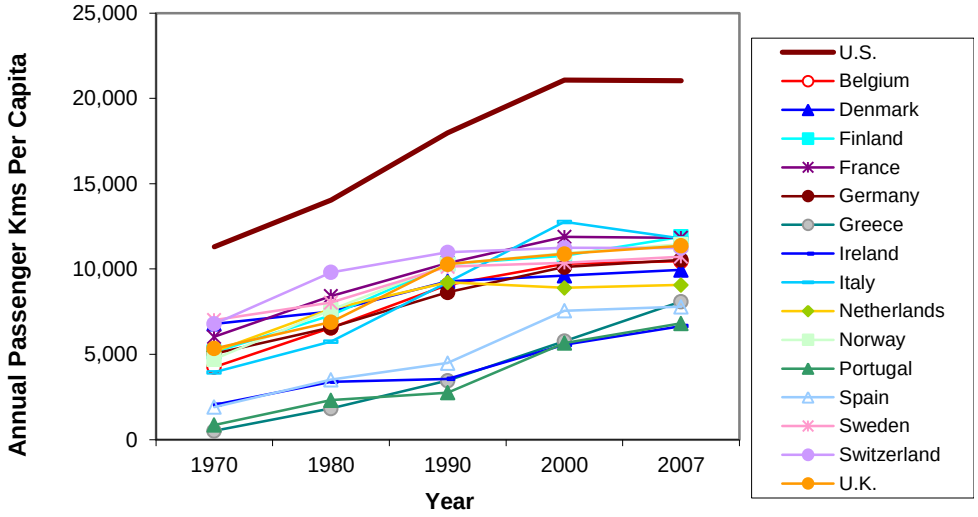
Figure 9 **Great Britain Road Traffic, 1949–2011** (Le Vine and Jones 2012)



Great Britain vehicle travel grew steadily during the Twentieth Century, but peaked in 2007.

Per capita vehicle travel has leveled off in most affluent countries and is far higher in the U.S. than elsewhere (Goodwin 2011; ITF 2013; Johnson 2021; Le Vine and Jones 2012; Metz 2010; Millard-Ball and Schipper 2010; Schwartz 2015). Current 18-24 year olds tend to own fewer cars and drive less than previous generations; although they will probably increase vehicle travel as they earn more and have more responsibilities (particularly parenting) they are unlikely to drive as much as previous cohorts (KiM 2014; Kuhnimhof, Wirtz and Manz 2012).

Figure 10 **International Vehicle Travel Trends** (EC 2007; FHWA, Various Years)[4]



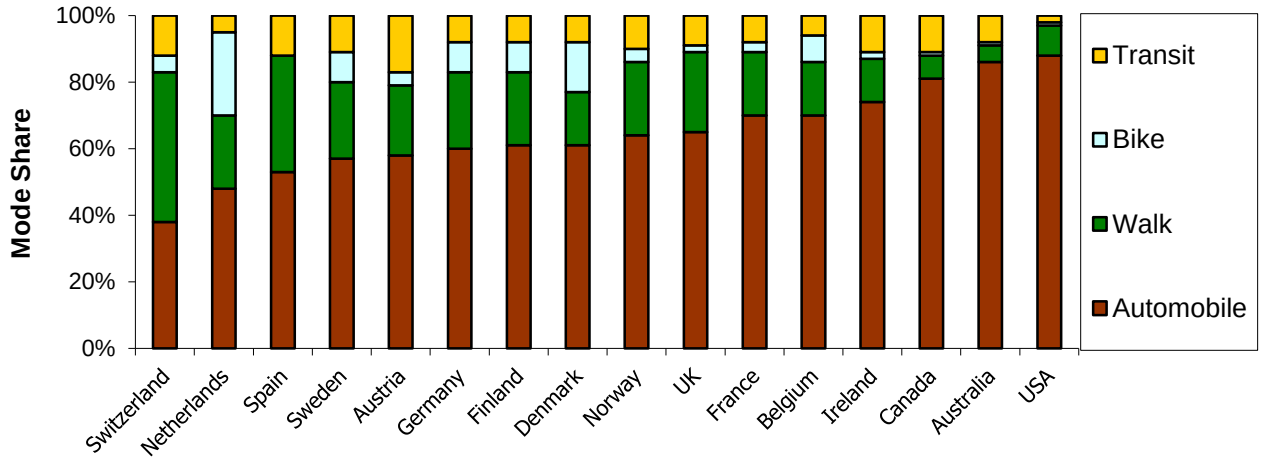
Per capita vehicle travel grew rapidly between 1970 and 1990, but subsequently leveled off and is much lower in European countries than in the U.S.

This peaking of motor vehicle travel can be partly explained by *Marchetti's Constant* which suggests that people's travel time budgets are limited (Puentes 2012, p. 12), so increases in per capita mobility during the last century can be explained by increased travel speeds. However, as described in more detail later in this report, average travel speeds peaked in the late Twentieth Century in most developed countries, and may decline due to increased congestion, while mobility substitutes that reduce the need for travel, such as telecommunications and delivery services, have improved.

International comparisons indicate that mode shares vary significantly between regions. Many wealthy countries, such as Denmark, Sweden and Switzerland, have relatively low automobile mode share, as indicated in Figure 11.

[4] U.S. passenger-kms based on FHWA vehicle-miles x 1.67 (miles to kilometers) x 1.58 (vehicle-km to passenger-kms) x 0.8 (total vehicles to passenger vehicles).

Figure 11 **Personal Travel Mode Share By Peer Countries** (Bassett, et al. 2008)

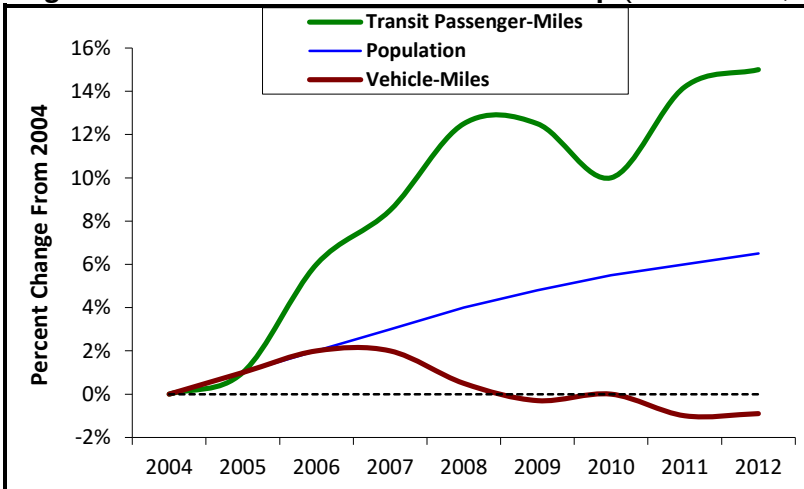


Transportation patterns vary significantly among peer countries.

These statistics tend to undercount non-motorized mode share because most travel surveys undercount short trips, non-commute trips, travel by children, and nonmotorized links of automobile and transit trips. If instead of asking, "What portion of trips only involve walking?" we ask, "What portion of trips involve some walking?" nonmotorized trips more than double (Litman 2003). Similarly, if instead of asking, "What portion of total trips are by public transit?" we ask, "What portion of peak-period trips on congested corridors are by transit?" or "What portion of residents use transit at least occasionally?" the numbers are much higher. Between 2001 and 2017 the portion of respondents who biked during the previous week increased from 7% to 12% and the portion that walked increased from 65% to 73%, indicating growing demand (NHTS 2017).

U.S. transit ridership declined during most of the Twentieth Century but increased after 1995 (Figure 12). Ridership grew more in communities that improve transit service, provide incentives and supported transit-oriented development (TRL 2004). Transit mode shares increased from a low of 1.6% of trips in 2001 to 2.9% 2017, although this trend was not evident in Census commute mode share data, indicating that most of the growth was in non-commute travel (Wang and Renne 2023). Coogan, et al. (2018) examined how various demographic, geographic and economic trends are likely to affect future transit demands, some trends are likely to increase and other to reduce ridership.

Figure 12 **U.S. Public Transit Ridership** (APTA 2013, Figure 2)

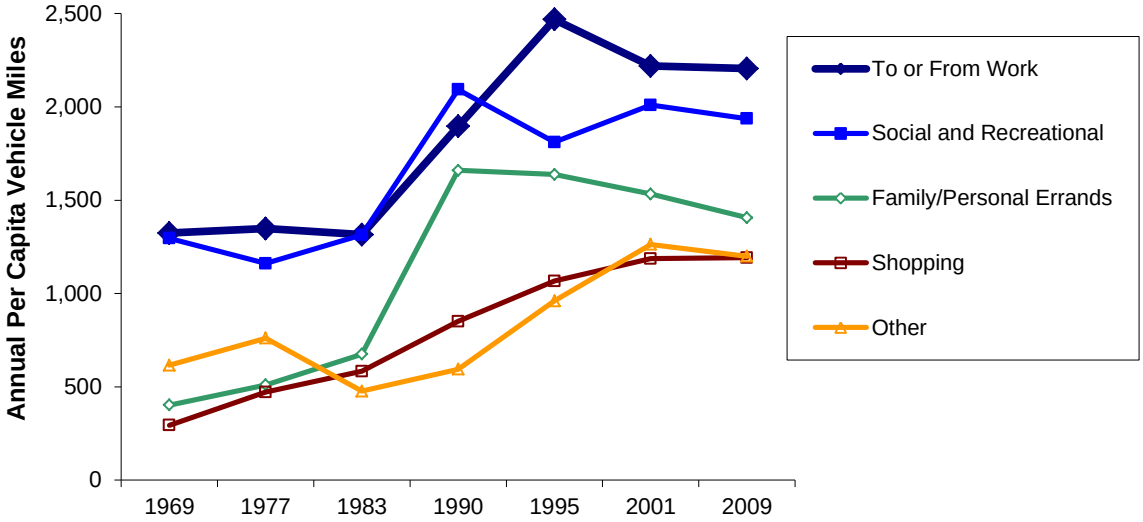


Between 2004 and 2012 the U.S. population grew 6%, transit ridership increased 14%, and motor vehicle travel declined 1%. These trends indicate that automobile travel demand is peaking, while demand for other modes is growing. Although few people want to give up driving altogether, many would prefer to drive less and rely more on walking, bicycling and public transit, provided they are convenient, comfortable and affordable.

Trip Purpose

During the Twentieth Century there were significant changes in the character of personal travel. Early in the century, most people worked, shopped and socialized close to their home. They might enjoy an occasional recreational bike ride or out-of-town train trip, but most travel was functional and local. As motor vehicle ownership grew, travel costs declined and households dispersed, people organized their lives around increased mobility. The greatest growth in motorized travel involved non-commute personal trips, including shopping, social and recreational, and family/personal errands, as indicated in Figure 13. Virtually all types of trips have peaked, and both commuting and household errand trips declined during the last decade.

Figure 13 **Vehicle Travel By Trip Purpose** (Santos, et al. 2011, Tables 2 & 6)



This figure shows per capita vehicle mileage by trip purpose.

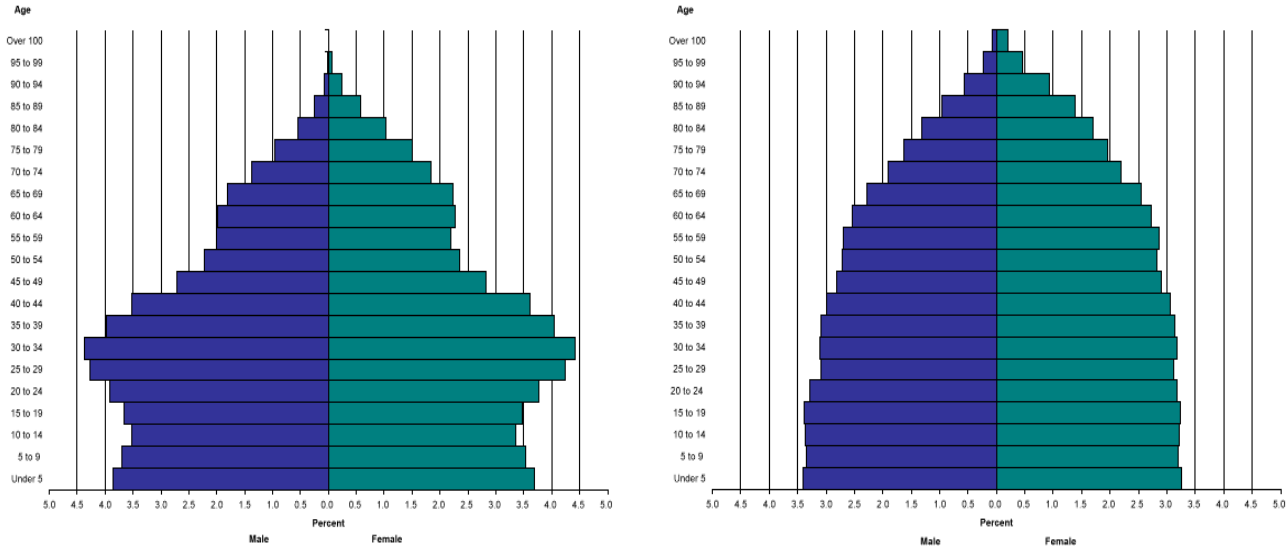
Factors Affecting Travel Demand

This section discusses demographic, geographic and economic trends that affect travel demands.

Demographics

The U.S. population is projected to grow to nearly 400 million residents by 2050, a large absolute increase but a lower growth rate than in the past. Figure 14 shows U.S. population pyramids for 1990 and 2050.

Figure 14 **U.S. Population by Age and Gender** (U.S. Census 2002)

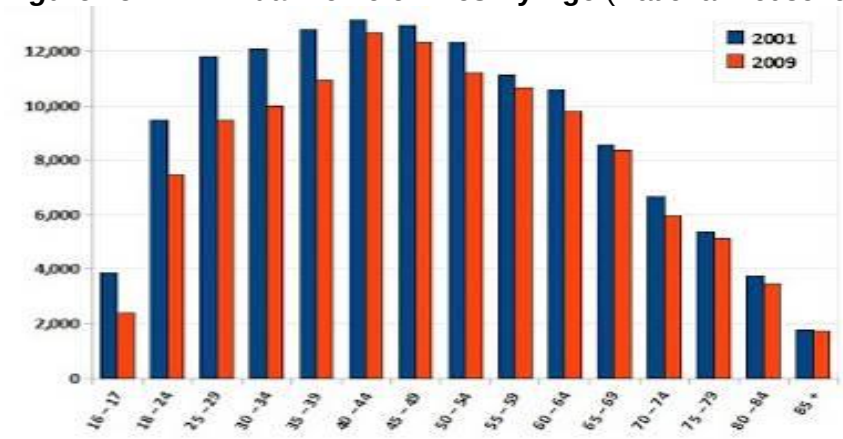


1990 **2050**

The portion of people who are retired and elderly is increasing significantly in developed countries.

