Paper presented at 11th International Conference on Automated People Movers, Vienna, 22-25 April 2007

PRT in Sweden: From Feasibility Studies to Public Awareness

Göran Tegnér[1], WSP Group Sweden AB;
Magnus Hunhammar[2], Institute of Sustainable Transport;
Ingmar Andréasson[3], LogistikCentrum AB ,
Jan-Erik Nowacki, Swede Track Systems AB,
Kjell Dahlström, Director General, SIKA[4] the Swedish Institute for Transport and Communication Analysis

Abstract

Podcars or Personal Rapid Transit (PRT) has been discussed and analyzed in Sweden since the late-60's. The pioneer City was in those days Gothenburg. Like business cycles the interests in PRT has gone up and down over time. From the Mid- 90's, however, the efforts of promoting PRT in Sweden became more serious and frequent. Many pre-feasibility and a few feasibility studies were undertaken by researchers, consultants and cities. It was a long way ahead to introduce a completely new mode of transport (and of thinking!) such as PRT, against a wide range of vested interests in the automotive and public transport industry.

This paper will address and summarize the efforts made of *PRT in Sweden: From Feasibility Studies to Public Awareness.* The paper will summarize a great number of studies, and try to explain why PRT has not yet materialized in to reality. Up to now, the crucial point seems to have been the imbalance between risks and financial support: No local authority, such as the Public Transport Authority can buy a system of its own, due to the development risks associated with PRT as long as it is an unproven technology; and no developer can investment full in development, as long as there is no (mass) market for the end-product.

Today the situation of podcar awareness in Sweden goes into a new era. A PRT test track is under construction in Uppsala, Sweden, by a vendor that believes in a mass market (Posco). Further, the criticism and the awareness of the un-sustainability of the current traffic situation (climate change and peak-oil) set the timing that we are now likely on the threshold to an acceptance of podcars/PRT.

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[1] Göran Tegnér, M Pol. Sc., WSP Group, Sundbybergsvägen 1A, SE-17 173, Solna, Sweden. Phone:+46-8-735 20 10; Fax: +46-8-735 20 30; E-mail: goran.tegner@WSPGroup.se
2 Magnus Hunhammar, Lic Arch & M Sc., Institute of Sustainable Transport, Stockholm, Sweden, Phone/Fax: +46-8-643 29 41; E-mail: magnus.hunhammar@podcar.org
3 Ingmar Andréasson, Ph.D, Logistikcentrum, Taljegårdsgatan 11, SE-431 53, Mölndal, Sweden. Ph: +46-31-87 77 24; Fax. +46-31-279442; E-mail: ingmar@logistikcentrum.se
4 Kjell Dahlström; Director General, Ph D, the Swedish Institute for Transport and Communication Analysis, Ph. +46 761 287 401; ; Fax: +46 631 40010); ; e-mail: kjell.dahlstrom@sika-institute.se

1 PRT Feasibility Studies in Swedish cities – an overview

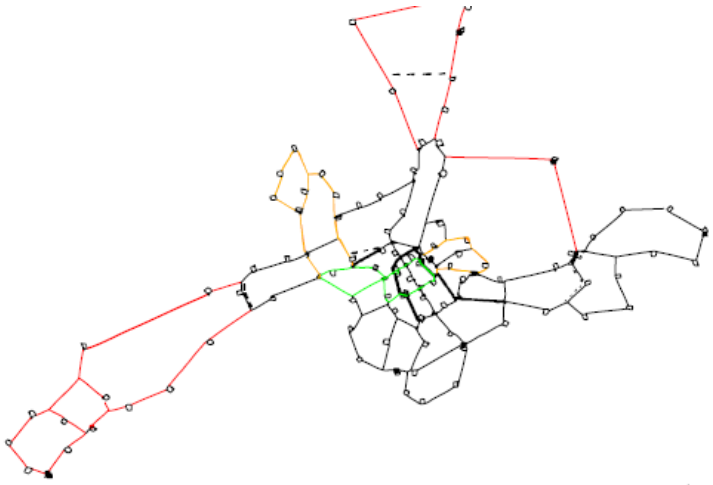
1.1 An early PRT interest in Gothenburg

The interest for Personal Rapid Transit in Sweden emerged already in 1971 in Göteborg. Two leading persons in the City of Göteborg, Mr. Sixten Camp and Rolf Oom, launched a study on PRT. Rolf Oom, a civil engineer at Kjessler and Mannerstråle AB[1] raised the question: "PRT - how realistic is this mode of transport?" And ever since several transport planners and researchers, not to mention decision-makers, have asked themselves and others the same question.

1.2 Simulation analyses of PRT 1991-94 in Gävle, Jönköping and Göteborg

The Swedish Transportation Research Board commissioned LogistikCentrum to develop what is now the generic PRT simulation software PRTsim in conjunction with the analysis of possible PRT networks for the Swedish **city of Gävle.** At the time there was no description of the control system and initial simulations assumed synchronous control. A PRT network for the whole city area was developed with 77 km of guide-way, 69 stations and 900 vehicles assuming 15 % of car trips would divert to PRT.

Figure 1. The Gävle PRT network in 4 development steps (with step 1-4 in green, yellow black and red)



During 1994 the control system was changed to point-synchronous (a variant of asynchronous control invented by LogistikCentrum). Thanks to the control changes it was possible to increase capacity by 50 % and avoid 18 bi-level intersections and 4 km guide-way.

