# *Personal Rapid Transit: Mass Transit for Today*

A Report on
the Status of
Personal Rapid Transit technology

January 24, 2003

SoundPRT

## Contents

### Personal Rapid Transit: Definition

- PRT uses a network of slender, elevated rail
- A large fleet of small, 3-6 seat vehicles travels on the elevated rail
- A city will have many small PRT stations, close together, in all neighborhoods
- PRT does not use schedules, service is demand-responsive.
- A journey on PRT is nonstop between any two stations in the network, with no need to transfer to another vehicle or transit mode.

### PRT Rationale

All the usual transit technologies have been tried in the U.S., somewhere. While some recent projects have not failed, none has been truly successful. Buses stop too often and get stuck in traffic. Light rail and monorail trains are expensive to build, and depend on the slow buses to get riders to and from the train stations. Even when ridership goes up, it doesn't keep pace with the increase in automobile traffic. Traffic congestion persists.

PRT borrows principles of "just in time" manufacturing methods and interprets them for application to transit. Simply put, PRT identifies 1-3 persons as the most natural size for a group of transit riders, and allocates transit resources in response to *actual demand*. In contrast, conventional transit modes presuppose large groups of riders, deploying resources *in anticipation of demand.*

### PRT Features

Conventional transit is usually inconvenient and time-consuming to use. By eliminating these drawbacks, PRT will be attractive to more people for a wider variety of their travel needs. This is how PRT will take pressure off the road system, reducing congestion.

**Demand-Responsive**

Demand-responsive, or on-demand, service does away with timetables. PRT recognizes that the only reason people travel on transit in large groups is that the timetables require them to show up at the same times and ride together. If people are allowed to ride transit at times of their own choosing, demand for transit service would primarily be people traveling alone or with one or two friends. Thus, PRT will use small vehicles with only a few seats.

Fig. 1: Small vehicles *Taxi 2000 Corp. photo*

**Low Capital Costs**

PRT will require **minimal infrastructure and low cost.** The cost advantages derive from PRT's on-demand service characteristic. Because people are transported singly or in small groups, the ideal size for PRT vehicles is small and therefore lightweight. Lightweight vehicles mean the elevated guideways need only be small as well, as are the supports holding them up. The supports do not have to be buried deeply in the ground, and can be quickly and easily installed by teams working from trucks. PRT rails are therefore cheaper to buy and install than light rail or monorail

Small vehicles mean short turning radii, so guideways can be built to go around buildings and other community features-- PRT is low-impact because **nothing is really in PRT's way, nothing needs to be demolished**.

Small vehicles are cheaper than trains and buses

Fig. 2: Low impact *Taxi 2000 Corp. illustration*

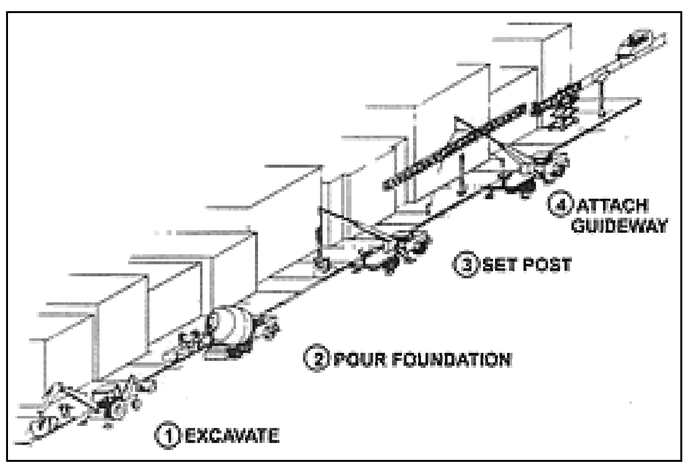


Fig. 3: Simple, rapid construction *Taxi 2000 Corp. illustration*

Stations don't need surrounding acres of parking, since each neighborhood would have its own station. Small stations therefore mean low cost of building materials and land

On-demand service means PRT riders aren't waiting around in stations. Stations therefore don't need large waiting areas, and can be as small as an average house. Stations are usually only a half-mile apart, each serves only those within a quarter-mile area, which is convenient walking distance for most people.

