Q&A following presentations by Dr. J. Edward Anderson, PRT International, LLC

Questions asked following a presentation to the Branson City Council on Nov. 19, 2007

1. Who would build the system?[1]

   Our plan is that final design and construction supervision for the test system be managed by a small group of system engineers under my direction. Building the test system requires structural engineering for the guideway, mechanical engineering for the chassis, a specialty design firm for the cabin, electronic and control engineering for the control system, and civil engineering for the station and maintenance facility. Thus, we have prepared a series of requests for proposals for the various specialty tasks to be given to a selection of firms known to us. The fabrication and construction will be contracted similarly. From our experience, this procedure is preferable to trying to find one large firm to oversee the whole project because it is more difficult in such a case to ascertain that the individual engineers are truly educated and motivated to the success of the project. Once the test system is built and the testing is completed, the system will be ready for deployment, a process that will be managed either by the same system engineering team expanded, or it is possible at that point that the company will be bought out by a large firm.

2. If you have a city who wants to do this where would they come up with the money to pay for it?

   a. The first necessary step is a planning study

      i. to determine the precise layout of guideways, stations, and maintenance and storage facilities,

      ii. to estimate the peak-hour and yearly ridership,

      iii. to estimate the capital and operating costs, which will require information developed in detail during the test phase, and

      iv. to explore how the system could be financed.

[1] We have chosen to call our system an "Intelligent Transportation-Network System," or ITNS. This is a new and unfamiliar name. ITNS is of the class of systems called High-Capacity Personal Rapid Transit, or HCPRT. In the text I often shorten the name to PRT.

FTA grants are available for this planning process if a city petitions for them. Federal planning money has been provided for PRT studies in Providence, SeaTac, and Cincinnati. The Federal Role since the early 1980s is summarized on page 19.

b. The second step is to build the system. Our studies show that the costs will be low enough and the ridership will be high enough that all or almost all of the funds can be recovered from fares. Thus, with data from the test and planning programs available, past experience has shown that financing can likely be provided from one of the large investment houses.

3. Where will you build the test system?

This depends on the source of financing. If financing came from the Branson Area, the test system could be built nearby and the financier would have major ownership in the detailed plans and specifications needed to build similar systems anywhere.

4. Would off-line stations present problems with parking?

I have noticed that there are very large parking lots all along the portion of the Highway 76 corridor where the theaters, hotels, and restaurants are located. With our system in place, one can easily envision people arriving in Branson along U.S. Highway 65 wanting to park near the junction of Highways 65 and 76. Thus, major parking would have to be provided near that junction, but not necessarily at one spot since the system can be designed to loop to several parking lots.

5. What would the maintenance cost be?

A number of studies of the maintenance cost have been made that indicate a figure in today's dollars of about 20 cents per vehicle-mile. The major cost is for labor for operators and maintenance personnel. To that is added the cost for energy and for spare parts. One can note that these vehicles are much simpler than automobiles, and thus the maintenance cost will be proportionally less, but we have added the cost of maintaining the stations and guideways. Moreover, since the vehicles run in the shade on smooth rails with no rough roads to traverse, the maintenance of the wheels and tires will be substantially less than with automobiles.

6. Did you say 2 to 14 berths per station or 2 to 14 berths?

   I meant 2 to 14 or perhaps more berths per station depending on the estimated maximum flow of people per hour.

7. What is the grade ability of these motors, i.e., linear induction motors (LIM)?

   In amusement parks, LIM propulsion has been used to drive cars vertically, i.e., at 90 degree slopes. With these types of motors, the grade ability depends on getting rid of excess heat, and thus it depends on the power expended as the vehicle moves up a hill, which is proportional to the grade times the speed. For a relatively flat city, forced air cooling is used, and should be adequate for grades up to about 10% or 12% provided they are not excessively long. For steeper, longer hills liquid cooling can be used. The bottom line is that the motors will be designed to the grade requirements of the city.

8. What will be the length of a station?

   Ten feet multiplied by the number of berths for the station platform. The length of the transition curves in and out of an off-line station are proportional to the line speed. For example, at 25 mph, the transition curve is 125 feet long. So the total off-line guideway length for a three-berth station counting waiting berths would be 340 ft.

9. Is air conditioning, heating and ventilation a problem?

   We will use a standard small-auto air conditioning system with the compressor operated by an electric motor. We will use electric heating and ventilation fans. Units are commercially available for all of these functions.

10. Do you have an estimate of cost per mile for the system?

    We have made many estimates of cost. They depend very strongly on production quantity and labor costs. With two stations and 50 vehicles per mile, we estimate between $12M and $15M per mile.