Age affects travel patterns in several ways. Vehicle travel tends to increase as adolescence become adults, peaks at 30-60-years when employment and childrearing responsibilities are greatest, and then declines as people retire and age, as illustrated in Figure 15 (for British data see Le Vine and Jones 2012). The portion of households raising young children declined from about half in 1950, to about a third now and only a quarter by 2030 (Nelson 2006).

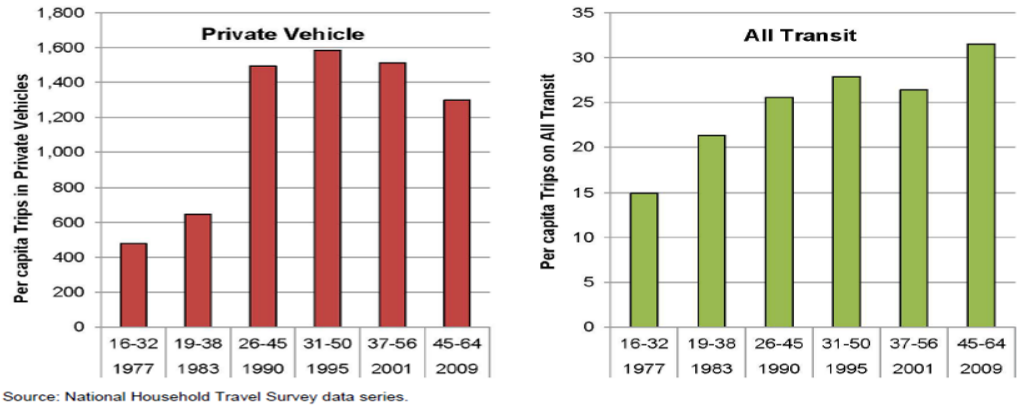
Figure 15 **Annual Vehicle Miles By Age** (National Household Travel Survey)



Annual vehicle travel tends to peak during the 30 to 60 age period, and then declines significantly.

Although Baby Boom seniors tend to drive more than seniors of previous generations, they drive much less than during their peak driving years, when they were employed and raising children, and use public transit more, as illustrated in Figure 16.

Figure 16 **Baby Boomer Annuel Vehicle Trips** (McGuckin and Lynott 2012)

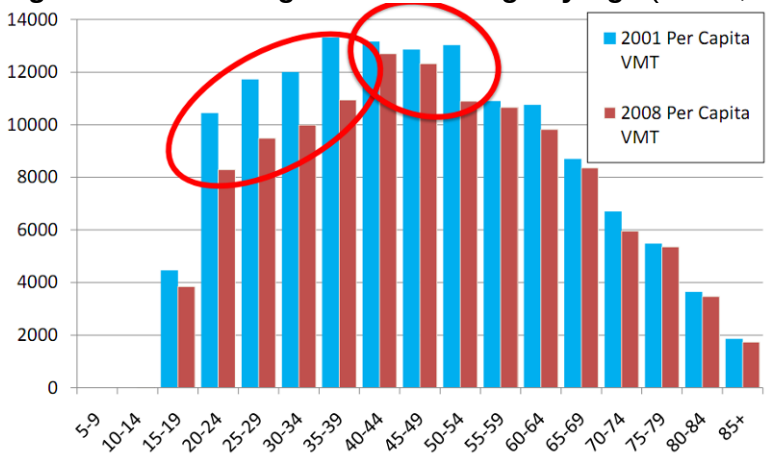


Source: National Household Travel Survey data series.

As Baby Boomers age they drive less and rely more on public transit.

There is evidence that future generations will drive less at each age level than Baby Boomers (APTA 2013; McDonald 2015; Santos, et al. 2011). Average annual vehicle miles traveled (VMT) was about 20% less in 2008 than in 2001 for under-40 age groups, as illustrated in Figure 17. Blumenberg, et al. (2012) argue that these travel behavior changes primarily reflect economic factors such as employment and income, but because travel habits tend to be durable, significant changes are likely to continue even if that generation becomes more affluent.

Figure 17 **Average Annual Mileage by Age** (Polzin, Chu and McGuckin 2011)



Annual motor vehicle travel is significantly lower for people born between after 1978 than older cohorts at the same age. This indicates intergenerational changes in consumer preferences and lifestyles. Although younger people are likely to increase their vehicle travel as they earn more and become parents, they are unlikely to drive as much as the Baby Boom generation.

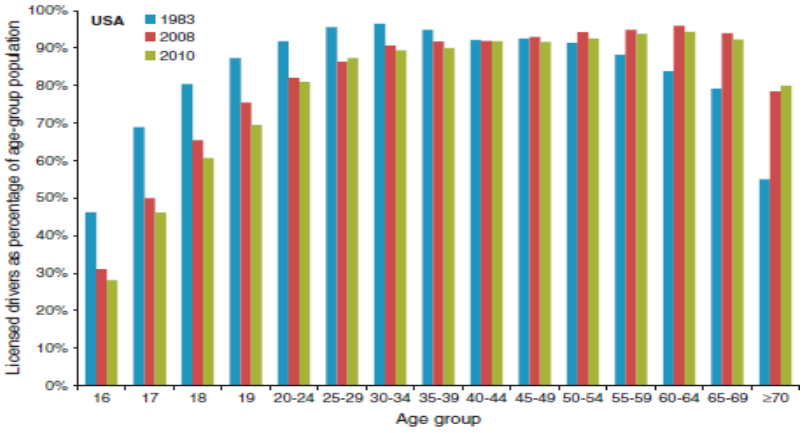
Similar trends are occurring in other developed countries (Le Vine and Jones 2012). Car ownership and travel declined, and use of other modes has increased, among German and British 20-29 year olds (Kuhnimhof, Wirtz and Manz). The younger generation appears to place less value on vehicle ownership and suburban living due a combination of high costs, improved travel options and changing preferences (Santos, et al. 2011). Sivak and Schoettle (2011) find a positive correlation between Internet use and drivers' license rates, while Blumenberg, et al. (2012) find positive relationships between telecommunications and motor vehicle travel.

Davis, Dutzik and Baxandall (2012) find that between 2001 and 2009, U.S. 16- to 34-year-olds:

- Reduced per capita vehicle-miles 23%, from 10,300 to 7,900 annual miles.
- Took 16% more walk trips and 24% more bike trips.
- Traveled 40% more annual passenger-miles on public transit.
- Reduced the share that has a driver's license from 79% to 74%.
- Have different transport and housing preferences.

The portion of young people with driver's licenses declined significantly in developed countries. In 1983, 87.3% of U.S. 19 year olds had a driver's licenses, but this declined to 69.5% in 2010, as illustrated in Figure 18. Although some non-drivers may eventually obtain licenses, their experience with multi-modal lifestyles will probably influence their future travel habits toward reduced vehicle travel.

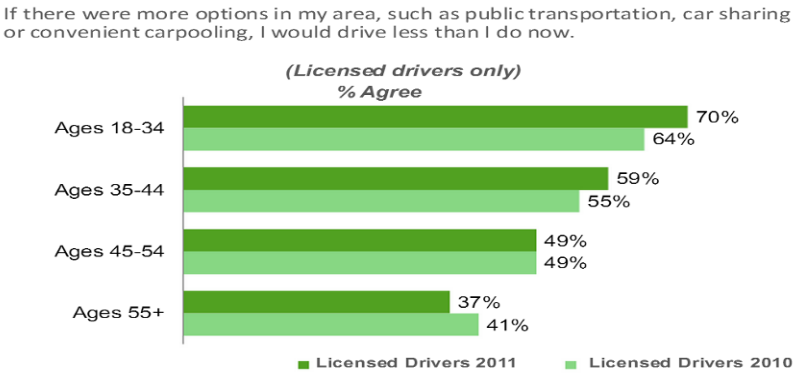
Figure 18 **Licensed Drivers Rates By Age Group** (Sivak and Schoettle 2012)



Driver's license rates are much lower for younger people now than for past generations.

A travel preference survey indicates that younger people are interested in reduced driving and relying on alternative modes than older age groups, as illustrated in Figure 19 (Zipcar 2011).

Figure 19 **Willingness to Use Alternatives by Age Group** (Zipcar 2011)

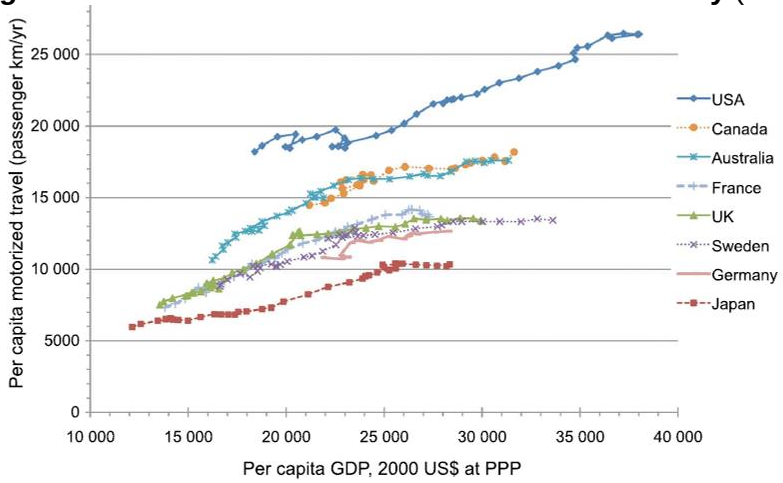


Consumer preference surveys indicate that younger people want to drive less and rely more on alternative modes than older people.

Income

Motor vehicle ownership and travel tend to increase as household incomes rise from low to moderate levels, but plateaus at high incomes (Luoma, Sivak and Zielinski 2010). Millard-Ball and Schipper (2010) find that per capita vehicle travel tends to plateau at about $25k annual GDP in most countries, excepting the U.S. which peaks at about $35k, as indicated in Figure 20. Most wealthy countries are approaching vehicle travel saturation (BITRE 2012).

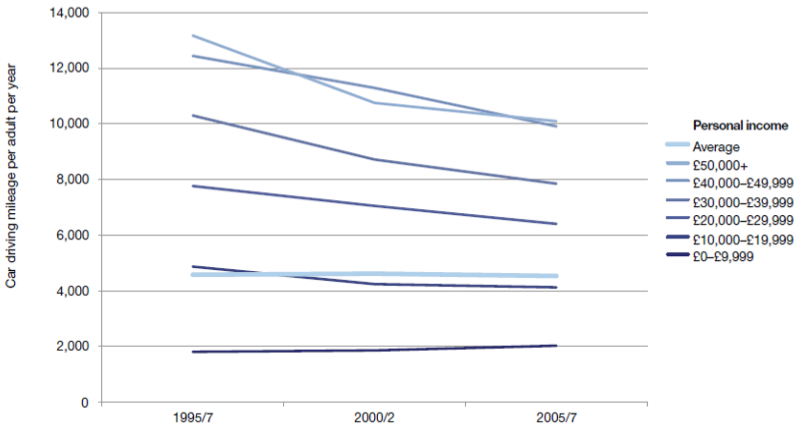
Figure 20 **Vehicle Travel and National Productivity** (Millard-Ball and Schipper 2010)



Per capita vehicle travel tends to increase with national productivity, but eventually plateaus.

Although per capita vehicle travel tends to increase with income in Britain, it declined significantly between 1995 and 2005, as illustrated in Figure 21. This probably reflects, in part, stricter limits on company car use (Le Vine and Jones 2012).

Figure 21 **British Car Mileage By Income Class** (Le Vine and Jones 2012)



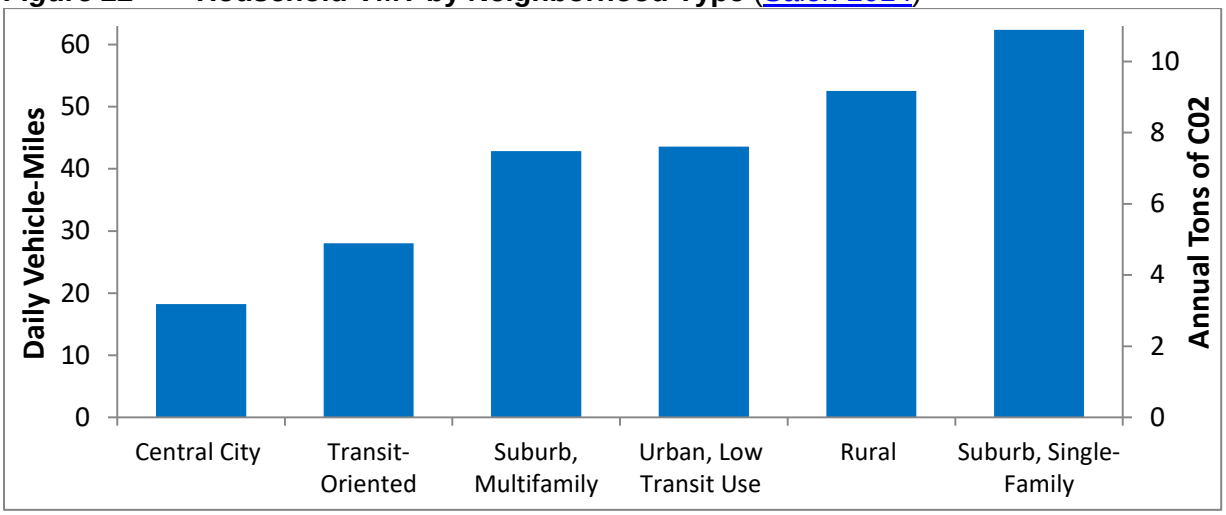
Although per capita annual vehicle travel increases with income, it declined significantly between 1995 and 2005 for higher income classes.

