TRANSPORTATION FUTURES

Influence of Technical Advances on Transportation Behavior

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White Paper for the Transportation Futures Task Force

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Summary

This white paper presents analysis of likely influences of key technological advances on travel options and behavior in the region. It suggests how technological changes should be considered as the Task Force makes recommendations about ways to finance the region's transportation future.

Technological changes affecting all modes of transportation are occurring at an accelerating pace. Technology has an increasingly important role in determining the public's travel choices, which in turn affect plans for funding and delivery of new public transportation infrastructure and services. New technology necessitates new policies and regulations. It is difficult to predict with certainty the timing of expected trends, so planners will be required to address uncertainty itself as a dimension of future regional transportation planning.

We divide the major areas of technological change into:

- Information technology
- Vehicle technology
- Technology employed in transportation finance and traffic management

Information Technology

Traveler Information

More accurate up-to-the minute information will be delivered to travelers through a wide variety of media smartphones, in-car information systems, voice recognition systems, virtual kiosks, electronic signs on transit vehicles and above freeway lanes - making access to this information ubiquitous. Travelers will learn about available travel options for their current and future travel needs and obtain real-time performance information that will allow them to choose the best available mode or route for any trip. Where good travel options exist, improved access to information will also increase the use of those travel options, decreasing the use of single occupant vehicles (SOVs).

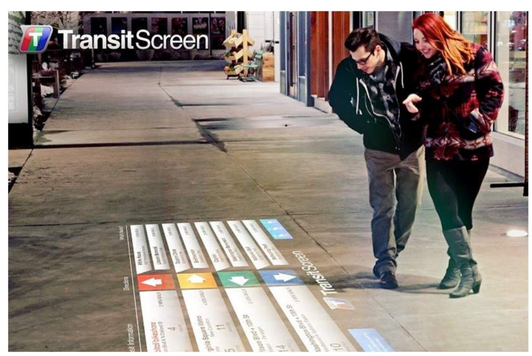

Figure 1.
Possible Future Transit Information Display

New Transportation Services

Information technology, in-vehicle displays, social media, and electronic billing have allowed the creation of new transportation services such as Uber, Lyft, and the Pronto Bike, car2go, and Zipcar short duration rental services. These and other emerging services such as real-time transit arrival and trip planning services, and real-time parking availability, reservation and payment systems, as well as shared use parking systems (where owners of individual parking spaces—such as in condominiums—rent those spaces on a short-term basis) are changing how a large percentage of trips are made in urban areas, as well as helping increase the attractiveness of living and working in dense urban settings. These have the potential to change relationships between driving and using shared vehicles, taxies, and public transit.

Implications of Better Information

Decline in Car Ownership. These new transportation services likely will have their greatest impact where transportation demand is high and road capacity is hard to increase (e.g., denser urban areas with limited road space and parking spaces) These services are likely to result in a decline in individual car ownership but not in travel in the most densely developed parts of the region.

Increase in Multi-modal Travel. New technology enabled transportation services are expected to significantly affect how people travel throughout the region, especially when they are used together. For example, depending on congestion levels and costs, a commuter might complete a trip that once was practical only by driving by first making a reservation for a parking space at a park and ride, then taking an express bus to a regional center, and then securing either a short-term bike or car rental to travel the last mile or two to their work place if they discover that they have missed their normal transfer to a local bus. That multi-modal trip would be competitive with, and perhaps more reliable in travel time than, driving alone on a congested freeway. Car travel will also continue to grow as regional population increases, and during congested conditions, information services will encourage increased vehicle use of smaller roads not intended to serve regional movements.

Figure 2.
Example of Possible Multi-Modal Trip

Increased Use of Mass Transit. Emerging transportation services and more timely information about transit options are also expected to significantly improve access to light rail and express bus service, increasing demand for those fast, reliable transit services as alternatives to driving in growing congestion. These changes will result in greater need for high capacity, high speed, transit service in dense corridors.

Advanced and Autonomous Vehicle Technology

Vehicle technology will continue to improve at an accelerating pace, but the region should expect the transition to fully autonomous vehicles to occur more gradually than is often presented in the popular media. Whether or not fully autonomous vehicles will be available is difficult to predict with certainty, but at a minimum, vehicles will contain a variety of features that improve their safety, energy efficiency, and performance. It is likely that partial automation, especially for long-distance freeway portions of longer trips, will be available earlier than the full automation that is the popular public perception.

For the foreseeable future, drivers will be required in every moving vehicle. This limits the increase in vehicle travel that would be expected with fully autonomous vehicles (e.g., a commuter sending his car home after the morning commute and having it return to pick him up at 5:00 PM, rather than paying to park it). Fully autonomous vehicles will initially be deployed in more controlled settings, such as discrete campuses, where the complexity of a vehicle's interaction with its surroundings can be limited to situations that can be anticipated and correctly handled by the vehicle's software.

Implications

Increased Throughput and Decreased Congestion - Eventually. As the number of increasingly automated vehicles increases, modest increases in roadway throughput should occur because of decreasing crash rates and the ability to drive vehicles more closely together. This will result in some congestion relief on the region's freeways. Congestion relief will be modest until all vehicles are equipped with high levels of vehicle automation. That is likely to take at least 15 to 20 years.

