SMART

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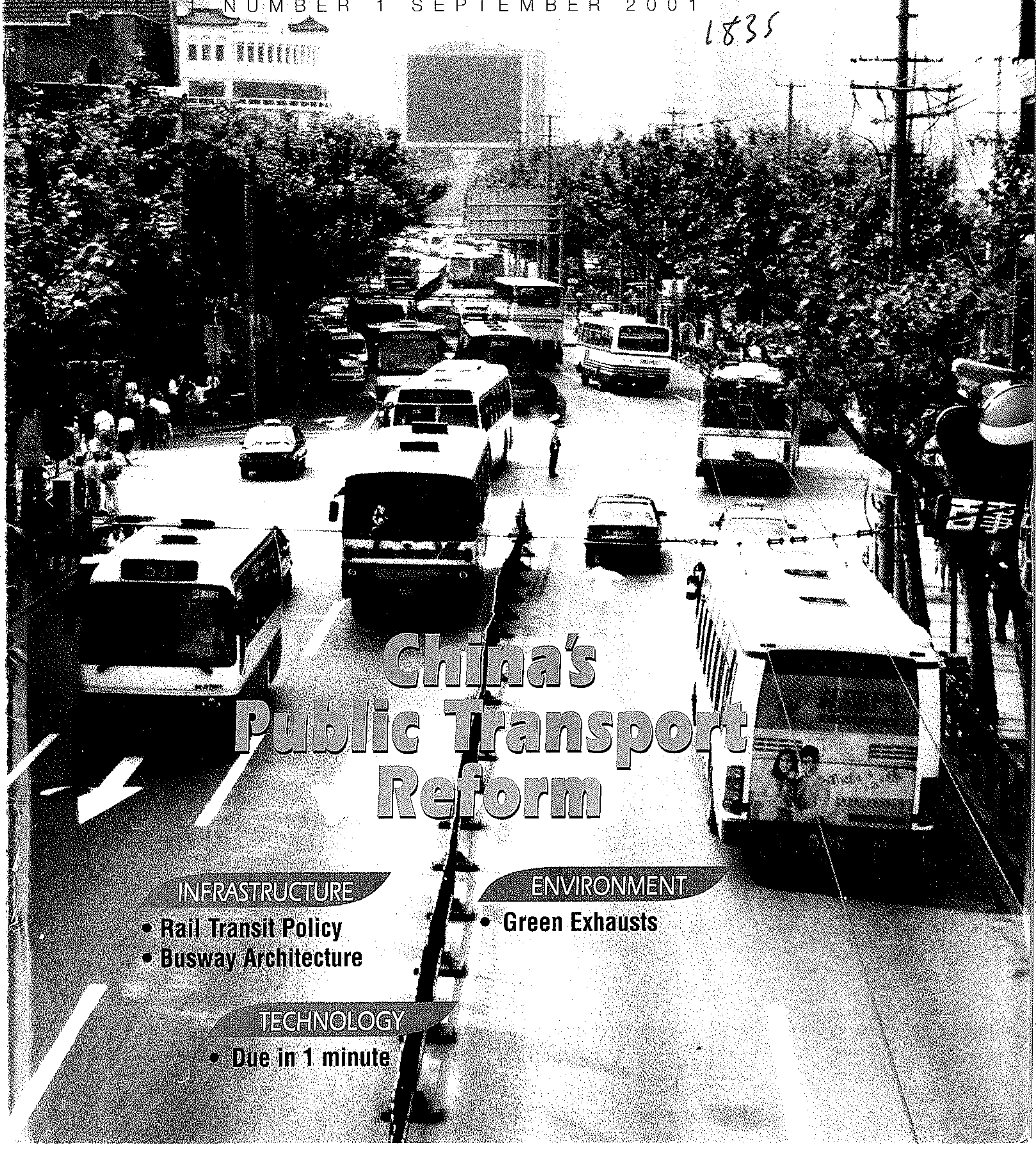

China's Public Transport Reform

INFRASTRUCTURE

- Rail Transit Policy
- Busway Architecture

ENVIRONMENT

- Green Exhausts

TECHNOLOGY

- Due in 1 minute

Welcome

Welcome to the first print edition of Smart Urban Transport.

Most of you have probably received the email newsletter edition of this multi-media publication — a monthly email newsletter plus three magazine editions a year.

Why do this? Because two billion people live in the Asia Pacific. With increasing living standards comes more urbanisation and the need to transport large numbers of people and their freight in ever more densely populated cities and regional centres.

Without smart urban transport, the Asia Pacific will not be able to make the 21st Century its own.

We have identified the 10,000 people who will be the key decision makers in planning, financing and operating the traffic and transport systems in the Asia Pacific.

Your job is a vital cog in bringing a quality of life that most people in the region aspire to.

We hope we can help by transmitting information that helps provide solutions for smarter urban transport.

The editors Professor Phil Charles and Phil Sayeg have excellent contacts from around the world in traffic and transport, and a depth of knowledge of the practical problems and possible solutions in the Asia Pacific.

We welcome your feedback. In fact, we have designed the format using the email newsletter so that you can easily email a response, whether a quick comment or a well argued critique, or you may just want to email some links to an area we should investigate.

Andrew Stewart
Director, PSA
for the Smart Urban Transport Partnership.

About the editors

Professor Philip Charles has expertise and experience in transport strategy development, including infrastructure development and management, intelligent transport systems and road safety and traffic management, strategic analysis and futures scanning, institutional strengthening, professional capability development and business planning, including market assessment for new transport technologies.

He has undertaken these roles in Australian road authorities, as chief executive of a national association, as a management consultant with Booz Allen and Hamilton and as part of a University research centre. Professor Charles has graduate and postgraduate qualifications in engineering, and public and business management.

Philip Sayeg has specialised in transport planning, policy and related management issues for 25 years. Clients have included all levels of government in Australia, Thailand, the World Bank, international organisations and private companies. He has held advisory positions to senior public officials in Asia and has lived and worked in Asia (12 countries) for 10 of the past 18 years.