11. Would there be federal money available for a smaller city like Branson to do a study?

    Federal planning money for PRT has been obtained by Providence, RI, Cincinnati, OH, and SeaTac, WA. The FTA policy is to help a city achieve the transit goals it sets for itself. All FTA planning money must be sent through a Metropolitan Planning Organization, of which I understand there is one for Southwest Missouri. Branson officials would have to work with their MPO to obtain planning funds, but with political support that should be possible.

12. Does the federal government provide money to build the system and then rely on the local population to support it?

    The federal government has provided about 50% of the cost of construction of rail systems and then expects the local population to pay any operating subsidy. Methods of financing of an ITNS would be one of the tasks of a planning study. We expect that the ridership for our system will be sufficiently high that a reasonable fare will cover all of the operating costs and a very significant portion of the capitol cost, possibly all of it. In this case, as mentioned in my response to question 2, private financing may be possible.

13. Do you generally have to shore up your subsidy regionally?

    See Question 12.

14. What is a typical fare?

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On the Minneapolis rail system, the peak-period fare is currently $2, the off-peak fare is $1.50, and the mobility-impaired fare is $050. I believe that is quite typical of many cities.

15. What is the break-even fare?

    a. For the above-mentioned Minneapolis rail system the break-even fare is $9.62.

    b. For the ITNS of our design, we expect the break-even fair to be lower than a reasonable average fare that the city could charge.

16. Would Branson have 7.25 acres available for a test system?

    Only the local leadership can answer that.

Questions asked following a presentation at the Springdale, AR Regional Planning Office, 9:30 am, Nov 20, 2007

1. How would construction time compare to a standard road system?

   Construction of ITNS is much simpler since much less land is required. The guideway-support posts are about 22 inches in diameter at the base. The first task is to build a foundation for each of the posts, which are spaced nominally 90 feet apart. The type of foundation depends on the type of soil, thus foundations may be a flat concrete slab about four-feet on a side, or they may be a three-foot diameter circular column of concrete to a depth that again depends on the soil conditions. Digging the hole and pouring the foundation, with reinforcing bars and studs inserted, is a task that may take with an experienced crew two to four hours. Once the foundation has cured, a crew will align and bolt a factory-manufactured post to each foundation, possibly using shims for accurate alignment. Allowing an hour per post is quite ample. The next crew will appear with factory-manufactured and preassembled guideway sections, typically 45 feet along and then welded into 90-foot sections. Bolting and aligning a 90-foot section, and connecting power and communication cables, can be done with an experienced crew in no more than about two hours. So the installation time for one 90-foot section would be about a day, so we are looking at about two to three months per mile. This compares the time for installing a surface rail system of two to three years.

2. The slides didn't show a guideway that looked like a truss. It showed a guideway that looked more substantial. Is there a reason for that?

   I showed in one picture a side view drawing of a truss guideway, and then another picture in which the guideway was covered. With a little more time in a presentation, I could have explained this process better and I could have discussed the nine reasons for the covers. You can read them in my paper "HCPRT," which can be found on www.prtnz.com.

3. How many PRT companies are there?

   There are two PRT companies, one in England and one in Korea that are currently building systems. There are several other companies that have small test systems and a great many small companies and individuals working on PRT designs. The best list can be found on http://faculty.washington.edu/jbs/itrans/

4. One slide showed a PRT system built with a pipe for a guideway. This would have the advantage that water or something else could be run through the pipe.

   This is true, but the weight to be supported would then substantially increase, with thus a substantial increase in cost. Power or telephone lines could be run through a pipe guideway, and we can do that by running lines in the space between our covers and the steel truss guideway.

5. How would extreme topography affect the system?

The beauty of our small truss guideway is that it can be bent in a factory accurately in computerized jigs and fixtures to follow any reasonable hill or curve. By "reasonable" I mean that the curves must be designed to ride comfort limits, which are based on international standards (ISO). If a hill is too steep, the ride will be uncomfortable to a person when going downhill. In the previous set of questions (question #7) I commented on the hill climbing ability of our system.

6. Could we place guideways at grade?

Certainly, but that means they become a barrier to cross traffic and would have to be fenced off to prevent injury or malicious damage, thus taking up much more land than if they were elevated. Along a freeway, where cross traffic wouldn't be a problem, they could be placed near the ground. Because of the need for drainage, I don't recommend placing them on the ground, unless underground. Placement is a planner's decision.

7. In running along Highway 76 through Branson, the overhead wires would have to be incorporated in the guideway and much of the signage would have to be repositioned.

After driving down Hwy 76 through Branson, I can easily see that a lot of retrofitting would have to be done to install our system, but considering the retrofitting done to accommodate a conventional rail system, much less. In the 2006 Branson Transit Study the consultant recommended incorporating the overhead wires in the guideway.