Small vehicles running on-demand are **more efficient** than buses and trains. Buses and trains must meet their schedules even when partially full or empty; hauling around empty seats and frequent stops waste energy. A PRT vehicle runs only when someone needs it.

**High Capacity, Network Service**

On-demand service also means it is practical for a comparatively inexpensive fleet of PRT vehicles to achieve mass transit levels of service. A person will board PRT, ride through the network nonstop to their destination; the PRT vehicle is then immediately available for another rider. This means each PRT vehicle is capable of making many trips per hour, and the overall PRT fleet has an hourly capacity of many times the number of seats. Thus, a 5,000-vehicle PRT fleet, with each vehicle averaging 7 minutes per trip (just over 4 miles traveled per trip), could make 40,000 trips per hour, in any direction in the network. If each trip carries an average of 1.25 passengers, the number of people served per hour is actually 50,000.

**Flexible application**

High ridership capacity combined with low capital cost means PRT is suited to both high-demand urban and lower-demand suburban applications. Low cost of guideway and stations mean PRT can recover its costs by serving existing neighborhoods. Transit oriented development, to create large numbers of origins and destination near stations, is therefore not needed.

## PRT Systems

### Advanced systems

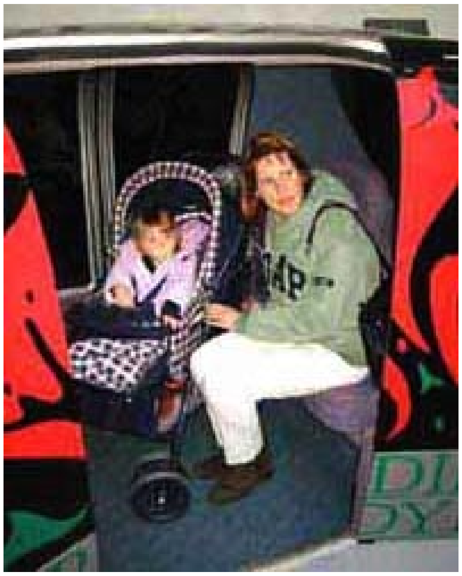

Fig. 4: ULTra *ATS Ltd. photo*

*Urban Light Transport (ULTra)*

ULTra was developed by the Advanced Transport Group at the University of Bristol, the program was spun-off to become Advanced Transport Systems Ltd. An ULTra demonstration and testing facility has been constructed in Cardiff, the capital of Wales.

The system is distinguished by its method of navigation, which is known as Free Ranging On Grid (FROG), a technology developed by a separate Dutch company. Under this method, the computer of each ULTra vehicle possesses a map of the guideway network, and navigates by following magnetic markers embedded in the guideway surface. FROG has previously been proven in a driverless peoplemover operating at Schiphol Airport, Amsterdam.

$68 million has been appropriated to the test, and to construction of an approximately 8 mile system in the center of the city. Operations with paying passengers are planned for 2005.

*Taxi 2000*

Taxi 2000 Corp. is a technology spin-off of the University of Minnesota. Taxi 2000 was formed around patented technologies developed at the university by a team led by Dr. J. Edward Anderson, who is generally recognized as the leading theorist in Personal Rapid Transit. The Taxi 2000 design reflects his 30+ years of scholarship and design in the field.

This system has been the longest in development, and is responsible for solving many of the design questions surrounding the development of the PRT concept. Extensive studies of past PRT efforts programs in the U.K., France, Germany, Korea, Japan and the U.S. have culminated in Anderson's present design. It overcomes the problems uncovered by these previous development efforts and is now a world technological leader.