Benefits to Freight and Mass Transit. Automated vehicle technology is also likely to reduce the cost of long-haul trucking and improve transit services. With partial automation, drivers can be removed from at least some portion of some truck trips, significantly reducing the cost of freight and goods movements. Where one driver can be paired with multiple trucks for long haul operation—a process called "truck platooning"—terminals will be needed on the outskirts of urban areas from which local drivers can drive individual trucks the last few miles from the outskirts to their final destinations. For transit, the primary benefits from autonomous vehicle technologies will be a reduction in crashes and possibly some improvement in the vehicle capacity on transit only facilities.

Better Fuel Economy and Lower Gas Tax Income. Another key change in vehicle technology is that vehicles will rely upon engines that are increasingly energy efficient, use far less gasoline, and produce less air pollution and greenhouse gases. Better fuel economy will mean that gas tax revenues will decline even if vehicle travel increases as the population and economy grows.

Implications of Advancing Technology

Transportation Technology Will Change Urban Form. Some technologies, such as those supporting Uber and car2go will encourage living in dense, mixed use areas, which lower the need for road capacity and increase the need for transit and non-motorized travel modes. Other technologies, such as autonomous vehicles that do not need a driver, may increase demand for single occupant vehicle travel. Different parts of the region will see different rates of adoption of these technologies.

Figure 3. car2go in Seattle

Regional planning should integrate urban form and land-use strategies with advances in transportation technology. For example, development of on-demand, short-term rental transportation modes such as go and Pronto bike complement denser living environments that have lower parking space requirements. In suburban areas, technologies that provide "last mile" alternatives to transit nodes can be fostered, especially where those services provide alternatives to the construction of additional, expensive, park and ride spaces. Future paths are uncertain based on technological changes alone, while regional planning can play a role in encouraging and facilitating desired changes.

Transportation Finance and Traffic Management

Because motor fuel taxes provide the dominant share of transportation funding to the region, the single most pressing policy challenge arising from technological changes in the coming years will be declining fuel tax revenue and increasing revenue from other sources to fund system improvements, maintenance, and ongoing operations. While there is wide agreement that new revenue is needed, there is not yet a clear consensus on whether new forms of user fees or reliance on general revenue sources, such as general sales taxes, will be most useful in producing the needed revenue.

Technology Changes the Ability to Compute and Collect User Fees

Some see road user fees as a way of levying charges for road use that are both more efficient and fairer than gasoline taxes and traditional tolls. Charges can also contribute to management of traffic flows. Improved technology makes the process of collecting user fees more practical, convenient, and cost effective.

Twenty-six states are considering the introduction of mileage-based user fees or road user charges, a new form of user fee made possible by recent advances in telecommunications. Such fees are still viewed skeptically by the general public and their elected officials. In Germany and New Zealand, GPS-based systems are already utilized to charge road users for their travel.

In their simplest form, road user charges can be:

- flat fees levied per mile of driving based on odometer readings to measure the distance traveled (although this mechanism raises issues when one state charges fees for mileage driven in another state),
- fees levied for the use of specific facilities, such as the fixed fee charged for driving the Tacoma Narrows Bridge,
- time variable fees, such as the tolls for using the Evergreen Floating Bridge, or
- fees that vary with roadway conditions, such as the prices charged for using the SR 167 High Occupancy Toll (HOT) lanes.

With more sophisticated systems of road use monitoring (GPS or smartphone based options), it is also possible to vary road use charges by time-of-day, political jurisdiction, road class, and vehicle characteristics.

There is also great potential to incorporate road user charges into a larger system for charging vehicles for many services, such as liability insurance and parking. This approach would lower the operating costs attributable to collecting road use revenue. However, there is uncertainty as to whether the public will widely adopt some of these new technologies and services. For example, “pay as you drive” insurance, currently being marketed by Progressive Insurance (its “Snap Shot” product), has a very small market share. If the pubic widely adopts products such as this, it may also be willing to adopt GPS-based, per mile user fees.

User Fees Can Help Manage Demand and Change System Performance

If a goal of the region is to reduce congestion, then it is both necessary and technologically possible to link revenue production with active management of travel on the transportation system. Advancing technology makes this possible.

Tolls, charges, and fees affect travel choices, and these in turn affect flows on networks in ways that significantly determine network performance. The more direct the charge or fee, the more that charge affects travel behavior. For example, when drivers are making travel decisions, the recent reimposition of the SR 520 bridge toll has lowered the number of people who drive across the bridge. These behavior changes have other related impacts, in this case an increase in the number of transit riders, and a shift of many trips to the “free” road options, I-90 and SR 522.

Examples of where system performance improves from the application of new technology include; congestion free toll collection from use of WSDOT’s *Good To Go!* Tags and faster transit passenger boarding and lower transit travel times through use of ORCA fare cards. Dynamic pricing of parking and advanced notification of parking availability are coming. These will improve the efficient use of curb and off-street parking spaces, lower travel time spent searching for parking, and reduce congestion associated with searching for parking.