8. Do you have comparisons of PRT with roads of various types?

The first part of the answer to this is that our system (ITNS or HCPRT) is a transit system, a system designed to service people who cannot or should not drive automobiles as well as people who can, but in many cities the argument for a rail system is that it will cut congestion – indeed that is often the major argument given. The concept is that a land-efficient system will provide capacity using much less land. To make this argument stick, a new guideway system of any type must be able to attract enough riders so that it will indeed reduce road congestions. Conventional systems have had very little effect on congestion in most cities, which is a major reason we have continued to work on our new system. In making a comparison with roads, the cost of congestion must be included, and in many places that is substantial. Another argument is that a secure system like ITNS will reduce accidents substantially. Many, but not enough, studies have been made in the United States to look at the overall community benefit of a rail system of any type. Many of such studies have been made in Sweden, which I will make available on request, or you can find some of them on the Internet.

9. Is there a national study that compares PRT costs with the auto?

   Not recently in the United States, but there have been such studies in Europe. One can be found on www.advancedtransit.org. See page 19.

10. What is our cross section width?

   Our guideway, with covers attached, is about three feet wide.

11. How much right-of-way do you need?

   Only about 10 square feet every 90 feet for a post and a space about 12 feet wide by 40 feet long every half mile or so for a station.

12. Do passengers have any control mid-trip to change destination?

   We recommend three buttons in each vehicle – a GO button, a STOP button, and an EMERGENCY button. The first will work just like in an elevator. The STOP button will stop the vehicle in the next station, where the passenger can get out and reorder a trip. If you press the third button, an operator will ask via the intercom what is wrong. If you say you are sick you can be rerouted to the nearest hospital faster and more reliably than possible via an ambulance. We think that the trip should be ordered in the origin station so that the absolute minimum of action is needed once on board. If the destination could ordered on board 1) an extra machine would have to be placed on board, 2) some people would fumble around and delay the trip and hence others behind, and 3) if the fare is a function of distance, people would quickly realize that they could pay for the shortest trip then while on board change to the desired destination hoping to leave without paying, thus complicating system operation. The bottom line though is that we talk here of features that can be specified by the system purchaser. This is one of the policy issues that must be negotiated between the supplier and the purchaser.

13. What about less densely populated areas?

For an HCPRT system to break even, it is necessary for the population density to be above roughly 3000 people per square mile. But if the same economic criteria were applied to HCPRT as are currently applied to so-called "light rail," which in the case of Minneapolis has a deficit of $8.63 per trip, then a much lower population density could be served. Here we could enter the debate between those who strongly believe that urban sprawl must be contained, those who argue that sprawl is good and is the life style people want, and those in the middle who see that the vast single-family-house density will remain and needs to be served. I lean with those who believe that in a future energy-and-resource-starved world that those who have opted to live far out from town willing to endure a long commute will suffer the most as the cost of energy increases. If possible they should be given incentives to move to higher density areas, but there are many factors besides transportation that drive decisions as to where to live.

14. What is your next step to get your test track funded?

We are in discussion with several groups, both inside and outside the United States, about funding our test program, and have been working on that problem for some time.

15. Isn't there a system possibility in Dubai?

There are in the cities of Dubai and Abu Dhabi in the United Arab Emirates. This and other oil-rich nations are beginning to think in terms of a world of decline of cheap oil, but one can only hope that there are America investors who see the need to finance HCPRT development.

16. I would like more information on Alternatives Analysis – it sounds like the Feds have already determined that PRT isn't an option. Is that right?

    The questioner should consult the Federal Transit Administration web site www.fta.dot.gov to get the latest rules. The constraints lie more in the consulting community. You simply can't expect a transportation consultant to recommend a system that is not fully proven in daily operation. The cases, mentioned above, when local people have received funding for planning studies that include PRT, there were local influential people who studied PRT sufficiently to advocate strongly that it be included. If certain people in a community, through study of the various web sites, decide that PRT should be given a fair shake in an alternatives analysis, they should meet frequently to study the issues carefully, ask all of the questions they can, and on that basis make informed recommendations.

Questions asked following a presentation at the Bentonville, AR Public Library,

noon, Nov 20, 2007

1. How does the system add cars when many people are getting on the system a fair distance away and no empties are being freed up?

   As soon as a trip is complete, the vehicle used for that trip is freed up for another trip and can be called by a downstream station that needs an empty vehicle. During the night, there will be many unneeded vehicles, which will be stored on special sidings where they can be called quickly to meet demands for service. If the line speed is 30 mph the time to traverse one mile is 2 minutes. Thus, in a very short time vehicles can be called from remote parts of the network. The system software is designed to reroute empty vehicles from stations of excess to stations of need any time of day or night. More detail can be found in the paper "A Review of the State of the Art of Personal Rapid Transit," www.prtnz.com. How quickly a demand can be served is measured in terms of wait time, which depends on the number of vehicles in the system. The number of vehicles required is the total demand in groups traveling together per unit of time multiplied by the average trip time in the same units of time, and must be sufficient to meet a given wait-time criterion. The number of vehicles required and the number of berths required in each station is determined from a series of detailed simulations of the system based on given demand between all station pairs.