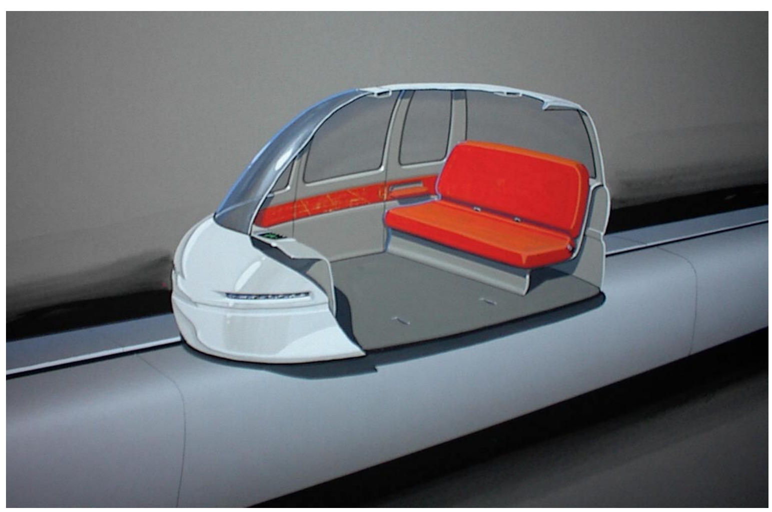

Fig. 5: Cutaway of PRT vehicle *Taxi 2000 Corp. illustration*

The development of Taxi 2000 is also notable for the transparency of its activities, a great many of the company's concept papers and schematics have been made available to the general public.

In 2002 Taxi 2000 raised funds from private investors to build a first-stage working prototype that will be unveiled in February 2003. Consisting of a functioning vehicle and a 60-foot section of guideway, Taxi 2000 hopes the prototype will attract additional funds to enable construction of an outdoor test loop with 2,200 feet of guideway and fully functional station and vehicles. Taxi 2000 receives no government financial support.

*MicroRail*

MicroRail's parent company, MegaRail Transportation, was established in 1997 to create transportation systems developed around patented components designed by company CEO Kirston Henderson. Extensive testing has been conducted, and a system mockup is on display at MegaRail's Texas offices. In addition, MicroRail guideway will also accommodate special street-capable electric vehicles, which will also be produced by MegaRail.

MicroRail is distinguished by its vehicle, which has four wheels, two on the left and two on the right like an automobile. The wheels extend out slightly, and run inside two parallel guideways.


Fig. 6: MicroRail *MegaRail photo*

If a near-term customer for the first MicroRail system can be found, MegaRail indicates that it could have the system in service sometime during 2004 in a manually operated "train" mode, with a plan to later upgrade it to single-car fully automated operation as soon as control system testing is completed.

**Planned Systems**

*SkyTran*

SkyTran is a very popular design among PRT supporters. The aerodynamic, two-seat PRT capsule is suspended under a slender guideway. The capsule's interface with the guideway will use "passive" magnetic levitation instead of wheels. The system's design vision is provided by Douglas Malewicki, a respected engineer with a long record of accomplishment in aeronautics and astronautics, and the design of fuel-efficient concept automobiles. SkyTran's design is reportedly at a very advanced stage. However, its maglev component, to be produced by a third party company, is still at the research and development stage. There are also questions regarding the degree to which the system complies with the Americans With Disabilities Act.

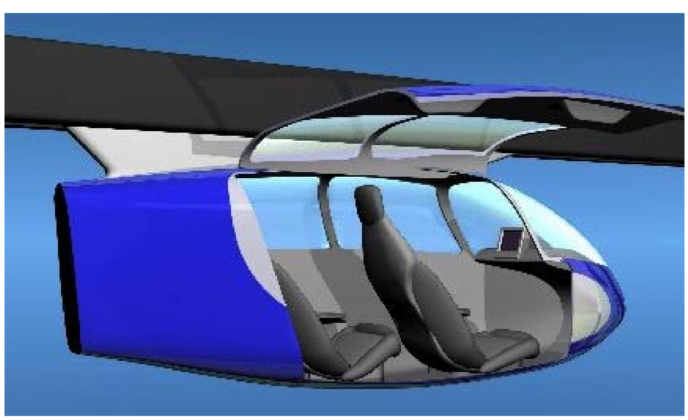

Fig. 7: SkyTran *SkyTran illustration*

*NanoRail*

This is a companion product to MegaRail Corporation's MicroRail. NanoRail will employ the design principles used in MicroRail, but achieve even lower capital cost through use of smaller vehicles and guideway.

