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Personal vs Public Transit In America

A battle that shouldn't be fought

Stephen Hamilton

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The human being may be the original mobile device. Even in ancient times some human beings managed to travel great distances – as in intercontinental distances. But until relatively recently, most humans lived mostly local lives. As recently as a 100 years ago, America was still a mostly rural nation. Most people lived on farms and only left those farms occasionally, usually to travel only to a small town center nearby. The average per capita miles per day travelled was comfortably in the small single digit range.

But in the second half of the twentieth century Americans migrated in vast numbers to the cities, and more specifically to the suburbs surrounding cities. Public roads and private automobiles facilitated this expanse of the suburbs, by allowing greater and greater distances to be traveled between home and work, thus allowing sprawl as a mechanism to control housing prices. Today most Americans are suburban dwellers, and the average per capita miles traveled is in the mid thirties (~34.2).

So "transit" – using a vehicle of some sort to get from one place to another in a relatively short period of time – is an integral part of American life. Our society has evolved to provide a multitude of transit systems which may be used. Understanding and utilizing these systems is now a part of our culture. But real understanding, and application of critical thinking and analysis to these systems is something only a few experts and urban planners typically do.

This document is intended for that expert audience. A taxonomy is offered for organizing and categorizing the transit options. The economics of transit are examined (in a qualitative fashion) to explain how the systems have evolved to their present status in America, and to predict their future health. This analysis is used to propose new alternatives which are a better fit for the market demand.

All Transit is "Personal"

It is important to start out by making a perhaps obvious, but nonetheless very important point – all transit demand is "personal". If transit is travel from one place to another, then those endpoints are unique to the commuting individual. Also, the time the travel is performed is unique to the individual. So the total market demand for transit is defined by a population of "personal" trips. Those "personal" trips are sometimes clustered into small groups, such as a part of a family travelling together for shopping or entertainment. But a large percentage of the demand is truly individual, and those individual trips are the units of the market demand.

Each of the transit systems that exist today are an attempt to serve a specific portion of this population of personal trips. Most of them are "mass" transit systems. The purpose of a "mass" transit system, as the name suggests, is to move a large number of people to or from a common location in a short period of time. So it serves a subset of the personal transit demand defined by the common endpoints of the individual trips. Mass transit systems are a natural fit for core areas in cities. High density is part of the very nature of a city. A city is the clustering of people around a set of shared public locations – museums, sporting arenas, concert halls, government buildings, etc. When an "event" is held at any of these locations it requires a large number of people to gather at the appointed time for the event. Most of these people do not live within walking distance of the event location. Therefore the event generates demand for a mass transit capability – generates demand for a large number of personal transit demand units (trips) having a common endpoint and time.

Mass transit systems are of necessity shared vehicle solutions. Large vehicles are needed to accomplish the "mass" movement. Large occupancy of those vehicles is necessary to operate them cost effectively. This means mass transit destinations must be chosen carefully, as those frequently common to a large number of personal trips. The practical outcome of this limitation is that mass transit systems can only fulfill a portion of each personal transit trip. So even a mass transit trip implies personal transit. For example, personal transit is used between home and a light rail station, so that the mass transit light rail can be used to and from a downtown arena.

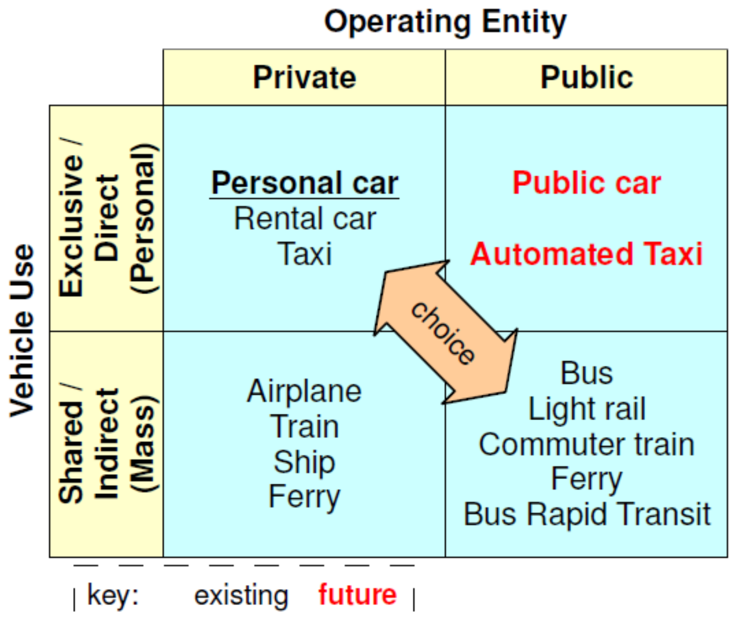
It is a reality, that cities create their own refugees. The very density of a city creates a high degree of competition for space. This tends to drive up the price of that space. This of course drives a number of people to seek a less expensive place to live (and perhaps work), usually in the area surrounding the city. The America suburbs are the compromise solution – enough room to live comfortably at a reasonable price; yet dense enough to reasonably support commercial and governmental services. By 2010 86% of the American urban population actually lived in the suburbs - that is about 6 people live in the suburbs of a city for each one that lives in the city core.