2. What sensors are there in case of a break in the track or if a car stops in front of you?

Frequent conferences are held around the country on “Smart Structures.” These are structures, such as bridges, in which strain gages have been placed at strategic locations to report severe strain or, heaven forbid, a break. As a back up to the normal control functions (see the paper “Control of Personal Rapid Transit,” www.prtnz.com) each vehicle will be equipped with a sonic sensor that will detect the presence of a vehicle closer ahead than it is supposed to be, either straight ahead or on a merging guideway. When triggered, this independent control system has an independent path to cause the brakes to be applied and signals the malfunction to the cognizant zone controller, which if it were functioning normally would have already have sensed the failure.

3. An affirmation of the idea of placing solar panels on the sides of the guideway to drive the system.

I had commented that based on calculations from data provided by a solar-energy expert, solar panels on the sides of the guideway could collect about 400 kW per mile, whereas the system needs a maximum of only about 200 kW per mile. A means of energy storage would of course have to be part of the system.

4. How can the system be used for goods movement? Wouldn’t truckers unions be against that?

Once the system is in place, it will be obvious that passenger vehicles can be used in off-peak hours for movement of many types of goods, and that special freight vehicles could be added for freight not suitable to be carried in passenger vehicles. This would affect some types of local truckers, such as UPS delivery trucks, but would have no effect on long-haul trucking. It raises the classic problem that occurs whenever a new technology is introduced. This is one reason to introduce any new system gradually.

5. It appears that these systems are designed for urban and suburban applications. Are there areas where the system is not practical?

   The main factor here is the acceptable line speed.[2] As line speed increases, the power required to overcome air drag increases as the cube of speed and factors such as kinetic energy, curve radius, and stopping distance increase as the square of speed. On the other hand, ridership to a point will increase with line speed. The equation for cost per passenger-mile will thus have both the numerator and the denominator increasing with speed, and there will be a speed that will minimize the cost per trip. I have found that this value is lower than one would guess. Yet, many people wonder if the same system can be used for intercity travel, which, to be competitive, would require higher speed. I have found that the guideway I have designed[3] permits a speed above 100 mph, so the speed limitation for a vehicle designed for normal urban speeds will depend on the power rating of the motor. A tradeoff decision would have to be made as to the maximum speed permissible with a given motor. It is possible that vehicles having motors of two different sizes could run on one guideway, meaning that one would have to transfer to go from an urban trip to an intercity trip. This assumes that it would not be economical to use the largest motor for all trips. Once the off-line station system is in operation, it will be quickly seen that it has a major advantage for interurban travel: Every town along the way could have a station without sacrificing trip speed for any trip. A problem with proposals for intercity rail using on-line-station technology is that the cost is thereby higher because large vehicles are needed to obtain adequate capacity, and the ridership will be lower because the stations must be much farther apart to keep the average speed competitive. Higher cost and lower ridership mean of course higher cost per passenger-mile. In the one case I illustrated the cost per passenger-mile would be higher by a factor of at least 12 when compared with an optimized PRT system.

6. In terms of long-distance travel is there a point where the PRT vs. auto tradeoff no longer favors PRT?

   Answered following question #5.

[2] J. E. Anderson, "Morphology of Urban Transportation," section on "Theory of Optimum Speed," pp. 288-290, *Personal Rapid Transit,* Institute of Technology, University of Minnesota, April 1972.
[3] J. E. Anderson, "The Structural Properties of a PRT Guideway," contact author.

7. What is the carrying capacity of the vehicle built and shown?

The vehicle I showed has a seat about the width of the back seat of a luxury automobile, and there is room for two fold-down seats in the front of the cabin, thus giving a five or six passenger capacity, depending on how large the passengers are. I set the maximum load at 950 lb, but that is a policy issue to be settled with the buyer. In a new design, the maximum load and vehicle layout will be two of the issues negotiated.

8. If someone is running late to a meeting, this isn't the way to go is it?

That depends on how close you are to the origin station and destination station. If reasonably close, the system would get you there faster and more reliably than by any other means.