Air travel probably continues to increase at high incomes. Wealthier travelers tend to be less sensitive to price and more sensitive to service quality, which helps explain why public transit ridership is relatively high in some affluent cities which offer high quality but expensive public transit service (Hass-Klau and Crampton 2002; Litman 2004).

Geographic Location

Where people live and work significantly affects their travel activity (Figure 22). Residents of more compact, multi-modal urban communities tend to own fewer motor vehicles, drive less, and rely more on alternative modes than they would if located in automobile-dependent, suburban communities (Litman 2008). More compact, multimodal neighborhoods have significantly lower per capita VMT than conventional sprawl development (Anbinder 2015). Residents of multi-modal communities tend typically drive 20-40% less than they would in automobile-dependent areas (Arrington and Sloop 2010).

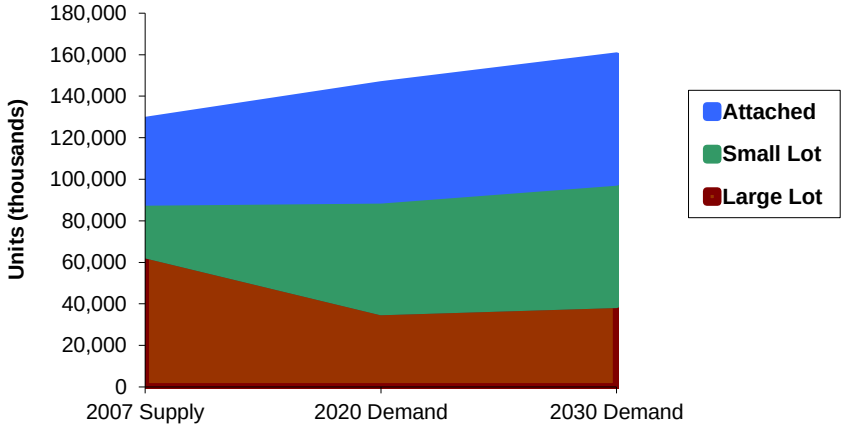
Figure 22 **Household VMT by Neighborhood Type** (Salon 2014)



All else being equal, household vehicle travel varies significantly depending on home location and type.

Demographic and economic trends, including smaller households, rising fuel prices and changing consumer preferences are increasing demand for more accessible, multi-modal locations (Litman 2009; NAR 2017). In recent years an increasing portion of population growth has occurred in existing cities, and many suburbs are becoming more compact and multi-modal (Newman and Kenworthy 2011; SGA 2012). Market surveys indicate that an growing portion of households prefer smaller-lot, urban home locations if they provide suitable travel options (good walking, cycling and public transit), local services (nearby shops, schools and parks) and other amenities (NAR 2019; ULI 2009). Real estate market studies predict that by 2030 more than two thirds are likely to prefer more compact housing types and more urban locations, as illustrated below.

Figure 23 **Demand For Housing By Type** (Nelson 2006)



Housing market analysis based on demographic trends and consumer preference surveys project that demand for large-lot housing will decline and demand for small lot and attached housing will increase during the next two decades.

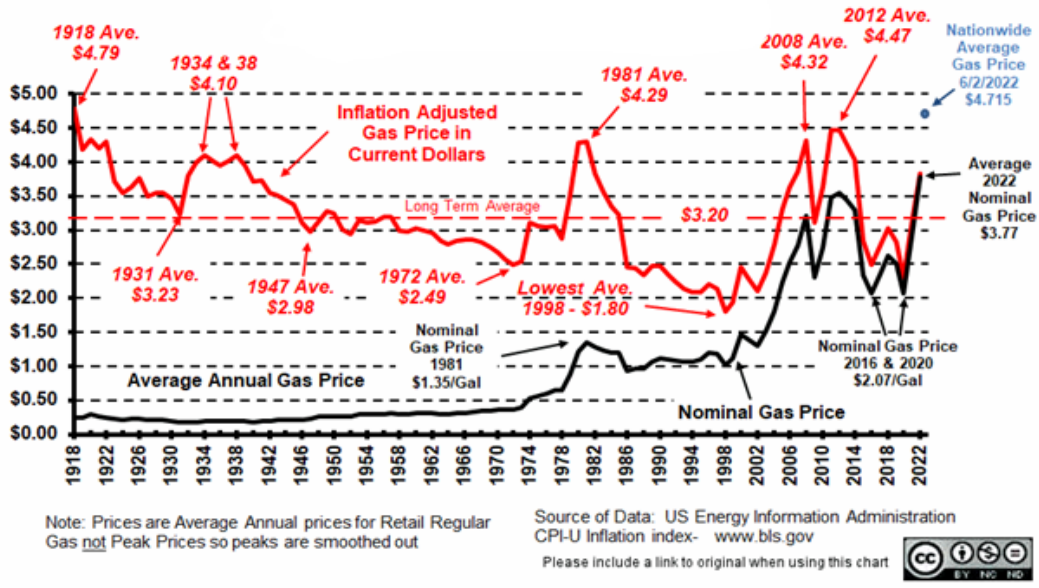
Vehicle Costs

During most of the Twentieth Century a middle-priced new vehicle generally cost 35% to 50% of average annual wages. For example, in 1914, a Ford Model T cost $220, about 40% of average annual wages. In 1953 a Plymouth Cambridge could be purchased for $1,618, about 48% of the $3,387 average annual household income. In 1967, an average new car sold for $3,212, 40% of $7,933 average income; in 1977 the average car sold for $5,814, 36% of $16,009 average income; and in 1987 the average new car sold for $13,657, 46% of $29,744 average income.[5]

However, new car prices are a poor indicator of overall vehicle affordability because lower-income households tend to purchase less expensive used vehicles, because many vehicles include costly luxury features, and because vehicle ownership includes additional expenses such as registration and licensing fees, repairs, and insurance. For many lower-income motorists, insurance costs are a larger constraint on vehicle ownership than purchase costs. Ownership trends suggest that vehicles have become more affordable over time, as indicated by rising vehicle ownership rates among the lowest income quintile from 1970 through 2000.

Real, inflation adjusted fuel prices declined during most of the Twentieth Century as illustrated below. In 1920 gasoline cost 30¢ a gallon, when wages averaged about 50¢ per hour. Fuel prices are predicted to increase during the Twenty-First Century as demand grows and production peaks (Ramsey and Hughes 2009). Although substitute fuels are available, none is likely to be as cheap or convenient as petroleum was during the mid-Twentieth Century.

Figure 25 **Average Fuel Prices** (Inflation Data, 2022)

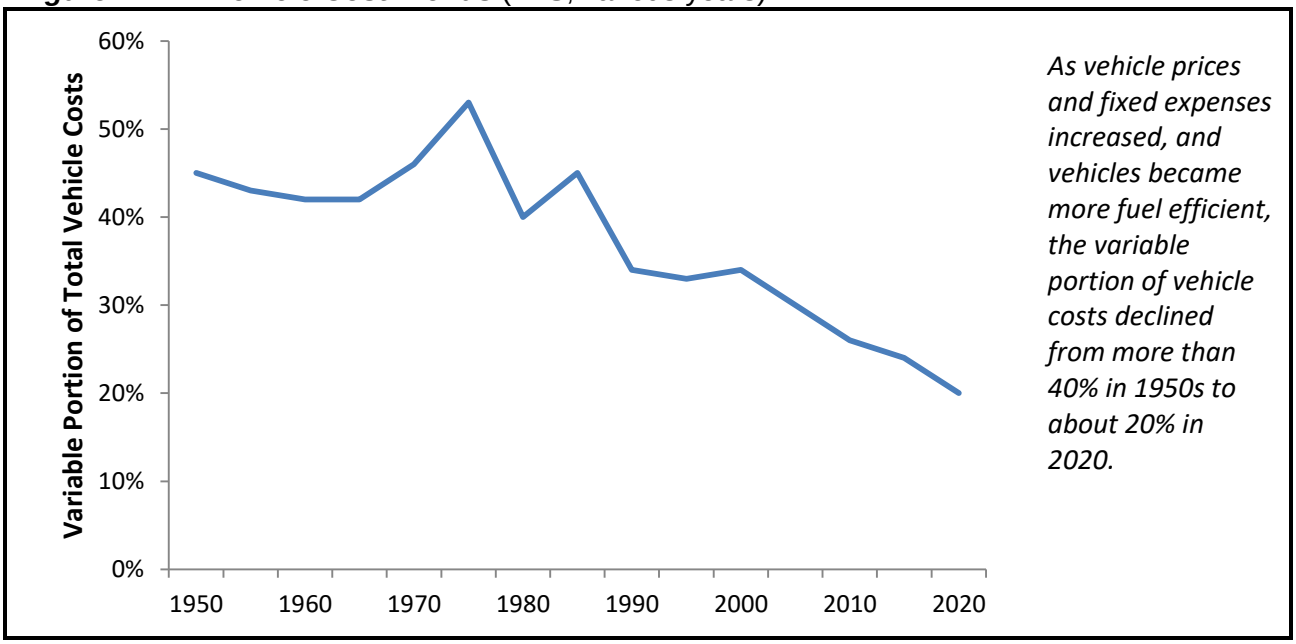


Real fuel prices declined and fuel efficiency increased during most of the Twentieth Century, but have started to increase.

[5] Model T price information from *Forbes Greatest Business Stories* (www.wiley.com/products/subject/business/forbes/ford.html). Wage information is from the U.S. Census Department (www.census.gov/hhes/income/histinc/p53.html). Plymouth prices are from (www.allpar.com/old/plymouth/plymouth-1953-54.html). Information on average new automobile retail prices relative to wages, 1967 to 1994 is in MVMA 1995, p. 60. For additional discussion of past transportation costs see the "Transportation Productivity Trends" section of Litman 2010.

Annual vehicle mileage is affected by the financial, time and discomfort costs of driving. Per-mile vehicle operating costs declined during most of the Twentieth Century, due to cheaper tires, increased vehicle reliability (and therefore less frequent repairs), increased vehicle fuel efficiency, and declining real fuel prices. Variable costs decreased relative to fixed vehicle costs, as indicated in Figure 24. This gives motorists an incentive to increase their mileage to earn a reasonable return on their fixed investment. Motorists think, "Since I spend so much on payments and insurance, I may as well drive."

Figure 24 **Vehicle Cost Trends** (BLS, various years)



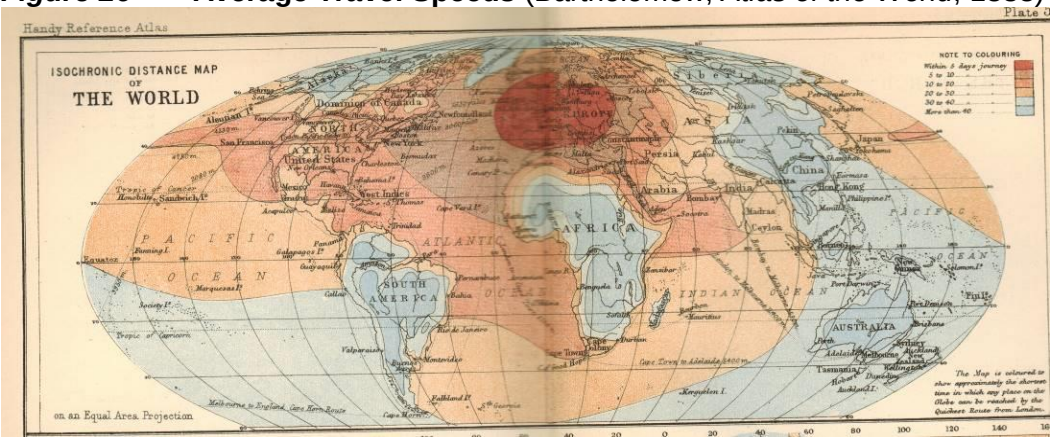
These fuel price increases will probably cause modest mileage reductions. The long-run price elasticity of vehicle fuel is –0.3 to –0.7, meaning that a 10% price increase causes consumption to decline by 3% to 7% over the long run, but about two thirds of this results from shifts to more fuel efficient vehicles and only about a third from reduced VMT ("Transport Elasticities," VTPI 2005). As fuel prices increase motorists will probably more efficient and alternative fuel vehicles.

During the Twentieth Century driving became significantly more convenient, comfortable and safer per mile of travel due to improved vehicle and road design. Incremental improvements will probably continue, with quieter operation, more comfort and safety features incorporated in lower-priced models, but future improvements will probably be modest compared with what occurred in the past.

Travel Speeds

Personal and freight travel speeds accelerated significantly during the last two centuries (Edwards 2015). Figure 26 illustrates travel time from London to world destinations in travel days (red up to 3, brown 5-10, blue more than 30). It is accurate if the units are measured in hours rather than days, indicating travel speed increased approximately 24 times.

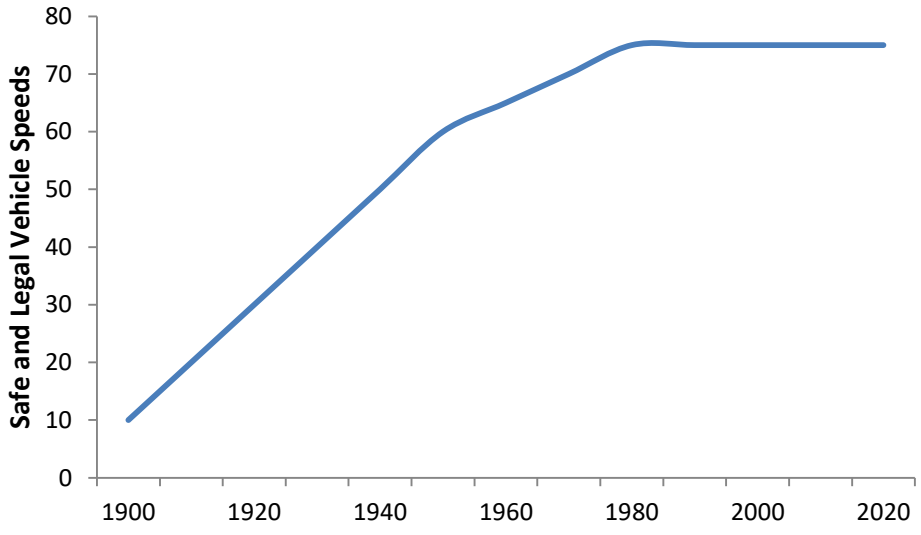
Figure 26 **Average Travel Speeds** (Bartholomew, *Atlas of the World*, 1888)



This map indicates the number of days required to reach global destinations from London in 1888. It is approximately accurate for current travel if measured in hours, indicating a 24x speed increase.