The lower density of the suburbs make them a poor fit for mass transit systems. Suburban transit demand is perhaps only slightly more spread out in time than mass transit demand – as one might compare the evening commute hours vs the starting time of the baseball game or concert. But suburban transit lacks the common origin or destination of mass transit. Suburban commuting is the classic example of personal transit – a large number of people travelling at the same time from a large number of origins to a large number of destinations. They all live in different houses, and work at different job sites, and transit between the two locations twice a day.

Taxonomy and Analysis

The following taxonomy is proposed as a useful way of organizing the transit systems for analysis. The systems are grouped in two dimensions. The first dimension describes the entity that operates the transit system as either a private individual or company, or as a public entity like a city government or a transit district. The second dimension describes how the transit vehicles are used by the riders. The vehicles are either used exclusively for one trip at a time, or are shared by a collection of people on separate trips. The figure below shows this organization, and places within it a set of transit systems that are most commonly found in America.

When the transit vehicles are "personal", they tend to be smaller. Because they are exclusively used, for one trip at a time, they tend to travel along a direct route between the endpoints specific to that trip. This minimizes travel time, which maximizes re-use of the vehicle by other travelers, thus improving the cost effectiveness of the solution. Personal vehicles also tend to be highly accessible and nearly immediately available. They are usually stored in a parking lot which is only a short walk from the endpoints of the trip, or are dispatched specifically to the location starting the trip on demand. So there is typically very little wait time, and most of the transit time is in the vehicle rather than getting to or from the vehicle.



"Mass" transit vehicles tend to be larger in order to accommodate servicing multiple travelers simultaneously. Because they are shared for multiple trips at a time, they tend to travel mostly along heavily travelled routes, connecting destinations frequently used as intermediate points for personal trips. These intermediate points are an approximation for collections of endpoints. This tends to increase the travel time for personal trips for multiple reasons. First the travel distance is longer, since the route is indirect so it can include the intermediate points to intersect with mass transit. Second, the travel rate is slower since the shared vehicle must stop and start along the way to let off and take on new riders. Third, a greater amount of time is needed for the personal travel between the endpoints and the intermediate points – walking or driving to/from the mass transit station. Fourth, wait time is greater. The shared vehicles are too big to be stored locally, and are too costly to be left idle. So they typically travel along the shared route according to a pre-designated schedule. When the traveler arrives at the station, there is some amount of time lost waiting for the next vehicle to arrive at the station. Mass transit vehicles are made cost effective by the degree of sharing they accomplish. Good scheduling and routing usually permits mass transit vehicles to operate more cheaply than personal transit vehicles.

There are multiple types of mass transit vehicles, including airplanes, trains of various sizes and with various interior configurations, boats of various sizes and with various interior configurations, and busses of various sizes. Generally in America the larger vehicles are used for the longest distance travel. For the most part long distance travel – that is inter-city travel - is serviced by private companies (recognizing that Amtrak is a company set up by and subsidized by the US government). This document is focused upon urban transit, and so it will not speak more about private mass transit. Urban mass transit in America is mostly run by public entities.

