Improving Transportation Requires a New Solution

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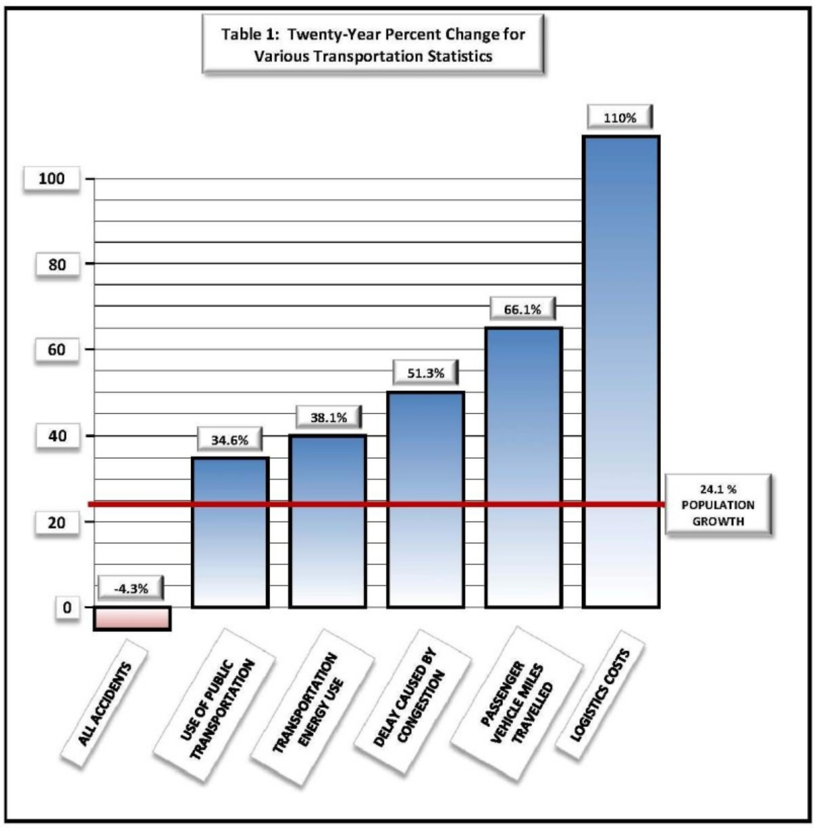
A review of the major characteristics of our urban transportation system quickly reveals that historic trends are leading towards ever-worsening traffic problems and are likely difficult to change. Most solutions currently gaining traction will do little to solve the most pressing problems. The present focus is on improving existing transportation systems. This paper argues for a promising solution involving the introduction of a new transportation system into the present mix.

The problem

Table 1 lists major transportation characteristics and their growth over a 20 year period. The horizontal red line shows the U.S. population growth over that time (about 24%), and the discussion below compares the growth of each characteristic to the population growth, in order to put things in perspective (if nothing changed, these characteristics could all be expected to grow at the same rate as the population has grown).



Accidents.[1] The total number of accidents has actually declined. While this is the only factor to decline, and clearly a good thing, it is still not nearly enough. Over 40,000 people are killed on US roads annually (compared with total U.S. deaths in Vietnam – 58,159; Iraq – 4,334; 9/11 – 2,993), and road traffic injuries are one of the top three causes of death for people aged between 5 and 44 years worldwide.[2] The U.S. is not any safer than the rest of the world. There are approximately 60 countries with lower death rates per 100,000 population. Improving safety is no easy feat, since advances in safety technology can be diminished by societal changes, such as texting while driving.

[1] U.S. DOT Bureau of Transportation Statistics
[2] World Health Organization

Use of Public Transportation.[3] Transit use grew a little more than population but much less than passenger vehicle miles traveled. Try as we might, we just cannot convince people to leave their cars for transit. During the recent period of high gasoline prices, a small jump in transit use was experienced. This caused problems for transit agencies around the country, because they lost money on each rider! This unsustainable practice was exacerbated by reduced tax-based subsidies and meant that many agencies had to reduce service at the precise time they should have been increasing it. Subsidized transit systems may be necessary to ensure that the disadvantaged have reasonably priced transportation. However, a sustainable transit system, that can rise to meet changing demand, needs to cover at least its operating expenses from the fare box - something that few U.S. transit systems can accomplish.

