Speed Versus Affordability

Social Equity Implications of Current Transportation Planning Practices

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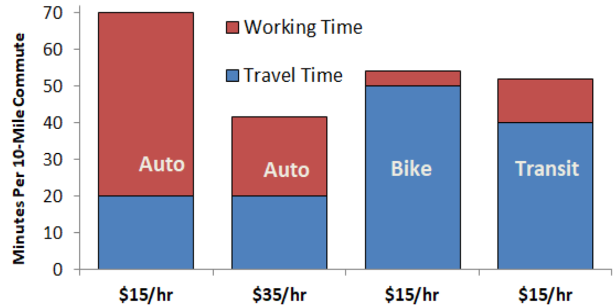
Abstract

Planning decisions often involve trade-offs between travel speed and other goals. It is important to consider all impacts when making speed-related decisions. This presentation examines why and how to do that. It describes various benefits and costs of faster travel; examines how speed valuation affects planning decisions; and provides guidance for comprehensive evaluation of these impacts. This analysis indicates that conventional planning tends to exaggerate the benefits and understate the costs of higher speeds. This favors faster modes, such as automobiles, over slower but more affordable, equitable and resource-efficient modes such as walking, bicycling and public transit; favors higher roadway design speeds; and favors sprawl over compact development. Increasing the speed of slower modes tends to provide more benefits than for faster modes. Surveys indicates that many people want to drive less, rely more on slower modes, and live in more compact, walkable communities. Serving these demands requires more comprehensive analysis of speed-related trade-offs.

Effective Speed



Measured by effective speed (time spent travelling and earning money to pay travel expenses), bicycling and transit are often faster than driving for lower-wage workers.

Commute Duration

Although suburban areas tend to have higher traffic speeds then central neighborhoods, they tend to have longer commute duration, because their higher speeds are offset by longer travel distances. This and other research indicates that travel speed increases are often offset by reduced accessibility, which increased total travel time costs.

Key Findings

- Transportation planning often involves trade-offs between speed and other goals. It is important to consider all speed-related impacts in planning.
- Higher speeds are inherently costly. Faster modes require much more expensive vehicles and infrastructure, more space and energy, and impose greater external costs, often by orders of magnitude. Because travel speeds tend to increase with wealth, speed-prioritizing planning tends to be inequitable; it increases costs that affluent travellers impose on disadvantaged groups.
- Current planning practices tend to exaggerate the benefits, underestimate the costs, and ignore the inequities of faster travel. This results in overinvest in faster modes and higher roadway design speeds.
- The inefficiency and inequity of speed-prioritizing planning is evident if transport performance is evaluated using *effective speed*: travel distance divided by time spent traveling *and* earning money to pay travel expenses. Measured this way, automobile travel is often slower than bicycling and transit, and is regressive because it benefits affluent motorists who value time more than money, but harms lower-income people who prefer lower-cost modes.
- More comprehensive speed analysis is likely to result in less investment in urban highways and more in active and public transport modes, lower roadway design speeds, more planning to improve travel comfort and convenience rather than speed.

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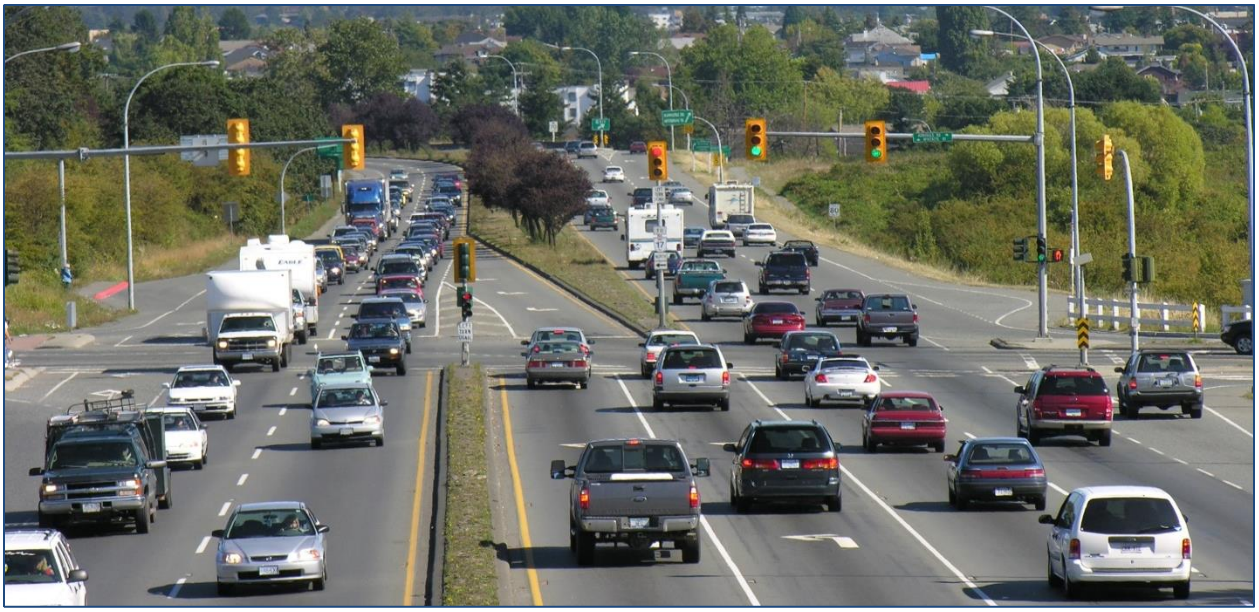


Conventional planning practices tend to exaggerate the benefits and understate the costs of faster travel. This results in planning decisions that favor automobile travel over slower modes, higher roadway design speeds than optimal, and more sprawled development.

Abstract

Planning decisions often involve trade-offs between travel speed and other goals. It is important to consider all impacts when making speed-related decisions. This report examines why and how to do that. It describes various benefits and costs of faster travel; examines how speed valuation affects planning decisions; and provides guidance for comprehensive evaluation of these impacts. This analysis indicates that conventional planning tends to exaggerate the benefits and understate the costs of higher travel speeds. This favors faster modes, such as automobiles, over slower but more affordable, equitable and resource-efficient modes such as walking, bicycling and public transit; favors higher roadway design speeds; and favors sprawl over compact development. Increasing the speed of slower modes tends to provide more benefits than increasing the speed of faster modes. Surveys indicates that many people want to drive less, rely more on slower modes, and live in more compact, walkable communities. Serving these demands requires more comprehensive analysis of speed-related trade-offs.

Key Findings

- Transportation planning often involves trade-offs between speed and other goals. It is important to consider all speed-related impacts in a planning process.
- For some trips, such as urgent errands, faster travel can provide large benefits, but higher speeds are inherently costly. Faster modes require much more expensive vehicles and infrastructure, more space and energy, and impose greater health risks and environmental damages, often by an order of magnitude. Because higher speed travel tends to increase with wealth, speed-prioritizing planning tends to be inequitable; it increases costs that affluent travellers impose on disadvantaged groups.
- Planners often assume that faster travel provides time savings, but people tend to maintain fixed travel time budgets, they devote about the same number of daily minutes to personal travel regardless of speed. As a result, faster travel increases travel distances rather than saving time. This causes *mobility inflation*, it ratchets up the amount of travel people require to meet their needs, which is costly to communities and unfair to people with limited mobility.
- Current planning practices tend to exaggerate the benefits, underestimate the costs, and ignore the inequities of faster travel. Current planning generally recognizes trade-offs between speed and safety, but overlooks other impacts such as reduced affordability, public health, and mobility for non-drivers. This results in overinvest in faster modes and higher roadway design speeds, which over the long run increases total vehicle travel and sprawl.
- Higher travel speeds do not necessarily support economic development. Faster travel can increase productivity if it increases overall accessibility, but those benefits are often offset by the additional costs of increased vehicle travel and sprawl.
- The inefficiency and inequity of speed-prioritizing planning are evident if transport performance is evaluated using *effective speed*, defined as travel distance divided by the time spent travelling and earning money to pay travel expenses. Measured this way, automobile travel is often slower than bicycling and public transit, and is regressive because it benefits affluent motorists who value time more than money, but harms lower-income people who prefer lower-cost modes.
- Faster travel is not *bad*, but it is costly. For efficiency and equity sake planning should favor slower, affordable and resource-efficient modes over faster, costly modes, and traffic speeds should be set to optimize community livability. Travel time savings to slower modes should be weighted higher than travel time savings to faster modes.
- To their credit, many policy makers and planning practitioners support slower modes and traffic speed reductions more than their economic models justify; they realize intuitively that slower modes play important roles in an efficient and equitable transportation system, and so deserve public support. However, this occurs *despite* rather than *supported by* standard analysis practices. Reforming these practices can justify much more support for slower modes.
- More comprehensive speed analysis is likely to result in less investment in urban highways, more investments in active and public transport modes, lower roadway design speeds, more planning to improve travel comfort and convenience rather than speed.
- Of course, every traveller has unique needs and preferences. Many choose faster modes, such as automobiles, despite their higher costs, for convenience or status sake. However, current demographic and economic trends – aging population, increasing urbanization, plus growing affordability, health and environmental concerns – are increasing demand for slower modes and livable neighborhoods. Given better options, many people would choose slower travel modes for many trips. Everybody benefits if our planning practices respond to these demands.

"Haste makes waste."

Introduction

Travellers often make trade-offs between speed and other goals such as affordability, comfort and safety. For example, commuters sometimes choose slower but cheaper modes, motorists sometimes choose slower but more enjoyable routes, and drivers often slow down to reduce stress and increase safety. When offered the option of paying a toll to use a faster traffic lane, most motorists choose to save money rather than time. Many planning decisions also involve trade-offs between speeds and other goals. For example, transportation agencies can invest in faster modes, such as driving, or slower more affordable, healthy and resource-efficient modes such as walking, bicycling and public transit. Roads can be designed for higher traffic speeds, with wider lanes, longer blocks and fewer crosswalks, or to accommodate more diverse modes and increase safety with more sidewalks, bike- and bus lanes, and lower design speeds. The question explored in this report is whether current planning practices accurately reflects community preferences when making such trade-offs.

Faster travel has both benefits and costs, as summarized in Table 1. It increases the destinations that affected travellers can access in a given time period, and therefore their economic and social opportunities, but inevitably increases many costs to users and communities, and often harms people who cannot use the faster mode, such as when wider roads and increased traffic speeds degrade walking and bicycling conditions, or if automobile-oriented planning stimulates sprawled development.