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[1] Now: WSP Group Sweden

[3] Now: WSP Group Sweden

Finally we analyzed stepwise implementation in 4 stages. The first stage was 2 loops and 9 km. The second stage was 5 loops and 23 km. The initial stages were designed to cover the largest trip generators so that they were more cost effective than the full network.

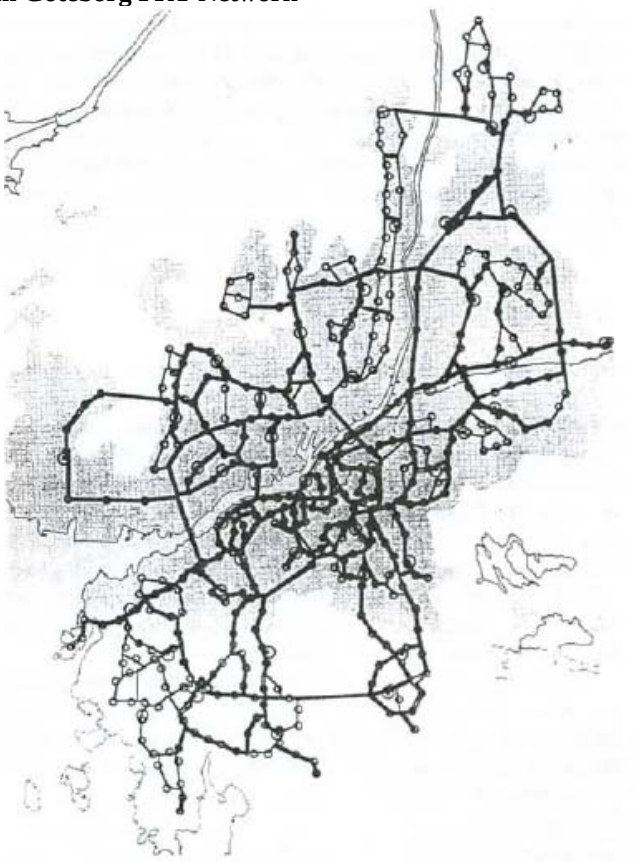
The city of Gävle commissioned architects FFNS to visualize how a PRT system could be designed and integrated in the cityscape.

Figure 2. A Design sketch for the Gävle PRT

Kjessler & Mannerstråle AB[3] lead studies in a suburb **of Göteborg** (1991) of a 27 km PRT system and of a 10 km system for **Jönköping** in 1993.

The **Gothenburg Traffic Authority** led a PRT study in 1993. The task was to establish whether a PRT system could replace all existing public transportation (buses and trams) and up to 60 % of car trips. Such a system would be theoretically possible requiring 728 km of single guide-way, 391 stations and up to 17 000 vehicles. Transit travel times would be reduced by about 50 %.

Figure 3. The 728 km Göteborg PRT Network



In a subsequent study PRT was compared to a light rail loop for central Gothenburg. With the same investment PRT would offer 50 stations, much better accessibility and attract 70 % more passengers compared to LRT with 11 stations. Yet the decision was to build the LRT loop.

Figure 4. The Central Göteborg PRT network

The Göteborg study started with a question if a GRT would be possible to introduce in a 10 km circle line. One of the bidders was Siemens together with SwedeTrack quoting the H-Bahn technology – used in Dortmund. However the political majority in Gothenburg shifted and it was decided to build the same line with conventional tram technique instead.

1.3 Market Demand and Social Benefits of a PRT System - A Model Evaluation for the City of Umeå, Sweden

In the city of Umeå (80 000 inhabitants) a Transport Plan has been carried out with the aim to reduce the typical traffic problems of similar cities - increased congestion, road accidents and environmental pollution caused by an increase in motorized traffic in the city center. Conventional bus service attracts 8 percent of all daily trips.

Transek Consultants has carried out a comprehensive travel demand analysis and to contribute to the evaluation and assessment of the four alternative proposed transport strategies for the city of Umeå:

- by-passes to divert trough traffic outside the city center
- an improved bus service with a doubled service frequency
- an automatic guided rapid transit line (AGT) system
- a personal rapid transit system (PRT).

Our results showed that the by-passes divert more than 20 percent of total car traffic volumes from the city center to more peripheral and to less environmental sensitive areas. This would be a necessary strategy to improve the environmental conditions for the city life. Compared to both an improved conventional bus service and an Automated Guided Transit system, only a PRT system would be able to provide a substantial decrease in door-to-door travel times for the transit users. The PRT system would more than double the transit modal split from 8 to 17 percent; reduce the average transit trip time from 62 to 32 minutes. This system would also reduce the number of auto trips by 14 percent. In the study, the PRT was the only transit system that yielded a positive net social surplus.
That study was presented at the International Conference on PRT & Other Emerging Transportation Systems, University of Minnesota, Centre for Transportation Studies November 18-20, 1996