Transportation Energy Use.[4] This is growing an alarming 50% faster than the population and a large portion of this energy comes from foreign oil suppliers. 96.6%[5] of all transportation energy use is petroleum-based and any growth at all is problematic. As cheap oil resources are depleted, and as countries such as India and China dramatically increase their oil use, cost of oil is likely to rise steeply and cause serious problems for transportation.[6]

Delays Caused by Congestion.[7] As more and more cities face rush-hour gridlock (and rush-hours get longer and longer), this factor is growing twice as fast as the population, and congestion now wastes 3.5 billion man-hours every year. We seem unable to build ourselves out of this problem. Consider I-25 through Denver; two years after a major improvement project took it from six to eight lanes, plus light rail, it regularly suffers congestion similar to what it did before the construction. Paradoxically, even in bad traffic, the light rail train seldom passes the automobiles. This is because the light rail system only averages less than 25 mph. Incidentally, the light rail's two lines cost about the same to build as the eight lanes of highway, even though they carry much less traffic.

Passenger Vehicle Miles Travelled.[8] The amount of driving we do is outgrowing the population by almost three times! This high level of passenger vehicle use is widely seen as being unsustainable. The energy used (and the related foreign oil dependence) is seen by many as being the major issue. However, automobile use brings numerous other problems. While accidents and congestion are discussed separately, two other problems are real estate/infrastructure and automobile manufacture. Each car typically requires four parking spaces (one at home, one at work and two others for intermittent use). The cost of this infrastructure (these spaces are typically paved and often roofed) and the street/road/highway infrastructure, needed to support our automobile use, is enormous. At the same time, the real estate used to support automobiles increases the cost of other utilities and decreases the quality of urban living. Furthermore, the cost of highways is increasing as design

[3] U.S. DOT Bureau of Transportation Statistics
[4] U.S. Department of Energy
[5] American Council for an Energy-Efficient Economy
[6] Steiner, C., $20 Per Gallon
[7] 2009 Urban Mobility Report
[8] Federal Highway Administration

standards are continually raised in an attempt to reduce accidents. In addition, the tax revenue to support this infrastructure has not kept pace with need, and we are likely to face increased taxes and/or more and more tolled highways. The cost to society of individual automobile ownership is rising as we strive to make cars more sustainable. It's time we took a long hard look at what automobile ownership really costs.

Logistics Costs.[9] These are the costs of moving goods and they have increased far faster than the population has grown. At this pace, logistics costs are set to have major impacts on our economy. Part of the reason is that we move a very large proportion of goods by semi trucks rather than rail. Rail is a far more efficient way to move goods, but we lack the infrastructure to economically collect and distribute goods at the ends of the rail lines. Shipping suffered from a similar problem, wherein the cost of handling goods in harbors exceeded the cost of shipping them over the seas. This changed with the advent of container ships. A similar revolution is needed for rail.

Greenhouse Gas Emissions.[10] Transportation accounted for 47% of the net increase in total U.S. greenhouse gas emissions since 1990. It currently contributes 34% of all greenhouse gas emissions. Reducing transportation-related greenhouse gases requires reducing the amount of energy used by transportation, as well as changing the primary source of that energy.

A solution

Conventional transit is not the solution. In the U.S., transit uses (wastes) as much energy per passenger mile as the automobile.[11] This is largely because trains and buses run around empty most of the day. Transit infrastructure is expensive to build, consumes much real estate and resources, and its construction contributes significantly to greenhouse gases. Americans have a long history of not using transit and this is unlikely to change, unless the characteristics of transit are radically improved. High speed rail and air travel may be good solutions for long distances, but both suffer a last mile (or last many mile) problem and do nothing for urban mobility.

It is amazing to think that we are still using the stagecoach model for transit. A stagecoach runs on fixed routes with designated stops. There is seldom a stop at the desired origin and destination (the first/last mile problem mentioned above). The vehicle accommodates many people, to spread the cost of the driver, and has to stop whenever somebody needs to get on or off. All we have done to this model is make the vehicles bigger, turn the stops into stations and the routes into corridors. The ride may be a little smoother and the speed a little higher, but the quality of service has hardly improved. A rail system, with top speeds in the fifties and stations every mile, has an average speed under 25mph. "Modern" street cars often have average speeds in the single digits. It is no wonder transit only achieves a mode share of around 4%. The model is broken and we need to quit trying to fix it. We need a new model.