Table 1 **Typical Benefits and Cost of Faster Travel**

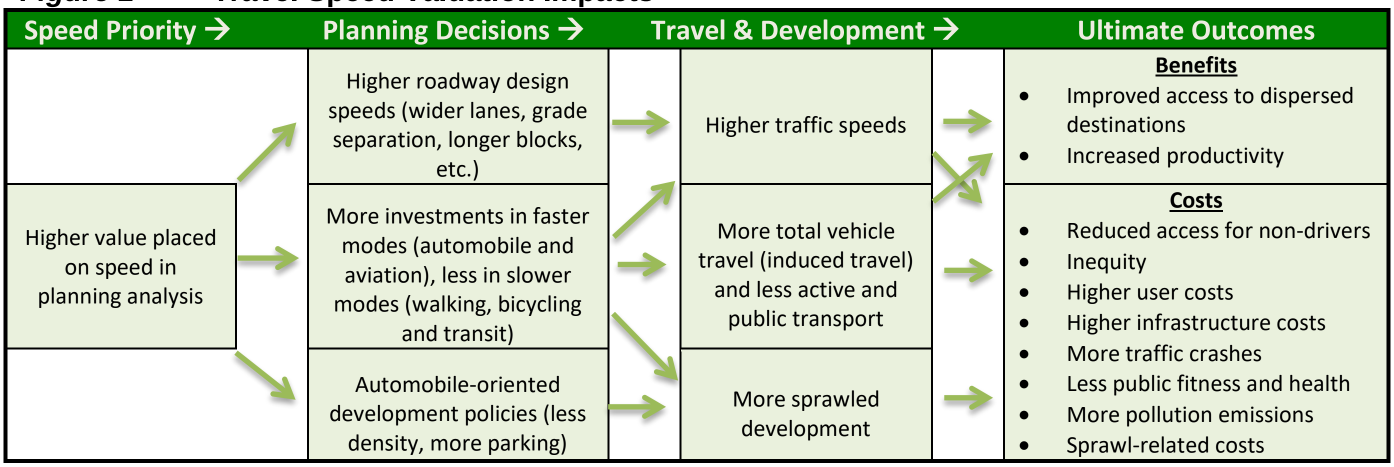
Benefits	Costs
• People sometimes enjoy the experience of speed. • Short-term travel time savings. • Long-term increases in travel distance, expanding the destinations motorists can reach.	• Reduced accessibility by slower modes. • Reduced traveller comfort and increased driver stress. • Increased user costs and reduced affordability. • Increased road and parking infrastructure cost. • Increased traffic congestion and barrier effects. • Increased crash costs. • Increased energy consumption and pollution emissions. • Reduced community livability and cohesion. • More automobile dependency and sprawl. • Inequity imposed on disadvantaged groups.

Higher speeds provide user benefits and increase various user and community costs.

Conventional planning often assumes that higher speeds provide travel time savings, giving people more time to work or spend with their families, but over the long run people tend to maintain *fixed travel time budgets* (daily minutes devoted to out-of-home personal travel stays relatively constant), so speed increases usually cause proportionate increases in travel distances. For example, if a road improvement increases traffic speeds by 30%, affected motorists will make more and longer trips, so their vehicle-miles increase about 30%. Although the additional vehicle travel ("mobility") provides user benefits, these tend to be modest because they consist of marginal value vehicle-miles that users are most willing to forego if their travel time costs increase, and the additional vehicle travel increases external costs such as roadway costs, congestion, crash risk, and pollution emissions.

The value placed on speed significantly affects planning decisions, and therefore various benefits and costs, as illustrated in Figure 1. Conventional planning considers some of these impacts but often overlooks or undervalues others, particularly long-term effects caused by changes in accessibility, total vehicle travel, and development patterns. To the degree that a planning process exaggerates the benefits or overlooks some costs of speed, it will result in faster traffic, more vehicle travel, and higher total costs than travellers and communities actually want.

Figure 1 **Travel Speed Valuation Impacts**



Higher values placed on speed favors faster modes, higher traffic speeds and dispersed development, which reduces non-auto modes, and increases total vehicle travel and sprawl.

Optimal travel speeds vary widely depending on conditions. Compact community design maximizes accessibility which minimizes the travel distances required to access services and activities, so optimal speeds are low. Sprawl reduces accessibility which increases distances and therefore optimal speeds. These approaches often conflict: higher traffic speeds are unsuitable in compact and multimodal neighborhoods, while automobile-oriented communities are dispersed by wide roads and large parking lots, and are unsuitable for walking, bicycling and transit travel. As a result, speed-prioritizing planning forces people to travel faster and farther to meet their daily needs.

Consider these examples.

1. In a typical community, 10-20% of trips are made by slower modes (walking, bicycling and public transit), 20-40% of residents rely on these modes at least sometimes, surveys indicate that many travellers want to use slower modes more, and accommodating this latent demand helps achieve many economic, social and environmental goals. Yet, most communities devote much less than 10% of transportation funds and road rights-of-way to these modes, less than their mode shares.

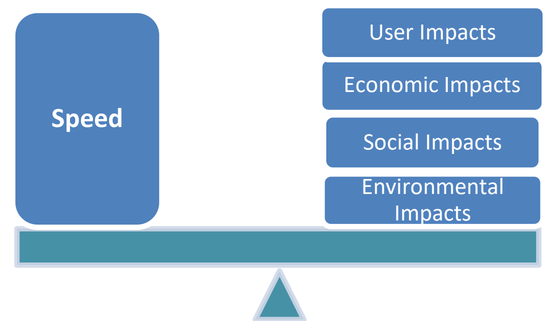
2. Most urban streets have design speeds and speed limits over 30 miles per hour (mph), although extensive research indicates that 20 mph speeds significantly increase all road users' safety and comfort, particularly active modes, and therefore increases their use.

3. During the last century many high-accessibility urban neighborhoods were displaced and degraded by freeways. This increased suburban motorists' travel speeds, improving their access to city jobs and services, but degraded urban neighborhoods and displaced many of their residents, forcing many households into more automobile-dependent lifestyles.

These examples illustrate how conventional planning often contradicts community goals such as efficiency, equity, health and safety, and environmental quality. There are many ways to explain why such practices are common. They may reflect consumerist assumptions that automobile travel is better than slower modes and suburbs are better than cities; the political influence of vehicle and petroleum industries; the biased experiences of policy makers and planning professionals who themselves lead automobile-dependent lifestyles, and racist assumptions that considered urban neighborhoods as "blight" to be displaced. These are all legitimate critiques. However, the *mechanism* which allows a planning process to favor faster modes over slower modes and sprawl over compact development is the excessive value placed on speed, plus a tendency to overlook many of the external costs of faster modes and higher traffic speeds.

This report investigates these issues. It examines how the benefits of speed are valued compared with other goals (Figure 2), and how this affects planning decisions. It explores various benefits and costs of faster travel, how this valuation affects planning decisions, and the resulting impacts on people and communities. This should be of interest to policy makers, planning professionals, advocates of slower modes, and anybody interested in creating more sustainable communities.

Figure 2 **Balancing Goals**

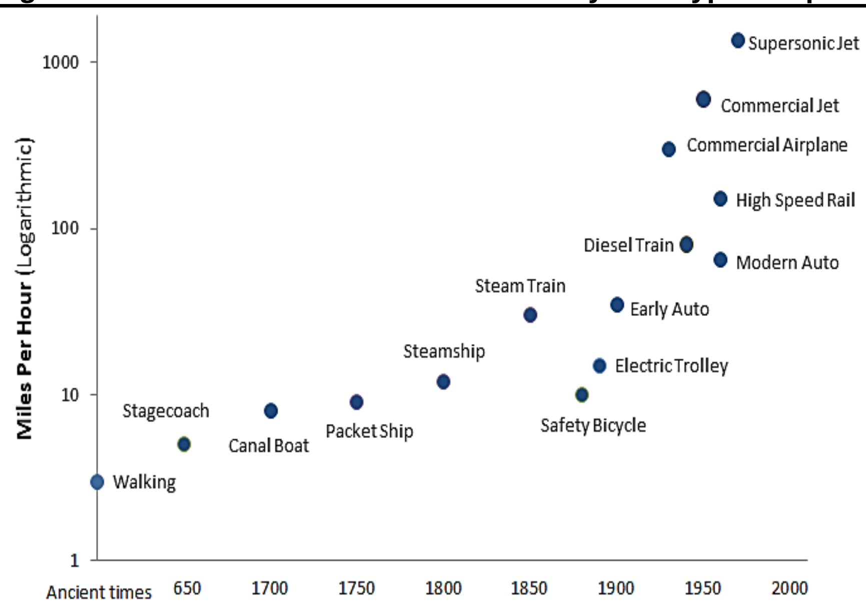


This report examines whether speed is overvalued compared with other planning goals. Current practices often give speed more weight than all other impacts combined.

A Short History of Speed

Until recently, transportation progress consisted of faster modes, from walking to horse travel, sailing ships, bicycles, trains, automobiles, airplanes, to supersonic jets, as illustrated in Figure 3.

Figure 3 **New Modes' Initial Availability and Typical Operating Speed** (Various Sources)

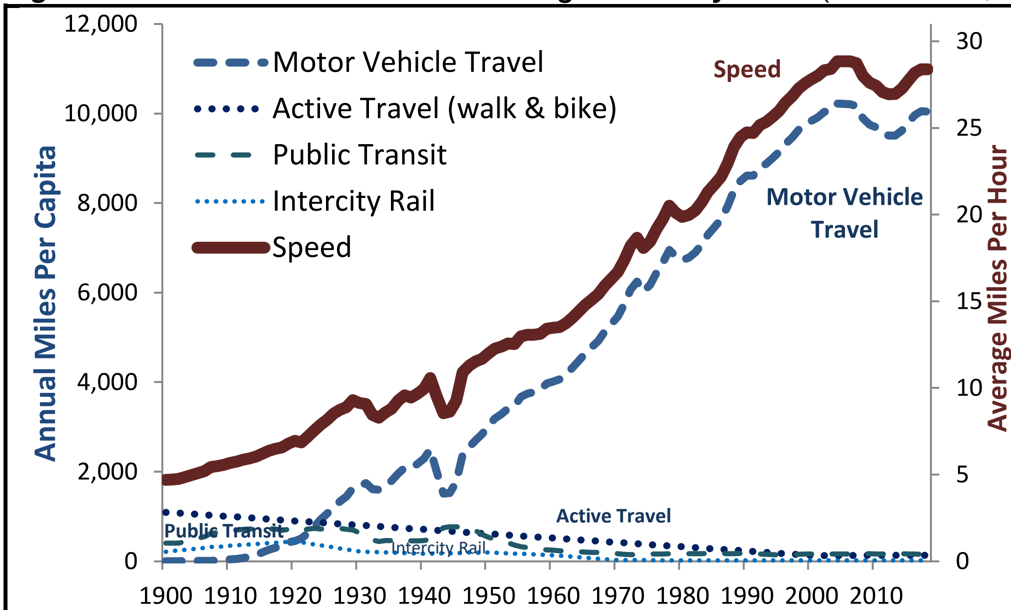


For most of history, transportation progress consisted of the development of faster modes. Increased travel speeds provided many benefits, but also imposed many costs.

Note that speed is indicated on a logarithmic scale so small increases in height indicate large increases in speed.

In recent decades this significantly increased people's average speed and distance, as illustrated below. During the Twentieth Century, motorization increased average travel speeds from about 4 to 30 mph, and per capita travel from about 1,000 to 10,000 annual miles or 12,000 annual miles per motor vehicle.

