Bus Rapid Transit

Traffic congestion in the urbanised areas of the Netherlands is reaching critical levels. Rail-based mass transit systems have always been considered the solution, but the costs are often prohibitive. Modern Bus Rapid Transit systems are more affordable, flexible and clean, and can be readily integrated into the urban fabric of existing and planned developments. The Phileas in Eindhoven demonstrates their potential.

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Mobility and environmental quality are key issues in urban planning. In the Netherlands, traffic congestion is a daily occurrence and the problem is growing as population numbers and car ownership rise and the urban area expands. Per person we use more traffic space and floor space than ever.
The most recent wave of large urban extensions (the 'VINEX' districts) are a major contributory factor because they were built without good quality public transport links, leaving them effectively isolated from other areas of the city and residents completely dependent on their cars. Although many of these districts are now served by tram and bus lines, and temporary train stations have been built, the relation between urban function, density and public transport remains limited.
Although the motorway network is continually being improved, congestion is worsening, not only during the rush hour but also during the day, in the evening and at the weekend. A minor accident is enough to cause long tailbacks, but increasing the capacity of existing motorways and building more roads is not the solution. Satellite images reveal the shocking air quality in the Netherlands.[1] Although vehicle emissions of fine particulates and NOx are only partly to blame, there is a real problem in the most densely populated areas in the west of the country.[2] The problems of traffic congestion and unacceptably high levels of air pollution are not restricted to motorways and ring roads, but also affect the quality of life across wider urban areas and in the city centres.

What is Bus Rapid Transit?

Bus Rapid Transit is high-quality, customer-orientated transit that delivers fast, comfortable and low-cost urban mobility. BRT systems have some or all of the following elements; many of these can also make a valuable contribution to improving regular bus services.

- Dedicated bus corridors with strong physical separation from other traffic lanes.
- Modern bus stops that are more like bus 'stations', with pre-board ticketing and comfortable waiting facilities.
- Multi-door buses that 'dock' with the bus station to allow rapid boarding and alighting.
- Large, high-capacity, comfortable buses, preferably low-emission.
- Differentiated services such as local and express buses.
- Bus prioritisation at intersections, either as signal priority or physical avoidance (e.g. underpasses).
- Coordination with operators of smaller buses and paratransit vehicles to create new feeder services to the bus station.
- Integrated ticketing that allows free transfers, if possible across transit companies and modes (bus, tram, metro).
- Use of GPS or other locator technologies with a central control area that manages bus location at all times and facilitates rapid reaction to problems.
- Real-time information displays on expected bus arrival times.
- Good station access for taxis, pedestrians and cyclists, and adequate storage facilities for bikes.
- New regimes for bus licensing, regulation and compensation of operators.
- Land-use reform to encourage higher densities close to BRT stations.
- Park and ride lots for stations outside the urban core.
- Well-designed handicap access, including ability for wheelchair passengers to quickly board buses.
- Excellence in customer services that includes clean, comfortable and safe facilities, good information and helpful staff.
- A sophisticated marketing strategy that encompasses branding, positioning and advertising.

Compared with regular bus services, BRT offers higher speed, higher frequencies, better information and more comfort. BRT is a concept which covers infrastructure, vehicles, urban design and management.
Source: Wright, L., Bus Rapid Transit: Sustainable Transport: a Sourcebook for Policy-makers in Developing Cities, ITDP, New York, USA, 2002

CLEAN MASS TRANSIT: RAIL OR ROAD?

There are two main types of mass transit: road and rail systems. Road transit is generally thought of in terms of the bus, a slow, low-quality, polluting and inadequate carrier. Rail systems, such as tram, light rail, metro or train are higher in the hierarchy of public transport systems because of their faster operating speeds and greater capacities. Bus Rapid Transit (BRT) may change this. The International Energy Agency (IEA) claims that the quality of bus systems can be improved to a level normally associated with rail systems[3] and BRT is far less expensive and more flexible than light rail.
The IEA further states: 'Compared to cities dominated by small private vehicles, those with well designed bus systems have much less traffic congestion, lower pollutant and CO_2 emissions, and offer better mobility for all social and economic classes. Bus systems ... are responsible for only a small part of traffic congestion, energy use and pollution.' And more importantly: 'Even "dirty" buses emit far less pollution and CO2 emissions per passenger kilometre than most other types of vehicles.' Of course, this figure depends on the level of occupancy of buses and the technological level of other types of vehicles, but we may conclude that offering high quality public transport – either BRT or Light Rail Transit (LRT) – alleviates traffic congestion, parking pressures and air pollution in the city.