For a number of years, Phil Sayeg has specialised in studies relating to Asia's urban and regional commercial fleet operations, Intelligent Transportation Systems, environmental issues related to transport, and the impact of Asia's development and socio-economic change on the future demand for transport.

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New Ways

Any regular traveller through the Asia Pacific over the last 30 years probably underestimates the development of transport systems in the region.

That may sound strange given that regular travellers would regularly use the new airports and mass transit systems.

But a colleague who was transferred back to Asia after a few decades based mainly in Europe and America said absence had highlighted the changes.

With not only an intense interest in aviation and airport developments, but a regular user of land based public transport through most Asian cities including in China, he believes this region has the best chance to get transport right.

John's assessment of the transport world is this:

This is where the planning of whole systems becomes important.

If a city or region is starting with a low level of car ownership but high economic growth rates, there's an ability to plan traffic and transport systems to favour the community benefit — ease of movement for the greatest number, best environmental outcome, lowest infrastructure investment.

On that basis, the choice may be between a full freeway network and accept congestion of high car ownership (The 1950s US approach), or build roads primarily as freight networks and public transport systems as people movers (perhaps the closest model being Singapore as a city state, with Malaysia and China more relevant models for geographically and demographically diverse economies).

"... this region has an opportunity to develop its own transport mix, without slavishly following the less than perfect model from Europe or north America."

Europe: a few clever projects hide a lot of old infrastructure and systems. With a static (in some cases falling) and ageing population, european governments are struggling to devote the funding to keep up at the leading edge. The debate about private vs public ownership is stalling much planning and investment.

USA: a lack of coordination is seen by any pilot — or transport user. The competition ethic has led to many clever short term answers and tactics, but a distinct shortage of long term strategic planning. Long term infrastructure tends to be funded directly from Congress which is very much subject to 'flavour of the month' influences. So many cities in the USA are getting light rail systems because that's what Congress loves to fund at the moment, but there's little planning to help the traveller who wants to travel across the city using public transport by various providers and modes.

Asia: some grandiose projects are at the leading edge and have forcefully lifted the level of expertise in project planning and engineering. The challenge now is to have the maturity to plan, develop and manage transport systems. With the best of modern technology, often a greenfields start (so there's no legacy of old technology or management or assets), and governments with an authority to 'get things done'.

"But John," I can hear you asking as I did, "what about the money?"

The second choice requires taxing the freight as a user-pays (tonne/km electronic tracking) to pay for the enhanced roads and highly taxing cars for their full road and externalities (especially pollution) costs — which provides a system attractive to private financiers. Government investment effort can then be on people movement systems. But long term systems and infrastructure packages are now becoming available from major suppliers and financiers, in part as better Information Technology allows higher net fare collection.

One of the problems is the alignment of economic development with transport and planning.

Some countries regard development of a car industry as so important to their economic and technological growth that they prefer to follow the US model of encouraging private car ownership and (relatively) low car operational costs.

Having a strong car industry (given most are for export to high wage western countries) does not preclude good internal transport planning or a high use of public transport. It could be that efficient freight routes and low internal car ownership/effective people transport systems is actually a better economic model — and better for quality of life.

As John points out, this region has an opportunity to develop its own transport mix, without slavishly following the less than perfect model from Europe or north America.

SMART
URBAN TRANSPORT

2ND INTERNATIONAL CONFERENCE ON

Smart Urban Transport — Integration and Performance

19-21 November, 2001, Brisbane

Heavy investment is being made in busways/ transitways throughout Australasia, North America UK and elsewhere. Attention has now turned to the operation of this infrastructure to create a true bus-based rapid transit (BRT) which is fully integrated with other modes. Recent advances in the contracting of bus services, vehicle design, clean engine technologies, and intelligent transport systems (ITS) offer great potential to support BRT. Ultimately BRT and mass transit of all types (rail and bus) will be judged on their ability to attract significant patronage — recent experience with new mass transit systems opened in the Asia — Pacific region provides some insight into how they are perceived by potential riders.

Following calls for a follow-up to the First Smart Urban Transport Conference (SUT) held in October 2000, Transport Roundtable Australasia (TRA) are organising this second SUT conference to be held in Brisbane, Australia at the 5-star Stamford Plaza Hotel on the Brisbane River. It will be held on Tuesday 20 November and Wednesday 21 November. An optional short course will be held on 19 November on evaluation of multi-modal transport infrastructure projects.

The conference objective is to provide a forum where transport professionals, operators and contractors can learn of the latest international developments, share experiences and lessons learned and develop solutions.
A global, state-of-the-art view will be provided featuring the most recent North American and Australian experience with busways, bus system reform and performance. A detailed update will be provided on Brisbane's 15km state-of-the-art South East Busway which was fully opened in early 2001.

An invited group of international and Australasian experts will make presentations on the following topics:

- Busway Rapid Transit — the US TCRP Project*
- Los Angeles Metro Rapid BRT success
- Transit development and reform
- Designing transit services to meet market needs
- Developments in transit infrastructure and vehicles
- Integration of transit services
- Intelligent bus systems
- Institutional issues, evaluation and lessons learned.

* Sam Zimmerman project manager US TCRP confirmed

For details of the Second International Conference on Smart Urban Transport Conference please contact:

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Bus Rapid Transit Primer

By Samuel L Zimmerman, Principal for Transportation Planning DMJM-Harris – Arlington VA USA

The worldwide recognition that Curitiba, Brazil has received for its innovative urban planning and related "Surface Metro" bus rapid transit system has induced many elected officials and urban transport planners in the United States to begin considering "BRT" (Bus or Rubber-Tyred Rapid Transit) as a potential solution to their respective urban transportation problems.

Unfortunately, as well known as BRT appears to have become, there are still many misconceptions that prevent BRT from being given a fair appraisal in many cases.

These misconceptions include the claim that customers with a car choice who would use a rail-based rapid transit mode, will not use it and that developers will not see its stations as part of a quality, high performance rapid transit system worthy of locating next to.