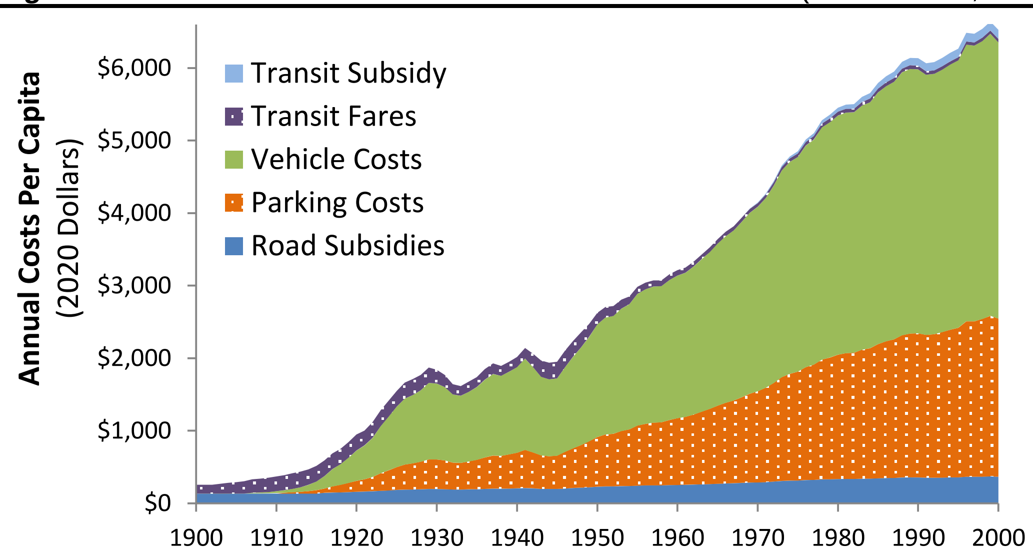
Figure 4 **Estimated Annual Passenger-Miles by Mode** (Litman 2020, Exhibit 8)



Before 1900 travel most people travelled primarily of walking, with occasional bike and rail trips. During the Twentieth Century, motor vehicle travel grew. This increased average speeds from about 3 to 30 mph, mobility from about 1,000 to 10,000 annual miles per capita, and reduced travel by other modes.

Increased motorized travel significantly increased transportation costs, as illustrated below.

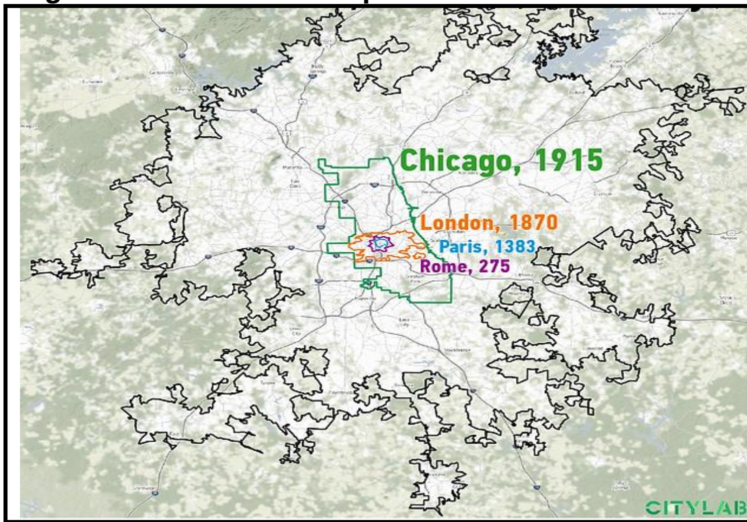
Figure 5 **Estimated Vehicle and Infrastructure Costs** (Litman 2020, Exhibit 36)



As vehicle travel increased during the Twentieth Century, transportation costs increased significantly. Per capita inflation-adjusted expenses are estimated to have increased from less than $200 in 1900 to more than $6,000 dollars in 2000.

Expanded roads and parking facilities, increased motor vehicle traffic, and reduced investment in slower modes degraded urban areas and encouraged sprawled development, illustrated in Figure 6.

Figure 6 **How Transportation Affects Urban Development** (English 2019; Mouzon 2012)



Ancient Rome and Paris were compact walking cities. London and Chicago expanded along rail lines to create transit-oriented suburbs. Greater Atlanta is a sprawled, automobile dependent city where it is difficult to get around without a car.

These examples illustrate how faster travel encourages urban dispersion – sprawl – which increases the travel distances required for a given level of accessibility. As a result, speed increases do not usually provide travel time savings; over the long run they generally cause people to travel more.

During the Twentieth Century, planners used optimistic assumptions about the benefits of faster travel in order to justify highway projects. For example, they used high values of travel time savings, and ignoring potential costs of induced travel and sprawl (Litman 2017; Metz 2021). However, many of the demographic and economic trends that increased demand for higher travel speeds are changing. Traffic speeds and per capita vehicle mileage have peeked in most developed countries, and many urban regions have reached the practical limits of expansion (OECD 2012). Surveys indicate that many people want to drive less and rely more on slower modes (NAR 2017). New technologies, such as e-bikes and telework, improve alternatives to driving. Planning increasingly evaluates transport system performance based on *accessibility*, not just *mobility*, which places a higher value on slower modes and compact development (Litman 2013). Traffic speeds *could* increase if citizens were willing to bear higher costs but there appears to be little support; few protest, "Raise my taxes to finance urban roadway expansions!"

The Demand for Speed

Travel demand refers to the type and amount of travel that people would choose in a particular situation. A key question in this analysis is the demand for speed and for slower modes, and the degree that conventional planning reflects these preferences.

Of course, people are sometimes willing to pay a high price for faster travel, for example, in an emergency, but travellers often value other goals. For example, motorists often choose a slower but more scenic route, and commuters will sometimes walk, bike or use public transit for the sake of affordability, health or enjoyment. Surveys also indicate that, although few motorists want to give up driving altogether, many want to drive less, use slower modes, and reduce their transportation costs. The National Association of Realtors' *Community Preference Survey* (NAR 2017) found that most respondents prefer walkable neighborhoods over automobile-dependent areas, even if that requires living in a townhouse or apartment rather than a detached home; 86% prioritize sidewalks and other walking facilities; 62% prioritize public transit access; 54% prioritize bike lane, path and trail access; and 59% said they drive more than optimal because they lack alternatives.

Some highways have tolled express lanes that test motorists' demand for faster travel. They indicate that, although some motorists are willing to pay cost-recovery tolls (tolls sufficient to finance highway expansions), most would rather save money than time, indicating that they will only choose faster roadways if the higher costs are subsidized (Howard and Williams-Derry 2012; Parsons Brinckerhoff 2012; Prozzi 2009). For example, on the Katy Freeway, only about 10% of motorists are willing to pay tolls to avoid congestion delays, indicating that 90% of motorists value their time at less than $8 per hour (Burris 2016).

In addition, many communities recognize new planning goals such as affordability (cost burdens on lower-income households), equity (impacts on disadvantaged groups), public health, community livability, and environmental quality, which slower modes and traffic speeds tend to support. The table below compares the range of benefits provided by various speed-related planning decisions.

Table 2 **Comparing Transportation Improvement Options**

Community Goals	Improve Auto Travel	Expand Roadways	Improve Slower Modes	Reduce Road Design Speeds
Total Vehicle Travel	*Increased*	*Increased*	*Reduced*	*Reduced*
Increase motorists' speed and access	✓	✓	✓/×	×
Increase non-drivers' speed and access	×	×	✓	✓
Consumer savings and affordability	×	×	✓	✓
Traffic safety	×	×	✓	✓
Physical fitness and health	×	×	✓	✓
Road and parking cost savings	×	×	✓	✓
Energy conservation reduced pollution	×	×	✓	✓
Community livability and cohesion	×	×	✓	✓
Reduce sprawl-related costs	×	×	✓	✓

Improving automobile travel and expanding roadways increases motorists speed and access, but tends to contradict other community goals. Improving slower modes (walking, bicycling and public transit) and reducing traffic speeds improves non-drivers' accessibility, and by improving affordable and resource-efficient mobility options and reducing total vehicle travel, these actions help achieve a wider range of goals. (✓= supports goal. ×= contradicts goal.)

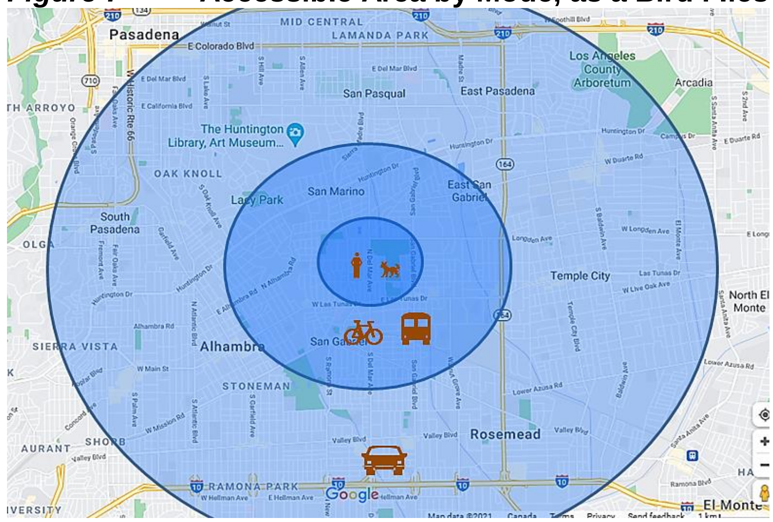
Speed Benefits and Costs

This section examines various benefits and costs of increased travel speed.

Increased Access

Faster travel expands the area that people can access. In 20-minutes a pedestrian can typically reach an area of about 3 square miles, a bicyclist or transit passenger about 30 square miles, and a motorist averaging 30 mph about 300 square miles as illustrated to the right

Figure 7 Accessible Area by Mode, as a Bird Flies

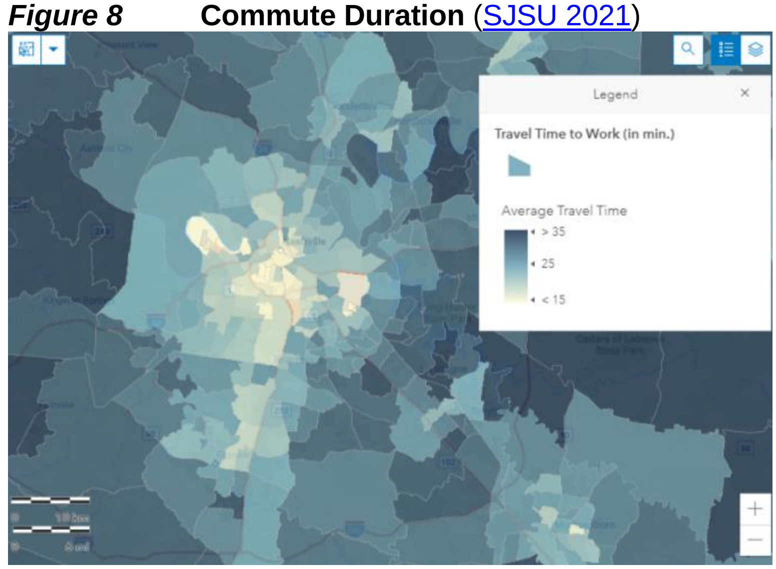


In 20-minutes a 3 mph pedestrian can reach about 3 square miles of area, a 10-15 mph bicyclist or transit passenger about 30 square miles, a 30 mph motorist about 300 square miles, as the crow flies.