Other Technology Implications and Outcomes

- While technology allows faster, more efficient collection of user fees, some see the technologies that permit this efficiency as an invasion of privacy and raise concerns about data security.
- Pricing congestion can be more equitable than raising motor fuel taxes, but it raises social equity and geographic equity concerns, as lower income and disadvantaged populations can be unfairly impacted by such fees.
- For the moment, the cost of revenue collection using these methods, while declining rapidly, is still substantially higher than the cost of administering the motor fuel tax system.[i]
- And finally, the use of price to manage congestion also assumes that the public is willing to pay more for congestion relief. Historically, large segments of the population choose to sit in congestion rather than increase their transportation spending. For example, the vast majority of users of SR 167 do not pay to use the HOT lane.

Responding to Technological Change through the Planning Process

The pace of change has accelerated to the point that the basic approach to regional transportation planning and selection of financing must account for that change. The uncertainty produced by the rapidity of the changes requires a flexible and nimble approach to planning and delivering transportation infrastructure and services, and to collecting and using the revenue needed to fund infrastructure and services.

The best plan for the next 20 years may be one that performs quite well under many projected technological, social, and economic futures, rather than one that is optimal under an assumed future that never actually arrives.

The region must select revenue sources in light of the technologies that the public adopts. Charges and fees may change the speed of growth in some parts of the region, and consequently, the location and nature of transportation services necessary at different times during the next 25 years. The “best” financing mechanism may be one that provides publicly acceptable funding levels but also allows the region to address the uncertainty of how, when, and where it will grow and its citizens will travel in the next 25 years.

SECTION 1:

Introduction

This white paper presents to the Transportation Futures Task Force and PSRC staff analysis of likely influences of key technological advances on travel options and travel behavior in the region. It also suggests how those should be considered in long-range regional transportation planning and finance.

Technological changes are occurring at an accelerating pace. They will play an increasingly important role in determining the public's travel choices, which in turn affect policies and plans for new public transportation infrastructure, and services. It is difficult to predict with certainty the timing of expected trends, so planners will be required to address uncertainty itself as a dimension of future regional transportation planning.

Dramatic technological changes are rapidly taking place, some of which are governed by world markets and national policy and fall mostly beyond the scope of the PSRC. Vehicle safety improvements are an example, as they are largely responsive to federal regulation and world-wide automobile market forces. Vehicle crash rates likely will decline modestly but steadily until automated vehicles are the majority of vehicles in the fleet, and crash survivability will continue to increase as it has been doing for some time. Changes in engines and fuels will also respond to national regulatory requirements.

While many technological changes in transportation will be global in scale and beyond the control of regional authorities, some changes in technology will be of greater concern to local and regional authorities. Local adoption of those technology changes will dramatically affect land use, travel patterns, traffic flows, and modal distributions of travel within the region. Local policies and investments will greatly affect how that local implementation occurs, and thus the degree to which those technologies alter travel behavior and land-use patterns. In this short paper we concentrate on a few specific technological changes because of their significance to the responsibilities of the PSRC.

The areas of technological change that addressed in this paper are information technology, vehicle technology, and technology employed in transportation finance and traffic management. Because the rapidity of change and the increasing uncertainty created by that change affect both the nature of plans and the planning processes, their relationship to the nature of planning in a new environment will also be discussed.

SECTION 2:

Information Technology

Over the last two decades, the integration of transportation and telecommunications technology has changed the performance and use of transportation networks even more than alterations to physical facilities. The rise of "smart" transportation systems has presented travelers with new choices and has improved network performance. The Puget Sound region is home to many early adopters and is a center of innovations that have worldwide consequences. The pace of these changes is likely to continue and even to accelerate over the coming two decades.

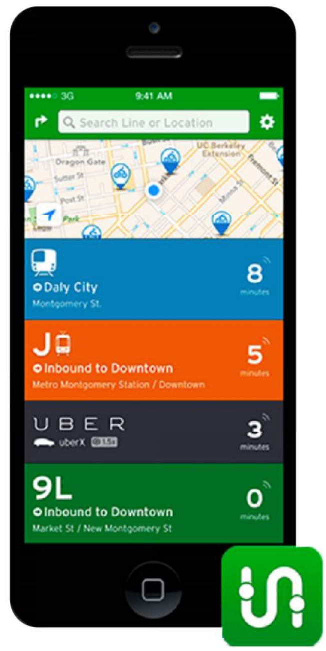

Figure 4.
Transit App

More precise, accurate, timely, personalized, and multi-modal information will be readily available through smartphones, in-vehicle displays, and fixed and virtual signs. Real-time information on current network performance and travel options is already increasingly influencing travelers' decisions before and while they travel. Having information about available options and the performance of those options provides travelers with better travel options that in the past many travelers simply did not know existed, and therefore did not use.

New applications of transportation in combination with information will include the following:

- Better real-time information on traffic flow, such as from Google Maps and Waze (a community-based traffic and navigation app)
- Better real-time information on transit and bicycle options
- "Smart parking," including space availability and increasingly sophisticated parking pricing
- The ability to park and ride transit using real-time information
- New opportunities to car share and rideshare for a wider range of trips
- Use of vehicles that are driven by commercial (paid) drivers or are self-driven
- Use of various "last mile" services electronically linked with transit services
- New forms of short-term car rental and partial or shared vehicle ownership

While most public attention has been directed at vehicles, it is important to mention that electronic sensors and management are being applied to highways and rights-of-way as well as to the vehicles. Automated vehicles will be traveling on systems on which vehicles are electronically "connected" to one another and to the roadways, allowing efficiency improvements through "active traffic management" for example by changing traffic signal timing far more aggressively than has been done to date.