9. Is it just "fear of the new" that has prevented your system from being built?

This is an interesting and complex question. A standard answer given over and over again is that a municipality can't select a system that is not fully proven. Following White House interest in PRT in the early 1970s, conventional transit interests and interests in new automated guideway systems that were clearly inferior to High-Capacity PRT combined to lobby to kill a budding federal HCPRT project. (See page 10 of my paper "High-Capacity PRT," www.prtnz.com.) For many years after that cities were told to only consider proven transit systems while no program was in place any more to prove new systems. It was perceived that the development of HCPRT would render obsolete other systems in which there were vested interests sufficiently strong to kill the HCPRT program. A problem is that conventional transit has strong, well funded lobbying while promoters of new systems have no serious money for lobbying and have to try to convince people with decision-making power that the new idea should be supported because of its superior characteristics. I am aware that there are people who oppose the new systems. You can read the debates on at least the following two web pages: http://faculty.washington.edu/jbs/itrans/ and http://kinetic.seattle.wa.us/prt. When people approach me wanting to work with me, I ask them to first read those debates and then decide if they want to assist our effort. No one who approached me thusly was turned away by the arguments given against PRT, but of course I was talking to a self-selected group of people who were not afraid of new ideas. History is full of cases like this. A problem with HCPRT is that the serious entry fee is high and it is necessary to convince not only engineers, but planners, politicians, financiers, and activist citizens that the effort is worthwhile. If the Wright Brothers had to go through all this to get an airplane flying, they may never have succeeded. Consider the article from an 1876 Boston paper that I have included on page 13.

10. Is there a city in the U.S. that is close to putting one of these in?

The closest I am aware of is Santa Cruz, CA. On the other hand, England and Sweden are moving ahead with PRT.

11. Why does the one in Sweden have such a big, bulky guideway?

The one in Sweden was built by the Korean steel company Posco and has the web page www.vectusprt.com. I showed a picture of it taken by a friend who attended a conference at its site in Uppsala, Sweden in October 2007. It uses as the basic guideway structure a steel pipe that appears to be about 20 inches in diameter. Any good structural engineer can easily calculate that, because the material in a pipe can’t all be used efficiently, use of a pipe as the basis for a crossing a span with a given load rather than a truss requires about four times as much steel. In designing a truss one puts as much material as possible in tension or compression, which is much more efficient. I puzzled as to why they did this. The only rational I can imagine is that Raytheon Company used a pipe as the basis for their guideway because they own a steel company that made that type of pipe for the oil and gas industry and the PRT project manager was told by higher authority to use the pipe, not thinking about cost minimization. Seeing that a large American company chose a pipe, perhaps the Korean company thought there must be a good reason and simply followed. There is still time for Posco to switch to a truss guideway.

12. Have you envisioned feeder systems for the stations, for example “park & ride” or something?

If you examine the surface rail systems called "light rail" that many U. S. cities have installed, you will find that they have the same problem – worse because for a given cost such a system has many fewer stations and hence the people will have to go to fewer, larger stations, but better because the service characteristics of "light rail" are markedly inferior to the service characteristics of PRT so for that reason "light rail" won't need as many parking spaces as PRT. In both cases, some people will walk to the stations and some will ride or be dropped off. For those who ride, there must be parking space, if not in lots then along nearby streets. Part of the planner's job in laying out a PRT system is to provide for parking. This requires a careful estimate of ridership projected into the future.

13. What would you recommend the average citizen do to promote PRT?

I would recommend teaming with similarly minded people and studying the literature starting by punching "Personal Rapid Transit" into Google. If you go to www.cprt.org you will find several citizens groups that promote PRT. For people with serious professional interest, I have outlined at the end of my paper "High-Capacity PRT" (www.prtnz.com) a series of four courses I can teach if invited to do so. Get together and talk to your political leaders until you find one or more who will work with you. In this way, at least the cities of Providence, SeaTac and Cincinnati obtained federal funds to do detailed PRT studies. In my case, while teaching at the University of Minnesota and at Boston University I made a great deal of use of senior engineering design courses in which I often assigned the class to do a layout design of a specific PRT system, which is the way to get into all of the practical problems of installing a system. There are a few basic guidelines that I can give you.

14. Where was Chicago going to put their system?

The first one was to have been installed in Rosemont, IL, but when the Chicago Regional Transportation Authority invited suburbs to be considered for the first installation 26 suburbs responded and some of them hired consultants to help them develop detailed proposals. Rosemont, for example, spent over $50,000 on their proposal.