Many jobs, lifestyles and hobbies are only feasible with the higher speeds offered by automobile travel. However, vehicle speeds are just one of many factors that affect accessibility; others include the quality of non-auto travel, network connectivity, development density and mix, and mobility substitutes such as telecommunications (Levinson, Marshall and Axhausen 2018). Development density tends to affect accessibility more than vehicle travel speed (Levine, et al. 2012). There are often trade-offs between these factors: money and road space invested in faster modes are unavailable investment in slower modes, designing roadways for maximize traffic speeds tends to reduce their connectivity and local accessibility, and highway-oriented sprawl increases the distances between destinations.

New accessibility models can evaluate and compare these factors (Sundquist, McCahill and Brenneis 2021). For example, the [*Metropolitan Chicago Accessibility Explorer*]() indicates that with a half hour maximum commute, central neighborhood residents can access more than 700,000 jobs by bicycle and 500,000 jobs by transit, which is more than many suburban motorists can reach in the same amount of time. On average, urban residents spend less money and time travelling than suburban residents, as illustrated in Figure 8. This indicates that traffic speed is less important than other accessibility factors, so more compact development with greater proximity and slower modes tends to maximize accessibility overall.

Figure 8 Commute Duration (SJSU 2021)



This map of the Nashville region shows that commute duration tends to be lower in central areas than outer suburbs, because their lower traffic speeds are offset by shorter trips distances.

Travel Time Savings

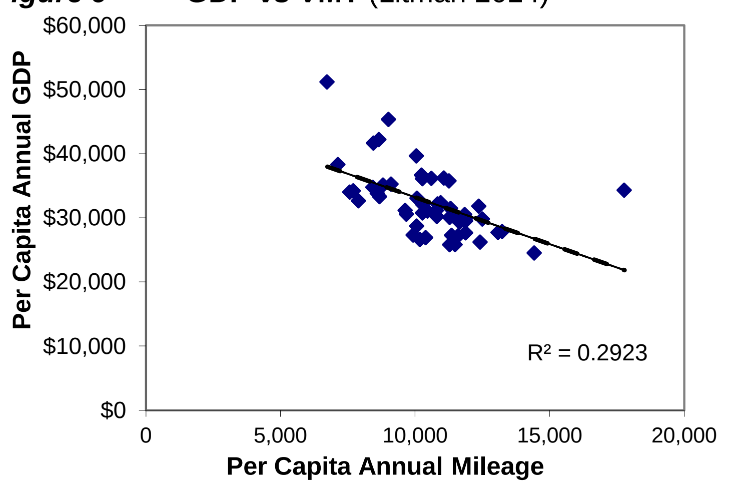
Transportation planners often assume that increased travel speeds saves travel time, and value these savings at 35% to 60% of wages for personal travel, and more for commercial travel ("Travel Time," Litman 2018; USDOT 2011). This approach tends to overvalue speed gains and undervalue slower modes. In practice, people tend to maintain fixed travel time budgets (Ahmed and Stopher 2014). Studies around the world indicate that most people devote 60-80 daily minutes to out-of-home personal travel, called *Marchetti's Constant* (Marchetti 1994). As a result, over the long run, travel speed increases usually result in more mobility rather than saving time. For example, when searching for a home or job, workers usually look for a 30 minute maximum commute, and shoppers generally choose stores they can reach in less than 15 minutes. If traffic speeds increase, commuters and shoppers expand their destinations, increasing vehicle travel. The resulting benefits tend to be modest since the increased mobility consists of marginal-value vehicle-miles that motorists are most willing to forego if their time costs increase, and the additional vehicle travel increases external costs such as facility, crash and pollution costs. The value of travel time can vary significantly depending on preferences and conditions, particularly for vulnerable modes such as walking, bicycling and public transit. Under favorable conditions, travel can have positive value, while under unpleasant conditions it has high unit costs (Mokhtarian 2005).

This has important implications for speed valuation (Metz 2015; Standen 2018). For example, although speed gains sometimes provide large benefits (motorists would pay a lot to save a few minutes), other attributes such as affordability and comfort are often more important (Burris, et al. 2016). Reductions in traffic speed and shifts from faster to slower mode do not necessarily increase travel time costs if they provide a less stressful or more enjoyable travel experience, and increased comfort, for example, by reducing transit crowding, can provide travel time cost savings equivalent to an increase in speed.

Economic Development and Opportunity

Faster travel can sometimes increase economic productivity and opportunity, for example, by allowing commercial vehicles to reach more destinations per shift, expanding the pool of workers available to employers, and increasing the jobs and services available to residents (Ewing, et al. 2016; Smart and Klein 2015). However, slower mode improvements often provide similar productivity gains with lower total costs, for example, if more compact development increases agglomeration efficiencies, or bicycle and transit improvements expand labor pools with lower total costs than roadway expansions. Since faster modes, increased vehicle travel, and sprawl increase many economic costs, it is unsurprising that productivity tends to decline as per capita vehicle travel increases, as shown in Figure 9 (Chatman and Noland 2013; Litman 2014). This suggests that improvements to slower modes and Smart Growth development policies often increase economic development more than automobile-oriented improvements.

Figure 9 **GDP vs VMT** (Litman 2014)

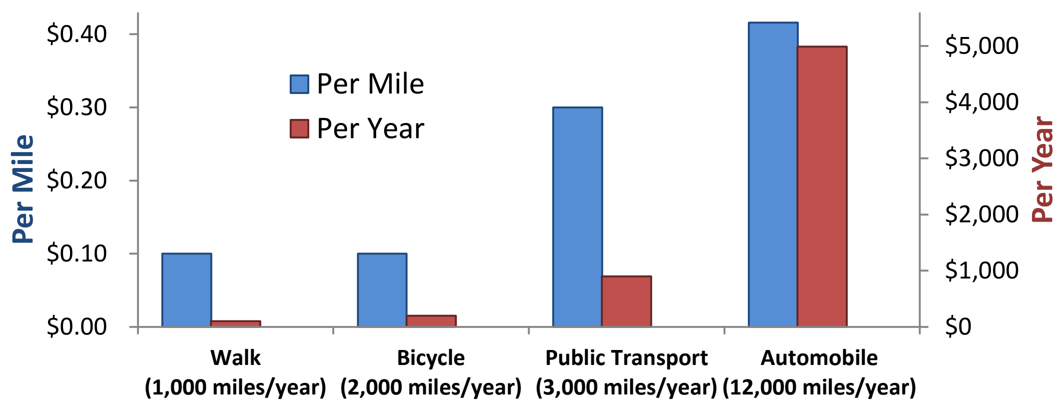


Per capita Gross Domestic Product (GDP) declines with per capita vehicle travel, indicating that faster travel does not necessarily support economic development. (Each dot is a U.S. state.)

Traveller Comfort and Stress
Although some motorists enjoy the thrill of speed, higher traffic speeds generally reduce travel comfort and increase driver stress. Motorists often choose slower roads, such as tree-lined city streets, windy country lanes, and scenic highways, over higher speed arterials and highways. Commuters who drive long distances tend to be less satisfied and more stressed than those who walk, bike, use comfortable public transit, or have shorter car trips (Wei 2015). This suggests that the quality of travel should be valued as much as speed, which justifies more investments in active and public transport, with particular attention to user convenience and comfort, plus lower roadway design speeds and more streetscaping.

Vehicle Expenses
Faster travel tends to increase vehicle costs. A typical pedestrian spends an extra $100 per year on shoes to walk 1,000 miles; a typical bicyclist spends $200 extra per year to ride 2,000 miles; a typical transit user spends $600 on fares to ride 2,000 annual miles; and a typical motorist spends about $5,000 per year to drive 12,000 annual miles. Figure 10 compares these costs measured per mile and year.

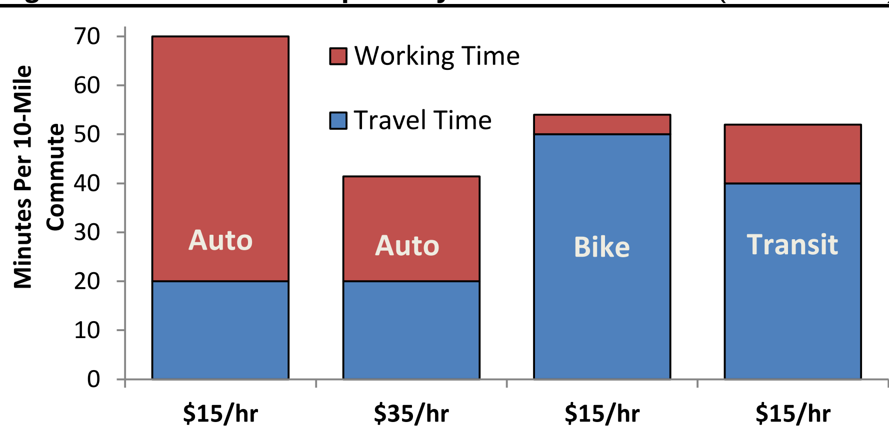
Figure 10 **Typical User Cost** (Litman 2020)



Faster modes tend to have higher costs per-mile, and much higher costs per year due to more annual miles.

These costs can be evaluated using *effective speed*, which measures distance travelled divided by time spent traveling *and* earning money to pay for travel (Tranter 2010), illustrated in Figure 11. Blue bars show time spent travelling and red bars show time spent earning money to pay travel expenses.

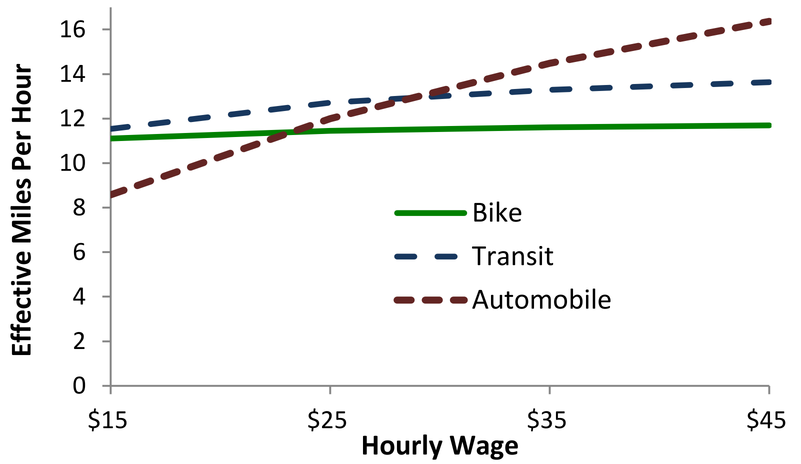
Figure 11 **Effective Speed by Income and Mode** (Litman 2020)



Measured by effective speed (time spent travelling and earning money to pay travel expenses), bicycling and transit are often faster than driving for lower-wage workers. (Assumes bicycling 12 mph, 10¢/mile; Public Transit 15 mph, 30¢/mile; Auto 25 mph, $5,000 and 4,000 annual miles for $15/hr. motorists and $7,000 and 12,000 annual miles for $35/hr. motorists.)

Since lower-wage workers must spend more time earning their travel expenses and drive fewer average annual miles, effective speeds increase with income, as illustrated in Figure 12. Measured this way, automobile travel is regressive, and improvements to slower modes increase affordability and equity.

Figure 12 **Effective Speed by Income**



Effective speed considers time spent traveling and working to pay travel expenses. It therefore increases with income. For lower-wage workers, bicycling and public transit are often faster than driving.

As a result, planning practices that favor automobile travel over more affordable modes are regressive, they favor higher-income over lower-income travellers.