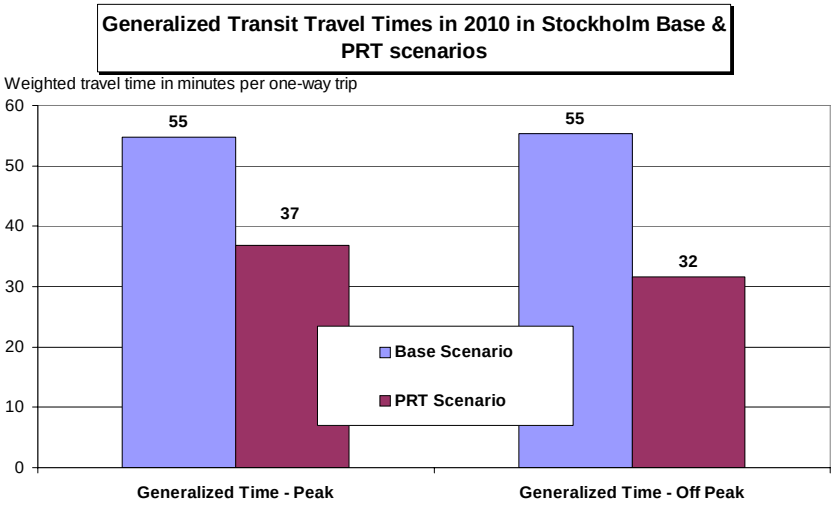
1.4 Personal Rapid Transit in Stockholm – Market Demand and Personal Economic Viability

Transek Consultants was commissioned by the Stockholm County Council Traffic Office in 1998 to carry out a PRT Market Demand Study including a social Cost-Benefit Analysis (CBA). The study was financed by the Swedish Research Fund for Transport and Communications (KFB).

Some major findings were:

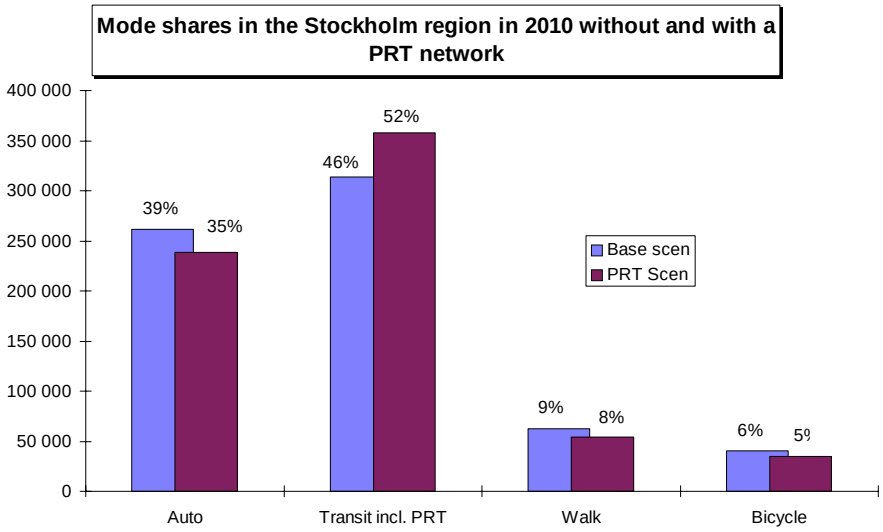
The highly competitive travel time performance of PRT – with waiting times between 1 and 3 minutes, a constant cruising speed of 36 km/h – yields substantial travel time gains for the users, especially in off-peak periods:

Figure 5. The impact of PRT on Generalized Travel Time from an area-wide PRT network in Stockholm



With an area-wide PRT-system, the demand for transit trips would increase by 31 % (from 21 to 25 % in peak and to 41 % in off-peak periods)

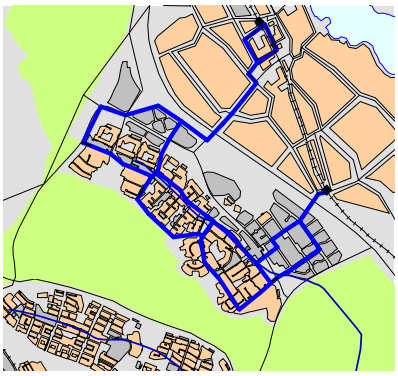
Figure 6. The impact of PRT on Modal split from an area-wide PRT network in Stockholm



Investment cost data were obtained from Raytheon's PRT2000, Swedetrack's FlyWay (a suspended PRT system) and from SkyCab (a Swedish supported system).

The PRT network for Akalla-Kista-Helenelund-Sollentuna C

Figure 7. The proposed PRT Networtk for Husby, Akalla, Kista connecting to 3 metro and 2 rail stations



A PRT demonstration network in the presented Akalla – Husby – Kista –Helenelund – Sollentuna area of Stockholm would be economically viable and well justified in the low cost alternative. The cost-benefit ratio was calculated to be 1,3, which means that one dollar spent on PRT in this area yields one dollar and 30 cents in total benefits. From the analysis, one could estimate the maximum investment cost per system-kilometer for a PRT network of the relevant size to be about 12m€ per track-km (corresponding to 14 million US$ per track-kilometer).

Our recommendation was therefore clear – a PRT system for Stockholm provides such a broad range of desired qualities, that it should be given highest priority in research, development, testing and demonstration for implementation in the Stockholm Metropolitan area.

This study was presented at the APM Conference in Copenhagen in 1999. However, due a shift in the political majority at the Stockholm County Council in 1998 the interest for PRT solutions faded away.