The Economics of Transit

Busses are the cheapest and most flexible among the urban mass transit vehicles. Since they share the same roadway infrastructure as cars, capital outlays are limited to the vehicle purchases. And routes can be changed easily to accommodate demand, using all but the narrowest of city streets. Ferries are similar to busses in that destinations and routing are flexible, and the systems have no right of way capital costs. But ferry systems are obviously limited to transit over waterways. Commuter train systems and Light Rail systems require right of way infrastructure (rails, crossing protection, etc) and stations, in addition to the rolling stock. So capital outlays are greatest for these systems. Commuter train systems are typically fully grade separated from pedestrian, bicycle, and automobile traffic, operating either as an elevated system or a subway, or sometimes a little of both. Subway construction is particularly expensive ($100M - $200M per mile), but elevating heavy rail is also costly ($40M - $60M per mile). Light Rail on the other hand, typically shares much of its grade with automobile traffic. So light rail capital outlays are somewhat lower than commuter rail ($20M - $50M per mile). However, the grade separation of commuter rail provides it with immunity to automotive traffic congestion. This is an attractive quality during rush hours, when automotive congestion is at its worst. Light Rail is not nearly so immune.

Very recently Bus Rapid Transit (BRT) has become popular in many metropolitan areas. BRT is a compromise between a municipal bus system and a light rail system. One way to think of it is as “Light Rail on rubber”. Busses are used as the vehicles, and city streets are used for right of way. However, some degree of grade protection is provided to permit the busses to move more rapidly and more independently from regular automotive traffic. This can vary between fully dedicated BRT lanes, to lanes shared with automotive “express” traffic. The busses make relatively fewer stops than municipal busses, and may use small street stations for these stops (similar to light rail stations). The busses are often slightly bigger than municipal busses. BRT is aimed at longer distance urban commuting, such as between the suburbs and the city core, or between different suburban centers. The frequent stops of municipal busses lower their pace to the point where they are very unattractive choices for long (metropolitan) rides. Capital outlays for the busses, the stations, and the grade protection are more expensive than for regular municipal busses, but far lower than for light rail equivalents. Route changes and extensions are far cheaper to accommodate than for light rail.

Essentially all of the public mass transit vehicles in America employ professional drivers/operators. Salaries and benefits for these operators represent the largest single piece of the operating expenses for these systems. Vehicle and road bed maintenance costs, including the salaries for maintenance personnel are the second largest operating expense. Insurance costs, energy costs, promotion costs, and administration costs are also part of the operating expense load. The total expense load includes amortized capital costs for construction, reserve funding for eventual replacement, and day to day operating expenses.

Revenues for public transit systems include transit fares and advertising. The large size of the mass transit vehicles, and their constant recirculating movement through highly populated areas make them effective venues for bill board advertising. Because the operating entities are public, subsidization from tax revenues is also a possibility. When revenues are not sufficient to cover total expense load, these entities have difficult choices to make between cutting back on less profitable service, raising transit fares, or relying upon subsidization. Either cutting back service or raising transit fares could reduce ridership, and therefore revenues, and so may not reduce the operating deficit. So there is a natural incentive to rely upon subsidization. This reliance is easy to argue, as the transit service is a public good. Most transit districts in America operate either at break even, or with some degree of subsidy.

Public subsidization of public transit makes rider cost for transit more difficult to calculate. Is the appropriate cost the ticket price alone, or is it the ticket price plus the portion of the rider's taxes used to subsidize the ride ?

Essentially all "personal" transit in America is operated by private entities. Essentially all personal transit in America relies upon the automobile as the vehicle. The dominant form of personal transit system is the individually owned and operated automobile. This form is dominant for economic reasons.

First, use of a personally owned car is expensive! It is an all expense and zero revenue endeavor. The owner is responsible both for the amortized purchase costs (auto loan or lease payment) and for all the operating expenses. These expenses include insurance costs, fuel costs, maintenance costs, and registration costs. The owner may also be responsible for storage/parking costs when he is not using the vehicle.

Use of a rental car is just like use of a personally owned vehicle, except the user is not directly responsible for the ownership costs of the vehicle – purchase, registration, and maintenance. The user is still responsible for insurance costs and fuel costs and parking costs. Insurance costs are usually higher than for personally owned vehicles. But the private company offering the car for rental does have to pay the ownership costs for the vehicle, and it needs to operate at a profit. So all the ownership costs plus the profit are passed through to the renter in the form of the rental fee. In the end the renter pays more for vehicle use than if he owned the car personally. This economic reality is why rental car systems serve a niche of the personal transit market. They are good for short term demand where vehicle purchase is not pragmatic.