Infrastructure Costs

Faster modes, higher travel speeds, and the additional vehicle travel they generate increase the size and costs of transportation infrastructure (Mouzon 2012). Building and maintaining sidewalk and bikeways typically costs $20-50 annual per capita, public transit services typically cost $50-100 annual per capita, while public road cost about $800 and off-street parking facilities $2,000 to $4,000 annual per capita (FHWA 2018, Table HF10; Litman 2018). Higher speeds require more *shy distance* (clearance between vehicles and other objects), which requires more and wider traffic lanes, and more complicated intersections. For example, at 20 mph a car requires approximately 500 square feet (sf) of road space, but at 60 mph requires about 1,500 sf, as illustrated below.

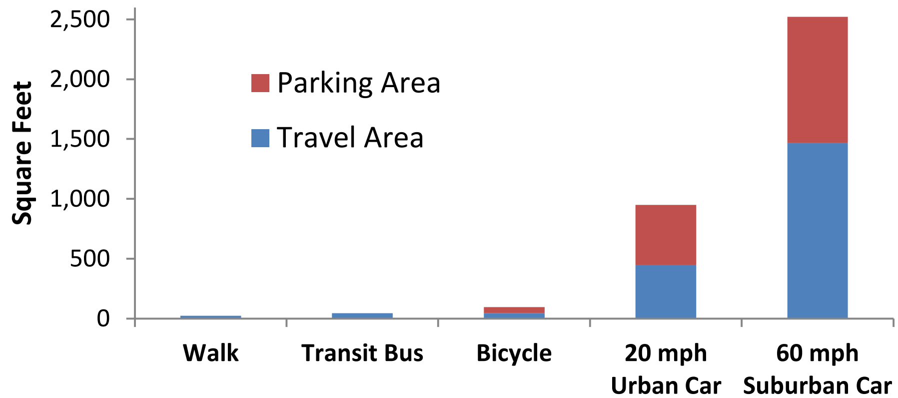
Figure 13 **Road Space Requirements by Vehicle Speeds**

MPH	Road Space Required	
20		15’ x 3 x 11’ = **490** sf
40		15’ x 5 x 12’ = **900** sf
60		15’ x 7 x 14’ = **1,470** sf

As traffic speeds increase vehicles require more shy distance (clearance from other objects), including space ahead and to the side. Assuming one 15-foot car length for each 10 miles per hour (mph), an increase from 20 to 60 mph approximately triples a vehicle’s road space requirements and associated roadway costs.

In compact areas motorists often share parking spaces but sprawl requires more off-street spaces, increasing land consumption, as illustrated below. Higher speeds also increase highway safety requirements. All these factors increase infrastructure construction, maintenance and operating costs.

Figure 14 **Road and Parking Space Required by Travel Modes**

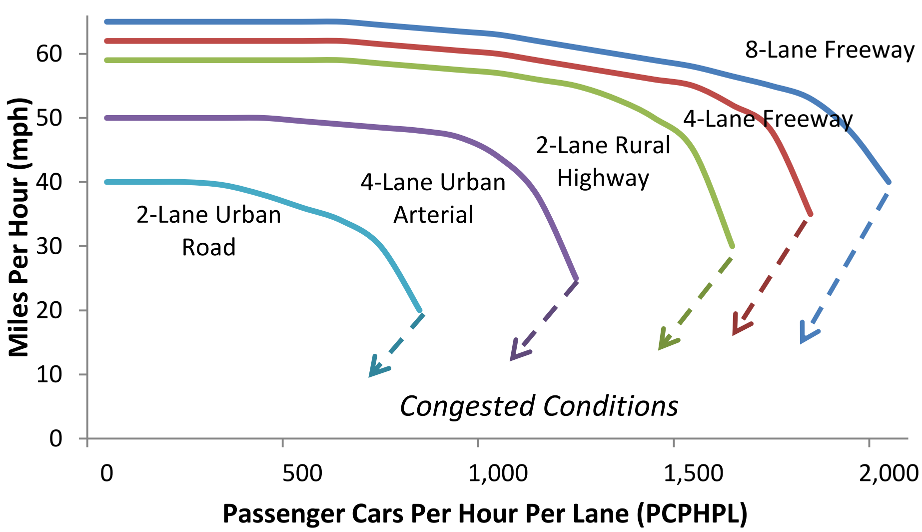


Faster modes and higher speeds require more space for travel and parking, plus more complex intersections, more road maintenance, and more traffic safety programs. As a result, higher speeds increase infrastructure costs.

Congestion and Barrier Effect Costs

As previously mentioned, automobiles require far more travel space per passenger-mile than slower modes, and their space requirements increase with speed. Roadway capacity, the maximum number of vehicles a road can carry per hour, tends to peak at 30-50 mph on highways and less on surface streets, as illustrated below. As a result, increased speed increases the congestion costs vehicles impose on other road users, or requires costly roadway expansions.

Figure 15 **Speed Flow Curves** (based on Hall 1994)



Although details vary depending on roadway design and conditions, traffic capacity (vehicles per hour) is maximized, and therefore traffic congestion is minimized, at moderate traffic speeds, typically 20-40% lower than maximums.

As a result, speed reductions tend to increase peak-period roadway capacity and reduce congestion.

Wider roads and higher vehicle traffic speeds also increase the delay and risk imposed on pedestrians and bicyclists, called the *barrier effect* (Litman 2018). This harms active travellers and causes some to shift to motorized modes, which increases traffic problems.

Crash Costs

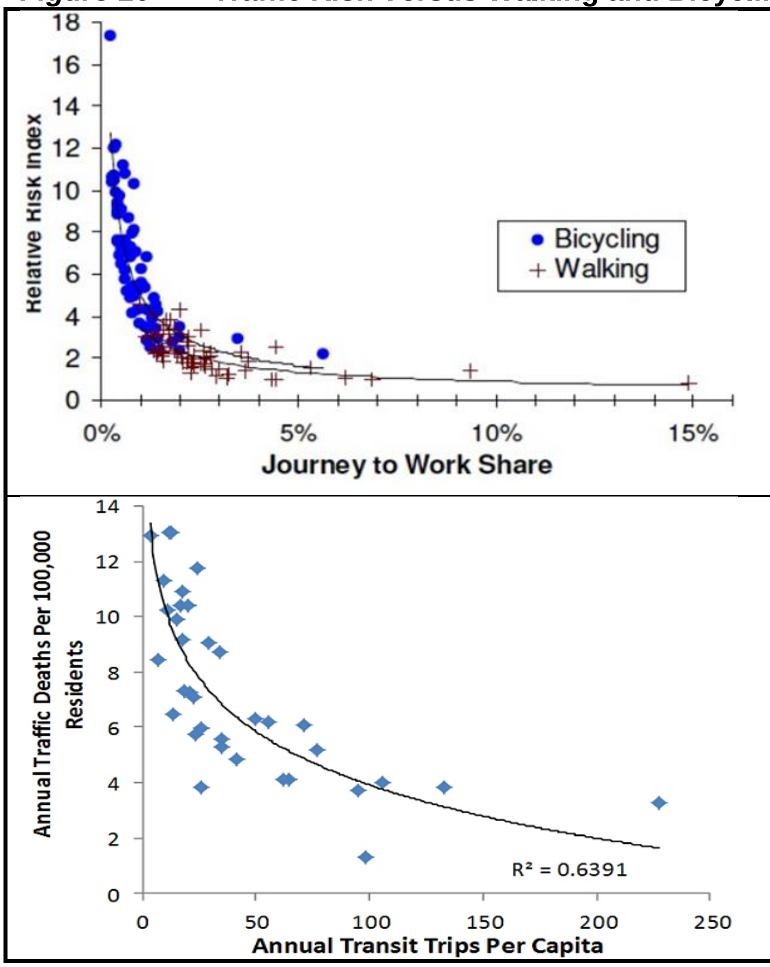
Crash casualties increase with speed for reasons described in the box to the right. These speed-related factors help explain why per capita traffic fatality rates are five to ten times higher in sprawled, automobile-dependent areas than in compact, multimodal communities (Ewing, Hamidi and Grace 2015).

Total traffic casualty rates tend to decline with reduced vehicle travel, lower traffic speeds, and increased active and public transit travel (Larson 2018; Welle, et al. 2018), as illustrated below. Elvik (2005 and 2009) found that crash casualty rates increase exponentially with speed, so a 1% change in speed causes more than 1% change in crashes. Taylor, et al (2000) estimate that each 1 mph traffic speed reduction reduces crashes by 3% to 6% on both urban and rural roads. Using U.S. data, Redelmeier and Bayoumi (2010) find that the travel time savings provided by higher speeds are more than offset by reduced longevity and increased crash delays.

Traffic Risks (NACTO 2020)
Higher speeds increase crash risk in these ways:

1. Reduces drivers' field of vision, reducing their chance of seeing and avoiding hazards.
2. Increase reaction and braking distances, reducing the chance of avoiding crashes.
3. Increase crash severity. For example, pedestrian crash survival rates decline from 90% at 20 mph to just 10% at 40 mph.
4. Increases total vehicle travel and therefore total risk exposure.
5. Automobile dependency and sprawl reduce traffic safety program effectiveness. For example, anti-impaired driving programs are more effective in multimodal communities where drinkers have alternatives to driving.

Figure 16 **Traffic Risk Versus Walking and Bicycling** (Jacobson 2003; Litman 2019)



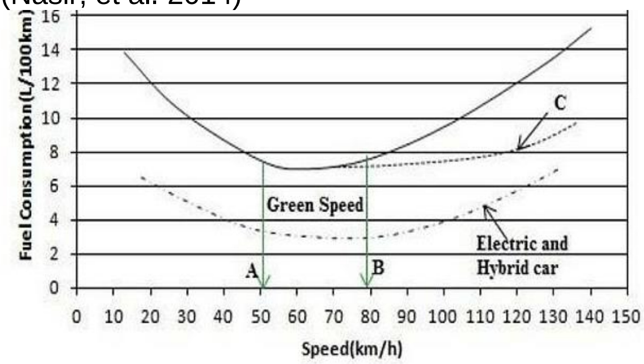
Several studies find that total (all mode) crash rates tend to decline as walking, bicycling and public transit mode shares increase in a community, an effect called "safety in numbers." This probably reflects the combination of reduced traffic speeds, more caution by drivers, reduced risk imposed by active travel, and reduced total vehicle travel.

This indicates that planning that improves and encourages slower modes tends increase safety for all road users, particularly if it helps reduce total per capita vehicle travel and sprawled development.

Energy Consumption and Pollution Emissions

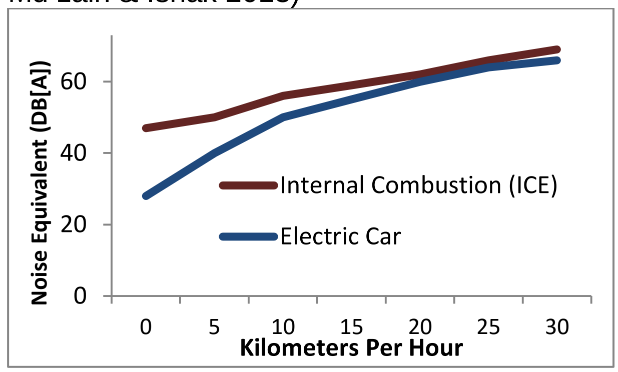
Under typical highway conditions, motor vehicle fuel economy peaks at 50 to 80 kilometers per hour (kph, about 30 to 50 mph), and less under stop-and-go conditions (Figure 17). One study estimates that reducing highway speeds from 120 to 110 km/h could reduce fuel consumption and related emissions by diesel cars by 12% and gasoline cars by 18% (EEA 2020). Motor vehicle noise also increases with speed (Figure 18). Although electric cars produce less noise than internal combustion engines at low speeds, the differences decline at speeds over 20 kph, as tire and wind noises increase.