1.5 SkyCab's Feasibility Studies in Sigtuna-Arlanda, Linköping, Malmö and Stockholm

SkyCab[5] made a study for the Swedish City of Sigtuna with an 82 km SkyCab PRT system, equipped with 87 Stations and 600 vehicles. This feasibility Study of a PRT network at Märsta-Arlanda Airport[6] shows that a development of a SkyCab PRT

[5] Source: www.skycab.se

[6] "Vision SkyCab in Sigtuna Municpality – a Description and analysis with illustrations of a new, user-.friendly automated transit system -SkyCab® - at Arlanda Airport and its surrounding settlements Märsta/Arlandastad on behalf of the Municipality of Sigtuna, the Swedish Civil Aviation Authority and Arlandastad. Stockholm, January 2000. Åredal, Å., m.fl., 1999, Att resa på ett nytt sätt i Linköping. SkyCab AB

system could replace the existing bus network and attract 10 million passenger trips in the target areas (see figure below).

In the peak hour 6 700 passenger trips would be made by 4 400 vehicle movements within the PRT system by 600 vehicles. 600 vehicles should cover the peak hour needs, i.e. each vehicle would be utilized 7.5 times per peak hour.

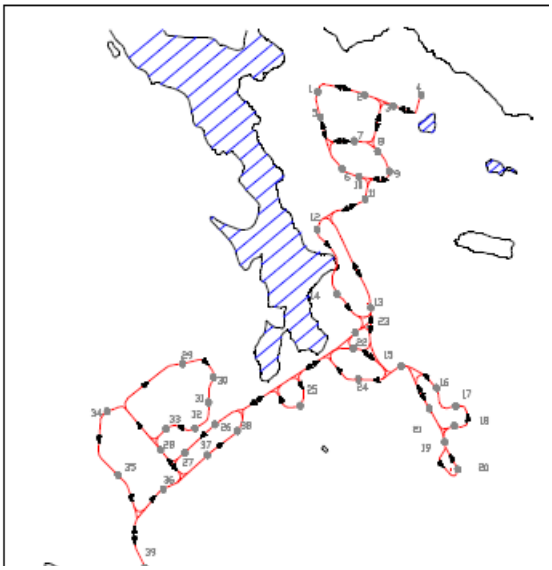
SkyCab also made a study for the City of Linköping in 1999. A first proposed implementation stage consists of 21 km guide-way and 100 podcars, linking the railroad station together with the university. To divert 100 % of Linköping's bus trips to SkyCabs, a network of 82 km track, 79 stations and 590 vehicles, will be needed.

In 2003, the City of Malmö studied a SkyCab-system for the redevelopment area "Western Harbour"

Figure 8. SkyCab's proposed PRT network for the "Västra Hamnen" development area in Malmö

A PRT network was designed buy SkyCab for the new development area **Vetenskapsstaden** "The Scientific City**, in Stockholm**. This area might connect the three university campuses of Karolinska Institutet, The Royal Institute of Technology (KTH), the Stockholm Business School and the University of Stockholm. Within this area some 85 000 workers will be occupied in 2015. The SkyCab project is aiming at total about 200 km track, 200 stations and 1.500 vehicles. Such a PRT network might be able to serve between 4.6 and 13 million passenger trips per annum, depending on how big share of all public transport trips that the PRT system would cover. The total average travel time (excluding walking time) is estimated to amount 3-4 minutes, according to the SkyCab study[7].

[7] Translated by the authors from SkyCab's Swedish text.



SkyCab vsion of a station

1.6 Comparison of Transit Modes for Kungens Kurva, Huddinge

The ”Kungens Kurva” business, shopping and amusement area in Huddinge, is an expansive development area SW of Stockholm. Today there is a lack of an adequate transit service to and within this area. In this pre-feasibility study we examined four different modes of transport – Bus, Light Rail Transit (LRT), Automated People Movers (APM) and Personal Rapid Transit (PRT).

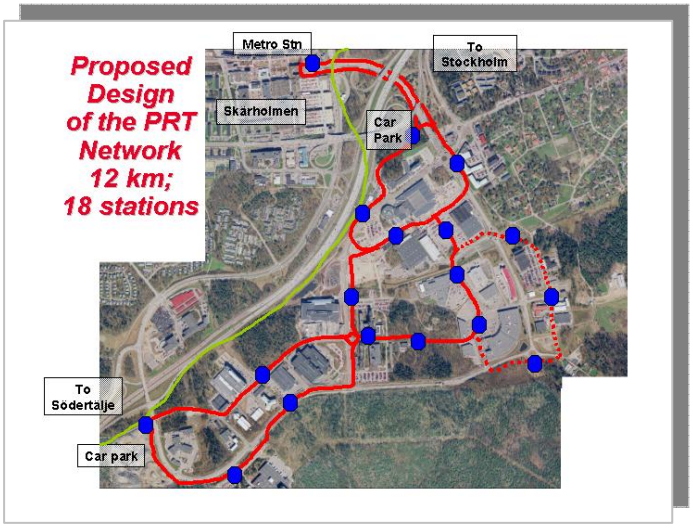
Our conclusion was that there is a need for an elevated guideway system separated from the ground street level to achieve a high performance transit level-of-service. With a doubled activity level and twice as many visitors to the area, a PRT or an APM system would double the market share for transit trips. With an augmented land-use in the area, all four systems show a positive benefit-cost ratio. However, the bus system would probably *not* be able to maintain its speed requirement, due to an enhanced congestion in the local road network. Thus, we recommend further investigations for an APM or a PRT system.
This study was presented at the APM-Conference in San Francisco in 2001.