There is also the feeling in some quarters that BRT's operating costs are too high ("One driver per 50 riders versus one per thousand with Light Rail Transit, LRT") and its capacity too low to be of relevance in any but the smallest cities.

The purpose of the USA's Transit Cooperative Research Program (TCRP) project A-23, BRT Planning and Implementation Guidelines is to dispel these notions by providing planners, engineers and architects with the facts they need to assist transit investment decision makers in judging the relative costs and benefits of BRT.

Two of the products of the project, a brochure and a video library are intended to assist decision makers directly, while technical guidance being prepared on the basis of worldwide case studies and experience is oriented to planning, architecture and engineering professionals.

The information that appears below was taken from the preliminary materials prepared for these products and is an attempt to provide the transportation community with some basic BRT facts.

The Primer begins with a definition of BRT developed in concert with the panel directing the TCRP project.

The Primer then proceeds with some basic information on BRT successes, costs and benefits and concludes with a series of illustrations of BRT's main elements from around the world, stations and terminals, running ways, vehicles and ITS applications.

What is BRT?

BRT is a flexible, rubber tired form of rapid transit that combines stations, vehicles, services, running way, and Intelligent Transportation Systems (ITS) elements into an integrated system with a unique identity. BRT applications are designed to be appropriate to the market they serve and their physical environment.

BRT can be incrementally implemented in a variety of environments, from totally dedicated to transit (surface, elevated, underground) or mixed with other traffic on streets and highways.

Where has BRT been implemented?

BRT has been implemented all over the World. In the USA, the best examples are in:

- Pittsburgh (South, MLK/East and Airport/ West Corridors);
- Miami (South Dade/US-1), Los Angeles (El Monte/I-10;
- Wilshire-Whittier & Ventura Blvd Metro Rapid Bus);
- Denver (16th Street Mall, I-25 North);
- Honolulu (CityExpress!);
- Houston (Transitways) and Orlando (LYMMO).

The best examples of BRT outside the US are in Ottawa and Vancouver, Canada, Curitiba and Sao Paulo Brazil, Adelaide and Brisbane, Australia, Paris, Rouen, Clermont-Ferrand, France, and Trieste, Italy.

Benefits of BRT

BRT is the most flexible rapid transit mode. BRT services can be precisely tailored so that BRT vehicles rather than BRT customers transfer. BRT vehicles, can be steered or guided mechanically or electronically and can travel in general traffic on any street or highway.

They can also be operated at high speeds safely and reliably on their own dedicated transit ways, without interference from other vehicles.

To guarantee the minimum running way cross section, the highest safety and the best ride quality, BRT vehicles can also be guided mechanically like a rail transit vehicle, or electronically.

Mechanically guided BRT vehicles have been operating for almost twenty years in

HAS IT BEEN SUCCESSFUL?

In virtually every fully integrated, full-feature BRT application to date, there has been the same customer, community and developer acceptance observed with the implementation of any high-quality rapid transit mode such as LRT.

Increases in ridership attributed to BRT have ranged as high as 100% or more over the initial application period.

For example, transit ridership in Miami-Dade's South US-1 Corridor has increased from approximately 7,000 daily trips in 1996 before the Miami South Dade Busway opened, to over 14,000 per day today.

In Honolulu, ridership has gone from approximately 3,000 on corridor bus routes to more than 6,500 trips per day in the year since "CityExpress!" opened.

Implementation of Metro Rapid Bus in LA's Wilshire-Whittier and Ventura Blvd Corridors has resulted in increases of, respectively, 20% and 50% in total corridor bus ridership.

Over one third of the new riders in the Metro Rapid Bus corridors did not use transit at all before the lines opened.

In the Wilshire-Whittier corridor, over 60,000 trips per day currently use Metro Rapid Bus, a number currently constrained by the capacity of 40-foot buses.

Experience in places as diverse as Ottawa, Pittsburgh and Curitiba has also demonstrated that when BRT is implemented as part of a comprehensive urban development strategy, it can have a profound impact on land use.

For example, since the Martin Luther King East Busway in Pittsburgh opened in the mid-eighties, there has been over $US300m in new development in the vicinity of its stations.

This has helped to create more pedestrian and less car-oriented communities.

There is growing interest in BRT Worldwide because it can provide attractive, cost-effective rapid transit at capital and operating/ maintenance costs extremely competitive with other rapid transit modes.

Before making a decision to proceed with any rapid transit investment, a detailed, objective analysis of all reasonable alternatives should be made for the respective application. ❖

Essen Germany and Adelaide Australia, and implementation of electronically guided BRT is under way in Las Vegas, Nevada, Rouen and Clermont-Ferrand, France.

BRT generally has modest implementation costs. Though desirable, it is not necessary to construct a fully dedicated transit way over the entire distance of a busy corridor to guarantee a high level of speed, safety and reliability.

For example, West Busway BRT users in Pittsburgh enjoy a congestion-free ride at all times of day, over the full 20 mile distance between the Airport and downtown Pittsburgh — though only the first approximately 8 miles from downtown Pittsburgh westward are covered by the West or Airport Busway.

I-279 is almost always free flowing over the rest of the distance, meaning that airport passengers and workers have a high speed, reliable ride of up to 20 miles over a corridor with only 8 miles of exclusive rapid transit BRT running way.

Running or transit ways are also invariably cheaper to construct from scratch than rail based modes per unit length because they are simpler. Their construction can be competitively procured from a much larger cadre of local firms than other forms of rapid transit.

BRT also does not require elaborate purpose-built signal or power supply systems, and implementation of BRT rarely means construction of totally new, expensive operating and maintenance yards and depots.