Travel speed affect mobility. People tend to devote an average of 1.2 daily hours to travel (Metz 2010; Puentes 2012), so higher speeds allow more distance within this time budget. During the last century, vehicle and roadway improvements increased travel speeds. Before 1940 few cars could exceeded 60 miles per hour (mph), and few roads were suitable for such speeds, but since the 1960s virtually all new motor vehicles can achieve legal speed limits and major highways were designed with 50-90 mph.

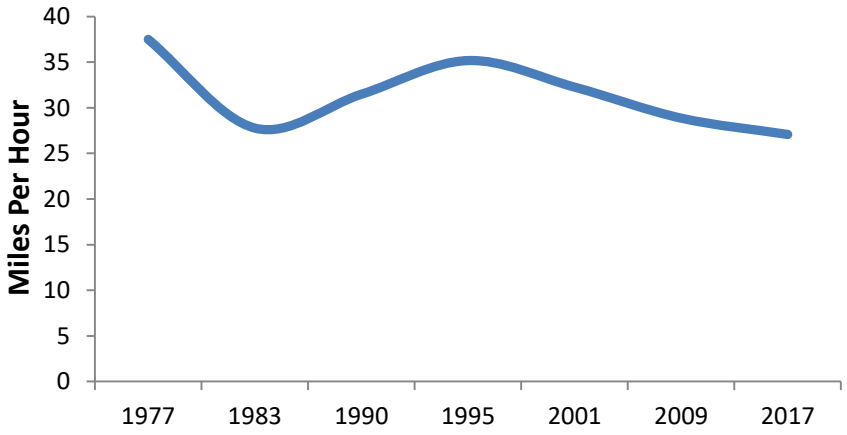
Figure 27 **Estimated Feasible Vehicle Speeds**



Maximum feasible (safe and legal) vehicle speeds increased during the Twentieth Century, from about 10 mph in 1900 up to 75 mph by the 1980s but have not increased since and many urban jurisdictions are reducing speed limits.

Interstate highway speed limits were reduced to 55 mph in the mid-1970s to conserve fuel, increased to 65 mph in 1987, and subsequently raised to 75 mph in some rural areas, but overall average travel speeds have peaked on most roads (Figure 25), and are unlikely to increase significantly in the future due to traffic congestion, improved speed enforcement, and reduced speed limits on many urban arterials to create safer multimodal streets. Average auto commute speeds peaked in 1995 at 35 miles-per-hour (mph), but subsequently declined to 29 mph in 2009 (Santos, et al, 2011, Table 27).

Figure 28 **Average Automobile Commute Speed** (NHTS 2017, Table 27)

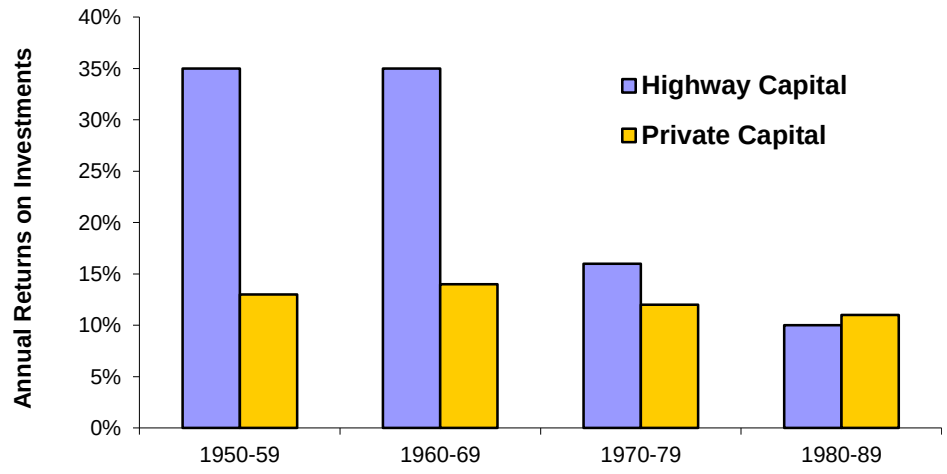


According to the U.S. National Household Travel Survey, average automobile commute speeds declined about 30% between 1970 and 2017.

Transportation Investments

During the Twentieth Century transportation the majority of transportation investments were spent on building highways. Now that the highway network is complete, additional highways provide declining marginal benefit since the most cost-effective roadway investments have already been made (Helling 1997; Goodwin and Persson 2001; Shirley and Winston 2004). During the 1950s and 60s highway investment economic returns exceeded those of private capital investments, but since the 1980s returns declined significantly (Figure 29). This indicates that shifting resources from highway expansions to improving alternative modes can provide greater economic benefits.

Figure 29 **Annual Highway Rate of Return** (Nadri and Mamuneas 1996)



Highway investments provided high economic returns during the 1950s and 60s when the U.S. Interstate was first developed, but have since declined, and are now probably below the returns on private capital, suggesting that highway expansion is generally a poor investment.

New Transportation Modes and Services

During the Twentieth Century, technological innovations significantly improved motor vehicle performance (power, speed, safety, reliability and comfort) which increased vehicle travel. Many recent innovations tend to improve non-auto modes and services. Table 2 categorizes technologies according to their vehicle travel impacts. More new technologies tend to reduce rather than increase vehicle travel. However, because they are more convenient, have lower operating costs, and can serve non-drivers, electric autonomous vehicles could significantly increase those vehicles' annual mileage, typically estimated at 10-30% (Litman 2018; Rodier, et al. 2018). To prevent this from increasing external costs, such as traffic congestion, many experts recommend policy changes to favor shared, electric, autonomous vehicles (Sperling 2017; *Shared Mobility Principles for Livable Cities*).

Table 2 **Travel Impacts of New Transport Technologies**

Increases Motorized Travel	Mixed Mobility Impacts	Reduces Motorized Travel
		Telework (electronic communication that substitutes for physical travel)
		Improved road and parking pricing
		Transit and carshare improvements
Increased fuel efficiency and cheaper alternative fuels.	Electronic vehicle navigation	Micromodes (e-bikes and e-scooters)
Increased vehicle comfort	Improved traffic signal control	Improved user information
Autonomous vehicles		Improved delivery services

Some new technologies tend to increase vehicle travel, others tend to reduce it.

My book, *New Mobilities: Smart Planning for Emerging Transportation Technologies* (Litman 2021), critically evaluates various costs and benefits of twelve emerging transportation modes. It concludes that some commonly promoted modes – sometimes called *hype mode* – such as autonomous vehicles, flying cars and pneumatic tube transport, are likely to have more limited applications, higher costs and more limited benefits than optimists predict, while new technologies that support resource efficient modes, such as e-bikes, public transit service improvements and efficient road and parking pricing, provide the greatest total benefits. Snellings and Caughey (2022) surveyed U.S. consumers concerning their attitudes are evolving toward electric vehicles, public transit, and micromobility. They found that more than half of respondents would like to buy an electric vehicle as their next car. About half predicted that public transit travel will increase in their lifetimes, and 16% of respondents reported regularly using micromobility for transportation. It identified various obstacles to their use: the largest barrier (33%) is safety concerns.

The mobility effects of some new technologies are discussed below.

Telework

Telework refers to the use of electronic communication and delivery services to substitutes for physical travel including commuting (often called telecommuting or work at home), education, e-commerce, e-medicine and e-government (van der Waard, Immers and Jorritsma 2012). The Covid-19 pandemic demonstrated the potential for telework to reduce vehicle travel if individuals, businesses and governments are motivated; in most developed countries, teleworking more than tripled. For example, 47% of employees in Australia, France and the United Kingdom teleworked at least part-time, and teleworking rates increased from 10% to 28% in Japan, although it had no national lockdowns (OECD 2021). The future potential is probably even larger as people and businesses become accustomed to teleworking technologies and activities, and incorporate it into long-term decisions.

However, by itself telework does not necessarily reduce vehicle travel since many employees use it to move to more sprawled, automobile-dependent areas, and because teleworkers often make additional errand trips that they otherwise would have performed while commuting. To maximize vehicle travel reductions, telework must be implemented with vehicle travel and sprawl-reduction incentives.

Intelligent Transportation Systems

Intelligent Transportation Systems (ITS) apply computers and electronic communication to improve transport services. Although ITS research initially focused on automated driving, which probably would increase vehicle travel, implementation of this strategy has been slow. It seems unlikely that driverless cars will become widely available during the foreseeable future. So far, ITS successes consist primarily of driver information and navigation services, transit user information, transit priority systems, and better road and parking pricing, which tend to reduce rather than increase motor vehicle travel.

Autonomous (Self-Driving) Vehicles

New technologies allow vehicles to operate automatically under some conditions, and may lead to fully autonomous (self-driving) cars in the future (Litman 2018). To the degree that they can provide independent mobility for non-drivers and increase vehicle travel convenience, comfort and affordability they are likely to increase total vehicle travel, or if implemented with incentives to share vehicles and reduce private vehicle ownership they could reduce total vehicle travel (Rodier, et al. 2018). Their overall benefits, costs and travel impacts are difficult to predict. Some benefits, such as independent mobility for affluent non-drivers, may begin in the 2020s or 2030s, but most impacts, including reduced traffic and parking congestion (and therefore road and parking facility supply requirements), independent mobility for low-income people (and therefore reduced need to subsidize transit), increased safety, energy conservation and pollution reductions, will only be significant when autonomous vehicles become common and affordable, probably in the 2040s to 2060s, and some benefits may require prohibiting human-driven vehicles on certain roadways, which could take longer.

New Modes

Some new modes could develop during the next century, such as micromodes (e-bikes and e-scooters and their variants), pneumatic tube transport (such as Hyperloop), magnetic levitation (maglev) trains, flying cars, and delivery drones, to name a few. Micromodes have the potential to approximately double travel by light two-wheelers (McQueen, MacArthur and Cherry 2020). Some new modes serve a limited portion of trips which limits their impacts. For example, even if pneumatic tube transport or maglev technologies are perfected, they are only suitable for medium-distance (30-300 mile) trips on heavy travel corridors; they may reduce some automobile and aviation trips but have little effect on other travel. Only if these services stimulate transit oriented development is overall travel likely to change, and this will result from land use changes, not the technology itself.

Alternative Fuels

Various alternatives may replace petroleum as the primary vehicle fuel, but virtually all currently being developed will be more expensive than what petroleum cost in the past, and most impose their own problems. From a motorists' perspective the primary change will be a gradual increase in costs over the century, regardless of which fuel is used.

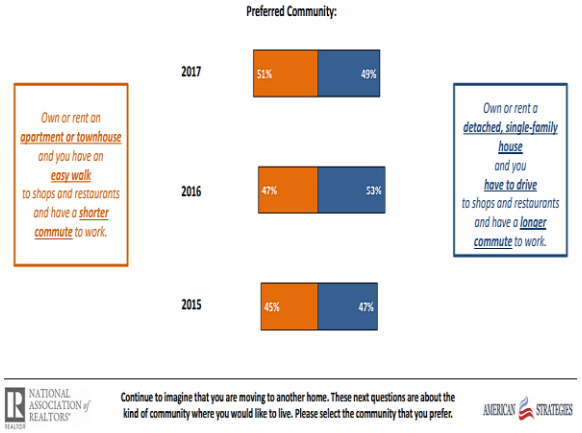
Consumer Preferences

For many people, automobile travel is more than just a mode of travel, it is also a symbol of success and freedom. Due to its status value, many consumers own more vehicles, purchase more expensive vehicles, drive more, and avoid using alternatives than is rational.

As described earlier, travel data and consumer preference surveys indicate significant differences in attitude and behavior between older and younger generations (McGuckin and Lynott 2012; Pearce 2011). Baby Boomers grew up during the period of automobile ascendency, when vehicle and roadway improvements provided direct user benefits, and problems associated with automobile dependency (congestion, isolation, pollution) were less visible. Subsequent generations tend to have significantly lower driver's licensure rates, drive fewer annual vehicle miles, rely more on non-auto modes, and prefer living in more compact, multi-modal urban environments (Davis, Dutzik and Baxandall 2012; Schmidt 2018). Younger people tend to place more value on communication technologies, such as mobile telephones, computers and Internet access, than cars (Sivak and Schoettle 2012; Hymas 2011).

During the Twentieth Century, walking, bicycling and public transit were stigmatized, but in recent years they have become more socially acceptable. Active modes are promoted as healthy and enjoyable activities, and transit travel is increasingly accepted in many cities. Similarly, urban living has become more convenient, secure and socially acceptable, attracting more households to live in more accessible, multi-modal neighborhoods where walking, cycling and public transit are common forms of travel (Litman 2009; Nelson 2006). Housing location preference surveys indicate a growing preference for living in accessible, multimodal neighborhoods (Burda 2014; NAR 2017). Although most respondents indicate that given unlimited resourced they prefer detached, single-family housing, if forced to choose, a growing majority would prefer to live in an apartment or townhouse located in a walkable urban neighborhood with a shorter commute over a single-family home in an area where residents must drive to shops and restaurants and have longer commutes, as illustrated below.

Figure 30 **Housing Location Preferences** (NAR 2017)



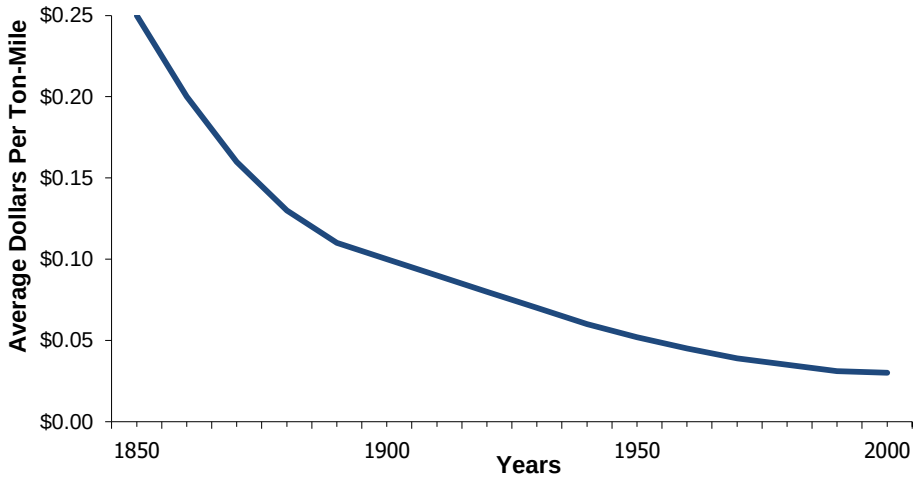
National Association of Realtor's "National Community and Transportation Preference Survey" indicates a growing preference for living in walkable urban neighborhoods even if that requires attached housing (apartment or townhouse). This and other evidence indicate growing consumer preferences for less automobile-oriented lifestyles.