1.7 The EDICT PRT feasibility study at Kungens Kurva

The European Demonstration of Innovative City Transport (EDICT) involved a consortium of 16 organizations; local authorities, consultants, industry and academia across 7 countries led by Cardiff County Council, with project management by Transport & Travel Research ltd. The work that was evaluated by an independent assessment team led by IABG. Seven other cities were associated as “follower cities” and will help to assess transferability. The project started at the beginning of 2002 and ended in the autumn 2004.

EDICT was financially supported by the European Commission Directorate-General Research through its Key Action “City of Tomorrow and Cultural Heritage”. The EDICT project used as a model the ULTra system (www.atsltd.co.uk) an innovative PRT system developed by Advanced Transport Systems Ltd. This was under engineering test in Cardiff, funded by the UK Department for Transport, with support from Cardiff County Council and the National Assembly of Wales. The ULTra system is now under construction as a first commercial system at London Heathrow Airport, aimed at being opened for passenger service in 2008.

A dense PRT network was proposed to connect Skärholmen residential and shopping area (and metro station) with Kungens Kurva with 12 km guideway and 12 stations, of which two inside a parking house:



Some of the major findings and conclusions form the Swedish test-site for a proposed PRT network between Skärholmen and Kungens Kurva were the following

Major advantages with PRT compared to traditional line-haul transit systems:

- Up to 50 % shorter travel times due to direct trips with very short waiting times with PRT
- 3 times more transit trips with PRT compared to today’s Bus
- Lower operating costs due to driverless operations
- Lower investment costs than LRT, due to a much lighter infrastructure
- Substantially higher willingness-to-pay for PRT compared to the bus mode, also demonstrated in Cardiff Bay (in the order 80 % higher)
- PRT reduces Car Traffic by 8 % and facilitates land-use for commercial activities
- Lower car ownership with PRT due to a much higher performance (lower travel time costs)
- Environmental-friendly
- Traffic-Safety
- Accessible to all groups of travelers
- PRT yields a positive Social Net Surplus to the Benefits of the Society
- Contributes to economic growth
- Positive attitudes towards PRT

However, due to a shift in the political majority in 2002, the interest for A PRT solution between Skärholmen and Kungens Kurva faded away.

1.8 Podcar feasibility study of Värmdö – Nacka - Stockholm

In 2006, the Värmdö municipality engaged the Institute for Sustainable Transportation (IST) to coordinate a feasibility study for the east region of the Stockholm County, i.e. connect Värmdö – Nacka –Södermalm with a podcar network. The study followed an implementation strategy of at least two stages, one for Gustavsberg - the capitol of Värmdö - and one for the full area.

The network for the full area consists of about 100 km guide-way and 94 stations. This large scale net needs a high-speed link to coop with travel time, capacity and energy efficiency requirements. The high-speed link is marked in purple in the figure.

When travel on the high-speed link the pods are expected to form a pod-train. The pods are electronically attached to each other, and can be separated in speed when one of the pods has to take off into a local loop. Estimated speed on the link is 70 – 90 km/h.

Pod-train, figure from SIKA (see #4)

2 SkyCab and SwedeTrack – Two Swedish PRT developers

2.1 SkyCab

SkyCab is a new "green" intelligent transportation system. SkyCab has no drivers (automatic) and no pollution. The SkyCab Project is working in a network with international relations together with several cities, R&D institutions and an industrial group. The aim of the SkyCab Project is to supplement buses, (local) trains and undergrounds with a convenient, non-polluting and cost effective new innovative form of public transport, a personalized rapid transit system.

2.2 SwedeTrack Systems

SwedeTrack has its roots back in the 70's when the present chairman in the board, Sten Staxler took part in the Gothenburg studies mentioned earlier. The company was formally funded 1991 though. The approach of SwedeTrack has been less focused on PRT and the main development line has been to focus on GRT and Dual Mode. The hope is that either of these development lines would make the first installation km profitable. SwedeTrack has thus cooperated with Siemens in quoting H-Bahn PRT systems for Gothenburg and Stockholm. SwedeTrack also later took part in the study for PRT in Gothenburg. SwedeTrack wants to develop "the H-Bahn system" into a new vision called FlyWay, which would accommodate busses, small passenger cabins and dual mode car movers, under the same beam. Presently SwedeTrack engages in many projects abroad.

3 PRT Research activities in Sweden

Chalmers' Research program on Automated Transit 1994-1997

A multidisciplinary research program was sponsored by the Swedish TRB and directed by Dr. Ingmar Andréasson during 1994-97. Four departments at Chalmers University of Technology and Gothenburg University researched the following aspects of PRT:

- User attitudes towards PRT
- PRT in cityscape
- PRT guideway design

- Operations and implementation strategies
- PRT demand modelling
- Socioeconomic costs and revenues.