Transit will continue to be very important, and these technologies will increase the efficiency of its use by making it easier to plan trips via transit and to catch transit vehicles with a minimum of waiting, but transit may have different characteristics than it does today, especially in dense urban markets. Improvements in information availability will make bicycling options, including bike sharing as part of multi-modal trips, more available to travelers in denser urbanized areas, even as changes in motorized technologies also offer wider ranges of choices.

Institutions that study the future and concentrate on the integration of social and technological trends are foreseeing changes that will enhance personal mobility while reducing dependency on privately owned automobiles that remain parked most of the time. This will be especially true in urban settings where good alternatives to the private automobile exist. Thus, decreases in travel noted for the Millennials in the Demographics white paper could well be suggestive of much broader changes to come. The Rocky Mountain Institute, for example, foresees that in regions like Seattle, people can be more mobile in the future by relying upon a combination of short-term car rentals (e.g., Zipcar), social network mobility services (e.g., Uber, Lyft, Sidecar), public transit routes, and short-term cycle rentals. Their smartphones will link them into a network that functions increasingly seamlessly by providing information on availability, schedules, and prices, and by billing the users as they formulate their choices. [ii]

Figure 5.
Bike Sharing

The transition to shared mobility, which markedly decreases the need to pay high fixed costs associated with private vehicles, is countered by a rise in the variable or marginal costs of travel. The speed of change as this occurs will reflect the existence or absence of public policies that encourage the transition, and the relative costs borne by travelers in different parts of the region. So, for example, increased tolls, gasoline taxes, parking costs, and reduced parking space availability downtown may speed the transition, whereas low energy costs and provision of ample free parking may slow it. Similarly, people who live in dense areas where garage parking is expensive and good alternative modes of travel are convenient are much more willing to adopt changes that decrease their need to pay high fixed costs (by owning one less vehicle) in return for minor increases in variable costs (by taking Lyft periodically). In contrast, people living in low density areas where parking is free and alternative travel choices are slim are less likely to change their travel behavior. Indicative of these increasingly expected changes, though certainly not yet definitive, is the observation that automobile manufacturers are realizing that the

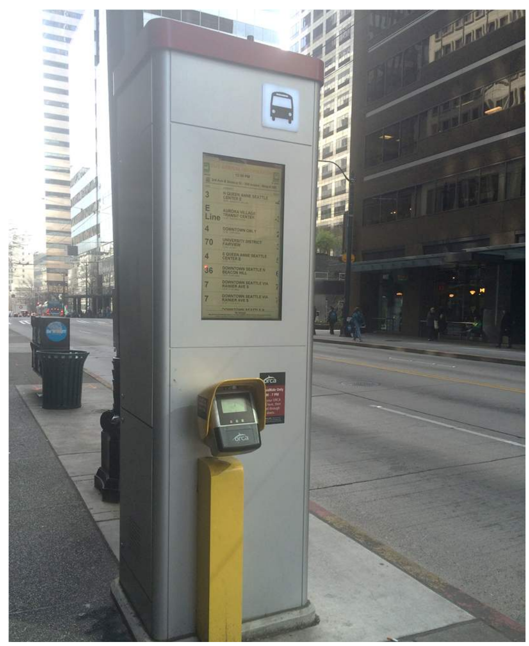

Figure 6.
Automated Bus Information

link between mobility and vehicle ownership may be weakening. BMW—in a shift away from its sole identity as an automaker—has launched a series of “mobility services,” including access to company owned vehicles through short-term rental and an app that has real-time information on twelve major public transit systems in the U.S. and the U.K. Similarly, Daimler has launched an app in Germany called “moovel,” which provides the various options for bus and rail connections, ridesharing opportunities, and a taxicab call function.

The RAND Corporation, under contract with BMW’s Institute for Future Mobility (IFMO), has also suggested the likelihood that shared mobility—reflective of the increased integration of transportation with information technology—will likely influence people to reduce private vehicle travel in favor of shared or social transportation options that will enhance mobility. Recognizing how difficult it is to read long-term evolutionary patterns from ongoing trends, RAND suggests a future similar to that suggested by the Rocky Mountain Institute, but it also enumerates several scenarios that could either result in, or interfere with, its attainment. For example, RAND’s analysis suggests that long periods of very low petroleum prices could make this projected trend less likely to occur, whereas higher prices for road use and more stringent limits on auto use that reflect concerns over greenhouse gases might increase the probability of earlier occurrence.[iii]

A consensus is emerging that the future holds gradual but increasing replacement of some singly-owned vehicles, especially in multi-vehicle households, by shared or social forms of mobility. However, the RAND report on this topic highlights the uncertainty of the timing and even extent of this trend. In Seattle, public policy toward transportation network companies has highlighted the uncertainty associated with such projections. The City Council recently capped the number of mobility services hailed by smartphone that could operate in the city but soon reversed itself in the summer of 2014, allowing expansion without capping the number of vehicles in operation. It is clear that policy regarding such services, including licensing, insurance, and other regulation, is evolving and inconsistent, and this adds uncertainty to projections regarding the timing and extent of such trends.[iv]

Another area of uncertainty is the manner in which public agencies make available to private companies data on the current performance of transportation facilities, such as real-time traffic flow. Transportation agencies will need to address the technology by which they provide information and also must consider institutional issues such as privacy, access to information, data security, and new ways of billing for services. Their decisions will impact—and be impacted by—the trends described above.