Consumer preferences can be difficult to measure and these trends are not universal. Certainly, many young people love their cars and are reluctant to use alternative modes, and some young people who currently drive little will probably drive more as they become more economically successful and have children. However, available evidence indicates that consumer preferences are changing in ways that support more urban, multi-modal lifestyles, particularly for younger people, which is likely to reduce automobile travel demand and increase demand for alternative modes.

Freight Transport

Freight transport volumes grew significantly during the Twentieth Century due to declining shipping costs, increased trade and industrial growth (Glaeser and Kohlhase 2003). At the start of the century freight was transported by horse-drawn wagon, railroad and sail or steam ships, which is expensive, slow and unreliable. Containerization, intermodalism, deregulation, and various technical and logistical improvements significantly reduced costs and increased speeds. Unit costs declined by orders of magnitude (Figure 31). Although information technologies are expected to automate and optimize freight transport, future cost reductions will probably be more modest, and may be offset by increased fuel prices, particularly for truck transport.

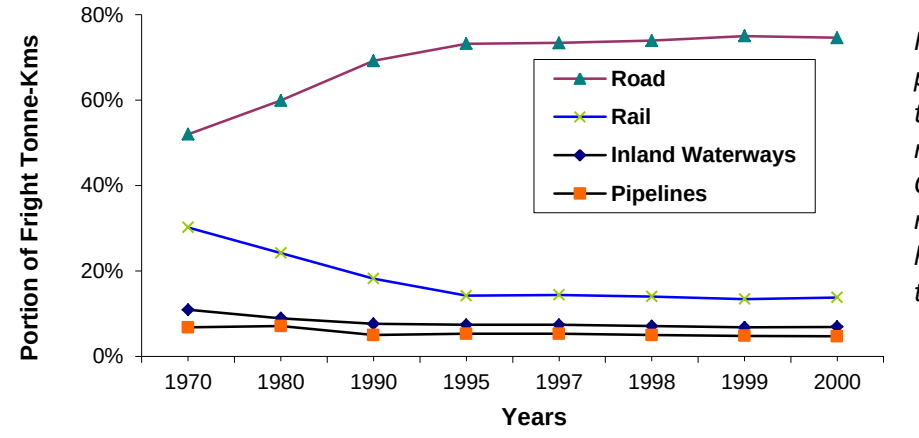
Figure 31 **Railroad Freight Costs** (Garrison and Levinson 2006, p. 290)



Shipping costs per ton-mile declined significantly during the last 150 years.

Truck transport grew as a portion of total freight during most of the Twentieth Century, but this leveled off and declined a little toward the end of the Century, as containerization and improved intermodalism made rail and marine transport more competitive, as illustrated in Figure 32. Freight volumes are likely to continue growing on major international routes, but other corridors are likely to experience little or negative growth.

Figure 32 **European Freight Mode Share** (EC 2002, Table 3.4.3)



Road transport grew as a portion of total freight tonne-kilometers during most of the Twentieth Century, but the growth rate has leveled off and has recently declined due to more intermodalism.

Trend Summary

The Twentieth Century was a period of tremendous growth in motor vehicle travel. During this period motor vehicle travel generalized costs (time and money) declined by an order of magnitude, resulting in order of magnitude increases in personal and freight transport. In 1900 most people lived and worked on farms and a typical urban commute was a one-mile walk or a three-mile trolley ride. In the 1920s and 30s only wealthy people could afford daily automobile commuting. Now, most people drive ten to twenty miles to commute, and even more for other types of trips. Many of the factors that contributed to vehicle travel growth are changing, as summarized in Table 3. It is unlikely that per capita vehicle ownership, automobile mode share, vehicle travel affordability, or vehicle traffic speeds will increase significantly in the future.

Table 3 **Factors Affecting Future Vehicle Travel Demands**

Factor	Impacts on Travel Demands
Demographics	Significant declines likely due to population retiring and aging, and fewer households with children.
Income	Mixed. Increased mileage likely among groups that shift from low- to medium-income, but little growth likely among middle- and higher-income groups.
Geography	Declines likely as more households locate in more compact, multi-modal areas.
Operating costs	Moderate declines likely due to rising fuel prices and possibly more road tolls.
Travel speeds	No change expected – average travel speeds will probably be similar in the future.
Transport options	Declines possible due to improvements to alternative modes, depending on transport policy and planning practices.
New technologies	Declines possible from improved non-auto modes (particularly micromodes, telework and public transit improvements), and traffic management (better road and parking pricing systems allow more deployment of user fees), if implemented with vehicle travel and sprawl reduction policies.
Consumer preferences	Some declines likely due to increased preference for alternative modes, urban living and walkable communities.
Health concerns	Increased demand for walking and cycling, for both transport and recreation.
Environmental concerns	Some declines likely due to energy conservation and emission reduction programs.
Freight transport	Further growth concentrated on high volume corridors.

This table summarized various factors expected to affect future vehicle travel.

This analysis indicates that in higher-income countries, reductions in per capita vehicle travel should approximately offset population growth for the next few decades, resulting in little or no growth in total vehicle travel demands. Automobile travel demand will probably grow in some areas and among some demographic groups, particularly those transitioning from low- to middle-incomes (Luoma, Sivak and Zielinski 2010), but will decline among other groups, such as aging Baby Boomers and residents of communities that implement mobility management and smart growth policies.

Official Predictions

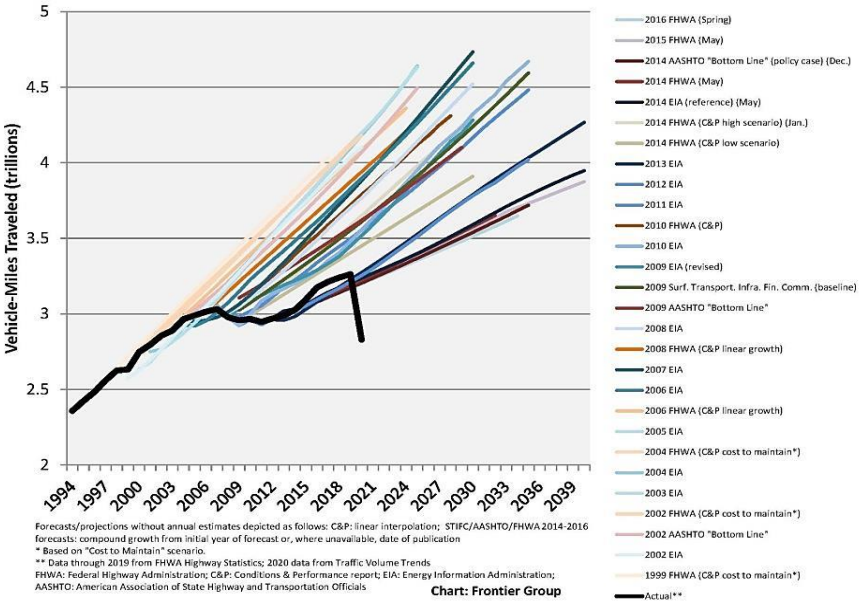
Various organizations publish long-term travel projections for policy and planning analysis. Such projections are often little more than extrapolations of past trends with little consideration of demographic or economic factors that may affect future travel demands. These models assume that recent vehicle travel declines are temporary, caused by recent fuel price spikes and the global financial crisis, so in the near future VMT will grow at similar rates as in the past. Such projections are proving to be inaccurate, yet the models are often not corrected to reflect underlying factors that affect travel demands.

As described by analyst Clark Williams-Derry (2012) in, *How Not To Forecast Traffic: How A Washington State Transportation Council Misuses Statistics*,

> "Running a linear regression, with no other information for context, is a nonsensical way to make a forecast of the future. Instead, a *real* estimate of future traffic would look at macro-economic forecasts, land use projections, future gas prices and fleet mpg, population growth, population age structure, recent trends by age and demographic groups, and a host of other factors. Even with all of that baked in, of course, a forecast will almost certainly be wrong; very few predictions, even the most sophisticated and thoughtful, hit their mark."

Although per capita vehicle travel peaked in 2004 and subsequently declined, many transportation agencies continue to forecast growth, based on older trends, as illustrated below. This helps create self-fulfilling prophecies as they expand roadways in anticipation of future needs.

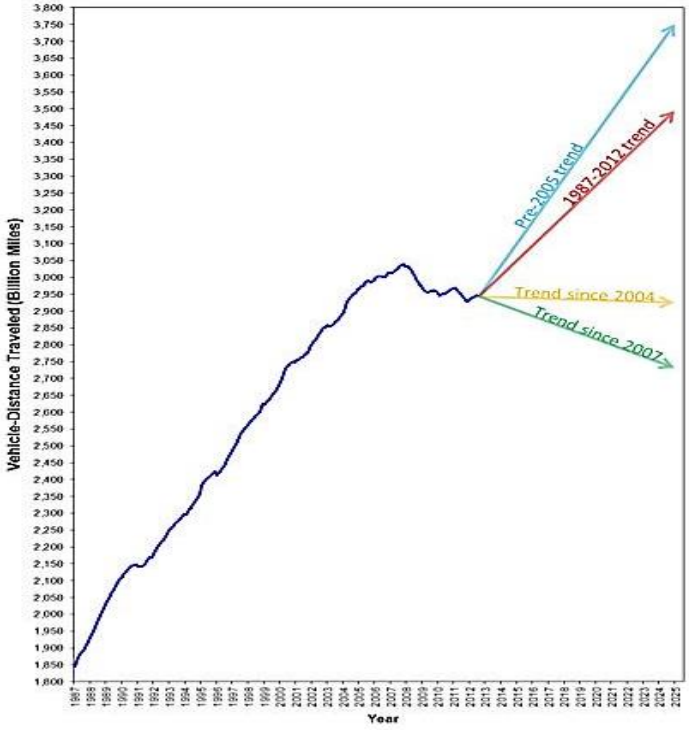
Figure 33 **Actual Versus Projected Traffic** (Dutzik 2021)



Although per capita vehicle travel peaked in 2004, and total vehicle travel has increased less than population growth, transportation agencies continue to constant growth.

These predictions depend on which time periods are used for analysis, as illustrated in Figure 34. Analysis based on pre-2005 trends show high growth rates, based on the 1987-2012 period shows moderate growth rates, based on 2004-2012 shows no change, and based on 2007-2012 shows declining trends.

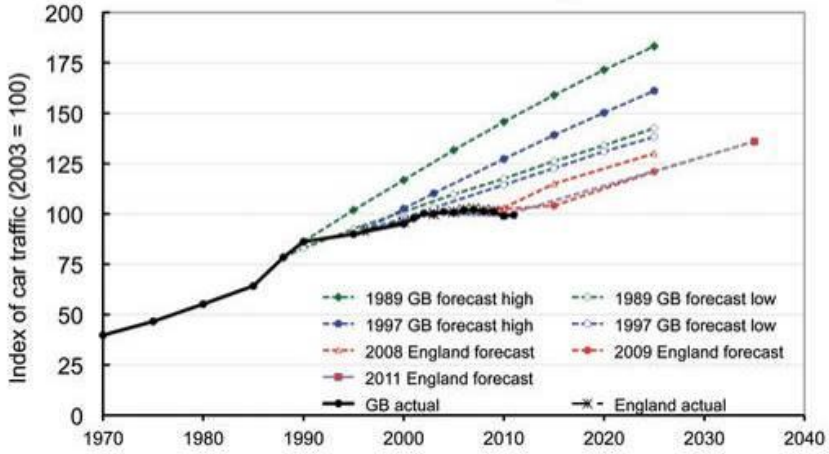
Figure 34 **U.S. Vehicle Miles Traveled** (Baxandall 2012)



Travel projections based on pre-2005 trends show high growth rates. Based on the 1987-2012 period show moderate growth rates. Based on 2004-2012 shows no change. Based on 2007-2012 shows declining trends.

Forecasters in other countries face similar challenges. For example, after 1990 Great Britain vehicle travel growth rates slowed, peaked in 2007, and subsequently declined slightly, yet official forecasts continue to predict growth based on pre-1990 rates as illustrated below.

Figure 35 **British Travel Forecasts and Actual Traffic Growth** (Goodwin 2012)



Great Britain (GB) vehicle travel growth rates slowed after 1990, peaked in 2007, and subsequently declined, but official travel forecasts continued to predict steady growth based on pre-1990 trends.

Studies for the National Surface Transportation Policy and Revenue Study Commission (NSTPRSC 2007) predicted that continued growth in GDP, household income and suburbanization, in conjunction with relatively low fuel prices will result in 2.3% annual VMT growth. However, the analysis was speculative and did not account for many of the factors discussed in this report, including declining demand by younger people, rising long-term fuel prices, and increasing urbanization.