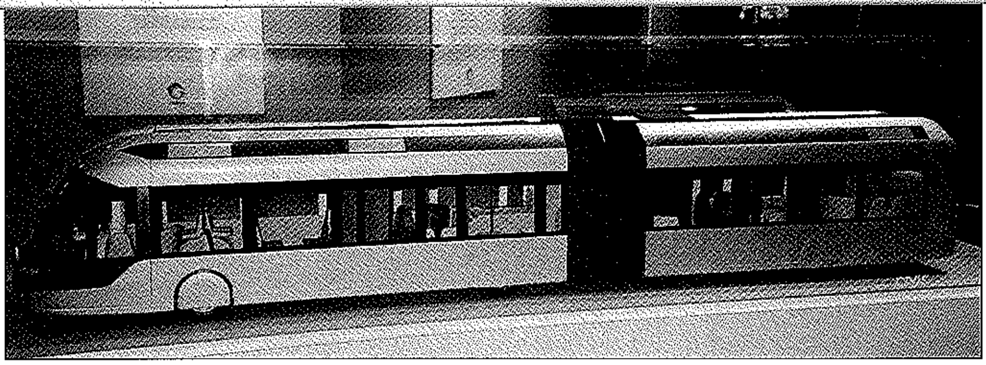
Even sophisticated, electronically guided BRT vehicles can be maintained and stored off-line where convenient, at an existing bus operating and maintenance facility.

BRT vehicles can be conventional, low floor, low noise and low air emissions buses.

With seating and doors configurations optimally suited to the nature of the given market, they can be painted in special livery with special graphics to provide a system identity consistent with the rest of the given line's stations, running ways, etc.

At the other end of the spectrum, manufacturers around the world are producing special rubber tyred, steered or guided rapid transit vehicles.

Irrespective of whether they are conventional buses or purpose built BRT vehicles like Irisbus's Civis vehicles or Bombardier's Rubber Tyred Tram, BRT vehicles are almost always cheaper than other rapid transit vehicles, even adjusted for capacity and service life, for a variety of factors, including component economies of scale, competition, and lower structural strength requirements.


Model of the Civis rubber-wheeled tram for Las Vegas

Only after an application-specific analysis that covers the entire transit system, including rapid transit and feeders, can there be a determination of which comprehensive rapid transit alternative is cheapest to implement.

BRT can be the least expensive rapid transit mode to operate and maintain with the demand levels found in most US corridor applications, the major operating and cost difference between any form of rapid transit and local bus service is operating speed, not the size of the basic service unit.

For example, all things being equal, local buses going 12 miles per hour(mph) in mixed traffic, stopping at every street corner, are one half as productive as BRT vehicles or LRT trains making limited stops on a dedicated transit guideway where they average 24 mph.

The basic unit of capacity for BRT is an individual vehicle of up to 82 feet in length which is smaller than many LRT consists.

This means that the number of BRT consists required to carry a given number of passengers past a point can be higher than with rail rapid transit, all thing being equal; however, BRT line-haul services can be integrated with collection/distribution, meaning that the costs of having separate rapid transit, feeder and circulator services can be eliminated.

Also, the marginal costs of maintenance of way, signal and power for BRT are either non-existent or low. BRT vehicle maintenance costs are also relatively low (even adjusted for capacity), and implementation of BRT usually does not mean staffing a wholly new maintenance and operations base. BRT vehicle operations and maintenance can usually be competitively procured from any number of local transit providers.

Unless transit volumes are high enough so that their savings in vehicle operating personnel (ie, drivers) compared to BRT offsets the higher fixed costs of all forms of maintenance for other types of rapid transit, BRT will have the lowest cost per unit ridership (ie, passenger mile) for operating and maintenance.

BRT has been very successful in attracting new ridership to public transportation.

Increases in ridership attributed to BRT have ranged as high as 100% or more. Implementation of Metro Rapid Bus in LA's Wilshire-Whittier and Ventura Blvd Corridors has not only boosted passenger demand by up to 50 percent, it is estimated that approximately 33 percent of trips are being made by riders totally new to transit.

This performance should not be surprising. In 2001, the Nobel Prize for Economics was won by Dr Daniel McFadden, a professor at the University of California, Berkeley.

He pioneered the use of models originally developed for psychological research into consumer choice mechanisms, in economics, notably travel demand forecasting. During the Bay Area Rapid Transit (BART) System Impact Study, sponsored by the US Department of Transportation (USDOT), Dr McFadden directed two surveys of transit users across San Francisco Bay from the east to downtown.

One was collected before the BART was open, when the Trans-Bay transit system consisted of over-the road coaches operated by Greyhound into the Transbay terminal over the tolled TransBay Bridge.

The other survey was done afterward, when the BART System, then the most advanced heavy rail rapid transit system in the world, began operating. Dr McFadden performed a number of statistical tests to determine whether people valued their time differently when making a choice between driving and transit if the transit choice was rail transit (BART) as opposed to the kind of high quality, high performance bus option that existed pre-BART.

Were they more likely to use transit if the choice was a rail one or was the decision process dominated by time and cost, irrespective of mode?

In his words:

"The hypothesis is accepted that the Coefficients of bus and BART on vehicle times are equal and that the coefficients of bus and BART walk times are equal, bus and BART transfer-wait times are equal ..."

In other words, all things (origin to destination times and costs) being equal, travellers are as likely to use high quality bus (BRT) as they would rail transit for work trips.

In 1990, Dr Moshe Ben Akiva of the Massachusetts Institute of Technology (MIT) did further research on the same subject for the Federal Transit Administration.

After a similar statistical analysis of survey results from Washington, DC that compared decision factors in a Metrorail Corridor (Red Line to Silver Spring) and a quality bus Corridor (I-395 HOV Way), Dr Ben Akiva concluded:

"The findings of this study imply that there is no justification to the introduction of a rail reference bias in a mode choice model which is employed to analyse alternative transit service including both rail and high quality express bus. A bus service with "metro like" attributes should be analysed using the same alternative specific constant used for a comparable rail service."

Again, the essence of the finding is that all things (times and costs) being equal, a traveller is as likely to use public transportation for work instead of driving if the transit choice is high quality bus (eg, BRT) as if it is some from of rail rapid transit.

Dr Ben Akiva found that potential travellers perceived more similarity between a quality bus option and rail transit than between either one and a typical local bus service.