SECTION 3:

Vehicle Technology

3.1 Automated and Autonomous Vehicles

Vehicle technology will continue to advance at an accelerating pace, but planners should expect the transition to fully automated vehicles to occur more gradually than is often presented in the popular media. Whether or not fully autonomous vehicles will be available is difficult to predict with certainty, but at a minimum, vehicles will contain a variety of features that improve their safety, energy efficiency, and performance. It is likely that partial automation, especially for long distance freeway portions of longer trips, will be available earlier than the full automation that is the popular public perception. For the foreseeable future, drivers will be required in every moving vehicle, limiting potential increases in travel in fully autonomous vehicles. Higher levels of automation (including driverless vehicles) may be achieved earlier in select, more controlled environments, such as college campuses and industrial complexes.

Experts on vehicle technology discuss vehicle automation in terms of levels of transition, and it is useful for planners to recognize these stages. These levels have been explained in several articles by Steven Shladover of the University of California, Berkeley:

1. The first is automation of particular driving functions, such as speed or steering control of the vehicle. For example, adaptive cruise control systems are already available on many cars and adjust speed in response to that of the vehicle traveling directly ahead of it.
2. The second level refers to a vehicle that combines automated functions, such as speed and steering control. Mercedes has recently introduced a vehicle that has that capability, but it permits the driver to take his or her hands off the wheel for only a short time. After five or ten seconds, the system deactivates and warns the driver to re-engage.
3. At the third level, the vehicle would allow the driver to do something else while traveling but requires that the driver still be prepared to take control if the system should get into trouble.
4. The fourth level would add the capability to bring the vehicle to a safe state if the driver failed to re-engage.
5. The fifth level represents a fully autonomous system that could basically go anywhere and do anything under automatic control, without driver involvement. Industry experts, including Dr. Shladover, have frequently expressed the view that Level 5 vehicles could become available commercially before 2030, but only in the most optimistic of scenarios.[v] [vi]

These same technological changes are also likely to have a major impact on how trucks haul and deliver freight and goods. Technology such as automated braking and acceleration, that allows trucks to travel in very closely spaced groups, such as in Levels 1 and 2, will provide considerable improvements in fuel economy. Once Levels 4 and 5 have been reached, drivers could be removed from at least some portion of some truck trips, significantly reducing the cost of freight and goods movements. The shift from partial automation to "full autonomy" has significant planning and facility implications. When and where one driver can be paired with multiple trucks for long haul operation – a process called "truck platooning," terminals will be needed on the outskirts of urban areas so that local drivers can drive individual trucks the last few miles from the outskirts to their final destinations. When truck driving is fully automated, companies will need to determine which loads can be off-loaded without a driver (and therefore do not need a person to accompany the load) and which will require a person to accompany the truck to deliver the final payload—even if they do not physically drive the truck. This distinction may change how some businesses choose to receive freight deliveries, as they may want to unload the truck themselves rather than have the driver haul goods a few hundred feet to the destination.

For transit, the primary benefits from the autonomous vehicle technologies in the foreseeable future are will come from a reduction in crashes and possibly some improvement in the vehicle capacity on transit only facilities. Autonomous vehicle operation may also come about more quickly for transit vehicles than for conventional vehicles, at least for those limited transit services where transit vehicles run entirely on grade separated right-of-way, and the complex vehicle-to-environment interactions can be more fully controlled.

Figure 7.
Robotic Electronic Self-Driving Car – Stanford University

Advances in vehicle autonomy technology will affect all modes of urban travel, including bicycles, public transport, multi-modal travel, and freight goods and movement. For regional, long-range planning, it is important to develop infrastructure and institutional arrangements, such as licensing requirements, that support the phased but constant transition toward automated vehicles but, simultaneously, to not exaggerate their arrival nor presume that they will arrive inevitably without careful planning and supportive public policy. It will also be important to routinely engage with private business groups working in these fields, such as trucking firms and social network based ride services, to stay abreast of the need for, and implications of, policy changes required to address the effects of new technology adoption. Some of the issues in need of resolution, including liability in the case of crashes, require reapplication of basic legal principles in new contexts, and these will contribute to the slower pace of universal adoption than is portrayed in the popular media.[vii]

3.2 Engines and Energy Efficiency

Even as society moves gradually toward more fully automated vehicles, other technological changes are also occurring that will strongly influence travel and transportation policy. Motorized vehicles, including passenger cars, vehicles that haul freight, and public transit vehicles, will incorporate engines and rely upon fuels that are more energy efficient and that will produce less harmful air pollution than those in use today.