Figure 17 **Fuel Economy Versus Speed** (Nasir, et al. 2014)



Under typical highway conditions, motor vehicle fuel economy peaks between 50 and 80 kph (30 to 50 mph). Although electric and hybrid cars are use less energy they have similar efficiency curves

Figure 18 **Noise Versus Speeds** (Salleh, Md zain & Ishak 2013)



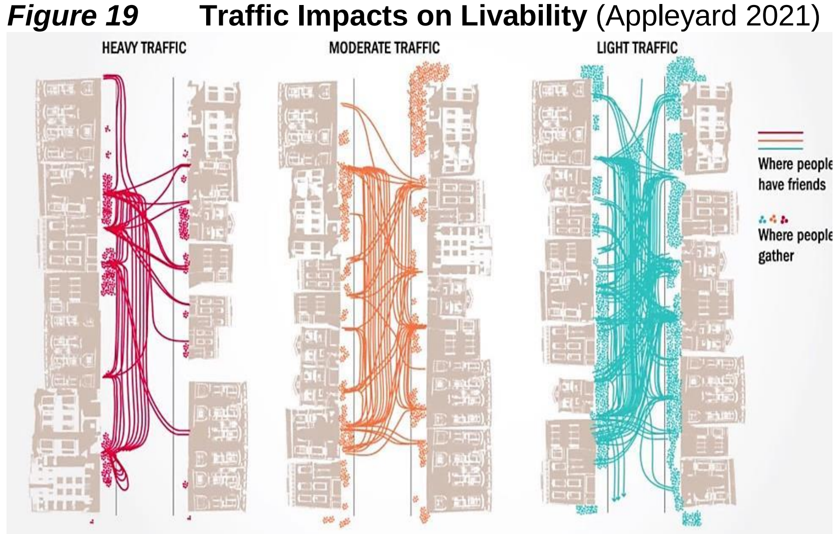
Vehicle noise increases with speed. Although electric cars produce less noise than internal combustion engines (ICEs), the differences decline with speed.

Community Livability and Cohesion

Higher traffic speeds tend to reduce *community livability* (local environmental qualities such as safety, quiet, air quality, and attractiveness), and *community cohesion*, the quality of interactions among residents in a neighborhood, as illustrated to the right. Higher travel speeds offer fewer opportunities for social interaction, such as unplanned conversations that occur among residents, businesses, pedestrians and transit passengers.

Cortright (2017) found a negative correlation between travel speeds and transportation system satisfaction: residents in lower speed regions tend to be more satisfied than those in higher-speed regions.

Figure 19 **Traffic Impacts on Livability** (Appleyard 2021)



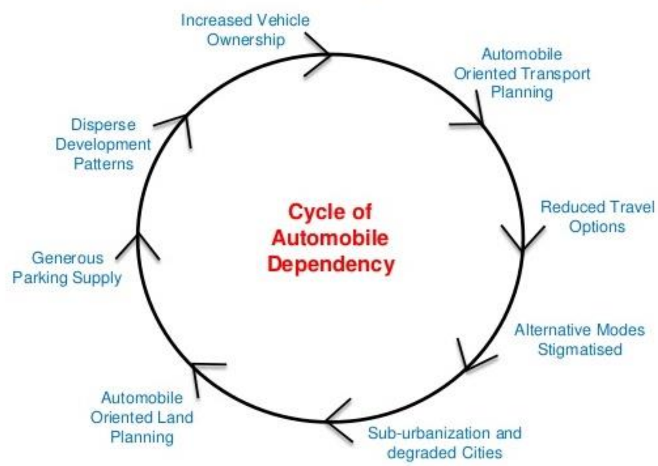
As traffic speed and volumes increase, community livability features, such as neighborhood social interactions, tend to decline.

Automobile Dependency and Sprawl
Speed-prioritized planning tends to increase automobile dependency and sprawl in the following ways (Ewing and Hamidi 2017; Handy, Weston and Mokhtarian 2005; Shill 2020):

- Roadway expansions and resulting increases in traffic speeds create barriers to active travel (called the *barrier effect*), and degrade urban environments, making slower modes less efficient relative to automobile travel and urban locations less attractive relative to sprawled locations.
- Minimum parking requirements increase the costs of infill in areas with high land values, which favors development at the urban fringe where land is cheaper.
- Many urban highways displaced high-accessibility urban neighborhoods (Brinkman and Lin 2019).
- Public expenditures on faster modes leave less money to invest in slower modes.

These factors contribute to a self-reinforcing cycle of automobile dependency and sprawl, as illustrated to the right. Together they reduce non-auto travel options and create more dispersed communities where people must travel farther to reach services and activities, reducing accessibility, particularly for non-drivers. This tends to be costly (Handy 2020). People who live or work in automobile-dependent, sprawled areas must drive more, spend more money on transportation, require more costly infrastructure, and spend more time travelling than residents of compact, multimodal neighborhoods. These additional costs can be considered indirect, long-term impacts of speed-prioritizing transport planning.

Figure 20 **Cycle of Automobile Dependency**



Past trends contributed to the cycle of automobile dependency and sprawl. Many are starting to change.

Social Equity Impacts
Social equity refers to the distribution of impacts (benefits and costs) and the degree that those are considered fair and appropriate. *Horizontal equity* (also called *fairness*) assumes that similar people should be treated similarly. *Vertical equity* (also called *justice* or *progressivity*) assumes that physically, economically and socially disadvantaged people should be favored over people with more advantage. Speed can have the following equity impacts:

- Speed-prioritizing planning favors faster modes, particularly automobiles, over slower but affordable and inclusive modes. The result is often unfair (motorists receive an excessive share of funds and road space), and since vehicle travel often increases with income, it tends to be regressive.
- Higher speeds increase delay, risk, noise and pollution that vehicle traffic imposes on active modes.
- Urban highways often displace lower-income neighborhoods, which is unfair and regressive.
- Automobile-dependency and sprawl reduce affordable and inclusive transport options, which harms people who cannot drive or have low incomes. This reduces their economic opportunities, their ability to access schools, jobs and affordable services.

Summary of Impacts

Table 3 summarizes these impacts. Many of these effects are exponential, so modest increases in speed can cause large increases in costs. For example, increasing urban traffic speed from 20 to 30 mph tends to significant increase congestion, crash risk and noise.

Table 3 **Speed Impacts**

Impact Category	Effects of Higher Speeds
Accessibility	Increases the area that motorists can reach in a given time period.
Travel time costs	Allows travellers to save time, although, instead they usually travel farther.
Economic development and opportunity	Increase productivity and opportunity in some ways but reduces it in others. Automobile dependency and sprawl tend to reduce productivity overall.
Traveler comfort and driver stress	Generally reduces comfort and increase stress.
Vehicle costs	Faster modes and speeds usually increase vehicle costs.
Infrastructure costs	Faster modes require much more costly roads and parking facilities.
Congestion and barrier effect	Requires more road space, which increases congestion delays.
Crash costs	Significantly increases crash frequency, severity and exposure.
Energy consumption and pollution emissions	Beyond optimal speeds (30 to 50 mph on highways and less on surface streets) increased speed increases energy consumption, noise and pollution emissions.
Community livability and cohesion	Faster traffic tends to reduce community livability factors including safety, quiet, and community cohesion (positive interactions among people).
Automobile dependency and sprawl	Contributes to a cycle of automobile dependency and sprawl, which increases driving, reduces non-auto modes, and disperses destinations.
Social equity	Speed-prioritizing planning that increases traffic speeds, automobile dependency and sprawl tend to be unfair and regressive.

Higher speeds have various impacts on travellers and communities.

How Speed is Considered in Transportation Planning

This section examines how conventional planning evaluates various speed-related impacts.

Travel Time Savings

Conventional planning often assumes that faster travel provides time savings, ignoring travellers' tendency to maintain fixed travel time budgets, so increased speed actually increases travel distances rather than saving time. Planning often assumes that higher speeds increase productivity and leisure time, sometimes described as "commuters can spend more time with their family," when their actual benefit is increased access to more dispersed housing and shopping options, which increases external costs caused by vehicle traffic and sprawl. Planning also tends to exaggerate the value that travellers place on travel time. It often values personal time at 30-60% of traveller wages, which is often much more than they are actually willing to pay, for example, when choosing between a faster but expensive mode or route, and a slower but lower costs alternative (Burris 2017). This exaggerates the benefits and understates the costs of faster traffic (Litman 2016).

Accessibility Trade-Offs
Conventional planning often overlooks and undervalues trade-offs between traffic speed and other accessibility factors, and therefore delays to other travel modes. For example:

- Wider roads and faster traffic increase walking and bicycling delay and risk (called the *barrier effect*), which shifts some active travel to chauffeured car trips, imposing time costs on drivers.
- Hierarchical road networks (smaller streets that connect to larger arterials but not each other) and one-way streets reduce connectivity, which increases the travel distances between destinations.
- High parking minimums encourage sprawled development, and urban highways displace high-accessibility urban neighborhoods, which increase travel distances and reduce non-auto access.
- Resources devoted to increasing traffic speeds are unavailable for other accessibility improvements such as active mode facilities, and public transit service improvements, or affordable infill housing.

Cost Trade-Offs
Conventional planning often overlooks and undervalues many speed-related costs. For example:

- Reduced active travel comfort and safety, and increased driver stress.
- Increase user costs and reduced affordability (costs imposed on lower-income households).
- Increased road and parking infrastructure costs.
- Increased congestion and barrier effects.
- Increased crash costs. Planning generally considers how speed affects crash rates on a particular facility, but generally ignores the additional crashes caused by induced vehicle travel (TRB 2021).
- Increased energy consumption and pollution emissions.
- Reduced community livability and cohesion.
- More automobile dependency and sprawl reduce overall accessibility and travel options, and therefore increase the amount of vehicle travel required to access services and activities. These changes impose various economic, social and environmental costs.

Consumer Preferences
Conventional planning assumes that most travellers prioritize speed over other goals, and gives little consideration to preferences for slower but more affordable, healthy and low-stress mobility options. Standard performance indicators measure travel speed and delay, but overlook other impacts.

Social Equity Impacts
Conventional planning considers horizontal equity, such as whether each area receives their fair share of roadway funding, but gives less consideration to the fairness by which money and road space is allocated between faster and slower modes, or how those impacts affect disadvantaged groups (such as how slower traffic speeds affect people with disabilities or low incomes). Transportation agencies produce little data for evaluating such impacts.

Table 4 summarizes these impacts.