Full featured (ie, high all-day service levels, dedicated running ways, attractive stations with amenities) BRT has also been very successful in acting as a catalyst for positive land use changes. Experience in places as diverse as Ottawa, Pittsburgh, Denver and Curitiba has also demonstrated that when BRT is implemented as part of a comprehensive urban development strategy, it can have a profound impact on land use.

For example, since the Martin Luther King East Busway in Pittsburgh opened in the 1980s, there has been over US $300m invested in new development in the vicinity of its stations. This has helped to create more pedestrian and less car-oriented communities.

BRT has tremendous potential for incremental development, getting rapid transit operating as rapidly as possible with the least amount of funds while preserving options for latter expansion and upgrading. BRT's flexibility gives it a unique ability to be implemented incrementally.

Where a particular application would be in the continuum illustrated in the tables opposite dependent on the parameters of the application environment in terms of:

1) the nature of current and future land use and demographic (population, employment, densities) characteristics;
2) current and expected future transit markets, such as origin to destination patterns, expected rapid transit ridership, both total and maximum load point volumes;
3) right of way (stations and running way) availability and characteristics (eg, width, length, number and types of intersections, traffic volumes and ownership);
4) availability of capital, operating and maintenance funds.

Implementation and Operations Flexibility

A given BRT corridor may be made up of a number of different segments, each with a different running way treatment. For example, one corridor may contain the following segments:

- Dedicated kerb lanes on a one-way downtown street
- Operations in mixed traffic on a free-flowing arterial street leading to the downtown with insufficient room for dedicated lanes;
- Dedicated shoulder lanes on a wide arterial highway
- Fully grade-separated bus lanes in a freeway median with dedicated on/off ramps for buses into a major transit centre-park/rider facility
- A variety of stations may also be used in a given corridor, depending on station boarding and alighting volumes, and demand patterns. For example:
- a major intermodal terminal at the outer extremity of the corridor, incorporating parking, a taxi stand, facilities for transferring from community circulator vans to BRT vehicles;
- a mix of LRT station like "super stops" and transit/transfer centers in the middle of the corridor at a spacing of half to one mile;
- a CBD transit mall with stations every block. ❖

Example: Modest Demand and Cost BRT Application

The shading in the table below illustrates how these features would be packaged in a system for a relatively modest cost BRT application, appropriate in a low to medium demand operating environment. Such a system would likely include mixed types of bus service, super stops, standard vehicle in special livery (paint scheme), a mix of dedicated arterial and highway and mixed traffic running, and standard systems such as radios and on-board fare collection.

SERVICES	STATIONS	VEHICLES	RUNNING WAY	SYSTEMS
Primarily local	Simple stops	No special treatment	Mixed traffic	Radios, on-board fare collection
Mixed limited stop, local	Super stops	Special signage	Dedicated arterial kerb lanes, competing turns allowed	AVL for schedule adherence
All-stop (local), mixed local/ express	On-line, off-line stations, significant parking for transit patrons	Dedicated vehicles, special livery	Dedicated fwy median lanes, merge/weave access/egress	ITS passenger information, fare collection
Point-to-point express	Transfer/ transit centres	Dedicated vehicles, unique spec, (eg, double-artics, hybrid propulsion)	Fully dedicated lanes, exclusive fwy access/egress	ITS vehicle priority
	Inter-modal transfer/ transit centre		Partial grade-separation	
		Mechanical or electronic guidance	Full grade-separation, curbed/ striped/ cabled for guidance	ITS vehicle lateral guidance
		Fully electric propulsion system	Overhead power contact system	ITS automation, electric power system

Example: High Demand, Higher Cost BRT Application

For the BRT application described in the table below to be justified, there would need to be a relatively large market and an operating environment that allowed the highlighted package to be implemented cost-effectively for the size of that market.

At this level of development, a BRT would include mixed local and express services and point-to-point expresses, developed on-line and off-line stations with parking – possibly with transfer centers, uniquely developed rail-like vehicles, fully dedicated right-of-way, and ITS systems for off-board fare collection, passenger information and transit vehicle priority.

SERVICES	STATIONS	VEHICLES	RUNNING WAY	SYSTEMS
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		Mechanical or electronic guidance	Full grade-separation, curbed/ striped/ cabled for guidance	ITS vehicle lateral guidance
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Rapid Transit Architecture

The Design of Rapid Transit Bus Stations – South East Busway, South East Queensland Regional Busway Network

by Derek Trusler FRAIA Bus Station Architect, 3D WORX Australia, Brisbane Australia

RAPID TRANSIT STATION

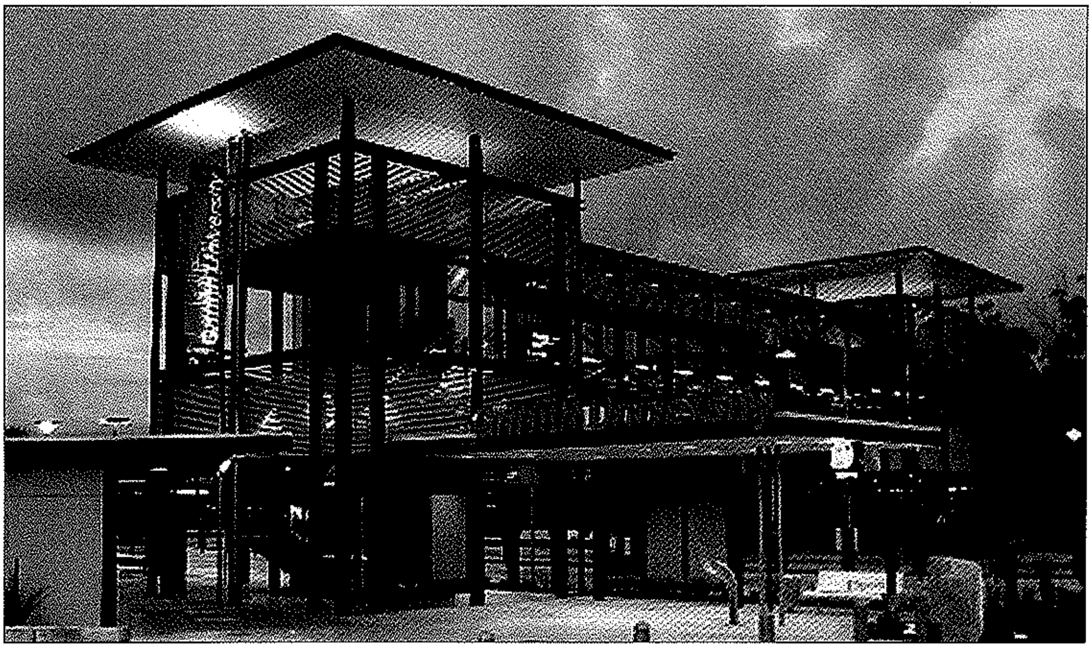
Rapid transit station structures serves to satisfy two broad purposes.