BOSTON, 1876

A MAN ABOUT 40 YEARS OF AGE, GIVING THE NAME OF JOSHUA COPPERSMITH, HAS BEEN ARRESTED IN NEW YORK FOR ATTEMPTING TO EXTORT FUNDS FROM IGNORANT AND SUPERSTITIOUS PEOPLE BY EXHIBITING A DEVICE WHICH HE SAYS WILL CONVEY THE HUMAN VOICE ANY DISTANCE OVER METALLIC WIRES SO THAT IT WILL BE HEARD BY THE LISTENER AT THE OTHER END. HE CALLS THE INSTRUMENT A "TELEPHONE," WHICH IS OBVIOUSLY INTENDED TO IMITATE THE WORD "TELEGRAPH" AND WIN THE CONFIDENCE OF THOSE WHO KNOW OF THE SUCCESS OF THE LATTER INSTRUMENT WITHOUT UNDERSTANDING THE PRINCIPLES ON WHICH IT IS BASED. WELL-INFORMED PEOPLE KNOW THAT IT IS IMPOSSIBLE TO TRANSMIT THE HUMAN VOICE OVER WIRES AS MAY BE DONE WITH DOTS AND DASHES AND SIGNALS OF THE MORSE CODE AND THAT, WERE IT POSSIBLE TO DO SO, THE THING WOULD BE OF NO PRACTICAL VALUE. THE AUTHORITIES WHO APPREHENDED THE CRIMINAL ARE TO BE CONGRATULATED, AND IT IS TO BE HOPED THAT HIS PUNISHMENT WILL BE PROMPT AND FITTING, THAT IT MAY SERVE AS AN EXAMPLE TO OTHER CONSCIENCELESS SCHEMERS WHO ENRICH THEMSELVES AT THE EXPENSE OF THEIR FELLOW CREATURES.

Q&A following presentations by Dr. J. Edward Anderson, PRT International, LLC

Questions asked following a presentation at the Springfield, MO City Hall, 1:30 pm, Nov 21, 2007

1. Do you address how many people these systems may employ?

   In a $1.5M PRT Design Study for Chicago a detailed model was developed to estimate operating and maintenance costs. It included estimates of the number of operations, maintenance, and cleaning personnel required, which will decrease as people learn their tasks.

2. How often would the cars need maintenance?

   We planned that the interior of each car, which will be designed for easy cleaning, be cleaned once a day and more often if necessary. Since the cars generally run on elevated guideways, the exterior will not have to be cleaned as often. How often depends on the amount and type of dust particles in the air. The linear induction motors themselves have no moving parts – there is no need to change oil or oil filters because there are none. The motors normally will be air cooled with electrically powered fans equipped with sealed bearings. The wheels will have sealed bearings. The cabins will be equipped with heaters, ventilation fans, and an air conditioner which will generally need servicing no more often that is the case with automobiles. The cabin will also have lights, a communications system, and, as mentioned above, three buttons. This equipment, as well as the on-board computer, will need occasional replacement, but no more often per mile of travel than we experience with automobiles.

3. The one at Heathrow – there were other systems, weren't there? What are some of the other systems. What happened to those other systems?

   The most complete list of PRT systems of which I am aware is given on Dr. Jerry Schneider's award-winning website http://faculty.washington.edu/jbs/itrans/. Here is a list of most of the systems developed during the 1960s and 1970s and my knowledge of the status of each:[4]

System	Status
Monocab	No longer active
Transportation Technology, Inc.	One system running at Duke U hospital
Alden StaRRcar	Was basis for Morgantown system, but the design was changed drastically.
Uniflo	No longer active
Dashaveyor	No longer active
Ford ACT (Automatically Controlled Transportation)	Operated in shopping center in Dearborn, MI. No longer active
British Cabtrack	No longer active
The Aerospace Corp PRT	Basis for 1972 White House initiative. No longer active.
Cabintaxi (DEMAG+MBB)	Test system operated in Hagen, FRG, from 1973-1979. Marketed in USA.
Japanese CVS	Test system operated near Tokyo. No longer active.
French Aramis	Test system operated near Paris. No longer active.
Swiss ELAN-SIG	No longer active.

A book can be written about each of these programs and some have been. The more interesting question is why these systems are no longer active and why that does not decrease our enthusiasm for PRT? Much of my answer can be found in my papers (www.prtnz.com or http://kinetic.seattle.wa.us/prt) and in my textbook *Transit Systems Theory*, which can now be downloaded free from www.advancedtransit.org

4. Would there be resistance from the auto manufacturers to this system?

One day in the early 1970s I got invited to breakfast with the President of the Motor Vehicle Manufacturers' Association (MVMA). He said they were interested in assisting the development of PRT and wanted to help. In 1975 I learned that General Motors was working on PRT and wanted to exhibit a 100-foot system at our September 1976 International Conference on PRT in Denver. Following that conference the conference committee determined to form a society (www.advancedtransit.org) to encourage the development of PRT and other types of automated transit. In our first year we received a check for $25,000 for our operations from the MVMA and in the subsequent two years we received a check each year for $10,000 from General Motors. This interest died when heavy lobbying from the

[4] See *Personal Rapid Transit II*, University of Minnesota, February 1974, for a description of each.

conventional transit community caused the Urban Mass Transportation Administration to withdraw their interest in PRT development. Recently, the World Business Council for Sustainable Development produced a report signed by CEOs of leading auto and energy companies (http://www.wbcsd.org/DocRoot/GBd1piGsgd7NfFnfuJwa/wbcsd-nairobi.pdf) that indicates great concern about future sustainability and even mentions PRT.