[9] Federal Highway Administration
[10] U.S. Environmental Protection Agency
[11] U.S. Department of Transportation

What if you did not have to wait for transit, you always got a seat, and it took you where you wanted to go without stopping? Would you use it? The only mode of transportation that currently operates this way is the automobile at 3:00 a.m. Even then, stops at "dumb" traffic signals for no crossing traffic at all are often required. Amazingly enough, transit that operates this way was invented over fifty years ago. It is called personal rapid transit (PRT) and it can be likened to automated (driverless) taxis operating on a system of guideways. The reasons PRT could help solve our transportation problems are:

1. It has a high level of service (more like a car than a bus) and really can attract drivers from their cars.
2. It uses about a third the energy of most other modes.
3. It is electrically powered so, as we convert the grid to renewable sources of energy, we automatically also convert PRT-based transportation.
4. It has proven to be about a hundred times safer than conventional transportation.[12]
5. Elevated or buried (PRT tunnels are much smaller to move the same number of people) guideways do not use up real estate or cause neighborhood severance.
6. Small vehicle sizes (like a small automobile) require minimal infrastructure.
7. Each automated T-Pod (transportation pod) will be reused fifty or more times a day – an efficient use of manufacturing resources and a reduced need for parking.
8. In off-peak times, unused T-Pods wait in stations or depots – so there is much reduced empty vehicle movement.

Figure 1. ULTra station and T-Pod at Heathrow

Figure 2. 2getthere Masdar T-Pod

Figure 3. Vectus T-Pod and Guideway

Figure 4. Skyweb Express T-Pod

[12] Muller, P.J., Personal Rapid Transit Safety and Security on a University Campus

Table 2 below shows the author's opinion of the extent to which various solutions are likely to have a positive impact on the transportation problems mentioned at the beginning of this discussion. 0 = no impact, 1 = some impact, 2 = significant impact. Certainly, some will argue with the ratings, which are based on the author's opinions and analyses. In addition, PRT has yet to be proven in large applications. The point is that PRT appears to have the potential for quite significant impacts across the board, yet it is receiving attention that is dramatically disproportionate to this potential.

Table 2. Comparison of Positive Impacts

	High speed Rail	Light & Commuter Rail	Street Cars	Demand Management	Hybrid cars	Electric cars	PRT
Accidents	1	1	0	0	0	0	2
Congestion	0	1	0	1	0	0	2
Energy use	0	0	0	1	1	2	2
Cost	0	0	0	0	0	0	1
GHG	1	1	1	1	1	2	2
Logistics	1	0	0	1	0	0	1
Severence	0	0	0	1	0	0	2
Real estate	0	1	0	0	0	0	2
Walkability	0	1	2	1	0	0	2

Three Roles for PRT

Campus-type applications. Initial PRT applications have been limited to situations having fairly high trip demands in a relatively confined area. The Morgantown PRT system, which went into service in 1975 at the University of West Virginia, the Masdar PRT system in the UAE, slated for commissioning in late 2009, and the Heathrow Airport PRT system, slated for commissioning in the spring of 2010, all fit into this category. Initial PRT systems are well-suited to these applications because high speeds and ranges are not required. This favors battery-powered systems and also allows headways as short as three seconds, while meeting railroad type "brick wall" stopping criteria.

PRT Consulting recently analyzed a campus-type PRT system for the Fort Carson Army Post in Colorado Springs. Table 3 compares this system to light rail and commuter rail systems proposed in Utah and Virginia respectively.

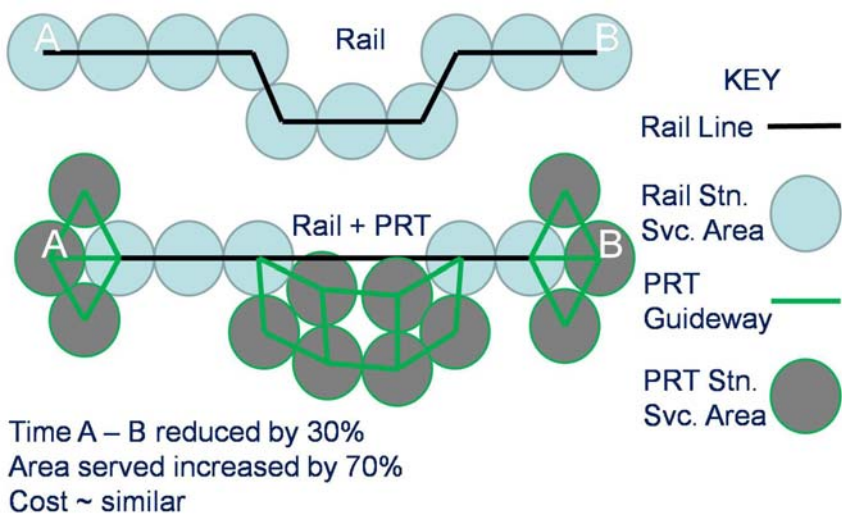
Table 3. Comparison of Light- and Commuter-Rail with PRT