The aesthetic purposes are to:

- Have a striking visual presence.
- Use mass, shape and colour to punctuate location.
- Use a small palette of corporate colours.
- Have a minimum footprint for optimal land usage.
- Be a 'low' impact structure for sensitive urban environments?
- Manage opportunities for retail components, operator and third party advertising.

The functional purposes are to:

- Use durable materials and finishes, which are 'robust'.
- Have standardised elements and components for ease of maintenance.
- Offer wide cover and protection from sunshine and rain.
- Provide covered arrival spaces, pedestrian bridge and platforms for all weather access between platforms.
- Create platform structures, which provide clear visibility to arriving and departing vehicles.
- Use 'white' light for correct colour rendering of station environments at night.
- Conceal and integrate all services into the structures unless services compliment the presentation of the stations.
- Provide bus service information to passengers in the form of dynamic real time displays, scheduled Bus information in the form of timetables and other supporting static displays in the form of maps and diagrams.

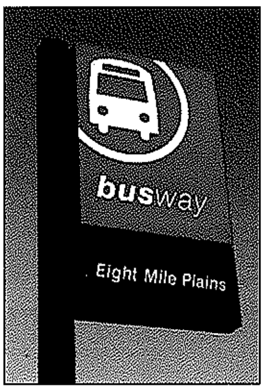


This article briefly discusses the design principles inherent in the architecture of rapid transit stations. It presents a range of fundamental design requirements, for stations to function successfully and achieve the identity of a rapid transit bus service using buses instead of trains.

Background

The South East Busway extends from the Brisbane (Queensland, Australia) Central Business District to the southern suburb of Eight Mile Plains adjacent to the South East Freeway.

The busway offers the commuter a reliable, efficient and comfortable alternative mode of transport to the use of the private motor vehicle.



The design of the rapid transit bus stations are a key component of the new South East Regional Busway Network and provide the visual 'signature' for the bus rapid transit service along the South East Busway.

The bus station is more than a passenger facility. Each station forms a significant part of the landscape and must sit comfortably in the urban context.

Stations can be located along designated busway corridors or as independent structures linked by priority bus lanes.

The built structures and environments of rapid transit stations, having a consistent corporate 'image', offer local, national and international recognition of the bus rapid transit service in Brisbane.

The visual 'signature' provides Queensland Transport, the manager of the facilities and bus services, presence and identity in a competitive market place.

Rapid Transit Bus Stations

The bus station forms the interface between passengers and the rapid transit system. The bus station creates a transport environment and provides the strongest recognisable public symbol of the rapid bus service. The station and its immediate environment form a fundamental part of the acceptability of the service and they establish the relevance of the rapid transit bus service to Brisbane and South East Queensland.

The bus stations on the South East Busway are grade-separated transport facilities with buses using exclusive road pavement unencumbered with people and other vehicles.

Each station provides facilities for passengers to safely access buses arriving and departing from two platforms. The rapid transit vehicle, the bus, 'platoons' into the stations behind another vehicle picking up and setting down passengers.

The bus station allows buses to pass other buses stopped at platforms by using through lanes for express and skip services.

Visual signature matches functional requirements

An important requirement was to establish a high level of aesthetic quality using the functional purposes of each station component. The strong horizontal lines of the station elements, ie roof structures and an emphasis on slender steel detailing and sizes produced sensitive structures and minimised any visual and environmental obstructions on adjacent urban environments.

This is an important principal when a generic design is applied to multiple sites in locations ranging from cultural, commercial, medical, educational, environmental and residential contexts.

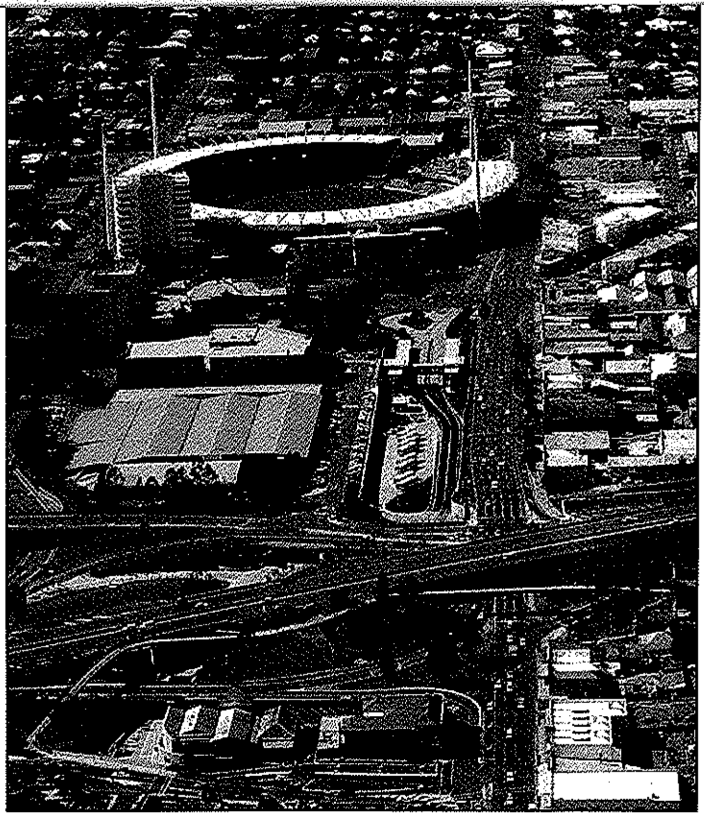
Bus Station Planning

The busway station is an unattended transport facility, open 24hrs per day that must provide convenience, comfort, safety and accessibility for all people.