BRT AN ATTRACTIVE OPTION

Rail-based public transport has always been seen as a solution in the Netherlands, but not every city or region can afford such expensive transport systems. According to the IEA, BRT infrastructure at grade costs between $1 and $8 million/km, compared with $10 to $30 million/km for LRT or metro systems. The costs double for elevated infrastructure and are twice as high again for underground systems. The IEA and Wright[4] state that the capacity of BRT is 50% higher than LRT, although this figure may vary according to vehicle capacity, operating speed and the frequency of the services. Dutch experts, on the other hand, state that BRT can never achieve a higher maximum capacity because of their lower operating speed and safety regulations for non-guided mass transit. A higher BRT network density and better integration into the urban fabric would compensate for a lower capacity, but this requires a different network configuration.
The most significant difference between rail and road transit is the infrastructure. Railway infrastructure is more dangerous for cyclists and pedestrians and less flexible in the event of accidents. The overhead lines and traction poles are intrusive features in the urban environment and create obstructions. It should be noted, though, that innovative solutions have been developed to avoid this problem. For example, the new wireless light rail in Bordeaux, Innorail, obtains its power from a third, central rail, which is only energised in sections directly beneath the tram. But BRT can also free city centres from overhead lines.

BRT and LRT compared

	Bus Rapid Transit	Light Rail Transit
Cost (million $/km)	1 – 8	10 – 30
Flexibility	+	–
Spatial implementation	+	–
Identity	–	+

The first wide scale and successful introduction of BRT was in 1974 in Curitiba (Brazil, 2.2 million inhabitants). Today, this →

famous system consists of several backbone corridors (over 50 kilometres of exclusive busways) and around 340 kilometres of feeder services. Although a number of cities have since introduced BRT, it was not until the late 1990s that the success of Curitiba was first replicated in Bogota (Colombia, 7 million inhabitants) with the TransMilenio system. The largest BRT system in the world, with 250 kilometres of exclusive busways, can be found in Sao Paolo. Besides these Latin American cities there are also good examples of BRT in more developed nations: Brisbane (Australia), Ottowa (Canada) and Rouen (France).[4]

BRT IN THE NETHERLANDS

BRT has been introduced at three places in the Netherlands: Utrecht (HOV), Amsterdam-Schiphol-Haarlem (Zuidtangent) and Eindhoven (Phileas). The HOV (literally 'High Quality Transit') is based mainly on a still expanding network of dedicated busways. The Zuidtangent consists of a single main line designed as a LRT but operated as a BRT. The Phileas in Eindhoven is so far the only specially designed overall concept of vehicle type, infrastructure and urban transformation in the Netherlands.
Following the publication in the early 1990s of various government policy documents, such as the National Transport Structure Plan, local authorities and regional transport authorities in the Netherlands sought to develop transport systems that offered an alternative to the private car. The city of Eindhoven drew up a set of requirements for a high-quality public transport system and examined a number of possible vehicle systems that would meet these requirements. Given the size of the city, a metro system was financially out of the question and even a tram was too expensive. Buses were considered to have a poor image and provide insufficient quality. The city, therefore, looked for an alternative that would combine the advantages of trams (image, capacity) and buses (flexible, cheap). They first examined the Guided Light Transit system (GLT) manufactured by BN/ Bombardier, a mechanically guided bus comparable to Innorail, until a regional consortium led by the Noord-Brabant Development Agency (BOM) and Nedcar came up with a new proposal: the Phileas. The special feature of this vehicle is that it has an electrical guidance system rather than a mechanical one. After a feasibility study confirmed the viability of the system, the regional and local authorities and the business community lobbied the government to support the introduction of the system, holding discussions with officials at the transport, planning and economic affairs ministries. Representations were made to the Ministry of Economic Affairs because at the time Eindhoven was going through an economically difficult period (mass redundancies at DAF and Philips) and was keen to obtain an extra stimulus for regional industry.
A financial package for the project was finally agreed in 1988, with a government subsidy covering 40% of the costs. The remainder was paid for by Eindhoven and Veldhoven municipal councils and the business community. European funding was also obtained for the development of the vehicle. The project was managed by the SRE (Eindhoven Regional Partnership). Having taken the original initiative, Eindhoven subsequently focused its efforts on building the required infrastructure.