3.3 Fuel Efficiency

The U.S. Environmental Protection Administration has issued historic and far-reaching federal fuel economy rules that aim to nearly double the present passenger fleet average by 2025. The Corporate Average Fuel Economy (CAFE) standards, approved on August 28, 2012, set a 54.5-

mpg average fuel-efficiency goal for the 2025 model year, up from 27.6 mpg in 2011. The rules are expected to shape the cars that automakers build over the next several years, changing their features and some of their basic functions.

Progress toward improved fuel efficiency has been steady. Overall, vehicle fuel economy is up 5.3 mpg since October 2007. [viii] This is an increase of more than 26 percent in the last 7 years. The average fuel economy (window-sticker value) of new vehicles sold in the U.S. in January 2015 was 25.4 mpg. Figure 8 shows both the historical trend and expected future changes to fleet fuel economy from 1975 to 2025.

In addition to obvious benefits to Puget Sound communities of lower driving costs, cleaner air, and fewer greenhouse gas emissions, improving fuel economy will also present major challenges to regional transportation planning and transportation system financing. Because vehicles will consume far less gasoline, gas tax revenue will gradually decline as the primary basis of financing transportation. Therefore, new forms of charging for road use and for funding some public transit services will be required. Because of the importance of this issue for regional transportation planning, it is explored further in the next section.

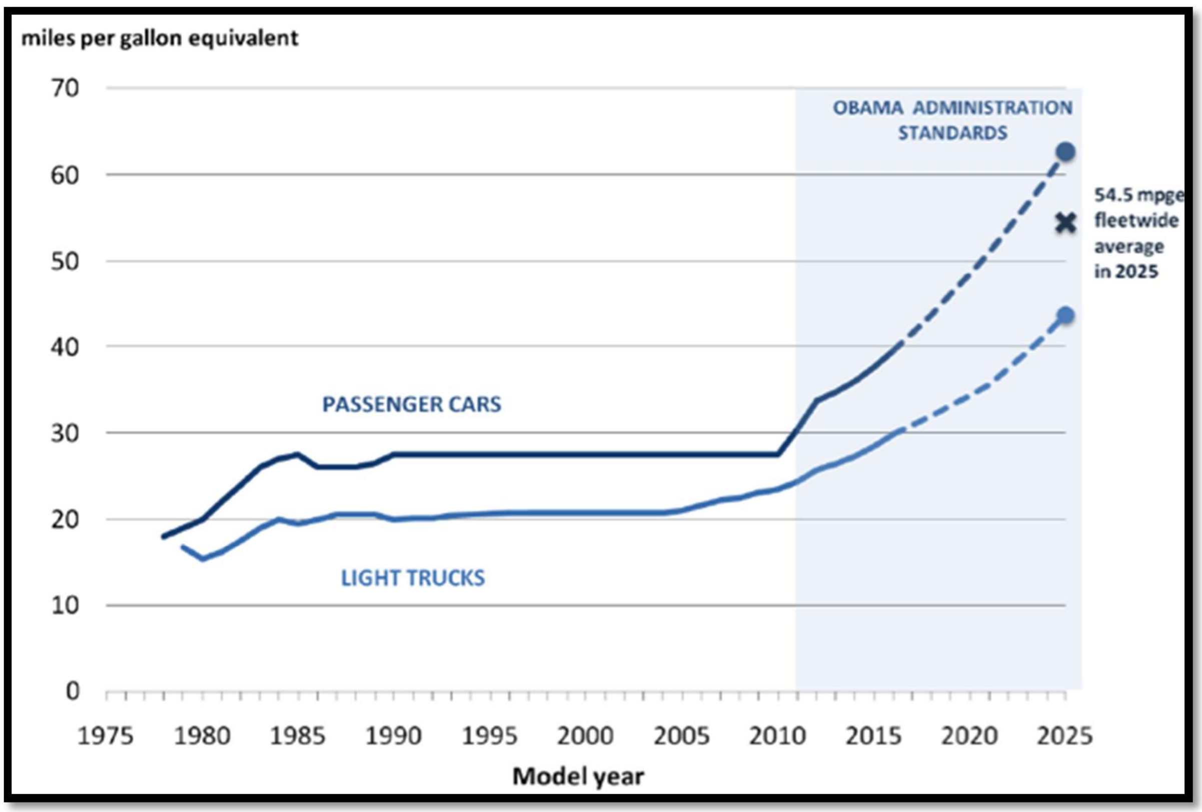

Figure 8.
Light-Duty Vehicle Fuel Economy Standards, 1978-2025

SECTION 4:

Transportation Finance and Traffic Management

While Americans can be pleased that the fuel economy of vehicles is improving at a dramatic rate, this will cause difficulties in raising tax revenue for surface transportation programs. Electric vehicles, which use no petroleum-based motor fuels, are today still a small portion of the vehicle fleet, but the promise of electric and hydrogen powered autos combined with the federal CAFÉ standards give rise to expectations that in the future gasoline consumption could drop precipitously. This calls into question the long term sustainability of the motor fuel tax as the primary source of transportation, in Washington State and throughout the nation. Consequently, the single most pressing transportation policy challenge arising from technological change will be identifying new sources of revenue to fund system improvements, maintenance, and ongoing operations.