The station must offer a function, which is efficient, and predictable. Predictable functional design and consistent components enable first time users and the public to gain immediate familiarity with the bus stations located in different urban environments.

Successful rapid transit architecture responds to the demands created by the movement of people and vehicles through open, semi enclosed or fully enclosed space. The movement of people must be simple, logical and in a clearly visible direction.

Cross conflicts caused by moving people across a defined path of travel creates confusion and unpredictability. The station design should establish opportunities for people to make decisions and have choices regarding a specific path of travel to and from a vehicle.



Planning and Design Manual for Busway Stations and Support Facilities

A planning and design *Manual for Busway Stations* was prepared illustrating the Architectural components of a rapid transit station. Its purpose was to achieve consistent presentation of stations irrespective of number or location.

This manual establishes the visual framework for corporate branding, communications and retail components for 'Busway'. It formed the basis for the detail design of generic busway stations.

This manual identifies key planning and design principles important for the design development process of busway stations by a range of professionals in the areas of architecture, structural engineering, electrical engineering, landscape architecture, and graphic design, civil engineering and project management.

Bus Station and Support Facilities – Fundamental Design Criteria

The bus stations are the result of using a set of coherent and consistent design standards for multiple transport facilities, which are functionally and visually similar. Collectively the bus stations create the perception that the rapid bus network is a linked, cohesive and a seamless public transport network.

Bus station architecture is the purposeful meshing of vehicle movements, civil design,

"Each station provides facilities for passengers to safely access buses arriving and departing from two platforms."

PLANNING MANUAL

Illustrates a range of alternative planning and design configurations for Busway Station elements to suit different situations, locations and functions including arrival plazas and platforms.

Illustrates a range of corporate signage components and passenger information displays.

And is used in conjunction with concept planning drawings for stations, a Concept report for the civil interface issues, preliminary civil planning layouts, and the documentation of a generic Busway Station to commence the design development of Busway Stations.

and building design, electrical design, Intelligent Transportation Systems (ITS), graphic design and landscape design.

They are the outcome of careful placement of infrastructure to ensure each station has a relationship with the existing urban context, achieves transparency and openness offering a high level of public safety day and night.

The bus station is part of a hierarchy of passenger facilities and components. The built elements can be scaled up or down, moved and reoriented as the need arises to achieve different design solutions for passenger facilities.

The stations should present a confident design using a framework of structure and contemporary symbols to identify a facility providing a reliable rapid transit bus service.

The stations should be a transparent structure using steel and glass signaling assured visibility and security.

The built elements of rapid transit bus stations are split into two categories, Macro elements and Microelements.

1. Macro Elements include:

An entry plaza, an arrival structure, ie lift and stair, a primary entry awning for passenger information displays, platform structures for the protection of passengers waiting for bus services, covered pedestrian bridge, corporate signature colours, station identification signage, passenger information displays in entry plaza and on platforms, lighting image and landscaping elements.

2. Micro Elements include:

Ticketing machines, public telephones, passenger seating, rubbish bins, drinking fountains, vending machines, retail kiosks, driver amenity facilities, public toilets, security systems, operator advertising, information maps, third party advertising, art and sculpture.

Metal building products have been used for the station superstructure including platforms, stairs, lift cars pedestrian bridge, awnings, street furniture, median barrier fencing, post-top lighting, ancillary pedestrian fences, balustrade and handrails.

"Lighting should be glare free, create a feeling of safety... be vandal, graffiti and weather resistant ..."

Role of lighting

The role of lighting bus stations and the station environment must achieve the following criteria to be successful.

Lighting should be glare free, create a feeling of safety, enhance the transparency of the building structures, be vandal, graffiti and weather resistant, render colour correctly and accurately, have long life, be easily maintainable and accessible, create a night image that complements the function of the space and have minimal impact on the architecture.

Information Technology Systems at Rapid Transit Stations

Real time information for bus arrivals and departures at stations is a fundamental component of advising passengers of the function and operation of a rapid transit bus service. Passengers need a range of information to understand which bus service best meets their transport requirements. Basically the passenger needs to know route, destination and time to departure of the intended bus, and the order of arriving vehicles stopping at a platform. The placement of this information must establish a direct relationship between the arriving vehicle, passenger waiting zones, and passengers on the platform. All components should be visible to the passenger facing the direction of the arriving vehicle. This enables the passenger to easily confirm which service to board and where a bus is likely to stop along the platform.

ITS components should be provided at entry locations to advise of the current bus activity at the station and on each platform identifying the current and impending activity of buses at each platform. Clocks forming a part of the real time information display or as stand alone components are also required at entry points and on platforms. These should be synchronised to the real time information displays.

Conclusion

The architecture of rapid transit bus stations establishes a vision for the creation and development of a public transport network called 'Busway'.

They offer the commuter an attractive alternative to the use of private motor vehicles and enable a bus operator to tailor a range of services and vehicle types to suit demand for public transport using buses. The rapid transit stations provide a visual signature, identity and relevance of a new public transport service called Bus Rapid Transit in the community of South East Queensland. ❖

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3D Worx Australia, Bligh Tanner, Barry Webb and Associates (1997), "Concept Design Report Busway Stations."

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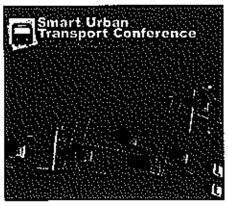

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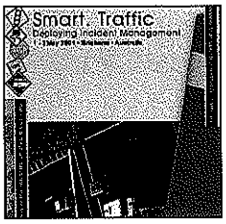

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Green Buses on Schedule

By Peter Anyon, Program Director, Parsons Australia

Buses are the mainstay of the public transport system in most cities typically carrying the majority of all trips made by public transport even where rail, and Light Rail Transit (LRT) schemes exist.