EINDHOVEN WEST CORRIDOR: TRANSPORT BACKBONE

Phileas runs from the centre of Eindhoven to Meerhoven, Eindhoven Airport and Veldhoven town centre, largely within the Eindhoven West Corridor. This corridor was a Key Project in the Fourth National Policy Document on Spatial Planning and is a high profile example of good coordination between mobility planning, urban planning and economic development. Much new development has been concentrated within this corridor and more is planned, such as the redevelopment of old Philips sites as new urban areas. The Meerhoven urban extension will provide in 6500 new houses and 200 hectares of employment land for business development. Right from the start the Phileas line has been a structuring element in this extension, creating the opportunity to plan the new housing around the public transport stops, unlike many other major urban extensions. The project started in 2003 as the backbone of an extremely modern, efficient and customer-friendly regional public transport network in a region well known for high-technology industries, innovation and creativity.
Eindhoven Airport is located at the end of the West Corridor. This regional airport is rapidly expanding and passenger numbers are set to

reach 2.2 million in a few years time; many of them are expected to use the Phileas to travel to or from the airport. The next corridor to be developed might be a north-south corridor to Aalst/Valkenswaard, passing the High Tech Campus.
An agreement has been reached with the government on supporting policy measures to increase the number of passengers using Phileas. Parking prices will be allowed to rise and paid parking will be introduced in more areas of the city. Public transport has been on offer in Meerhoven since the first residents moved in, and for a time public transport for these residents was free. A mobility shop in Meerhoven and the introduction of a Pioneers ticket providing a discount on travel by public transport in Meerhoven have raised public support for the project. In the years to come Phileas will demonstrate how a new and innovative form of public transport can be made to work in the Eindhoven region.

Phileas combines the flexibility of transport by bus with the reliability of transport by rail or underground

PHILEAS ADVANCED PUBLIC TRANSPORT

Advanced Public Transport (APT) has a number of characteristics – it is fast, flexible, comfortable, reliable, attractive, punctual, safe and environmentally friendly – and Phileas combines them all. The concept for Phileas is entirely new and combines the flexibility of transport by bus with the reliability of transport by rail or underground. This is of particular interest for medium-sized to large cities, where transport by bus is too small-scale and transport by rail is not economically viable. The concept was developed by a consortium of companies from the region under the leadership of APTS/Berkhof. The first prototype was tested in 2002 and scheduled services between Eindhoven and Veldhoven began in late 2004. Phileas is produced by APTS (Advanced Public Transport Systems) in Helmond, a subsidiary of VDL.

Dedicated infrastructure

To ensure optimum performance and benefits, Phileas runs on a dedicated route throughout virtually its entire length, unhindered by other traffic. The Phileas bus lane is made of 25 cm thick non-reinforced concrete and is 6.6 metres wide (for two directions). Concrete was chosen as the building material because it is rigid (non-deformable) – under constant use asphalt is subject to wheel track rutting – and because the difference in colour (grey instead of black) and structure makes it more readily identifiable. Moreover, concrete has a longer life than asphalt and is thus cheaper. At five places the Phileas line crosses other roads at grade-separated junctions and so loses no time. At the other crossings the Phileas has right of way or the sequence of traffic lights gives it priority, reducing journey times and ensuring a reliable service.
The busway is well integrated into the surrounding area and particular attention has been paid to the green landscaping on either side. Local support and agreement for the required changes to the road infrastructure in existing residential areas was obtained through active local participation in the planning and design work.

Comfort

Two versions of the Phileas are in service: a double articulated, 18 metre long version with a maximum capacity of 120 passengers and a triple articulated version, 24 metres long, with a maximum capacity of 180 passengers. Its special wheel suspension, entirely flat low floor, wide doors and well-spaced seating make the Phileas extremely comfortable and easily accessible. The platforms have been constructed on a higher grade, 30 cm above ground level and the same height as the floor of the Phileas vehicles, ensuring easy boarding and alighting without having to step up or down. The gap between the side of the vehicle and the edge of the platform is just 5 cm, presenting no insurmountable barrier for wheelchair access, prams and pushchairs. All the stops, which have a modern design, are fitted with a bus shelter and wooden bench, a line map and departure times, and a pillar with a dynamic passenger information display indicating the waiting times for the various services. The electronic passenger information system enables information to be obtained on timetables, departure times and any delays via the internet at home, in shops and theatres. In Phileas itself, information is given on the route, the following stop and the arrival time at the terminus.