4.1 Changing Technology and Transportation Revenue

While there is wide agreement that new revenue is needed, there is not yet a clear consensus on whether new forms of user fees or reliance on general revenue sources (such as general sales taxes) will be the most viable in producing that revenue. Although this is currently being debated at the federal level, Congress has repeatedly refused to raise the federal motor fuel tax, fixed at 18 cents per gallon since 1993, and instead has addressed Highway Trust Fund shortfalls with money from the general fund. Most observers believe this is not a long-term solution. In Washington state excise taxes on gasoline and diesel fuel are each 37.5 cents per gallon, but only a portion of this revenue can be used for operations, maintenance, and transportation investments because a substantial portion of the tax revenue is devoted to debt service. Even when alternative forecasts of fuel tax revenue are used by WSDOT, the trend is toward revenue that steadily declines in relation to travel.

Twenty-six states are considering the introduction of mileage-based user fees or road user charges, a new form of user fee that is made possible by recent technological advances in telecommunications but that is still viewed skeptically by the general public and their elected officials.

Figure 9.
Use Fee for SR 520 Evergreen Floating Bridge

In their simplest form, road user charges can be flat fees levied per mile of driving, based on odometer readings to measure the distance traveled, although this mechanism raises issues when one state charges fees for mileage driven in another state. They can also be fees levied for the use of specific facilities, such as the fixed fee charged for driving the Tacoma Narrows Bridge, time variable tolls for using the Evergreen Floating Bridge, or fees that vary with roadway conditions, such as the prices charged for using the SR 167 High Occupancy Toll (HOT) lanes. With more sophisticated systems of road use monitoring, some depending upon global positioning satellite (GPS) monitoring and others relying on smartphones, it is possible to vary road use charges by time of day, political jurisdiction, road class, and vehicle characteristics.

Some see road user fees as a way of charging for road use that is both more efficient and fairer than gasoline taxes and traditional tolls, but others object to them as an invasion of privacy. Still others object to user fees, and particularly facility tolling, as both geographically and socially inequitable. This is particularly true when tolls are applied on only a few roadways, or where tolls are imposed on roads that were previously "free" and after people have made residential location decisions based on different transportation costs. Finally, for the moment, the cost of collecting revenue with these methods, while declining rapidly, is still substantially higher than the cost of administering the motor fuel tax system. [ix]

There is also great potential to incorporate road user charges into a larger system for charging for multiple services, such as vehicle liability insurance and parking, which would lower the operating costs attributable specifically to collecting road use revenue. However, there is uncertainty about which opposing views will gain the upper hand and which systems will emerge as the most viable. The resolution of these issues is likely to depend both on technologies still under development and on public acceptance of different mechanisms for charging for transportation services.

Field trials of the options are likely to play important roles in the selection of alternative technical approaches. For example, the success or failure of "pay as you drive" insurance, such as that currently marketed by Progressive Insurance (its "Snap Shot" product), is likely to affect the region's willingness to adopt GPS-based, per-mile user fees.

Oregon will begin a field test of a mileage-based user fee in July 2015, and California legislation recently created a Road User Charge Task Force to plan a trial in that state. In 2014, the Washington State Legislature directed the Washington Transportation Commission to develop a steering committee to conduct advanced policy analysis, develop a concept of operations, and conduct a financial analysis of the concept of operations.[x] Because the technology is developing rapidly, and issues such as privacy and cost are universal in their impacts, it is likely that Washington will collaborate in these explorations with neighboring states and Canadian provinces through the relatively new Western Road User Charges Consortium, sponsored by the American Association of State Highway and Transportation Officials, which has eleven members and is growing.[xi]

The determination of whether the future of transportation finance in the Puget Sound will rely on new systems of user charges or will revert to general fund financing will likely take some years, but the choice of funding mechanism will have considerable impact on what transportation improvements the public expects to gain from those funds.

4.2 User Fees Can Help Manage Demand and Change System Performance

Whether or not a new universal system of road user charges is adopted in Washington, one clear principle that emerges from this discussion is immediately applicable to the Puget Sound region: if a goal is to reduce congestion, then it is increasingly both necessary and technologically possible to link revenue production with active management of travel patterns on the transportation system. Advancing technology makes this possible. Tolls, charges, and fees affect travel choices, and these in turn affect flows on networks in ways that significantly determine network performance. The more direct and obvious the charge or fee, the more that charge affects travel behavior. For example, the SR 520 bridge toll is very obvious and has lowered the number of people who drive across the bridge. Of course, the behavior changes caused by tolling SR 520 have other impacts, in this case an increase in the number of transit riders, and a shift of many trips to the “free” road options, I-90 and SR 522.

Singapore adopted road charges more than fifty years ago and has adjusted its pricing system numerous times to reflect the evolution of travel patterns in the region. Americans have been reluctant to price roads and transit for the explicit purposes of controlling congestion, influencing travel behavior, and improving network performance. However, with recent applications of road user charging in London and Stockholm and with eighteen HOT lane projects (providing access to express lanes for high occupancy vehicles or singly occupied vehicles that pay a fee) in operation or under construction in the United States, the use of fees to manage traffic has gradually become more common and will certainly be part of the policy debate in the Puget Sound region. For example, the concept is already included in T2040.