5. How big is the one at Heathrow and how much does it cost?

   I ask the questioner to go to the web site www.atsltd.co.uk for an answer direct from the supplier.

6. What about ventilation.

   We have designed ventilation into our cabins per specifications of the American Society of Heating & Ventilation Engineers.

7. So what is happening in Branson?

   That is entirely up to Branson leadership.

8. What would be the minimum height? In terms of safety?

   The clearance of the guideway depends mainly on cross traffic such as fire engines or moving vans. In the 2006 Branson Transit Study, the consultant specified 14.5 feet. Along the sides of freeways the guideway could be lower to the ground. How far from the ground is a planner's decision, but I would recommend it be high enough so that people and animals can comfortably walk underneath.

9. With gas prices and focus on sustainability are there federal dollars available?

Since the early 1980s federal dollars have been available for systems the local community would want. But to realize that conventional transit won't do the job and to determine what new system would be desirable requires local study. This will take a good deal of effort on the part of a few leaders. In the United States, such interest developed in Chicago, SeaTac and Cincinnati but is yet to lead to deployment of systems. On the other hand, as a direct result of the Chicago PRT project extensive planning work has been done on PRT in Sweden and England; and, as I mentioned, PRT systems are being built in both of those countries. With increasing gas prices, global warming and focus on sustainability there is every reason to believe that interest in PRT will increase in the USA. But see page 19.

10. What did Chicago do? How was Raytheon involved?

In April 1990 the Northeastern Illinois Regional Transportation Authority (RTA) released a request for proposals for two parallel $1.5M PRT Design Studies. My company, with Stone & Webster Engineering Corporation as prime contractor, won one of those studies. The other went to the Swiss company Intamin. After these studies were completed the next step was to pick one of these two groups to design, build, and operate a test system, with half the cost picked up by the private company. S&W was not in a position in 1992 to do that. In the last minute Raytheon Company, with whom I had been working for many years, decided to bid for the test program. In June 1993 they won, showing in their proposal that they were going to build the system that came out of the S&W study. When they started in October 1993, a new team of managers and engineers came in, threw out all of the previous plans, and proceeded to design a system with the vehicle weight increased by almost a factor of four, the guideway width and depth doubled, and the overall cost more than tripled. As a result the RTA simply stopped talking about PRT and Raytheon left the field – embarrassed for their lack of systems engineering.

11. Have any of the large metro hospitals talked to you? Would it be possible to have a hospital car?

Early in the start of my program I had a hospital car sketched and included it in our presentations. The University of Minnesota hospital has talked to me many times. I have visited many hospital complexes in the United States and find considerable interest *if* they can be shown a proven system. As mentioned above, TTI-Otis built a hospital system in the Duke University Hospital. Also the German joint venture DEMAG+MBB built and operated since about 1976 a hospital system for the Zigenhein Hospital Complex in Kassel, FRG.

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12. Is the sustainability and environmental community working with you?

    Some individuals in these communities have been interested in our work, but I can't say that that community is working with me. The main problem is to get enough information into the minds of enough people to make a difference. This is a difficult, expensive task.

13. Do you have a presentation that would be shorter and less technical that might be available to groups to show?

    I have one that I have been giving to high-school classes, but I have yet to record it and release it on a CD. If you go to www.prtnz.com you can find several videos that can be lifted into your own computers and run. They are very good.

14. What is missing from your presentation is the payback compared with conventional technology.

    I had time to show only one slide on such a comparison – the cost per daily rider between the Minneapolis rail system and a PRT system we designed several years ago, which showed that the cost per daily rider for PRT would be no more than about 1/12th the per daily rider cost of the rail system. An excellent paper has come out recently from Sweden on this subject: "Severe shortfalls in current public transport – and why Podcars (PRT systems) may make the difference," by Göran Tegnér and Elisabet Idar Angelov, WSP Analysis & Strategy, Stockholm, Sweden. This paper is on a CD that I left at the meeting.

15. Would you consider having a lifetime card?

    Any such feature would be up to the entity that acquires a system.

16. Could you talk about longer distance systems?

Please see my response to question #5 in my Bentonville presentation.

17. Could you run the cars in a tube?

One could. Uniflo, mentioned above, did that. The enclosed guideway ended up to be 14-feet high. One must design to a maximum horizontal wind of at least 120 mph, and with such a large cross section, the foundations for the posts get very large. Moreover, one would have to have windows in the tube. One of my mechanical-engineering colleagues calculated the air conditioning load for summer operation, which was enormous. In short, the capital and operating costs of an elevated system in a tube become too high to be competitive.