Another form of personal transit system that utilizes the automobile is the taxi service. In this case the taxi company is not just the owner of the vehicle, but also the operator. So the taxi company is responsible for all the ownership costs of the vehicle as well as all the operating costs of the vehicle. In this case the salary for the taxi driver is a large additional operating expense. Again all of these costs, plus a profit, must be passed through to the transit consumer. A driver earning a below national average income of $30,000/yr, carrying riders 8 hours per day, 5 days per week, and 50 weeks per year, and able to operate his taxi at an average speed of 15 miles per hour, (would be considered the most productive taxi driver of all time, and) would add an operating expense of $1.00 per mile to the taxi fare. Amortizing the driver's salary and benefits over a very small group of travelers makes taxi systems the most expensive form of personal transit. This economic reality is why taxi systems serve a niche of the personal transit market. They are good for extremely short term demand – single trips - where even vehicle rental is not pragmatic. They are especially good for trips where parking costs are prohibitive, or when capable drivers may not be available in the traveling group – foreigners or drinkers.

A few recent commercial experiments are worthy of note. A company called ZipCar seems to have been somewhat of a success in altering the rental car business. Traditionally the major rental car companies had pricing models that favored a minimum rental interval of 1 day. A few had hourly rates, but these rates were set to discourage use since the company incurs expenses performing car turn-around. ZipCar focusses upon short term (hourly) rental as its primary target market. One measure of its success is that most of the traditional rental companies have now set up their own programs to service this market niche. But ZipCar is just a rental car company, and nothing about it alters the fundamental analysis presented above.

Uber is another company frequently in the news lately. While Uber has unique dispatch technology, it is still essentially a taxi company (or at least a taxi collective). It is intended to entice a new pool of amateur drivers to enter the taxi driver profession on a part time independent basis. The effect is to replace the professional taxi driver work force with a lower cost work force. As quantified above, driving a taxi barely provides a sustenance income. But this extra income can be used to offset some of the operating expenses borne by a private owner of a vehicle. So that private owner may be willing to work part time for a lower rate than would a full time professional driver. By implementing an auction process for fares as part of the dispatch technology, Uber encourages a “race to the bottom” on the benefit to be gained by these amateur/ignorant independent drivers. An independent driver who picks up riders who share part of his normal commute path can benefit at almost any fare (since he sees some revenue and does not increase his operating costs appreciably). But an independent driver who picks up riders for trips un-related to travel he would otherwise do, must receive a fare at least as great as the operating expenses for his vehicle in order to see any benefit. The smaller the excess is of the fare over those operating expenses, the smaller payment he receives for his time (to offset the expenses of his personal travel). Therefore, Uber only improves taxi economics to the extent that it enables “natural ride-sharing” – that is riders being picked up by Uber drivers already travelling near the rider’s route. Ride-sharing boards have been facilitating this activity for years. Uber has provided a slick app to make it more wide-spread and to facilitate some economic benefit to the vehicle operator. It is yet to be seen whether the Uber economy will sufficiently develop so that Uber-taxi could be a cost competitor to personal ownership of a vehicle.

Private-Personal vs Public-Mass Transit

There has been, still is, and likely will continue to be a conflict/competition between mass transit solutions and personal transit solutions. They compete for use of land; they compete for public funding; and they compete for the time spent by people in transit.

Multiple transportation technologies exist for use in mass transit, as discussed above. These forms all possess the essential attributes for economic viability – large vehicles able to support high occupancy; and operation by individuals or very small crews. When applied in corridors having high demand, these technologies can be cost effective. Regular schedules can be run over routes relatively short in length, with operating costs being roughly proportional to route length times the frequency of operation. These operating costs and the labor costs associated with the operating crews can be amortized over the revenues produced by the high occupancy to achieve break even operation or better. Most transit districts do have at least a few transit routes that operate at a profit (even if the overall system does not).