Changing Community Demands

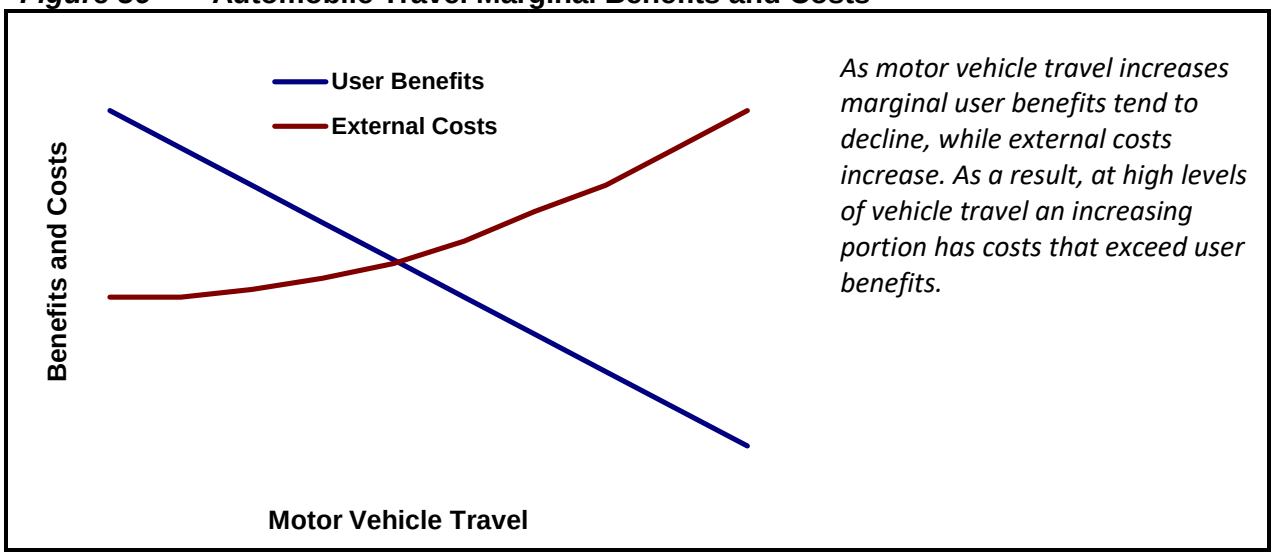
In addition to the changes in consumer travel demands there are changes in the types of transport systems considered optimal from a community's perspective.

Automobile-oriented transport planning was justified when vehicle travel demand was growing, the road network was underdeveloped, and there were economies of scale in vehicle and road production (McShane 1994). During that period, policies that stimulated vehicle travel tended to reduce unit costs (the costs to you of purchasing vehicles and the unit costs of developing roadway networks declined as your neighbors purchased more vehicles and drove more miles). There was little risk of overbuilding since any excess capacity would eventually be used. For example, in 1960 planners might assume that if a roadway's current traffic volumes required four traffic lanes, it would be prudent to build six lanes in anticipation of future growth.

During the growth period, automobile-oriented planning received broad public support. People who grew up between 1900 and 1970 personally experienced the benefits of expanding and improving automobile travel. During that period each new model year provided significant performance, efficiency and safety improvements, and new highways helped expand people's economic and social opportunities. Driving was considered exciting and fun.

However, like most goods, automobile travel experiences declining marginal benefits: as vehicle travel increases the incremental benefits decline for the simple reason that travellers are smart enough to choose higher value vehicle-miles before lower value vehicle-miles. Automobile travel imposes significant external costs, including infrastructure costs, traffic and parking congestion, crash risk, and pollution damages. The figure below illustrates vehicle travel marginal benefit and cost curves. As per capita motor vehicle travel increases and a community becomes automobile dependent, an increasing portion of vehicle travel has costs that exceed benefits. This is economically inefficient and inequitable. As a result of declining marginal benefits, increasing external costs, and growing demand by residents for alternative modes, communities increasingly favor more diverse and efficient transport systems.

Figure 36 **Automobile Travel Marginal Benefits and Costs**



As motor vehicle travel increases marginal user benefits tend to decline, while external costs increase. As a result, at high levels of vehicle travel an increasing portion has costs that exceed user benefits.

Implications For Planning

This analysis concerns travel *demands*, which refers to the amount and type of travel people would choose in particular conditions considering factors such as available transport options and prices. Changes in travel *demands* do not necessarily translate into changes in travel *behavior* without supportive planning. For example, rising fuel prices and increasing health concerns might motivate more people to walk and bicycle rather than drive for local trips, but they will only do so with suitable infrastructure such as better sidewalks, crosswalks, bike lanes and bike parking. As a result of these changing demands, traffic congestion problems will be less severe, roadway expansion benefits will be smaller, pricing reforms will have greater impacts on travel, and potential road toll revenues will be smaller than most models predict (Prozzi, et al. 2009).

Various transport policy and planning reforms are needed to respond to these changing demands (Boarnet 2013). This includes more comprehensive and multi-modal planning, less emphasis on roadway expansion and more implementation of transportation demand management solutions. This represent a *paradigm shift*, a fundamental change in the way a problem is defined and solutions evaluated. Table 4 compares the old and new planning paradigms.

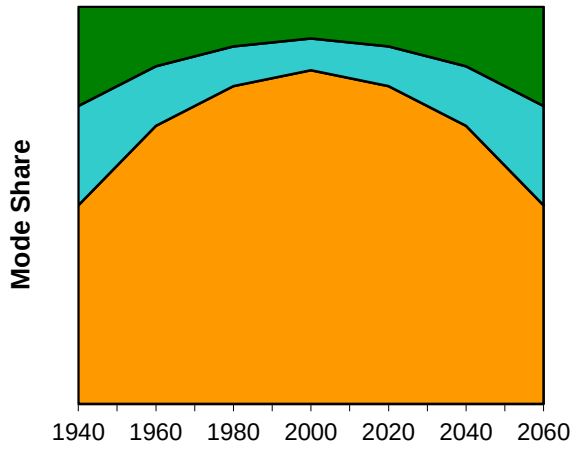
Table 4 **Old and New Planning Paradigms** (Litman 2012)

	Old Paradigm	New Paradigm
Definition of transportation	*Mobility* – physical travel (primarily motor vehicle travel)	*Accessibility* – peoples' ability to reach desired services and activities
Transport planning goal	Maximize travel speeds	Maximize overall accessibility
Transport system performance indicators	Roadway level-of-service (LOS), average traffic speed, congestion delay	Multi-modal LOS, time and money required by various people to access services and activities
Transport affordability analysis	Focuses on minimizing vehicle costs (fuel, parking and insurance), and transit fares	Minimizes total transport costs by supporting affordable modes (walking, cycling, carsharing and public transit) and affordable-accessible housing
Analysis methods	Focuses on quantitative factors such as speed	Considers qualitative factors such as convenience and comfort
Modes considered	Primarily automobile	Multiple modes (walking, cycling, public transport, carsharing, telework, etc.)
Solutions favored	Roadway expansion whenever possible	Transport demand management whenever justified
Consideration of land use	Supports sprawl	Supports smart growth policies that increase land use accessibility
Transport funding	Dedicated funds for roads and parking facilities	Least cost planning allocates funds to the most cost-effective and beneficial option

Conventional transport planning focuses on motor vehicle travel and so favors roadway design that maximizes vehicle traffic volumes and speeds. Accessibility-based planning recognizes other factors that affect accessibility and so justifies a wider range of transport system improvements.

Because there is uncertainty concerning future travel demands, the new planning paradigm should support diverse and flexible solutions, such as implementation of transportation demand management strategies instead of roadway expansion to address traffic congestion. The following figures illustrate mode share trends implied by this analysis. During the Twentieth Century automobile mode share increased, while walking, cycling and public transit mode share declined. These trends have started to reverse. Further growth in non-auto modes is likely due to the factors discussed in this report.

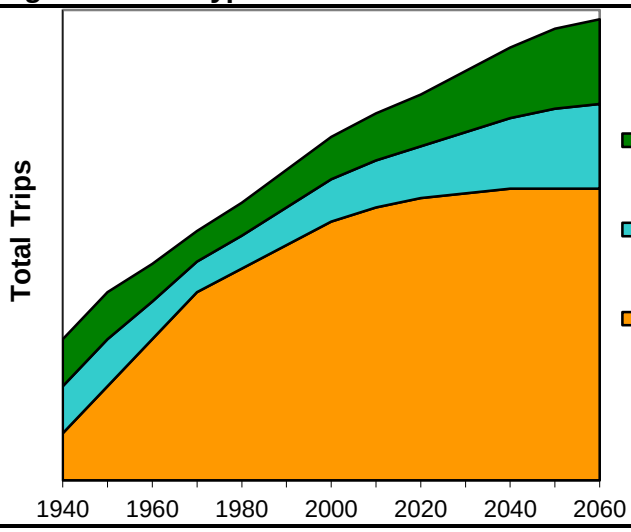
Figure 37 **Typical Mode Share Trends**



This graph illustrates typical mode share trends. The portion of total trips by automobile increased steadily during the Qlast century but this peaked about the year 2000. Use of alternative modes is likely to increase in the future due to various factors described in this report.

automobiles are likely to continue to be the dominant mode into the foreseeable future, demand for other modes is likely to grow. For example, if automobile currently has 90% mode share, a 10-point shift to alternative modes reduces automobile travel 9% but doubles use of alternatives. Many communities have underinvested in alternative modes. This suggests that large investments in alternative modes are justified to meet future demands.

Figure 38 **Typical Travel Growth Trends**



Automobile travel grew steadily during the Twentieth Century, but growth rates are declining. Although total motor vehicle travel is likely to increase somewhat in the future due to population and economic growth, the rate of increase is expected to decline and eventually stop due to various factors described in this report. Travel by alternative modes is likely to increase.

These changes are justified in developing as well as developed countries (Madre, et al. 2012). By learning from the mistakes made in developed countries they can avoid the problems that result from excessively automobile-dependent transport planning and create more efficient transport systems.

Benefits of Responding to Changing Travel Demands

Planning reforms that respond to these changing demands can provide various direct and indirect benefits. In most developed countries it is possible to drive from most origins to most destinations with reasonable convenience, comfort and safety, although traffic speeds may be reduced by congestion under urban-peak conditions. In contrast, it is often difficult to travel without a car due to poor walking and cycling conditions and inadequate and public transit services, due in part to transport planning practices that favor automobile-oriented improvements over other types of transport improvements. To the degree there is latent demand for walking, bicycling and public transport, improving these travel options supports consumer sovereignty: it allows transport system users to choose the travel options that best meet their needs and preferences. This directly benefits consumers.

Under optimal conditions, walking, bicycling, public transit and telework are less stressful (Legrain, Eluru and El-Geneidy 2015), are more affordable and impose lower external costs than automobile travel, planning reforms that allow travelers to shift from automobile to alternative modes tend to provide benefits. Even people who never use these modes benefit from reduced traffic congestion, road and parking subsidy costs, accident risk and air pollution. Since physically, economically and socially disadvantaged people tend to rely on these modes, improving them helps achieve social equity objectives.

Table 5 lists these benefits. Conventional planning tends to overlook and undervalue many of these impacts, and so tends to undervalue improvements to alternative modes. For example, commonly-used transport project economic evaluation models, which evaluate transport system performance based primarily on motor vehicle travel speeds, recognize the benefits of alternative mode improvements if that will reduce traffic congestion and vehicle operating costs, but overlooks the potential value of vehicle ownership cost savings (if improvement to alternative modes reduce household vehicle ownership requirements), parking cost savings, health benefits from more physical activity, or many environmental benefits. Conventional evaluation assumes that travelers always prefer faster options, and so places no value on transport system improvements that provide qualitative benefits such as improved convenience, comfort and enjoyment, for example, by being able to walk or bicycle rather than drive. New evaluation tools are needed to measure some of these benefits.

Table 5 **Benefits of Responding to Changing Demands**

Direct User Benefits	External Community Benefits
	Congestion reduction
	Road and parking facility cost savings
	Reduced accident risk imposed on other road users
	Energy conservation
Financial savings	Air, noise and air pollution emission reductions
Reduced chauffeuring burdens to drivers	Supports strategic land use development objectives (reduced sprawl)
Health (from increased physical activity and fitness)	Improved opportunities for disadvantaged people
Enjoyment	

Serving the latent demand for use of alternative modes can provide direct user and external community benefits. Many of these benefits are overlooked or undervalued by conventional transport planning.

Conclusions

Motor vehicle travel grew tremendously during the Twentieth Century due to favorable technical, demographic and economic trends. This growth is unlikely to continue. Current demographic and economic trends are causing motor vehicle travel to peak in most developed countries. Although automobile transport will continue to be an important mode, saturation of vehicle ownership and travel, aging population, rising fuel prices, increasing urbanization, improved mobility and accessibility options, growing health and environmental concerns, changing consumer preferences (particularly among younger people), and changing transport policies are all contributing to reduce automobile travel and increase demand for alternative modes. An increasing portion of travelers prefer to drive less and rely more on alternative modes, provided they are comfortable, convenient and affordable.

The degree changes in travel *demands* translates into changes in travel *activity* depends on the responsiveness of planning. Current transport planning often fails to account for changing travel demands. As a result, it tends to exaggerate future congestion problems, leading to overinvestment in roadway expansion and less support for other modes than overall optimal. Continuing automobile-oriented policies and planning practices will result in more automobile travel and less mode shifting than is optimal. Planning that better responds to changing travel demands can directly benefit travelers who prefer alternative modes, and because these modes tend to impose smaller external costs than automobile travel virtually everybody benefits, including motorists. Since physically, economically and socially disadvantaged people tend to rely on alternative modes, improving them helps achieve social equity objectives.

Because they are more convenient and cheaper to operate, electric autonomous vehicles tend to increase vehicles' annual vehicle travel, typically by 10-30%, in part because they do not pay road user fuel taxes, so wide adoption of these vehicles can increase total vehicle travel, traffic congestion and infrastructure costs unless they are implemented with efficient roadway management policies such as HOV lanes and decongestion road tolls.

Various planning reforms are needed to respond to changing demands including better transportation models that account for demographic and economic factors that affect travel demands, and more comprehensive and multi-modal planning that accounts for objectives, impacts and options that are often overlooked or undervalued in conventional planning. Planners must become more skilled at evaluating and improving transport options, and more articulate at communicating the full benefits of a more diverse and efficient transport system which responds to changing consumer demands. Declining vehicle travel demand will reduce the justification for roadway expansion projects, and will reduce fuel tax and toll road revenues, so new revenues sources will be needed to finance improvements to alternative modes.

It is not possible to predict future travel demands with precision, so transport planning should be flexible and responsive. For example, instead of responding to traffic congestion by expanding roadways communities should implement flexile transportation demand management programs that can be expanded as needed if travel demands growth.

Although this report investigates transport patterns in wealthier, developed countries, the analysis has important implications for lower-income, developing countries. It indicates that even wealthy people benefit from transport system efficiency and diversity. Such benefits are even greater in countries with limited resources. Developing country decision-makers have an opportunity to create efficient and diverse transport systems directly, and avoid the mistake of overemphasizing automobile transport.

References and Resources for More Information

Jacob Anbinder (2015), *The Road Less Traveled Is in Oregon*, The Century Foundation (www.tcf.org); at www.tcf.org/blog/detail/the-road-less-traveled-is-in-oregon.