Some of the conclusions were:
- PRT technology is available
- PRT can feasible solution for small and medium-sized cities and for feeders
- PRT offers capacity to replace buses and trams
- PRT cannot replace commuter train and subway
- PRT is accepted by users
- PRT can reduce transit travel times to half
- PRT may attract up to 25 % of car trips
- PRT can be socio-economically profitable
- Visual intrusion is the most difficult restriction

4 The Concept of General Transport System (GTS)

The Swedish Institute for Transport and Communication Analysis, SIKA, is a governmental agency under the Ministry of Industry responsible for developing forecasts and planning methods, publishing official transport statistics and carrying out comprehensive surveys of long-term sustainable development in the transport sector.

In the following we summarize a recent case study on what has been called a General Transport System (GTS) with strong links to APM, PRT and similar kind of transport solutions. The study is one of three whose aim is to highlight the question: *How can the planning process be organised to enable us to assess the value of alternative transport systems?* One identified weakness with the present planning model is its deficient capacity to detect radically different transport solutions and to assess whether they are superior to the established solutions or not.

What is a general transport system?

A General Transport System – GTS – is a name for something that can be described as a vision of what our combined transport systems would be like in the future. The vision does not mean that other transport systems will be replaced by GTS but rather that these gradually may be complemented by or become a GTS. We envisage that GTS has manifest advantages compared with existing transport systems as regards generality, safety, travel time, accessibility, the environment, energy and cost. However, we know little today about what a future GTS could entail, on the large and the small scale.

SIKA sees a need for new transport solutions in densely-populated urban environments – to start with, but at a later stage also outside of these – which reduce traffic congestion and emissions, while at the same time making possible safe, comfortable and efficient travel. SIKA considers that PRT could be a transport

alternative of this kind and the agency therefore regards it as important that more in depth knowledge is obtained about PRT (and GTS).

Considerable space is given to the effects of PRT in an underlying consultancy report[9]. The base material is studies made for a number of existing, planned and envisaged systems in Sweden and abroad. Among other things, they present estimated savings in journey times – which can be considerable – and the changes in shares for public transport – PRT increases the public transport's share of the transport market. The consultants also present calculations showing the socio-economic benefit of introducing PRT. According to a cost model presented in the consultancy report, PRT can offer transport at a lower cost than most other means of public transport.

The consultants then move on to discuss the design. There are a number of technical issues that must be investigated: Should the vehicles run on girders or be suspended below them? Should the vehicles go on tracks or on their own wheels? Should it be possible to connect the vehicles together on the track and how would that take place in that case? And so on. The consultancy group presents the questions but does not take a position in this type of "detail reasoning" with the exception of certain recommendations, for instance, they draw attention to the advantage of the linear engine for operating PRT vehicles.

Computer-generated picture of an envisaged PRT system in central Stockholm. Illustration: Hans Kylberg, Visulogik AB

The prerequisites for introducing PRT and GTS

The last chapter of the SIKA study report presents results from a couple of systems in the United States, which also show the socio-economic benefit. SIKA has not carried out its own assessment of the socio-economic estimates and therefore

[9] In Swedish only, made by LogistikCentrum, Transek and SwedeTrack Systems

refrains from taking a position on them at the present stage. However, the difficulties are underlined of making socio-economic estimates for a type of transport system which is not in operation anywhere in the world apart from in test facilities.

An examination of a number of preliminary studies of PRT systems has been made – in particular during the 1990s – in different municipalities in Sweden showing that work has been regularly discontinued when it has become apparent how large the initial costs associated with introduction of these systems could be. SIKA's preliminary assessment is that it may be justified for the government to take increased responsibility for the PRT issue in Sweden.

Why are these alternative transport systems not given scope in the process for infrastructure planning? Some working hypotheses on why there may be obstacles in the way for introduction of alternative transport systems have emerged:

- The initial, and often substantial, costs can be a deterrent for enthusiasm in particular if they are to be fully borne by a particular municipality.
- All new systems are perceived as "ugly" before you get accustomed to them.
- There are no natural representatives for alternative transport systems – and hardly any co-ordinating actor which takes a holistic approach.
- The value of the ground space saved that arises on implementation of above-ground transport systems is not included in the social efficiency calculations.
- Many people may feel hesitant about new developments in general – which may be expressed in their roles as officials, investigators or decision-makers.
- New developments can be counteracted by established actors from the point of view of self-interest.
- A general inertia in the social machinery can strengthen the two above effects. People often tend to rely on established actors.

Obstacles could be added to this list which is related to system faults in the planning process. All this, however, are questions that are to be dealt with in a future summary report.

5 From Technology to Marketing and Promoting PRT

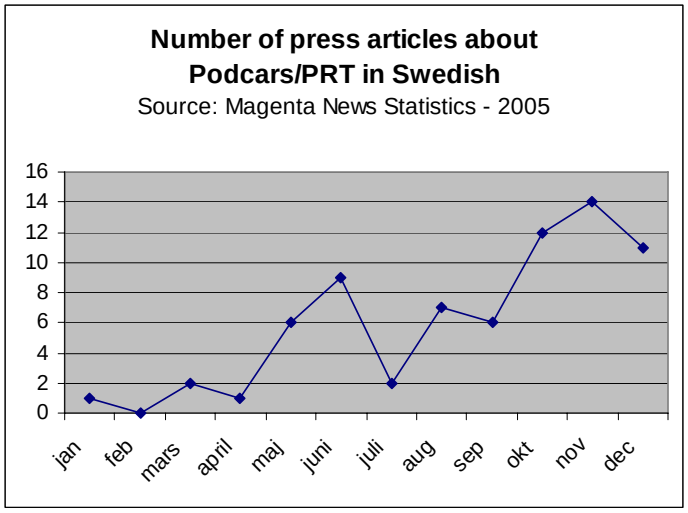
The Institute for Sustainable Transportation