To date the family sized (personal) automobile is the only transportation technology available for use in personal transit. It is dominantly applied as personal transportation, as explained above. The purchase costs and operating costs of a personal vehicle are somewhat less than those of a bus, but the primary reduction in cost is obtained by the use of an amateur crew (does not get payment for driving) of limited size (driver only). Since the average occupancy of a family vehicle is low (1 – 5 people), the lower operating costs still result in a higher average cost per passenger mile versus mass transit. But for many working Americans it is still an economically viable solution, even if an expensive one.

Since mass transit technologies are more readily available than personal transit technologies, and since mass transit economics are more understood and proven, transit districts have typically attempted to employ mass transit technologies to serve personal transit demands. After all, most mass transit demand is made up of at least one part personal transit demand – between one or both endpoints and the mass transit station(s). A large percentage of the mass transit riders destined for an event in the city core originate in the surrounding suburban area and will return there after the event. So in order to be useful, the mass transit coverage must extend out into those less dense suburban neighborhoods. In general transit demand in these less dense areas is not sufficient to support mass transit operating expenses, so these portions of transit routes must be subsidized by the more profitable routes and by funding from the transit district. So transit districts face difficult decisions to optimally manage mass transit systems – balancing profitability (or level of subsidization) with desires to increase ridership and utility.

One technique being applied by transit districts is coordination with city zoning and land use planners. If the fundamental force driving people from the city to the suburbs is land pricing, rather than space, then increasing the supply of urban space can work (to moderate its pricing). So by converting the sprawled suburbs into a cluster of small cities (urban villages) the urban space available is increased while the higher density is maintained in these urban centers. Transit demand will then be concentrated between these centers (and within each of them). Thus the transit problem is molded into a form that fits the available mass transit tools available to the transit district. This approach has many moving parts, and requires a long term focus.

Generally the transit consumer must make a competitive choice for each trip he takes – will he use a personal transit system (probably means drive his own car), or will he use a mass transit system. More precisely, since the mass transit system usually cannot fully support his personal transit unit, the competitive choice is usually between using a personal transit system for the entire trip, or using a personal transit system and a mass transit system in combination. In most cases the mass transit system is slower than the personal transit system, so the combination trip will be slower than the exclusively personal transit trip. An exceptional condition must be present for the combined trip to win this competitive choice. The rider may simply not be able to afford the more expensive personal transit system. Parking availability or costs may be extreme, and push the balance in favor of mass transit use. The trip may occur during rush hour when congestion slows personal transit to an extent that it is equally slow as mass transit. Lacking once of these exceptional conditions, the traveler will elect the personal transit system for the trip.

This is why the private ownership of personally operated vehicles is the preferred transit system in America. It is able to service all transit demand, and for all but the exceptional cases it is the fastest and most reliable transit system available at an affordable price.

It is difficult for public entities, which fund both mass transit systems and the infrastructure that supports cars, to invest too heavily in mass transit solutions in the face of this competitive reality. What is needed is a viable alternative technology to compete with the private-personal automobile system.

Possible Future Transit Systems

The distinction between mass transit and personal transit is critical to understanding the future opportunities for the success of transit districts. With few exceptions in America, mass transit systems can only operate profitably in the city cores (and between city cores). The economics of mass transit systems simply do not work for personal transit needs in suburban areas. The only transit technology available for personal transit needs is the family sized automobile. No proven model yet exists in America for anything other than large scale private ownership of cars for personal transit. So in America today, "personal" transit means the privately owned and operated automobile.

Note in the taxonomy figure above that there are currently no transit systems in the Public-Personal quadrant. It seems the analysis indicates pretty strongly this is where success lies. An individual's Private-Personal transit demand is simply too low to achieve significant re-use. Re-use is key to lowering cost, and has ancillary benefits to congestion and parking. This points toward a shared or "public" solution. Meanwhile mass transit cannot cost effectively address personal transit. This points toward an exclusive or "personal" solution.

So a public operated transit technology that is able to efficiently carry small (family sized) groups, on demand, directly between endpoints, and then be re-used for other travelers has the potential to be cheaper, widely used, and beneficial to the community. Are any on the horizon ?