Table 4 **Consideration of Speed Impacts in Conventional Planning**

Impacts of Higher Speeds	Consideration in Conventional Planning
Increased motorist access	Often described and sometimes quantified.
Travel time savings	Often quantified. Is generally the largest impact considered.
Economic development and opportunity	Often exaggerates the benefits and overlooks the costs of speed, and underestimates the economic benefits provided by slower modes.
Reduced traveler comfort and increased driver stress	Generally ignored. Seldom considers the discomfort and stress of higher speeds.
Increased vehicle costs	Generally ignores the increased user costs of shifts from slower to faster modes, and from induced travel and sprawl.
Increased infrastructure costs	Considers direct costs but not the added costs from induced travel and sprawl.
Congestion and barrier effect	Congestion costs are considered but barrier effect costs are generally ignored.
Crash costs	Considers how speed changes affect distance-based crash rates, but generally ignores the increased per capita crash rates caused by induced travel.
Energy consumption and pollution emissions	Considers how speed changes affect fuel consumption and emission rates, but generally ignores the impacts of induced vehicle travel and sprawl.
Community livability and cohesion	Generally ignored. Seldom considers qualitative factors.
Automobile dependency and sprawl	Generally ignored. Integrated transportation and land use models can predict these impacts, but they are seldom used for individual project evaluations.
Social equity	There is little analysis of the fairness of investments in faster vs. slower modes.

Conventional evaluation tends to describe and quantify the direct user benefits of increased speeds but overlooks or undervalues many costs, particularly the indirect and long-term costs of induced vehicle travel and sprawl.

Traffic speed optimization guides, such as the Transportation Research Board's *Development of a Posted Speed Limit Setting Procedure and Tool* (TRB 2021), consider trade-offs between travel time and crash rates but give little consideration to other community goals such as affordability, social equity and health (AARP and CNU 2021; Frith 2012; OECD 2020; Standen 2018). Many transport data sources, such as census and surveys, undercount slower modes and shorter trips, which makes them seem unimportant. Most of these models overlook or undervalue induced travel impacts, and so exaggerate the benefits and underestimate the full costs of highway expansions and higher traffic speeds (Sundquist 2020). Newer, accessibility-based models better reflect the benefits of slower modes and more compact development (Levinson and King 2020).

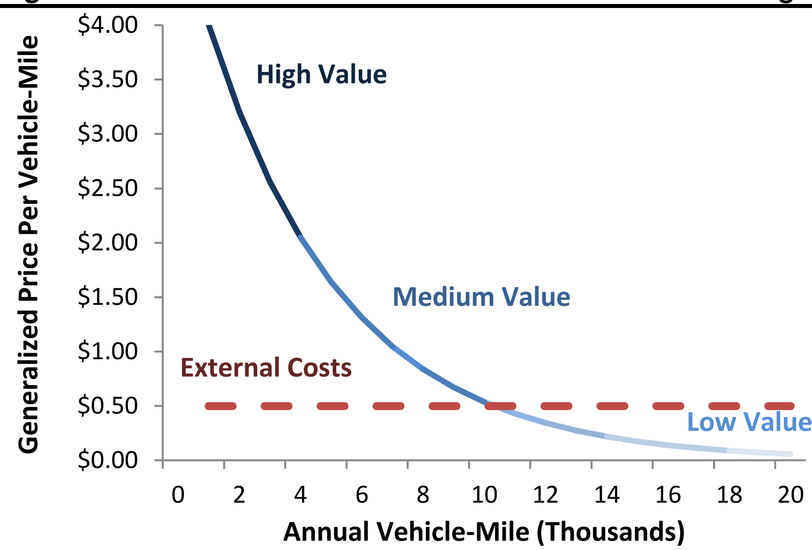
Conventional planning often does consider livability impacts through public consultation and political intervention, which sometimes limit urban highway projects and reduce design speeds (Brinkman and Lin 2019), but this occurs despite rather than supported by formal economic analysis. More comprehensive analysis of speed impacts and induced travel would reduce emphasis on mobility and increase emphasis on multimodal accessibility in the planning process.

Impacts on Planning Decisions

The previous section indicates that common planning practices tend to exaggerate the benefits and underestimate the costs of increased travel speeds. This favors faster over slower modes, higher roadway design speeds, and sprawl over compact development. These practices developed when most transportation professionals assumed that their job was to build highways, and so are unsuitable for achieving system efficiency or social equity goals.

Although automobiles are expensive to own, with thousands of dollars in annual fixed costs, they seem cheap to use, costing just a few cents per vehicle-mile. This price structure encourages motorists to maximize their driving in order to "get their money's worth" from their large expenditures. The demand for mobility is virtually unlimited: if travel time and money costs decline, people tend to travel more, although the benefits of each additional vehicle-mile decline, since rational travellers choose higher-value before lower-value travel, reflecting the principle of *declining marginal benefits*. Figure 21 illustrates a travel demand curve, which shows the relationship between marginal user costs and annual vehicle-miles. Because automobile travel imposes large external costs, much of this travel may be economically inefficient: its incremental user benefits are smaller than its total costs, including infrastructure, congestion, crash, and pollution external costs.

Figure 21 **Automobile Travel Demand Curve – A Long Tail**



Motorists only consider generalized prices – their perceived variable time and money costs – when making most travel decisions. They ignore large fixed and external costs.

Vehicle travel demand has a long tail; if driving becomes cheaper people tend to drive more, even if the additional vehicle-miles provide little user benefit; often less than the external costs it causes. By favoring faster modes, higher speeds and sprawl, speed-prioritizing transport planning encourages high-mileage, low benefit vehicle travel.

This indicates that speed-prioritizing planning practices have these results:

- Less affordable, healthy and resource-efficient travel. Communities are less walk- and bikeable.
- Faster and more vehicle travel than is optimal. A major portion of this additional vehicle travel is economically-inefficient; its incremental user benefits are less than its external costs.
- Communities are more automobile-dependent and sprawled. More vehicle travel is required to access services and activities. Total transportation costs increase, including external costs.
- The transportation system becomes less equitable due to reduced affordability, fewer mobility options for non-drivers, and increased external costs, including many that affluent motorists impose on disadvantaged people who walk, bike, ride transit, and live in urban neighborhoods.

Comprehensive Speed Evaluation

The following factors should be considered when evaluating travel speed changes.

1. ***Impacts on overall accessibility***, including accessibility by automobile and other modes. It should consider ways that wider roads and increased traffic may reduce access by non-auto modes.
2. ***Travel time cost variations*** and therefore the benefits (travel time cost reductions) of improving travel comfort and convenience, particularly for active and public transport modes.
3. ***Impacts on user costs and affordability*** (savings to lower-income households). Faster modes tend to be costly; lower-speed modes are more affordable.
4. ***External costs that increase with speed*** including road and parking infrastructure costs, congestion, crash risk and pollution emissions. These should be recognized, and where possible quantified.
5. ***Automobile dependency and sprawl.*** As much as possible, planning should describe, and if possible model, ways that increased traffic speeds will help create communities where it is difficult to get around without a car, and development is dispersed.
6. ***Social equity impacts*** including underinvestment in slower modes, harms that faster modes impose on slower modes, and impacts on disadvantaged groups. The table below indicates groups that benefit or are harmed by speed-prioritizing planning.

Table 5 **Speed-Prioritizing Equity Impacts**

Who Benefits	Who is Harmed
• Wealthier suburban motorists • Automobile industries and suburban developers	• People who need or prefer slower modes. • Motorists who spend more than they can afford on transport or have excessive chauffeuring burdens. • Urban residents harmed by traffic risk and pollution. • People harmed by environmental risks.

Speed-prioritizing planning tends to benefit some people, but harms others.

Because slower modes are so constrained, small increases in their speed or access can provide relatively large benefits. For example, a 1,000 foot shortcut saves pedestrians about the same amount of travel time as a motorist gains from two-mile shortcut. The value that people place on travel time varies. Under uncomfortable conditions, time spent travelling can have high unit costs, so improving travel comfort is comparable to increasing speeds, particularly for walking, bicycling and public transit travel.

It can be useful to compare the allocation of resources between faster and slower modes. Policies that favor faster modes often result in an unfair portion of funding and road space being devoted to automobile facilities to the detriment of walking, bicycling and public transit. Similarly, crash risk and casualty rates can be compared between faster and slower modes (Culver 2018).

New tools can help evaluate speed impacts. For example, multimodal level-of-service ratings can quantify the disamenity that higher traffic speeds cause to walking and bicycling (Dowling 2010). Integrated transportation-land use models that consider how transportation system changes, such as wider roads and public transit service improvements, affect accessibility, travel activity and development patterns, and how decisions related to the location and type of development that occurs in a community, will affect future accessibility and travel patterns (Levinson and King 2020).

Criticisms and Reforms

The tendency of planning to overvalue speed and undervalue slower modes has been criticized by urbanists such as Jane Jacobs and Louis Mumford, and by transportation experts such as John Adams (1999), and Paul Tranter and Rodney Tolley (Tranter 2010; Tranter and Tolley 2021). Others criticize the overemphasis on congestion problems (Cortright 2017; Litman 2016), automobile dependency and sprawl (Handy 2020; Shill 2020), including harms imposed on disadvantaged groups (Culver 2018).

Several current, overlapping policy trends and planning movements support lower-speed travel:

- ***Shifts from mobility-oriented to accessibility-oriented transportation planning.*** This recognizes that vehicle travel speed is just one of many factors that affect accessibility, and so acknowledges the importance of slower modes and compact development in improving accessibility.
- ***Vehicle travel reduction targets.*** Some jurisdictions have targets to reduce motor vehicle travel and increase use of slower modes (ACEEE 2019). This recognizes that current levels of mobility are economically-excessive. Establishing such a target can help coordinate policies between various agencies, jurisdictions and levels of government to favor compact, multimodal development. For example, vehicle travel reduction targets justify shifting road and parking facility investment to support slower modes; more compact development and less sprawl; plus parking policy reforms.
- ***Healthy, equitable, sustainable planning.*** Many communities and organizations have plans or goals to create healthy, equitable and sustainable communities. Since faster modes tend to be less healthy, equitable and sustainable than slower modes, these tend to support slower speed planning.
- ***Smart Growth, New Urbanism and Transit Oriented Development.*** These are planning movements that include various policies and programs to create more compact communities and multimodal transportation systems where residents can choose the most efficient option for each trip, including walking and bicycling for local errands, public transit when travelling on busy urban corridors, and automobiles when they are truly optimal, considering all impacts.
- ***15-minute or 20-minute neighborhoods.*** This refers to compact, mixed, multimodal neighborhoods where it is easy to access commonly-used services and activities within a short walk or bike ride. This emphasizes the importance of slower modes in an efficient and equitable community.
- ***Complete streets policies*** ensure that public roads are designed to accommodate diverse users and uses, including slower modes, sidewalk activities, and nearby businesses and residences. It includes specific road design practices including *streetscaping* (redesigning streets to include more modes, activities and aesthetic features), traffic calming (designing streets to reduce traffic speeds), and *placemaking* (designing streets to better integrate with local activities such as shopping, recreation, and community events, in recognition that streets are places, not just travel corridors).
- ***Car-free and car-lite planning*** are urban planning movements to create more communities with minimal automobile travel.

All of these contemporary planning movements favor slower over faster modes, and reducing urban vehicle traffic speeds to what is safe and comfortable for mixed traffic (Boarnet 2013; Brenneis 2021).

Prioritizing Speed Improvements

Conventional transportation planning tends to invest most resources to increase automobile traffic speeds, although slower mode speed gains often provides greater total benefits. To be more efficient and equitable, planning should develop better tools for evaluating travel time costs, and prioritize time savings that provide the greatest total benefits. There are good reasons to favor walking, bicycling and public transit improvements over investments to increase general vehicle traffic speeds.