18. Could your own car run on the system?

There is a whole body of literature on this idea. It is called “dual mode” and the best source of which I am aware is on Dr. Schneider’s webpage, which is mentioned above. The system I have designed, and the systems the Advanced Transit Association has studied in detail and advocated are single-mode systems in which the vehicles are permanently attached to the guideway, where maintenance is easier to monitor and control. To run your own car onto the guideway would require on and off ramps and inspection at each station, which would markedly increase the cost of each stations. Also, the guideway required to accommodate your own car would be much larger and more expensive than the narrow truss guideway I have designed. Compare our PRT system with the so-called “light rail” systems that are being installed in many cities. Our system will be in the range of 3 to 4 times less expensive per one-way mile than light rail system, and because you can place the stations on the average half the spacing of stations on a light-rail system, you would have 6 to 8 times as many stations for a given cost. If a transit system has n stations, for each of these stations there are $(n-1)$ possible trips, and thus a total of $n(n-1)$ possible trips. Ridership can be expected to increase roughly with the number of possible trips, so that for a given cost the PRT system will be able to attract a great many more riders, not only because of the increased number of trip possibilities but because of its 24/7 service with short to zero wait nonstop to the destination. Access to the PRT system will occur in exactly the same way as access a conventional light-rail system, and moreover you don't need a driver's license to use a PRT system. Thus, PRT enters the field of urban transportation from the transit side, i.e., how to design a transit system that will be low enough in cost and high enough in ridership to come close to or exceeding the breakeven cost. Dual mode enters the field of urban transportation from the auto side – how to increase the capacity of freeway lanes and how to avoid the tedium and attention required to drive an automobile safely. These are desirable goals. The problem has been to achieve them in an acceptable way.

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Devolution of the Federal Role in Urban Transportation

Edward Weiner

Introduction

During the last few years, the federal role in urban transportation has been changing. The Administration is proceeding on a path to reduce the involvement of the federal government in urban transportation decision-making. This change is a departure from the trend over the previous two decades which was characterized by increasing federal responsibility and participation in the process and results of decisions related to urban transportation. The consequences of this change for other participants in urban transportation decision-making are already apparent and are likely to become more pronounced in the foreseeable future.

The new federal role is based upon two premises. First, the state and local governments and the private sector are closer to the problems and issues in urban transportation and, therefore, are in a better position to make local transportation decisions. Second, transportation decisions should be guided by the marketplace rather than governmental regulations and requirements. Moreover, the Administration believes that institutions for urban transportation decision-making have matured to the point that the federal government no longer need be involved to the degree it was while these institutions were in their infancy.

A number of steps have already been taken to bring about the shift in the federal role. These steps involved changes to policies, legislation, regulations and programs. Others will likely follow. This paper reviews the actions that have been taken and looks ahead to the dominant trends that are emerging for the coming decade.

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Q&A following presentations by Dr. J. Edward Anderson, PRT International, LLC

Our Mission Statement:

> ***The Mission of PRT International, LLC is to plan, manufacture, and deploy intelligent transportation-network systems that minimize cost, energy use, material use, land use, and pollution while providing a high level of service safely, reliably, and in all reasonable weather conditions without the need for***

From my paper "High-Capacity PRT," www.prtnz.com:

20. Development Strategy

PRT International, LLC,[5] is ready to enter the HCPRT field with a new design, improved over prior work. Experienced systems engineers and engineering companies are ready to work with the company as soon as the needed funds are available. Our approach is as follows:

- Seek first an application where the decision process is relatively easy, and with investors who see that we can best meet their own needs. This first real people-moving demonstration must convince a skeptical transportation community that HCPRT will work as projected.

- With a group of investors interested in applications, fund first a full-scale test facility using a loop guideway large enough to achieve speeds of at least 35 mph and having at least one station, a maintenance facility, and three vehicles. Such a facility will enable us to prove the specifications needed to assure success of the first people-moving application and will provide a test bed for proving new design features apart from applications for many years. Drawing on many years of experience in HCPRT theory, development, planning, design, and construction, we estimate that we can complete this program in two years for no more than US$15 million. We have completed sufficient planning for such a program to enable us to proceed immediately, and today's design tools will enable us to ready the final designs for manufacture much more quickly than formerly possible.

- In cooperation with others, continue to inform consultants, planners, and financiers about HCPRT.

- Perform planning studies for specific applications.

- Teach and promote the teaching of the engineering, economic, and planning sciences of HCPRT per the syllabus given in the Appendix. A wide range of transportation consultants need to know the details if they are to be able to evaluate and plan HCPRT systems.

- Realize that in time HCPRT will become similar to other public works such as bridges, roads, rail systems, etc. on which companies bid and win projects based on competence, design superiority, and by giving the buyer assurance of multiple sources of supply. Investors who see the potential of HCPRT now will reap substantial profits before the field becomes saturated.

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