*PRTKorea*

PRTKorea is a program affiliated with Pohang University, South Korea. A linear-induction-propelled prototype has been constructed and has undergone testing. At last report negotiations were underway for an initial application in the Kangnam district of Seoul.

Fig. 8: PRTKorea *Postech photo*

*YorkPRT*

YorkPRT is a new organization which has purchased the Raytheon PRT technology, (see Current Action below) including the proven control software. YorkPRT dates to 1998, originally formed to explore construction of a monorail link between the city center of York UK and a suburban shopping mall. YorkPRT acquired the Raytheon system after a conventional monorail was deemed unfeasible. YorkPRT is currently engaged in updating the design of the primary components.

## Current Action

**Europe:** *Cardiff, UK*

The ULTra test project and initial Cardiff implementation is supported with funds from the British government's National Endowment for Science, Technology and the Arts, Department of Trade and Industry, Department of Environment, Transport and the Regions, and the county government of Cardiff. Cardiff will evaluate ULTra as a core element of its integrated transport plan. The European Union will also evaluate ULTra under the program Evaluation and Demonstration of Innovative City Transport (EDICT), which is seeking to identify new and sustainable forms of transit. EDICT candidate cities for ULTra are: Cardiff; Bristol, UK; Eindhoven and Almelo, the Netherlands; Huddinge and Sigtuna, Sweden; Ciampino and Cesena, Italy; Olomouc, Czech Republic; Marousi, Greece.

**United States**

While Europe innovates, current government policy on PRT in the United States can mostly be characterized as inaction or avoidance. The federal government had a brief flirtation with PRT in the early 1970s, the initial implementation at West Virginia University, directed by the Urban Mass Transit Administration, was (and still is) an operational success. In the 1990s, the Chicago transit authority joined with Raytheon to create a modern test system, also an operational success. However, the makers of both systems made conceptual errors in both vehicle and guideway size, resulting in systems too large and expensive for major urban installation. The West Virginia University system recently marked its 30th year of operation and 57 millionth passenger. Raytheon exited the PRT business, and recently sold its technology to the group based in York, UK (see Planned Systems above). While there are exceptions, the official policy at all levels of government in the U.S. is deference to transit agencies and associated private sector consultants, neither of which has the inclination or expertise to evaluate or adopt innovative transit technology.

Innovation on PRT has been left to a community of ordinary citizens with expertise in transportation, engineering and public policy. This network of activity has culminated in the systems described above.

## Recommendations

PRT embodies a number of significant implications for public policy.

The current state of the art of PRT is recognized as potentially low cost. The low cost of the Cardiff project certainly validates this expectation. It is therefore affordable to build an extended PRT network to reach all areas of a city, resulting in the ability to provide on-demand, seamless transit within the service area. Overlapping transit modes and their accompanying inconveniences of transfers, waiting times, multiple schedules, multiple fare systems, etc. become unnecessary. Using PRT to eliminate these disincentives to transit usage means that transit stands the change of achieving a double-digit mode share, and of being the most cost effective and best chance of reducing congestion.

Furthermore, low capital cost means it is affordable for PRT to be built in smaller municipalities, and for county governments to install them in unincorporated areas. Thus, it would be feasible for neighboring jurisdictions to join their PRT networks, forming a regional PRT network.

The Sound PRT organization observes that innovation requires support, and that new technologies do not spring into existence fully-formed. However, the "market" for transit technology is not an open one. Nearly all transit providers in the U.S. are government operated. Expertise in the planning mainstream of transit, both public and private, is nearly all in conventional technologies. Understandably, the mainstream experts are unfamiliar with the details of radical transit innovations and how to best evaluate them. This serves as an effective barrier to testing and adoption of innovation, and therefore as a disincentive to private investment in developing new systems.