Electronic guidance

Phileas is equipped with an electronic guidance system and follows a predetermined route via magnetic markers embedded in the road surface every four metres. This infrastructure is therefore much cheaper than rail and easy to maintain. The dedicated routes and guidance system greatly reduces strain on the drivers and ensures a high level of safety, particularly in busy city centres, while allowing the drivers to respond to any unforeseen situation as it occurs. →

Fast and reliable

The use of dedicated lanes, grade-separated junctions and priority at grade junctions allows Phileas to travel at higher speeds, reducing journey times. The electronic guidance system enables Phileas to pull up and stop accurately at the platforms. Along with the large sliding doors and electronic payment system, this keeps stopping times down to the minimum. Journey times are therefore considerably shorter than with regular bus transport. The journey time from the centre of Eindhoven to Eindhoven Airport and the Veldhoven town centre is less than 20 minutes.

In addition to speed and comfort, reliability is another important characteristic of good public transport. The electronic guidance system allows the control room to accurately follow the progress of each vehicle and adjust their speed to fit the timetable accurately. This means that Phileas services are punctual and very frequent: Phileas operates in both directions every five minutes on both lines.

LOW-EMISSION HYBRID DRIVE

Phileas has a hybrid drive in which all the wheels, apart from the front wheels, are driven by electric motors. The electrical energy is generated by an economical and environmentally friendly LPG motor that powers a generator with continuous rotational speed. A set of batteries provides a secondary power supply. The engine produces more power than necessary, and the excess energy and the energy released during braking is fed into to the batteries. Phileas is able to run purely on electric power supplied by these batteries, and thus emissions free, for three kilometres, making it ideal for use in the city centre. Because of the hybrid drive and its lightweight construction, Phileas consumes less energy than conventional vehicles and 25 per cent less energy than a conventional LPG motor. In addition, the materials used in Phileas are recyclable and environmentally friendly.

A FUTURE FOR BRT

Tackling the problem of traffic congestions and air pollution is not only a matter of designing a transport system or introducing environmentally-friendly technology; it is also a matter of spatial planning and urban design. At the grass roots level, people should be encouraged to use other modes of transport, such as walking, cycling and public mass transit. Building at higher densities around public transport nodes and locating schools, supermarkets and other public facilities and amenities within walking distance should make the use of sustainable transport modes a more obvious choice. All three approaches must be used together to create sustainable and liveable cities.

The choice between LRT and BRT is not just a matter of money and capacity. It also depends on the existing and future urban situation, existing transport modes and networks, and political preferences. In most German examples, BRT is not an issue: LRT connects with heavy rail and shares the same infrastructure.

Nevertheless, as a concept BRT seems to have a future. Curitiba, Bogota, Sao Paolo and many other South American cities illustrate that BRT is a cost-effective, efficient and more environmentally beneficial alternative to LRT. The introduction of Phileas in Eindhoven is the first step towards integrated transport and development in the Netherlands. Further steps are necessary to expand the network into a fully operational backbone and feeder structure.

Although BRT will contribute to upgrading bus services, in Europe it will probably never overtake LRT in the transport hierarchy. BRT is a good principle for upgrading feeder services for light and heavy rail, but its flexibility also makes it less permanent: if you take away the vehicles, all that remains is a simple piece of infrastructure.

Notes

1 See the tropospheric NO2 measurements on the KNMI website: http://www.knmi.nl/omi.

2 Hout, D. van den, Problems with Air Quality, TNO, Kennisdag Duurzaam Mobiel, TU Delft, 29 November 2005.

3 IEA, Bus Systems for the Future: Achieving Sustainable Transport Worldwide, International Energy Agency, Paris, France, 2002.

4 Wright, L., Bus Rapid Transit: Sustainable Transport: a Sourcebook for Policy-makers in Developing Cities, ITDP, New York, USA, 2002.

Websites

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