The first reason is diminishing marginal benefits. For example, bikeway improvements that increase average bicycling speeds from 6 to 9 average mph are likely to provide more benefits than a highway improvement that increases automobile traffic speeds from 55 to 58 mph. The bikeway improvements increase bicycling speeds by 50%, which approximately doubles the area that a bicycle can reach in a given time period. The highway improvements increase driving speeds by 5% and the maximum area that motorists can reach by about 10%.

The second reason is that slower modes tend to have smaller external costs than faster modes, so increasing their speed, which makes them more attractive, tends to reduce traffic problems. For example, providing grade-separated transit service (bus lanes or separated rail lines) on congested travel corridors can cause some travellers to shift from driving to transit, which reduces traffic and parking congestion, crashes and pollution emissions (Nguyen-Phuoc, et al. 2020). Similarly, improving walking and bicycling conditions can reduce neighborhood traffic problems.

A third reason is that, improving slower modes' speed, convenience and comfort helps achieve social equity goals. Physically, economically and socially disadvantaged people tend to rely on slower modes, and improving active and public transport tends to increase their economic opportunity and reduce income disparities (Frederick and Gilderbloom 2018).

Conventional planning tends to overlook these factors. For example, conventional planning tends to evaluate transportation system performance based on vehicle congestion indicators such as the roadway Level-of-Service and the Travel Time Index, which measure delays to motorists, but have no similar indicator for the *barrier effect*, the delay that wider roads and increased vehicle travel imposes on pedestrians and bicyclists. Conventional travel surveys and models tend to undercount active travel because they often undercount short trips, non-commute travel, travel by children, recreational travel, and the walking and bicycling links of motorized trips, so a auto-walk trip is coded as an auto trip, and a bike-bus-walk trip is coded as a transit trip; the bike and walk links are ignored even if they involve as much time as the vehicle link. As a result, traffic models will underestimate the delays caused to active travel by wider roads, longer blocks, hierarchical road networks, and sprawled development patterns. One way to help compensate for these biases is to give extra weight to slow mode travel time savings.

This suggests that to help achieve efficiency and equity goals, planning should improve tools for measuring how decisions affect the relative speeds and travel time costs of slower modes compared with faster modes, and give two or three times as much weight to slower mode time savings. For example, urban transport models should measure barrier effect delays caused by wider roads and increased traffic speeds, and assign higher unit costs to those delays than to automobile delays to reflect strategic goals. Traffic models should also account for qualitative factors such as traveller convenience and comfort by assigning higher unit costs to uncomfortable travel, and therefore the value of convenience- and comfort-enhancing investments.

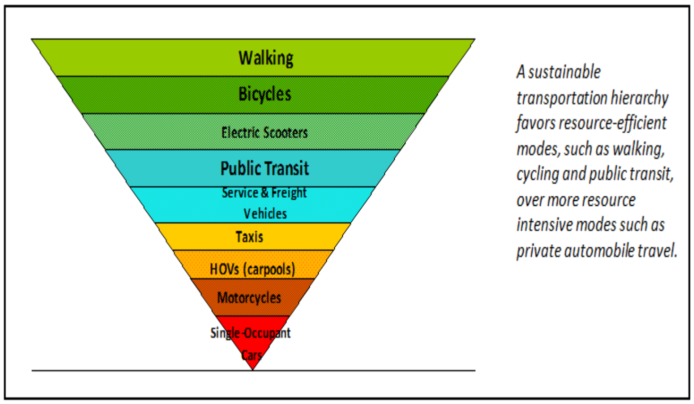
Principles for Optimal Speeds

This section describes four principles to consider for optimizing travel speeds:

1. **Consumer sovereignty** requires that planning responds to consumer demands. For example, if more people want to use slower, affordable, healthy modes increases, the planning process should investing more resources in these modes create more compact, multimodal neighborhoods.
2. **Efficient pricing** requires that, as much as possible, consumers should pay the marginal costs of the goods and services they use. For example, motorists should pay directly for using roads and parking facilities, with fees that are higher for larger vehicles and during congested periods.
3. **Social equity** requires that planning favors physically economically or socially disadvantaged groups over more able, affluent and advantaged groups. This means, for example, giving priority to modes commonly used by disadvantaged groups, such as walking, bicycling and public transit.
4. **Strategic planning** means that individual, short-term decisions should support strategic, long-term goals. For example, if a community wants to increase affordability, public health, social equity and environmental quality, individual planning decisions should support those goals.

These principles have important implications for speed optimization. They suggest that for consumer sovereignty and efficiency sake, travellers should be able to choose between lower-speed-lower-price and higher-speed-higher-price travel options, which provide incentives to choose the most appropriate modes for each trips, and for social equity and strategic goals sake, priority should be given to slower but resource-efficient modes over faster but costly modes. This is called a sustainable transportation hierarchy, as illustrated to the right. Comprehensive analysis also justifies Smart Growth development policies to create compact, multimodal neighborhoods that minimize the amount of travel, and therefore the travel speeds, needed for accessibility.

Figure 22 **Sustainable Transport Hierarchy**



Conventional planning tends to set traffic speeds based on safety goals, but more comprehensive analysis considers speed reduction benefits such as affordability, resource-efficiency and community livability, which justifies more priority for slower modes and traffic. For example, comprehensive analysis can justify more bus-lanes because they not only increase bus passenger travel speeds, they also favor a resource-efficient mode (Litman 2015). The table below illustrates typical maximum traffic speeds for various roads. These are lower than what is commonly used, reflecting the additional benefits of traffic speed reductions, besides safety.

Table 6 **Maximum Traffic Speeds for Safety, Efficiency and Community Livability**

Facility	Maximum Vehicle Traffic Speeds	
Suburban arterial	40 mph (64 kph)	*Comprehensive analysis that considers all impacts, including the comfort and safety of all mode users, livability, and overall accessibility, tends to justify lower traffic speeds than commonly used.*
Urban arterial	30 mph (50 kph)	
Residential street	20 mph (30 kph)	
Mixed traffic street	10 mph (15 kph)	

Conclusions

There are two very different visions of paradise. One envisions paradise as a distant place, such as an isolated suburban home or holiday resort far from congestion, noise and pollution. The other envisions paradise as existing communities enhanced to become more livable. These two visions conflict in their transportation goals. If paradise is a distant place, it requires abundant higher-speed mobility so people can travel quickly between dispersed homes, jobs, services and resorts. If paradise results from improving existing communities, it requires limiting traffic to protect their livability. These conflicting visions have important implications for speed evaluation.

Planning decisions often involve trade-offs between these two visions. Faster travel provides benefits and imposes various costs, as summarized in the table below. Conventional planning seldom considers all of these impacts. It generally recognizes that higher traffic speeds provide travel time savings, and increase infrastructure costs and crash rates, but often overlooks other economic, social or environmental impacts. Conventional planning tends to assume that travellers place a high value on faster travel compared with other goal, as indicated by the large portion of transportation resources devoted to roadway expansions compared with what is invested in slower but more affordable, healthy, equitable and resource-efficient modes. However, in practice travellers often choose slower vehicle and modes over faster alternatives, and when faced with the option of paying a toll to use a faster road or lane, most motorists choose to save money rather than time.

Planning often assumes that higher speeds provide time savings, but there is good evidence people tend to maintain a fixed travel time budget, so higher speeds increase mobility rather than saving time, and contribute to a self-reinforcing cycle of increased vehicle travel, automobile-dependency and sprawl. This causes *mobility inflation*, which ratchets up the distances people must travel to meet their needs, which is costly to communities and unfair to people with limited mobility.

During the last century, motorization significantly increased people's travel speeds and distance, but increased many costs by similar amounts. In 1900, people travelled mainly by walking about three miles per day, and spent negligible money on travel. Now, a typical motorist drives about 30 daily miles, but to do so must devote about 20% of their income, and therefore about 20% of their workday, to paying vehicle expenses. These higher costs offset much of the benefits of faster travel, and they tend to be regressive, since lower-wage workers much spend more time earning money to pay travel expenses.

The inefficiency and inequity of speed-prioritizing planning are evident if transport performance is evaluated using *effective speed*, defined as travel distance divided by the time spent travelling and earning money to pay travel expenses. Measured this way, automobile travel is often slower overall than active and transit modes, and is regressive because it benefits affluent motorists who value time more than money, but harms people who have other priorities. Conventional planning assumes that travellers prioritize speed, but in practice they often choose slower options for affordability, health, enjoyment and livability sake. Surveys indicate that many people want to drive less, rely more on slower modes, live in more compact communities, and reduce their transportation costs. To be efficient and equitable, planning must respond to these demands.

The benefits of slower modes and the external costs of higher speeds tend to increase with density. Wider roads and high traffic speeds degrade walking and bicycling conditions, increase road and parking infrastructure costs, impose significant traffic congestion, crash risk and pollution damages. In many communities, faster modes are primarily used by affluent non-residents who impose significant costs on physically, economically and socially disadvantaged urban residents (Figure 23). Urban communities have good reasons to limit traffic volumes and speeds to increase overall efficiency protect their community livability.

Speed optimization requires comprehensive impact analysis. Transportation engineers generally recognize the trade-offs between traffic speed and safety but undervalue other effects. Transportation planning tends to undercount demand for travel by slower modes and for shorter trips; planning analysis measures speed and distance but not the convenience and comfort of slower modes; and many external impacts that increase with speed, and the effects of induced travel and sprawl costs, are generally overlooked in conventional planning.

Figure 23 **Urban Highway Inequity**

Speed-prioritizing planning justified urban highway expansions that harmed minority communities.

To their credit, many decision-makers support slower modes and traffic speed reductions more than justified by their analysis models; they realize intuitively that walking, bicycling and public transit are important and deserve more investment. However, this occurs *despite* rather than *supported by* standard planning methods. Reforming these practices can justify much more support for slower modes. More comprehensive analysis of speed impacts is likely to result in less investment in urban highways, more investments in active and public transport modes, lower roadway design speeds, more effort to improving travel comfort and convenience than what currently occurs.

Consider the three examples described in the Introduction.

1. Currently, most transportation funding and road space is devoted to automobile travel. More comprehensive planning can justify more investments in walking, bicycling and public transit to achieve planning goals and ensure that non-drivers receive a fair share of public resources.
2. Currently, most urban streets are designed for traffic over 30 mph. More comprehensive analysis can justify lower speeds to what is safe and comfortable for vulnerable travellers and residents.
3. During the last century many high-accessibility urban neighborhoods were displaced by freeways. More comprehensive analysis can justify rebuilding and enhancing those neighborhoods, and increasing housing options so that any household, including those with lower incomes, can find suitable homes in an attractive, multimodal urban neighborhood.

Of course, every traveller has unique needs and preferences. Many will choose faster modes, such as automobiles, despite their higher costs, for convenience or status sake. However, current demographic and economic trends – aging population, increasing urbanization, plus growing concerns about affordability, public health and environmental quality – are increasing demand for slower modes and livable neighborhoods. Given better options, many people would shift from driving to slower modes, and from automobile-dependent sprawled areas to more compact, multimodal neighborhoods. Everybody benefits if our planning practices respond to these demands.

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