The Institute for Sustainable Transportation, IST, was founded in January 2002. IST is a competence centre consisting of a network of experts and individuals aiming to support the implementation of a social, economical and environmental sustainable transport system. The focus of IST is on podcars/PRT. IST is a politically and vendor independent body. The network consists of persons representing the last three decades of research and experience of PRT in Sweden and abroad.

From ignorance to an awareness among experts, media and the public

The year 2005 was a break-through in the Swedish media regarding podcars. IST has played a part in this. The vision of large scale podcar systems was promoted

by IST via a lot of activities, such as open seminars with experts and authorities, exhibitions, blogs, web-site, press articles, visualizations and a film *Podcars – Do they arrive on time?* (http://www.podcar.org/Vad/what.htm).



Lessons learnt:

- an independent body can in some cases easier promote a PRT-concept than a vendor who speaks for a specific product
- give your vision away and let it be transformed into the subject of the listener
- produce a lot of pictures – media love pictures (and animations for the television)

PRT and Political Decision Makers

During 2006 podcars was brought to the political arena by many activities. The governmental agency SIKA launched the report of GTS (as discussed in #4). Swedish Rail officially supported a test track initiative of SkyCab in Hofors, Sweden (discussed in #6.1).

IST arranged two political debates about podcars: one with the leaders of all the political youth organisations and another with all the political parties in the parliament transport committee. The latter debate was broadcasted in Swedish television (2.5 h).

The former Swedish Prime Minister Göran Persson started *the Commission towards Swedish Independency of Oil*, with the goal to be oil independent by the year 2020. Dr Ingmar Andréasson made a presentation of podcar/PRT to the commission.

6 PRT Tests tracks in Sweden:

6.1 First Swedish PRT test track in Hofors by SkyCab
Pilotbana Hofors

Hofors is a suitable location for establishing a PRT test site, according to SkyCab. Three alternative locations are at Hofors Industrial Estate, and two of these have existing buildings that could be utilized. The test site would occupy at least 15 persons. Altogether more than 400 persons might be involved in the Hofors test site project. The costs for investment and the first five years operations are estimated to be between 150 and 200 million SEK (approx. 17-22 M €).

6.2 Second Swedish PRT test track in Uppsala by Vectus

In spring 2006, the first dig of the ground was taken for Vectus PRT test track. The site for the 400-meter track is located close to the Biomedical Centre in Uppsala, Sweden . In addition to the track and its three vehicles, a workshop, station and showroom are also being built at the site. Regular news and updates about the construction and development of the test track will be posted on Vectus' this website.

Vectus chose Sweden partly on account of the Nordic climate. Any new transport system will have to handle ice and snow without any problems – which makes Sweden the ideal testing ground. Moreover, Sweden has an internationally recognized body for type approval of new track vehicles in the form of the Swedish Rail Agency, which is to verify that Vectus' PRT solution fulfils all applicable norms and safety requirements.

The test project consists of multiple parts. At the moment, various tests for wheel types and wheel durability, parts of the communication and control system, and the drive system are performed in Sweden, the U.K. and Korea. The test track in Uppsala is to be completed by the turn of the year 2006/07, subsequent to which,

tests of the whole PRT system will begin: initially using one car without passengers, then one car with passengers, then two cars without passengers, and so on. Everything that can be tested will be tested, primarily to ensure safety and that all the parts work together as intended. Other tests will be performed with aspects on reliability, availability, maintenance, durability and passenger-perceived qualities.

The first tests on the test track are scheduled for spring 2007, and the ambition is to receive approval from the Swedish Rail Agency by the middle of 2007. Vectus is planning to operate the test track until 2010.

7 Governmental support for PRT or not?

Let's rephrase the question, because the situation is more complex than that. Who decide about a new transportation mode and why do we need one? Traditionally, transport investments have been closely related to political decisions and local and regional planning. The economical and technical aspects have been dominant.

Today, we can see a shift of perspective on transports as a whole, from a pure local issue to a more combined view with what happening in the society, EU and elsewhere in the World. Some examples are:

- transport is now a university subject and is studied at many institutions, e.g. as a socio-technical system
- under-privileged groups (children, women, elderly, ethnics, handicapped etc) in the current car oriented society are more in focus, e.g. meet demographic changes, tackle urban spread, ease ethnic integration etc)
- the fear of an accelerating global warming and the risk that the era of cheap oil will take a sudden stop.

Today, the picture of the problems is more complex. Even if local problems as accidents, congestions and emissions are tough, the broader scope creates really challenging problems. The understanding of the necessity to form a more social, economical and environmental sustainable mobility situation for people and goods is growing. The Oil-commission is an example of that. However, the social de-construction of the problem picture of transportation and the possible solutions are not only a governmental task.