APTA (annual report), *Transit Statistics*, American Public Transit Association (www.apta.com); at www.apta.com/resources/statistics/Pages/transitstats.aspx.

APTA (2013), *Millennials and Mobility: Understanding the Millennial Mindset*, American Public Transit Association (www.apta.com); at http://bit.ly/PolOnv.

David Bassett, et al (2008), "Walking, Cycling, and Obesity Rates in Europe, North America, and Australia," *Journal of Physical Activity and Health*, Vol. 5, pp. 795-814; at http://policy.rutgers.edu/faculty/pucher/JPAH08.pdf.

Phineas Baxandall (2012), *Will Transportation Investments Keep Up With the Way Americans Travel?* StreetBlog (http://dc.streetsblog.org); at http://bit.ly/1MgXBsT.

Phineas Baxandall (2013) *Moving Off the Road: A State-by-State Analysis of the National Decline in Driving*, US PIRG (www.uspirg.org); at http://bit.ly/1DKhMeZ.

BLS (various years), *Consumer Expenditure Survey*, Bureau of Labor Statistics (www.bls.gov).

Evelyn Blumenberg, et al. (2012), *What's Youth Got to Do with It? Exploring the Travel Behavior of Teens and Young Adults*, UCTC-FR-2012-14, University of California Transportation Center (www.uctc.net); at www.uctc.net/research/papers/UCTC-FR-2012-14.pdf.

Marlon G. Boarnet (2013), "The Declining Role of the Automobile and the Re-Emergence of Place in Urban Transportation: The Past Will be Prologue," *Regional Science Policy and Practice*, Vo. 5, pp. 237–253 (doi: 10.1111/rsp3.12007).

BITRE (2012), *Traffic Growth: Modelling a Global Phenomenon*, Bureau of Infrastructure, Transport and Regional Economics (www.bitre.gov.au); at www.bitre.gov.au/publications/2012/files/report_128.pdf.

BTS (various years), *National Transportation Statistics*, U.S. Department of Transportation, Bureau of Transportation Statistics (www.bts.gov).

Cherise Burda (2014), *Home Location Preference Survey: Understanding Where GTA Residents Prefer to Live and Commute*, Pembina Institute (www.pembina.org); at www.pembina.org/pub/2014-home-location-preference-survey.

I. Cameron, T. Lyons, and Jeffrey Kenworthy (2004), "Trends in Vehicle Kilometres of Travel in World Cities, 1960-1990: Underlying Drivers And Policy Responses," *Transport Policy*, Volume 11, Issue 3, July, pp. 287-298; at www.worldtransitresearch.info/research/1508.

Changing Travel Behaviours (https://travelbehaviour.com) is a collection of studies that examines how and why travel behaviours, like commuting, change over the course of people's lives.

Cities of the Future (www.transfuture.net) contains futuristic images of cities.

Heather Contrino and Nancy Mcguckin (2009), "Travel Demand in the Context of Growing Diversity: Considerations for Policy, Planning, and Forecasting," *TR News*, TRB (www.trb.org), Sept.-Oct., pp. 4-9; at http://onlinepubs.trb.org/onlinepubs/trnews/trnews264TravelDemand.pdf.

Matthew Coogan, et al. (2018), "Understanding Changes in Demographics, Preferences, and Markets for Public Transportation," Report 201, Transit Cooperative Research Program; at www.nap.edu/download/25160.

Joseph Corn (1984), *Yesterday's Tomorrows: Past Vision of the American Future,* Smithsonian Institute (www.si.edu); at www.museumonmainstreet.org/yesterdaysTomorrows/index.html.

Christine Cosgrove and Phyllis Orrick (2004), "The Future That Never Was: Lessons from Visions of Transportation," *TR News 235*, Transportation Research Board (www.trb.org), Nov./Dec., pp. 3-9.

Benjamin Davis, Tony Dutzik and Phineas Baxandall (2012), *Transportation and the New Generation: Why Young People are Driving Less and What It Means for Transportation Policy*, Frontier Group (www.frontiergroup.org); at http://tinyurl.com/76ndnak.

Tim Denne and Louis Wright (2016), *Public and Passenger Transport: Historical Trends and Drivers of Demand*, NZ Transport Agency (www.nzta.govt.nz); at https://bit.ly/3P38EKG.

DfT (2009), "Driving License Holding and Vehicle Availability," *2009 National Travel Survey*, Department for Transport (www.dft.gov.uk).

DfT (2015), *Understanding the Drivers of Road Travel: Current Trends in and Factors Behind Roads Use*, U.K. Department for Transport (www.gov.uk); at https://bit.ly/2T8cat0.

Disney (1958), *Highways of the Future*, Disney Corporation; at www.youtube.com/watch?v=F6pUMlPBMQA#.

Dowling Associates (2010), *Complete Streets LOS: Multi-Modal Level-of-Service Toolkit*, Dowling Associates (www.kittelson.com); at www.kittelson.com/toolbox/complete_streets_los.

Tony Dutzik and Phineas Baxandall (2013), *A New Direction: Our Changing Relationship with Driving and the Implications for America's Future,* U.S. PIRG Education Fund (www.uspirg.org), Frontier Group; at http://uspirg.org/sites/pirg/files/reports/A%20New%20Direction%20vUS.pdf.

Tony Dutzik (2021), *Frontier Group at 25: Transportation for a New Generation*, The Frontier Group (https://frontiergroup.org); at https://bit.ly/3p0CfK0.

EC (2002), *EU Energy and Transport In Figures*, European Commission (http://europa.eu.int).

EC (2007), *Energy and Transport In Figures*, Directorate-General for Energy and Transport, European Commission (http://ec.europa.eu); at https://bit.ly/2W6tqxZ.

Phil Edwards (2015), *Travel Time is the Forgotten Breakthrough of the Past 200 Years*, VOX (www.vox.com); at www.vox.com/2015/3/11/8187033/maps-travel-times.

FHWA (various years), *Highway Statistics*, Federal Highway Administration (www.fhwa.dot.gov); at www.fhwa.dot.gov/policyinformation/statistics.cfm,

Ruud Filarski (2004), *The Rise and Decline of Transport Systems: Changes in Historical Context*, AVV Transport Research Center, Ministry of Transport, The Netherlands (www.rws-avv.nl).

Caralampo Focas and Panayotis Christidis (2017), "Peak Car in Europe?," *Transportation Research Procedia*, Vol. 25, pp. 531-550 (doi.org/10.1016/j.trpro.2017.05.437); at https://bit.ly/3zY6c3R.

William L. Garrison and David M. Levinson (2006), *The Transportation Experience: Policy, Planning, and Deployment*, Oxford University Press (www.us.oup.com).

Edward L. Glaeser and Janet E. Kohlhase (2003), *Cities, Regions and the Decline of Transport Costs*, Working Paper 9886, National Bureau Of Economic Research (www.nber.org); at www.nber.org/papers/w9886.

Phil Goodwin and Stefan Persson (2001), *Assessing the Benefits of Transport*, European Conference of Ministers of Transport; OECD (www.oecd.org).

Phil Goodwin (2011), *Peak Car: Evidence Indicates That Private Car Use May Have Peaked And Be On The Decline*, RUDI, Urban Intelligence Network (www.rudi.net); at www.rudi.net/node/22123.

Phil Goodwin (2012), *Peak Travel, Peak Car and the Future of Mobility: Evidence, Unresolved Issues, Policy Implications, and a Research Agenda*, Long-run Trends in Travel Demand, OECD Roundtable (www.oecd.org); at https://bit.ly/3bQ2ZY8.

Susan Handy (2015), *How Travel Demand Has Been Changing*, Transportation and Energy Policy in a Volatile World, 15th Asilomar Conference; at www.its.ucdavis.edu/files/III-Handy-FINAL-Asilomar-2015.pdf.

Carmen Hass-Klau and Graham Crampton (2002), *Future of Urban Transport: Learning from Success and Weakness*, Environmental and Transportation Planning (www.etphassklau.co.uk).

Amy Helling (1997), "Transportation and Economic Development; A Review," *Public Works Management & Policy*, Vol. 2, No. 1, July 1997, pp. 79-93.

Dario Hidalgo and Heshuang Zeng (2013), *On the Move: Pushing Sustainable Transport from Concept to Tipping Point*, The City Fix (www.thecityfix.com); at http://thecityfix.com/blog/on-the-move-pushing-sustainable-transport-concept-tipping-point-dario-hidalgo-heshuang-zeng.

Lisa Hymas (2011), "Driving has Lost its Cool for Young Americans," *Grist* (www.grist.org); at www.grist.org/transportation/2011-12-27-driving-has-lost-its-cool-for-young-americans.

ITF (2013), *Long-Run Trends in Car Use, Roundtable 152 Report*, International Transport Forum (www.internationaltransportforum.org); at www.internationaltransportforum.org/pub/new.html.

ITF (2021), *Reversing Car Dependency: Summary and Conclusions*, International Transport Forum (www.itf-oecd.org); at https://bit.ly/3claCEM.

ITF (2021), *Travel Transitions: How Transport Planners and Policy Makers Can Respond to Shifting Mobility Trends*, International Transport Forum (www.itf-oecd.org); at https://bit.ly/3BGJewh.

ITF (2023), *Shaping Post-Covid Mobility in Cities*, International Transport Forum (www.itf-oecd.org); at www.itf-oecd.org/shaping-post-covid-mobility-cities.

David S. Johnson, John M. Rogers and Lucilla Tan (2001), "A Century of Family Budgets in the United States," *Monthly Labor Review* (www.bls.gov/opub/mlr/2001/05/art3full.pdf), May, pp. 28-46.

Nathanael Johnson (2021), "The Evidence That the World has Passed 'Peak Car'. A Look at How Transportation Could Change Without an Addiction to Automobiles," *Grist* (https://grist.org); at https://grist.org/transportation/the-evidence-that-the-world-has-passed-peak-car.

S. Mitra Kalita and Robbie Whelan (2011), "No McMansions for Millennials," *Wall Street Journal* (www.wsj.com); at http://blogs.wsj.com/developments/2011/01/13/no-mcmansions-for-millennials.

KiM (2014), *Not Car-Less, But Car-Later: For Young Adults the Car is Still an Attractive Proposition*, KiM Netherlands Institute for Transport Policy for the Dutch Ministry of Infrastructure and the Environment (www.government.nl/ministries/ienm); at https://bit.ly/3yWoGQl.

KPMG (2020), *Automotives New Reality: Fewer Trips, Fewer Miles, Fewer Cars?* KPMG Advisory Report (https://advisory.kpmg.us); at https://bit.ly/3nnYurf.

Tobias Kuhnimhof, Matthias Wirtz and Wilko Manz (2012), "Decomposing Young Germans' Altered Car Use Patterns: Lower Incomes, More Students, Decrease in Car Travel by Men, and More Multimodality," *Transportation Research Record 2032*, TRB (www.trb.org), pp. 64-71; earlier version at http://amonline.trb.org/12k93j/1.

Tobias Kuhnimhof, Dirk Zumkeller and Bastian Chlond (2013), "Who Made Peak Car, and How? A Breakdown of Trends over Four Decades in Four Countries," *Transport Reviews: A Transnational Transdisciplinary Journal*, Special Issue, "Peak Car," Vol. 33, Issue 3, DOI: 10.1080/01441647.2013.801928

Benjamin Leard, Joshua Linn and Clayton Munnings (2016), *Explaining the Evolution of Passenger Vehicle Miles Traveled in the United States*, Resources for the Future (www.rff.org); at https://bit.ly/3bQJv5K.

Eric Lefcowitz (2001), *The Legend of 2000*, Retro Future (www.retrofuture.com).

Alexander Legrain, Naveen Eluru and Ahmed M. El-Geneidy (2015), "Am Stressed, Must Travel: The Relationship between Mode Choice and Commuting Stress," *Transportation Research Part F*, Vo. 34, pp. 141–151 (doi:10.1016/j.trf.2015.08.001).

Scott Le Vine and Peter Jones (2012), *On The Move: Making Sense of Car and Train Travel Trends in Britain*, Royal Automobile Club Foundation (www.racfoundation.org) and Independent Transport Commission; at www.racfoundation.org/research/mobility/on-the-move-main-research-page.

David Levinson and Kevin Krizek (2015), *The End of Traffic and Future of Transport*, Kindle (http://davidlevinson.org/the-end-of-traffic-and-the-future-of-transport).

Todd Litman (2001), "You Can Get There From Here: Evaluating Transportation Choice," *Transportation Research Record 1756*, TRB (www.trb.org), 2001, pp. 32-41; at www.vtpi.org/choice.pdf.

Todd Litman (2003), "Measuring Transportation: Traffic, Mobility and Accessibility," *ITE Journal* (www.ite.org), Vol. 73, No. 10, October, pp. 28-32; at www.vtpi.org/measure.pdf.

Todd Litman (2004), *Rail Transit in America: Comprehensive Evaluation of Benefits*, VTPI (www.vtpi.org); at www.vtpi.org/railben.pdf.

Todd Litman (2006), "Changing Travel Demand: Implications for Transport Planning," *ITE Journal*, Vol. 76, No. 9, (www.ite.org), September, pp. 27-33.

Todd Litman (2008), *Land Use Impacts On Transport: How Land Use Factors Affect Travel Behavior,* VTPI (www.vtpi.org); at www.vtpi.org/landtravel.pdf.

Todd Litman (2009), *Where We Want to Be: Home Location Preferences and Their Implications for Smart Growth*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/sgcp.pdf.

Todd Litman (2010), *Evaluating Transportation Economic Development Impacts*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/econ_dev.pdf.

Todd Litman (2012), "Changing North American Vehicle-Travel Price Sensitivities: Implications For Transport and Energy Policy," *Transport Policy*, (http://dx.doi.org/10.1016/j.tranpol.2012.06.010); full report at www.vtpi.org/VMT_Elasticities.pdf.

Todd Litman (2013), "The New Transportation Planning Paradigm," *ITE Journal* (www.ite.org), Vo. 83, No. 6, pp. 20-28, 2013; at http://digitaleditions.sheridan.com/publication/?i=161624; at www.vtpi.org/paradigm.pdf.

Todd Litman (2018), *Autonomous Vehicle Implementation Predictions: Implications for Transport Planning*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/avip.pdf.