	Mid-Jordan LRT Extension, UT	Dulles Rail Project VA	Fort Carson PRT Project CO
Miles of track	11 (two-way)	23 (two-way)	23 (one-way)
Stations	9	11	35
Daily passengers	9,500	60,000	53,500
Capital cost	$428,300,000	$5,200,000,000	$522,400,000[13]
Cost per mile[14]	$19,468,000	$113,000,000	$22,713,000
Cost per station	$47,590,000	$472,700,000	$14,926,000
Cost per annual passenger[15]	$150	$290	$33

Collector/distributor for conventional rail transit. People generally prefer rail to bus service. Rail usually provides a smoother, faster and more reliable ride. However, the faster service comes at the expense of fewer stations. Feeding a train system with buses does not work well, because people don't like to use two services that can both involve long, unpredictable wait times.

This dilemma can be solved by integrating a personal rapid transit (PRT) collector/distributor system into the rail system. People can be expected to view the combined systems almost as one, since the PRT system involves little or no waiting (typically less than one minute). The cost savings of the rail stations that can be eliminated could go a long way to paying for the PRT system, while allowing the trains to run faster. The combined systems (see Figure 1) will provide a much higher level of service with wider coverage, thereby enticing a higher ridership. A bonus would be the increase in land values of the wider area within walking distance of the combined systems.

Figure 1. Comparison of Rail with Rail + PRT



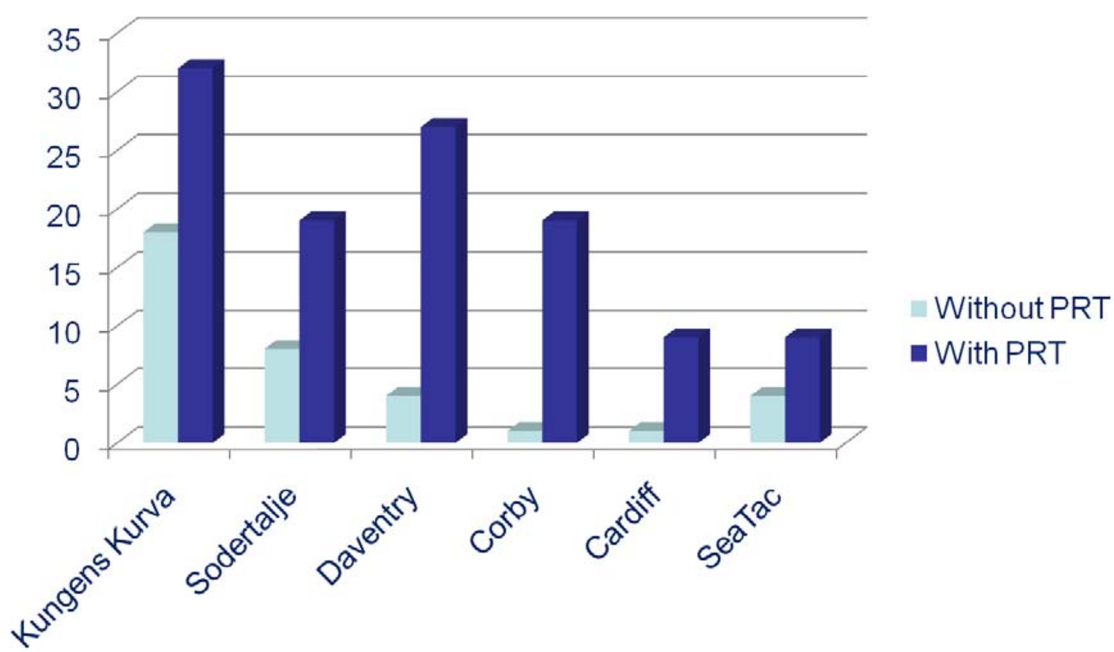
[13] Total cost excluding capital cost offsets
[14] One-way
[15] Daily passengers x 300

The Swedes are ahead of the U.S. on this concept and are seriously investigating PRT last-mile service between commuter rail and downtown business districts.

City-wide transportation system. In order to function as a city-wide transportation system, PRT systems will need to operate at speeds of 40 mph or more and have headways (time between vehicles) of approximately one second. Both of these characteristics are beyond the present capability of the initial systems being deployed but are expected to be reasonably easily attained.