Public cars:

Mass transit technologies exhibit a higher duty cycle (or degree of re-use) than does the sole personal transit technology – the automobile. When one passenger disembarks a bus, others board or remain on the bus. So the bus remains in productive use even though the disembarking passenger is finished with it. Personal vehicles (and rental cars) are parked when not being used by the owner (or renter). To date no transit districts have attempted to deploy family sized automobiles for public transit use, in a fashion to improve this duty cycle. In recent years a few private organizations (for profit and non-profit) have attempted to establish shared vehicle fleets using family sized vehicles, with limited success. ZipCar is an example of a private, for-profit company doing this.

Such a solution requires a certain critical mass – enough cars in enough locations - in order to be effective. So economic viability on a large scale is not yet proven. But the volume purchase power of a public entity should provide the ability to purchase, register, insure, fuel, and maintain vehicles more cheaply than individual owners can. Further the public entity probably already has parking spaces along streets and in buildings over a wide coverage area. To the extent this system works it will actually reduce parking demand (through higher re-use of cars in the coverage area).

The system would operate like a public Uber-Zip car. Riders would be issued a special transit card after demonstrating themselves as licensed drivers. Likely their driving record would assign them to a risk pool which would affect their pricing. The public entity would purchase a large number of vehicles and equip them with GPS and communications technology similar to OnStar. A number of dedicated parking locations would be set up spread out over the coverage area. Rental agreements might be established with commercial parking facilities to reserve a portion of their spaces. The cars would be parked in these parking spaces. A rider would access an on-line app (Uber-like) to specify their trip. The app would direct them to an available car parked nearby, and reserve the car and an empty parking space near the destination for a period of time. The rider would use his transit card to unlock the vehicle, and drive it to the destination, being directed to the reserved parking space by on-board navigation. He would then leave and lock the vehicle, and the transit fare would be deducted from his card. The vehicle would then be available for dispatch to another rider. The app could even detect and facilitate ride-share opportunities.

Since the operating expenses are lower than with private ownership, and since the public entity can operate as a non-profit, the “public car” system has the potential to offer riders lower cost transit than private-personal vehicles. The users also avoid parking expenses. Transit times should be identical to private-personal vehicles, with the possible advantage of time saved looking for parking. The transit district sees additional benefits. Because vehicle re-use is higher, time based expenses like financing and insurance are further reduced. Also because of higher re-use, fewer parking spaces are needed, and traffic congestion is reduced. Therefore fewer public dollars need be spent mitigating those problems. The system records transit use on a per trip basis. This can facilitate other public planning activities.

The system can start a certain size and then grow in increments as use warrants. Thus it offers considerably lower risk to a transit agency than does investment in a new mass transit system.

The system may not scale over large coverage areas. Often urban areas are zoned to create daily migration patterns – moving from residentially dominated neighborhoods to commercially dominated neighborhoods in the morning, and then back in the evening. This migration could saturate the system provisioning, so that vehicles or parking is exhausted in some neighborhood for a portion of the day. If this saturation were to occur, the system would become partially un-usable for that portion of the day. Deploying the system as a feeder system to existing mass transit tends to mitigate this effect. It becomes a combination of smaller coverage areas (surrounding the mass transit station) rather than one big coverage area. Some reverse runner work force might also be beneficial, to react to and counter the effects of near saturation situations.

Automated Taxis:

The automated (self-driving) car has been coming for some time (accelerated first by the DARPA challenge and recently by the Google car). The automotive industry is now committed to this direction of evolution. Incremental capability is already rolling out in new car offerings, and full mass deployment is predicted by about 2030 (15 years).

It is the intention of the automotive industry to deploy this technology to the traditional individual market for private-personal vehicles. This would be a mistake. It would be a missed opportunity – increasing the cost of transit and adding to the burden of transit districts, when it should instead lower the cost of transit and ease the burden on transit districts.

The autonomous capability added to cars requires additional advanced electronics and sensors, and software of considerable complexity. These add cost to the vehicle and as such will increase the purchase price. There will certainly be some degree of increased maintenance cost to keep this capability operating properly and reliably. The impact of the technology on insurance rates is yet to be known. It is likely that at least initially, with the technology unproven in widespread deployment, insurance underwriters will demand a risk premium. Whether vehicle manufacturers will offset this premium or it will be passed on to the vehicle owners is to be seen. In the long term, the equipment and maintenance adders may be quite small, and the feature may qualify for an insurance discount which more than offsets that adder. But for an initial period of years the capability will increase costs.