Advances in vehicles, vehicle to vehicle communications, and vehicle to highway communications will enable more effective traffic flow management by permitting closer integration of traffic management and finance. It has often been argued that pricing is needed to manage traffic flows in high volume corridors and that new highway capacity in major urban areas can quickly become congested unless it is properly priced. While motor fuel taxes, dedicated property and sales taxes, tolls and parking charges have all produced transportation revenue for many decades, a critical innovation over the coming twenty years will be the increasing use of charges to promote traffic management by inducing shifts in the times when travel occurs, the modes taken, and the routes selected.

In recent years, electronic toll collection technology, such as WSDOT’s *Good To Go!* tags, have revolutionized tolling, and in Germany, New Zealand, and a few other countries GPS-based systems are already utilized to charge road users for their travel. Dynamic pricing of parking to optimize the use of curb and off-street parking spaces is also gradually coming into use. New location-based financial services being introduced by the private sector allow more convenient payment for transportation services by linking those payments directly to the user’s bank or credit account. Location-based services also allow transportation agencies to compute and apply more refined user charges that reflect the real cost of travel and that permit those charges to be more directly allocated to jurisdictions.

However, the same technologies which make these improvements in user charges practical, convenient, and cost-effective also raise important concerns about personal privacy and data security. Pricing congestion also raises social and geographic equity concerns. Low income households are often not able to absorb added out-of-pocket transportation expenses, meaning direct user fees can be a significant burden on these populations. Low income families also may not have credit cards or debit cards used in some of the programs and may not be able to afford monthly discounted transit passes. Proponents of user fees, especially tolling, argue that user fees are very fair, in that users of the facility pay for that facility, and people who do not benefit from that facility are spared those expenses.

In addition, the use of price to manage congestion assumes that the public is willing to pay directly for congestion relief. Historically, large segments of the population have been willing to accept more congested roads rather than to increase their out-of-pocket transportation spending. For example, in England, expansion of the London toll ring has been voted down by the public, as was a similar facility in Manchester. In Seattle, public officials are concerned that too many vehicles will avoid the new Alaskan Way tunnel and use congested City of Seattle streets if the tunnel toll is even moderately high.

4.3 Traffic Flow Management and Pricing Impact Urban Form and Function

Advances in transportation technology and more refined pricing strategies will affect urban form. Regional planning should integrate land-use strategies with those related to transportation technology. For example, it appears that continued development of on-demand, short-term rental transportation modes such as car2go and Pronto bikes complements, and encourages denser living environments having lower parking space requirements. In suburban areas, technologies that provide "last mile" alternatives to transit nodes can be fostered, especially where those services provide alternatives to expensive park and ride construction. At the same time, policies that encourage the development and sale of low cost, fully autonomous vehicles could encourage the expansion of urban sprawl and greatly increase vehicle travel demand unless policies were designed to counter this trend. This is because not having to pay attention to the driving task, would decrease the time penalty associated with the longer trips in this land form, providing added incentive to live further away from cities. Fully autonomous vehicles would also log a large number of miles without drivers in them. For example, parents might frequently send their children to school in them rather than having them take school buses or ride bikes.

SECTION 5:

Responding to Technological Change through the Planning Process

Traditional transportation planning has been based on forecasting the future and assessing alternative networks and services for meeting projected demands. A benefit-cost framework has often been used to assess alternatives. However, the pace of change has accelerated to the point that changes to the basic approach to regional transportation planning may be needed. The rapidity of change and the uncertainty created by that rapidity suggests that traditional regional transportation planning—planning an optimum future system to meet projected needs—is becoming obsolete. Rather there is a growing need for approaches to planning that are more flexible and nimble.

What we require is a process that is robust in the sense that it does not aim toward meeting a fixed set of forecasts but instead responds more effectively to change as it is under way. **The best plan for the next twenty years may be one that performs quite well under many projected technological, social, and economic futures, rather than one that is optimal under an assumed future that never actually arrives**.

This means that the region must select revenue sources in light of the technologies that the public adopts. Those selections may change the speed of growth in some parts of the region, and consequently, the location and nature of transportation services necessary at different times during the next 25 years. The "best" financing mechanism may be the one that not only provides publicly acceptable funding levels, but that also allows the region to address the uncertainty of how, when, and where the region will grow and travel in the next 25 years.

About the Authors

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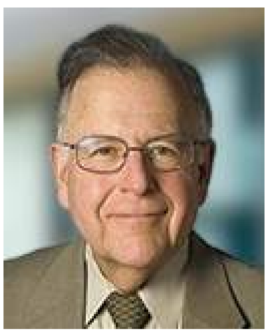

Martin Wachs, PhD., is an expert on transportation policy and has been Chair of the Department of Urban Planning at UCLA, Director of the University of California Transportation Center, and Director of the Transportation, Space and Technology program at the RAND Corporation. His career spans 45 years and includes authoring 180 papers and writing or editing five books on transportation policy. He was the primary researcher for the *Mileage-Based User Fees for Transportation Funding* study at RAND and *Exploring the Relationship Between Travel Demand and Economic Growth for FHWA*. Marty has been Chairman of the Transportation Research Board of the National Academy of Sciences, was appointed by the Governor to the California Commission on Infrastructure Improvement, and currently serves on the California Road User Charges program Technical Advisory Committee.

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