Todd Litman (2019), "The Future is Not What it Used to Be: Changing Travel Demands and Their Implications for Transport Planning," *Plan Canada* (https://bit.ly/2zGcgSi); winner of the Planning Institute of Canada's *Article of the Year / Article de l'année* award (https://bit.ly/32fpH7G).

Todd Litman (2020), *Our World Accelerated: How 120 Years of Transportation Progress Affects Our Lives and Communities*, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/TIEI.pdf.

Todd Litman (2021), *New Mobilities: Smart Planning for Emerging Transportation Technologies*, Island Press (https://islandpress.org); at https://islandpress.org/books/new-mobilities.

Allison Linn (2010), "Carmakers' Next Problem: Generation Y: People in Their Teens and Twenties are More Interested in Gadgets than Cars," *MicroSoft News*, 4 Nov. 2010 (www.msnbc.msn.com/id/39970363/ns/business-autos).

Juha Luoma, Michael Sivak and Susan Zielinski (2010), *The Future of Personal Transportation in Megacities of the World*, Transportation Research Institute, University of Michigan (www.umich.edu/~umtriswt); at https://bit.ly/3aW3phR.

Glenn Lyons and Phil Goodwin (2014), *Grow, Peak Or Plateau - The Outlook For Car Travel*, Discussion Paper, New Zealand Ministry of Transport; at http://eprints.uwe.ac.uk/23277.

Jean-Loup Madre, et al. (2012), *Are We Headed Towards a Reversal of the Trend for Ever-Greater Mobility*, Long-run Trends in Travel Demand, OECD Roundtable (www.oecd.org); at https://bit.ly/2IHfPKp.

Chris McCahill and Chris Spahr (2013), *VMT Inflection Point: Factors Affecting 21st Century Travel*, State Smart Transportation Initiative (www.ssti.us); at https://bit.ly/3aO5o85.

Noreen C. McDonald (2015), "Are Millennials Really the 'Go-Nowhere' Generation?" *Journal of the American Planning Association*, DOI: 10.1080/01944363.2015.1057196; summarized in "The Clearest Explanation Yet for Why Millennials Are Driving Less" (www.citylab.com); at https://bit.ly/2Bj1O0a.

Nancy McGuckin (2011), *Summary of Travel Trends 1969 to 2009*, Travel Behavior Associates (www.travelbehavior.us); at https://bit.ly/2F75ViF.

Nancy McGuckin and Jana Lynott (2012), *Impact of Baby Boomers on U.S. Travel, 1969-2009*, American Association of Retired Persons (www.aarp.org); at https://bit.ly/3IQHllj.

Michael McQueen, John MacArthur and Christopher Cherry (2020), "The E-Bike Potential: Estimating Regional E-bike Impacts on Greenhouse Gas Emissions," *Transportation Research Part D*, Vo. 87 (https://doi.org/10.1016/j.trd.2020.102482).

Clay McShane (1994), *Down the Asphalt Path*, Columbia University Press (New York).

David Metz (2010), "Saturation of Demand for Daily Travel," *Transport Reviews*, Vol. 30, Is. 5, pp. 659 – 674 (http://tris.trb.org/view.aspx?id=933522); summary at https://bit.ly/3ctAFxc.

Adam Millard-Ball and Lee Schipper (2010), "Are We Reaching Peak Travel? Trends in Passenger Transport in Eight Industrialized Countries," *Transport Reviews*, Vol. 30 (http://dx.doi.org/10.1080/01441647.2010.518291); at http://web.mit.edu/vig/Public/peaktravel.pdf.

MVMA (1995), *Facts & Figures*, Motor Vehicle Manufactures Association (Detroit).

M.I. Nadri and T.P. Mamuneas (1996), *Contribution of Highway Capital to Industry and National Productivity Growth*, FHWA, USDOT; at www.econ.nyu.edu/user/nadiri/pub104.PDF.

NAR (various years), *National Community Preference Survey*, National Association of Realtors (www.realtor.org); at www.nar.realtor/reports/nar-community-and-transportation-preference-surveys.

NCHRP (2014), *Strategic Issues Facing Transportation: Volume 6: The Effects of Socio-Demographics on Future Travel Demand*, Report 750, National Cooperative Highway Research Program, Transportation Research Board (www.trb.org); at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_750-v6.pdf.

Arthur C. Nelson (2006), "Leadership in a New Era: Comment on "Planning Leadership in a New Era," *Journal of the American Planning Association*, Vol. 72, Is. 4, pp. 393 – 409. Also see Arthur C. Nelson (2009), *The New Urbanity: The Rise of a New America*, University of Utah Metropolitan Research Center; summary at www.froogalizer.com/news/research-on-homeownership-rate-through-2030.html.

Peter Newman and Jeff Kenworthy (2011), "'Peak Car Use': Understanding the Demise of Automobile Dependence," *World Transport Policy and Practice*, Vo. 17/2, pp. 31-42; at www.eco-logica.co.uk/pdf/wtpp17.2.pdf.

NHTS (2017), *Summary of Travel Trends*, National Household Travel Survey, USDOT; at https://nhts.ornl.gov/assets/2017_nhts_summary_travel_trends.pdf.

NSTPRSC (2007), *Analysis of Changing Relationships Among Population Growth, Passenger Travel Growth, and Vehicle Miles Traveled Growth for Different Modes*, Commission Paper 4A-01, National Surface Transportation Policy and Revenue Study Commission (www.transportationfortomorrow.org).

Oak Ridge (2022), *Transportation Energy Data Book: Edition 40*, U.S. Department of Energy (https://tedb.ornl.gov); at https://tedb.ornl.gov/data.

OECD (2012), *Long-run Trends in Travel Demand*, Transportation Research Forum and OECD Roundtable (www.oecd.org); at https://bit.ly/2IHfPKp.

OECD (2021), *Teleworking in the COVID-19 pandemic: Trends and Prospects*, OECD (www.oecd.org); at https://bit.ly/3cweHJZ.

Fred Pearce (2011), "End of the Road for Motormania," *New Scientist*, 2825 (www.newscientist.com); at www.newscientist.com/article/mg21128255.600-the-end-of-the-road-for-motormania.html.

Alan E. Pisarski (2007), *Implication of Rural/Urban Development Patterns on Passenger Travel Demand*, Commission Briefing Paper 4A-05, National Surface Transportation Policy and Revenue Study Commission (www.transportationfortomorrow.org); at https://bit.ly/3vjGCkX.

Steven Polzin and Xuehao Chu (2007), *Exploring Long-Range U.S. Travel Demand: A Model for Forecasting State-Level Person Miles and Vehicle Miles of Travel for 2035 and 2055*, Federal Highway Administration.

Steven E. Polzin, Xuehao Chu and Nancy McGuckin (2011), *Exploring Changing Travel Trends*, presented at Using National Household Travel Survey Data for Transportation Decision Making: A Workshop, Transportation Research Board (www.trb.org); at https://bit.ly/3PpgrTV.

Jolanda Prozzi, et al. (2009), *Actual vs. Forecasted Toll Usage: A Case Study Review*, Center for Transportation Research, University of Texas at Austin (www.utexas.edu); at https://bit.ly/2Mbto3O.

Robert Puentes (2013), *Have Americans Hit Peak Travel? A Discussion of the Changes in US Driving Habits*, Brookings Institution (www.brookings.edu); at https://brook.gs/2OXrYzu.

Julia Pyper (2012), "Has the U.S. Reached "Peak Car"?: Traffic is Easing as More Americans are Deciding to Drive Less, Sell Their Cars or Not Buy One at All," *Scientific American*; at https://bit.ly/3RMVT9C.

Stuart Ramsey and David Hughes (2009), "The Challenge of the Oracle: Optimizing Transportation Infrastructure in a Changing World," *ITE Journal*, Vo. 79/2 (www.ite.org), pp. 69-73; at https://bit.ly/3cvDCNN.

RAND (2013), *The Future Of Mobility: Scenarios for the United States In 2030*, The RAND Corporation, IFMO Institute for Mobility Research (www.ifmo.de); at https://bit.ly/3v49xLI.

Caroline Rodier (2018), *Travel Effects and Associated Greenhouse Gas Emissions of Automated Vehicles*, UC Davis Institute for Transportation Studies (https://ncst.ucdavis.edu); at https://bit.ly/3iJVlB5.

Jeff Rubin and Meny Grauman (2009), "How Big Will the Post-Recession US Vehicle Market Be?" *StrategEcon*, CIBC World Markets Newsletter (http://research.cibcwm.com); at https://bit.ly/3og2LP9.

Deborah Salon (2014), *Quantifying the Effect of Local Government Actions on VMT*, California Air Resources Board; at ww3.arb.ca.gov/research/apr/past/09-343.pdf.

A. Santos, et al. (2011), *Summary of Travel Trends: 2009 National Household Travel Survey*, FHWA (http://nhts.ornl.gov); at http://nhts.ornl.gov/2009/pub/stt.pdf. Also see, *Summary of Travel Trends 1969 to 2009*, Travel Behavior Associates (www.travelbehavior.us); at https://bit.ly/2F75ViF.

Lee Schipper (2011), "Automobile Use, Fuel Economy And CO2 Emissions In Industrialized Countries: Encouraging Trends Through 2008?" *Transport Policy*, Vo. 18/2, pp. 358-372; at https://bit.ly/3v4axiW.

Angie Schmidt (2018), *Millennials Unhappily Stuck in their Parents' Transportation System*, Streetblog USA (www.usa.streetsblog.org); at https://bit.ly/2QLtml5.

Hart Schwartz (2015), *Driver Demographics: The American Population's Effect on Vehicle Travel and Fuel Demand*, The Fuels Institute (http://fuelsinstitute.org); at https://bit.ly/3IVVGgw.

SGA (2012), *City Versus Suburban Growth In Small Metro Areas: Analysis Of U.S. Census Data In Metropolitan Statistical Areas*, Smart Growth America (www.smartgrowthamerica.org); at https://bit.ly/2Tp1F3c.

Shared Mobility Principles for Livable Cities (www.sharedmobilityprinciples.org).

Clive Thompson (2010), "Clive Thompson to Texters: Park the Car, Take the Bus," *Wired Magazine*, March, (www.wired.com); at www.wired.com/magazine/2010/02/st_clive_thompson_texting.

Sarah Shenstone-Harris (2016), *Have We Reached Peak Driving?: A 25-year Decomposition of Vehicle Trends in Canada*, University of Ottawa (https://ruor.uottawa.ca); at https://bit.ly/2JjHRv0.

Chad Shirley and Clifford Winston (2004), "Firm Inventory Behavior And The Returns From Highway Infrastructure Investments," *Journal of Urban Economics*, Vo. 55, Is. 2, pp. 398-415.

Michael Sivak (2013-2015), *Has Motorization in the U.S. Peaked?,* University of Michigan, Transportation Research Institute (www.umich.edu/~umtriswt).

Michael Sivak and Brandon Schoettle (2011), *Recent Changes in the Age Composition of Drivers in 15 Countries*, University of Michigan Transportation Research Institute (www.umtri.umich.edu); at www.lapri.org/sites/default/files/UMTRI-2011-43[1].pdf.

Michael Sivak and Brandon Schoettle (2012), "Update: Percentage of Young Persons with a Driver's License Continues to Drop," *Traffic Injury Prevention*, Vo. 13/4, pp. 341-341; at https://bit.ly/3OhcAXX.

Michael Sivak and Brandon Schoettle (2016), *Recent Decreases in the Proportion of Persons with a Driver's License across All Age Groups*, University of Michigan Transportation Research Institute (www.umtri.umich.edu); at www.umich.edu/~umtriswt/PDF/UMTRI-2016-4.pdf.

Satchie Snellings and A.J. Caughey (2022), New Poll: The Era Of The ICE Vehicle Is Ending. What Comes Next?, *Protocol* (www.protocol.com); at www.protocol.com/manuals/future-of-mobility/chart-mobility-special-report.

TRL (2004), *The Demand for Public Transit: A Practical Guide*, Transportation Research Laboratory, Report TRL 593 (www.trl.co.uk); available at www.demandforpublictransport.co.uk.

ULI (2009), *Emerging Trends in Real Estate*, Urban Land Institute (www.uli.org); at https://bit.ly/3yUjblo.

U.S. Census (various years), *National Population Projections*, U.S. Census (www.census.gov); at www.census.gov/programs-surveys/popproj.html.

USDOT (2015), *Beyond Traffic 2045: Trends and Choices*, U.S. Department of Transportation (www.dot.gov); at www.dot.gov/beyondtraffic.

Jan van der Waard, Ben Immers and Peter Jorritsma (2012), *New Drivers In Mobility; What Moves The Dutch In 2012 And Beyond?, Long-Run Trends In Travel Demand*, OECD Roundtable (www.oecd.org); at https://bit.ly/2IHfPKp.

VTPI (2005), *Online TDM Encyclopedia*, Victoria Transport Policy Institute (www.vtpi.org).

Xize Wang and John L. Renne (2023), "Socioeconomics of Urban Travel in the U.S.: Evidence from the 2017 NHTS," *Transportation Research Part D*, Vo. 116 (https://doi.org/10.1016/j.trd.2023.103622).

John Elfreth Watkins Jr. (1900), "What May Happen in the Next Hundred Years," *Ladies Home Journal*, Vol. XVIII, No. 1, December, p. 8; at https://bit.ly/3iE3qVE.

Weekend Magazine (1961), "Will Life Be Worth Living in 2000?" *Weekend Magazine*, 22 July 1961; at www.pixelmatic.com.au/2000.

Clark Williams-Derry (2010-2013), *Dude, Where Are My Cars?* Sightline Institute (www.sightline.org); at http://daily.sightline.org/blog_series/dude-where-are-my-cars.

Clark Williams-Derry (2011), *WSDOT Vs. Reality: Puget Sound Traffic Forecasts Don't Even Pass the Laugh Test*, Sightline Institute (www.sightline.org); at http://daily.sightline.org/2011/07/13/wsdot-vs-reality.

Clark Williams-Derry (2012), *How Not to Forecast Traffic: How a Washington State Transportation Council Misuses Statistics*, Sightline Institute (www.sightline.org); at https://bit.ly/3cqsyBG.

Zipcar (2011), *Millennials & Driving: Survey Results*, Zipcar (www.zipcar.com); at www.slideshare.net/Zipcar_Inc/millennial-slide-share-final.