Sound PRT therefore recommends the following public sector action:

Government policymakers must recognize that it has a role in fostering innovation in transit. This role consists of the companion issues of **policy** and **funding**.

*Policy*

Technology assessment processes now stop at deciding whether new technology can go into public service immediately. PRT must be evaluated based on the their designed service characteristics and costs, whether those measures are equal or superior to conventional transit, and whether designs exist which can be constructed. This shift in policy will not be easy. Winning executive and legislative support for PRT will require vocal persuasion by citizen-based groups, as well as by government and quasi-government committees drawn from the ranks of ordinary citizens.

*Funding*

Once viable PRT systems are identified, public funds should be made available to them for testing and validation. It is likely that public funds would be matched by private investment; the above change in the policy environment would signal private investors that PRT is being fairly evaluated and, if successful, would be adopted, and investments recouped.

## Conclusions

PRT represents a revolution, it is like having a monorail nearby no matter what neighborhood you live in. PRT will provide fast, seamless, no-transfer transit. You'll be able to walk to the nearest station, and PRT will transport you, non-stop, to the station within walking distance of your actual destination.

Several visionary companies have designed PRT systems which can provide a true city-wide mass transit system—with lower operational cost than bus systems, and at a fraction of the capital cost per mile of train systems. PRT systems are not science fiction, they can be built today, with existing technology. PRT is the best hope for a transit system which is fast, affordable, safe, and will serve ALL neighborhoods and taxpayers footing the bill.

Transit that is faster, cheaper and better. This is the promise and potential of Personal Rapid Transit.

## PRT References and Resources

### Print

Irving, Jack H. et. al., *Fundamentals of Personal Rapid Transit.* D.C. Heath & Co., 1978

Anderson, J.E., *A Review of the State of the Art of Personal Rapid Transit.* Online at
http://www.taxi2000.com/pubspdf/StateOfArtOfPRT.pdf

Anderson, J.E., *Some Lessons From the History of PRT.* Online at
http://www.taxi2000.com/pubs/history.htm

Anderson, J.E., *Optimum Size of an Automated Transit Vehicle.* Online at
http://www.taxi2000.com/pubspdf/Optimum1.pdf

Bandrapalli, Suman. "My Mass Transit", *Christian Science Monitor,* Nov. 19, 1998. Online at
http://csmweb2.emcweb.com/durable/1998/11/19/fp11s1-csm.shtml

Lang, A. Sheffer, "A New Transportation Paradigm," *Transportation Quarterly*, 53:4, Fall 1999. Online at
http://faculty.washington.edu/~jbs/itrans/lang.htm

Dunning, Robert A. and Thomas M. Richert, *Applying Lessons From Lean Production Theory to Transit Planning.* Online at
http://www.oz.net/~cliff/APM2001g.PDF

SkyLoop Committee of Forward Quest (Ohio-Kentucky-Indiana Regional Council of Governments), "Central Area Loop Study" documents, Online at
http://www.skyloop.org/cals/cals-ending.htm

Gibson, Tom, "Still in a Class of Its Own," *Progressive Engineer,* March 20, 2002. Online at
http://www.progressiveengineer.com/PEWeb%2024%20Mar%2002-2/PRT.htm

### Online

Taxi 2000 Corporation, http://www.taxi2000.com
Advanced Transport Systems, Ltd., http://www.atsltd.co.uk
MegaRail Transportation Systems, http://www.megarail.com
*Innovative Transportation Technologies,* http://faculty.washington.edu/~jbs/itrans
*Get On Board! Personal Rapid Transit,* http://kinetic.seattle.wa.us/prt
Citizens for Personal Rapid Transit, http://www.cprt.org
Austin Citizens for Personal Rapid Transit, http://www.acprt.org