A broad society debate about problems and possibilities is needed, with a lot of aspects, and driven by experts, politicians, media, NGO and citizens. Because, transport issues are now far too embedded into the society, to only be handled only by transport experts/consultants/authorities. The task of making them visible and subject to broad interest, learning and involvement is as important as showing the importance of the new technology in terms of mere facts and figures. It will demand social networking, mobilisation and creativity.

In Sweden, a number of municipalities, politicians, media and NGOs are now debating transportation in a broad sense (but not as much or as loud as it should!),

and also bringing up podcars as a possibility. Support has also come from the government. The authors of this paper believe that podcars can contribute to a more sustainable society. But it has to be proven. Next step is to build pilot tracks, 3-15 km guideway, for public use and in the build-up environment. Evaluate and continue to the following step, implement commercial podcar networks.

8 Lessons to be learnt

• New systems are difficult to introduce no matter how good they are
• It is easier to get consensus to improve existing systems than to introduce a new system
• It is unrealistic to expect a local community to take the cost and risk of introducing an unproven system
• The benefits of PRT grow with the number of destinations served
• The initial stage of implementation is the most difficult one to prove profitable
• According to Darwin each step of development must give an improvement over existing solutions
• Test tracks and early implementations are crucial for credibility
• There is a window of opportunity for PRT in Europe now
• Political interest for PRT in Sweden is growing
• Several applications of PRT in Sweden have been proven feasible
• International cooperation would reassure pioneering cities

9 Summary and Conclusions

Podcars or Personal Rapid Transit (PRT) has been discussed and analyzed in Sweden since the late-60's. The pioneer City was in those days Gothenburg. Like business cycles the interests in PRT has gone up and down over time. From the Mid- 90's, however, the efforts of promoting PRT in Sweden became more serious and frequent. Many pre-feasibility and a few feasibility studies have been undertaken by researchers, consultants and cities during the last 25 years in Sweden. It was a long way ahead to introduce a completely new mode of transport (and of thinking!) such as PRT, against a wide range of vested interests in the automotive and public transport industry.

Up to now, the crucial point seems to have been the imbalance between risks and financial support: no local authority, such as the Public Transport Authority can buy a system of its own, due to the development risks associated with PRT as long as it is an unproven technology; and no developer can invest full in development, as long as there is no (mass) market for the end-product.

Besides, there is also a "political risk", as long as financial support is a prerequisite for the implementation. As most of the Swedish feasibility studies show, it is not

enough to convince the present political majority of the merits of a PRT system. Next election period, there is a more or less completely new set of politicians to convince.

Today the situation of podcar awareness in Sweden goes into a new era. A PRT test track is under construction in Uppsala, Sweden, by a vendor that believes in a mass market (Posco). Further, the criticism and the awareness of the un-sustainability of the current traffic situation (climate change and peak-oil) set the timing that we are now likely on the threshold to an acceptance of podcars/PRT.

In the final report from the EDICT-project[10], the following conclusions were drawn, and they still hold, we believe:

> "On paper, PRT looks much more attractive than conventional public transport. But as yet no system exists in public use, and although many public authorities are interested in the concept, not one has committed to installing such a system.
>
> The answer lies in risk. The ULTra system is one which is nearer to full practical development than any other. It has a working test system and two vehicles. So far, the development has kept within its intended time and budget, and most people who see and try the system are enthusiastic. But there is still a big gap between a test system and full public operation. For the investor, there are technical risks that the system will not ultimately perform as proposed, and that it may cost more and take longer to bring to satisfactory operation than the designers claim. Whether the decision is made by a local authority using public funding, or by a company using private capital (as for example in an airport) there are serious political risks attached to failure. However competent the developers, and however strong the reassurance they can give that all the uncertainties have been considered and addressed so far as possible, the commitment to install requires a high level of faith in the product, and strong leadership from purchasing body. This has been true with all major innovations, of course, but in the case of a public PRT system any failure will be highly visible. Against this, the lead city or company can expect to earn considerable attention and praise for the first successful system.
>
> It seems clear, nevertheless, that once a successful PRT system is in public operation, there will be a very large number of towns and cities which will want one.

One of the Swedish vendors, Mr. Jan-Erik Nowacki of SwedeTrack, put his conclusions in this way:

> "I thought that, when we first presented the FlyWay vision, the whole society would applaud and say – This is what we want!! That proved very over-optimistic! I have now worked mostly without funding for 20 years. I have learnt that the timing of efforts is much more essential than enthusiasm. The only way today's western societies will accept any changes in transport, will be when the oil supply is cut off completely and permanently. I guess that the Chinese or the Koreans will be far ahead of western societies then." /Jan-Erik Nowacki/

[10] EDICT Deliverable 8: Demonstration report, June 2004.

Kjell Dahlström, head of the governmental agency SIKA, want to stress the need for a standard development of such a new technique. Such a development is hard to realize without strong purchasing bodies which probably need to unite in a complex international technical competition. Such competition needs an advanced cooperation between governmental and market bodies; neither of these main actors in society can have progress in the matter of this paper without a strong cooperation. When the now established transport modes, like roads, railways, air and sea transport were in their innovation phases they certainly had a tough way to go to convince the general societal establishments. Today we also have to face the fact that society is filled by different physical networks and their supporters who naturally try to keep their business alive and consider new modes as a major threat.

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