For some considerable length of time (decades perhaps) autonomous vehicles will share the roads with human driven vehicles. Google initial experience report – which covers a very small volume limited local deployment - already indicates some problems may result from this. Machine reaction times are faster than human reaction times, which is leading to judgment errors. How is a human driver to know quickly that the other vehicle is autonomous, and therefore adjust his expectations for braking speed and distance ? So accident rates may increase even though "its not the machine's fault". This drives up local insurance rates, average maintenance/repair costs, and policing and liability adjudication activity. All these costs are ultimately borne by the existing car owners and tax payers. More frequent accidents also add to the average level of traffic congestion, with increases transit times.

An owner of an autonomous vehicle has other incentives which work counter to the public good. Since the owner is freed from the task of driving, he can make other productive use of his commute time. This may promote him to travel more and farther. So the number of vehicles on the road will increase. If parking rates are high locally and cheaper some distance away, there is an incentive to have the car park itself farther away. This means more miles driven and more cars on the road at any given time. In fact there may be an incentive to not park at all. If the vehicle can be operated for O $/mile, and can drive at a slow rate S mile/hour, then if parking rates exceed O*S $/hour it is cheaper to have the car just drive around empty. This not only adds more cars to the road, it adds more slow moving cars to the road (since O*S is minimized by lowering S).

Now consider the missed opportunity. Consider if a large entity – public or private – uses the autonomous vehicle technology to increase re-use of the vehicles – an autonomous taxi entity. The additional expense of salary and benefits for the driver is eliminated from the economics of the taxi. So it should be able to operate as cheaply as a private-personal vehicle. In fact the re-use drives up miles driven per month, which lowers per mile costs associated with time based expenses such as financing. And volume purchasing lowers the other costs associated with vehicle ownership. So the taxi ownership and operating expenses should be lower than for individual ownership. These savings can be passed through to riders in the form of lower taxi fares to the point where taxi transit is cost competitive with private-personal transit. This should promote market share growth.

Taxi travel is already competitive with private-personal transit from the perspective of transit time. Widespread use of automated taxis would reduce the number of cars on the road (by increasing re-use), which would ease congestion and lower transit times for everyone. It would also shift the mix of autonomous and human operated cars more rapidly in favor of autonomous. The real safety and transit time benefits of autonomous vehicles will not be seen until there are no human operated vehicles. The higher re-use also minimizes the need for parking and allows that parking to be more conveniently located.

If a public entity (non-profit) is the autonomous taxi operator, then transit rates can be lowest since no profit is included in them. It also makes integration with mass transit and regional parking planning easiest. Implementation by this entity of the "public car" concept previously described becomes easier. User qualification as drivers is no longer required, nor is a staff of runners to fight saturation situations.

Conclusions

Transit districts in metropolitan areas in America have struggled for years to provide popular (functional, convenient, user-friendly) and cost effective transit. They have largely failed to come to grips with the reality that metropolitan life is a mixed of urban and suburban environments, biased in favor of suburban. The only tools these districts have been able to employ are mass transit technologies. These technologies are a poor fit for suburban environments. The only way transit districts are going to meet with full success is to shift their focus to deploying personal transit solutions. Personal transit – vehicles available on-demand, that travel directly between the desired endpoints – is necessary in order to offer competitive transit times. Fleet ownership and vehicle re-use (time multiplexed sharing) is necessary in order to lower transit cost. Competitive transit times with lower cost will successfully garner transit market share.

Technologies already exist today to support this different focus. The automotive industry is already moving in a direction with the autonomous vehicle that will better serve this focus over the coming decades. But transit districts cannot delay in adopting this new direction. If they wait too late, then existing commercial forces will deploy autonomous vehicles in manners which increase the burdens on the transit districts, and make it more difficult for them to move later.

About the Author

Stephen Hamilton is a newly retired individual who just concluded a 40 year career as a computer and integrated circuit designer. He has had a lifelong interest in physics, cars, and transit technology in general. Believing that climate change is a species threatening reality, and that governments have failed to face it, he has decided to spend his remaining time and talents trying to use commerce to impact it. Stephen has decided that personal travel in America is the area where his impact can be greatest. He has spent the past 18 months studying this area, and thinking about its challenges and possible/likely solutions. CityTram.org was created to encapsulate these efforts.