Numerous studies indicate that urban PRT systems will significantly increase the transit mode share (see Table 4.) Since PRT uses about one-third the energy per passenger mile of conventional transit, this would significantly reduce both transportation energy use and emissions. It should also reduce congestion and accidents.

Table 4. Transit Mode Share With and Without PRT



Source: Various studies in the named communities.

Hurdles to be overcome

PRT could make a significant impact on the transportation problems described above. However, this is likely to take a long time, or not happen at all, without impetus from the government. In the three years since BAA committed to a pilot project at Heathrow Airport, only tow other PRT projects have been announced worldwide. One is for the carbon-neutral city of Masdar in the UAE. The other is for the City of Suncheon in Korea. While three of the four leading vendors now have commercial clients, the financial stability of many of these vendors remains uncertain. BAA is struggling financially and is unlikely to move quickly with expanding its Heathrow system. Masdar is likely to move ahead quickly if the economic downturn does not slow them down. However, some fear that they are moving too quickly and that their undue haste may cause problems for PRT development. Their sustainable city has gained worldwide attention. It relies on a 100-station, 2,000 T-Pod PRT system for the bulk of its interior transportation (people, goods and garbage). If the PRT system fails, it will be a major setback for PRT and sustainability around the world.

Two major hurdles currently prevent rapid PRT deployment. The first is institutional resistance and the second is lack of proof that PRT will work in a city-wide deployment.

Institutional resistance. Local authorities are understandably reluctant to promote PRT projects because they do not understand PRT, the benefits it brings, or how to go about a PRT deployment. Transit agencies seem to be focused on surviving and maintaining services in the present difficult times. The trend appears to be that initial PRT projects are more likely to be located in communities that are open minded than in those that are best suited for PRT. It is, therefore, important to identify the two to three best opportunities in the United States for large-scale PRT deployment, and develop these opportunities to the point where all major hurdles have been overcome; local and federal agencies can work with private companies to finalize the deployment.

A country-wide search is needed and should initially identify up to one hundred candidate PRT applications. Each candidate application should then be weighed against a set of criteria and the best five to ten identified. Preliminary feasibility studies should be undertaken for the short-listed applications. These studies should include public participation, benefit/cost analyses, route and station locations, financing considerations and hurdles to be overcome. The best two or three opportunities for PRT deployment should then be selected from these preliminary studies. Detailed feasibility/master plan studies can then be undertaken for the two or three best candidate applications. The result of this work will be not only the identification of the best two or three PRT opportunities but also the completion of the groundwork necessary to almost ensure their implementation. These projects will have community buy-in, financial feasibility, and high benefit/cost ratios and will be environmentally feasible. In short, they will greatly help jump-start PRT deployment in the United States at a very reasonable cost and without getting the government directly involved in PRT development. Once again, the Swedes are ahead of us having already completed a screening process and selected four cities as finalists.

Scalability. The second major hurdle relates to scalability. There is concern that initial, small PRT systems may not be able to scale up to provide city-wide service. The three major factors of concern are speed, headway (time between T-Pods) and control system. Speed and headway issues can be (and mostly have been) resolved on test tracks and through experience gained with initial deployments. Large control systems have been shown to work by simulation. However, these simulations have never been verified since this has been considered impossible to accomplish without a large-scale deployment. We have developed a verification methodology to prove the scalability of PRT control systems to the capacity needed for city-wide deployment (many hundreds of stations and thousands of T-pods). Our verification methodology consists of using small pilot systems (with more than two stations and more than ten T-Pods) to verify PRT simulations and PRT simulations to verify the scalability of small pilot systems. The key to the methodology is our proprietary protocol for integrating the pilot system with the simulation. This has been problematic in the past because of the issue of dealing with real T-Pods leaving the pilot and becoming ghost T-Pods in the simulation and also dealing with ghost T-Pods becoming real when they pass from the simulation into the pilot system. We have developed a unique solution to this problem that allows intermingling of real and ghost T-Pods with very few compromises.

Conclusions

It is clear that most solutions to the transportation problems, currently being considered, will either not be very effective or will only address a few specific issues. At the same time, PRT, a system whose basic technology has been proven in public service for over thirty years, appears likely to bring significant improvements across the board. The emerging modern PRT industry is not well established, and we believe it behooves the Government of the United States to take the necessary steps to validate the viability of this technology and encourage its swift deployment.