However, the exhaust from the diesel engines powering buses has become an important and controversial environmental issue. The problem is compounded as buses are intensively-used vehicles and traverse the streets of major activity areas where their passengers and other people are.

Despite major improvements to engine design in recent years, diesel engines contribute a substantial portion of the following emissions from mobile sources: Nitrogen Oxides (NO_x), Particulate Matter (PM), Carbon Dioxide (CO_2), sulphur emissions (virtually all) and to a lesser extent Carbon Monoxide (CO) and Hydrocarbons (HC). Diesel exhaust contains over 40 substances that are regarded as toxic and some 15 which are regarded as carcinogenic.

Almost all of the diesel particulate mass is in the fine particle range of 10 microns or less in diameter (PM_{10}). Diesel exhaust, particularly PM_{10} and finer particles, has numerous adverse short and long-term impacts on humans.

"... driving in congested traffic generates an enormous fuel consumption (and hence greenhouse gas) penalty, and has an even more drastic effect on emissions of fine particulate matter."

Big cities have large bus fleets and usually experience serious traffic congestion. It is well known that bus operation at low speeds in "stop start" conditions greatly exacerbates emissions.

This point is illustrated by the results of some recent projects to investigate diesel vehicle emissions undertaken by Parsons Australia (Anyon et al 2000) on behalf of the National Environment Protection Council (NEPC) Australia. All testing was conducted at Parsons' heavy-duty vehicle emissions laboratory in Sydney.

Test Protocols

A suite of "Real-World" transient drive cycles was developed by the New South Wales Environmental Protection Agency (NSW EPA) under a separate contract to NEPC.

These drive cycles — the "Composite Urban Emissions Drive Cycles" (CUEDC), were synthesised from extensive data generated by instrumented vehicles in the Sydney metropolitan region. They accurately simulate the aggressive driving patterns and speeds typically experienced in Australia's larger cities.

Table 1 – Comparison of Exhaust Emissions and Fuel Consumption in different urban driving conditions

	Exhaust Emissions (g/km) and Fuel Consumption l/100km)				
	Constant 50 km/h	Constant 80 km/h	Congested Flow	Minor Roads	Arterial Roads Roads
CO_2	865	964	1541	997	1080
NOx	8.78	12.16	13.37	9.89	11.18
PM_{10}	0.241	0.344	1.051	0.770	0.545
F.C.	32.69	36.43	58.24	37.47	40.63

Note that the data tabulated in Table 1 are the results from a single, but representative, vehicle. Although fuel consumption, and hence CO_2 emissions are generally quite predictable for any given vehicle mass or type, other pollutants can vary considerably, depending on the age, condition and emission control technologies associated with individual vehicles.

Table 2 – Comparison of Exhaust Emissions and Fuel Consumption for alternative 10km Urban Journeys

Journey Type	CO_2 (grams)	NOx (grams)	PM_{10} (grams)	Fuel (litres)	Time (mins)
7km Arterial, 3km Congested	12.183	118.4	6.97	4.59	35.08
10km on 80km/h Busway	8.650	121.6	3.44	3.64	7.50
Ratio	**1.41**	**0.97**	**2.03**	**1.53**	**4.68**

The speed/time trace for the CUEDC applicable to Australian Design Rule category NC vehicles (12.0 to 25.0 tonnes Gross Vehicle Mass) is reproduced in Figure 1.

The Congested segment is characterised by low speeds, frequent rapid accelerations and braking patterns punctuated by short periods at idle. Minor road driving is mostly below 60km/h, with only infrequent periods at rest, indicating more free-flowing traffic, roundabouts and turns into lightly trafficked intersections.

Arterial driving has rapid accelerations to higher speeds, interspersed with more extended periods at rest (at traffic signals). Highway driving is at higher speeds, with few interruptions and more extended periods of cruise.

The data presented in the following table are measured emission rates (in grams/kilometre travelled) for CO_2, NOx and PM_{10}, plus fuel consumption (l/100km) for a typical 1994 model year diesel vehicle, with a test mass of 16 tonnes. (One of the 80 vehicles tested by Parsons in the first of their vehicle test programs.)

It is immediately apparent from the above table that driving in congested traffic generates an enormous fuel consumption (and hence greenhouse gas) penalty, and has an even more drastic effect on emissions of fine particulate matter (PM_{10}).

What would be the impact of operating the same vehicle on a busway ie with the bulk of the congestion removed?

Comparing a typical commuting journey of 10km, 7km in arterial flow and 3km in congested conditions with a journey of the same length at 80km/h on a dedicated busway, the differences in fuel usage and exhaust emissions are quite stark.

Thus it can be seen that, for a typical Australian specification vehicle, very significant environmental and economic advantages flow from a constant operating speed regime, such as on a busway.

But development of busways will not always be possible. And buses operating on a busway should be as clean as possible. Unless the vehicles operating on the busway are inherently low emitters, the air quality benefits could be far from optimal.

For the vehicles themselves to be clean, three simple, interdependent criteria need to be satisfied:

(a) Vehicles should have low emission levels when new (certification standards)
(b) They should remain low emitters throughout their operating lives (good maintenance)
(c) They should operate on the cleanest, economically viable fuels.

New Vehicle Standards

Until 1995, in Australia there were effectively no controls on emissions from diesel powered vehicles, and at that time diesel fuel was almost universally used in route buses.

Over the phase-in period 1995-97, Australian Design Rule 70/00 (ADR 70) required that all new diesel vehicles met the Euro1 regulations (or the nearest Japanese or US equivalent).

Government policy decisions taken in 1999 will lead to the rapid uptake of increasingly stringent standards for all heavy-duty vehicle engines, again based on the Euro series of regulations.

Figure 1 – Speed-Time Trace for Typical Composite Urban Emissions Drive Cycle (CUEDC)

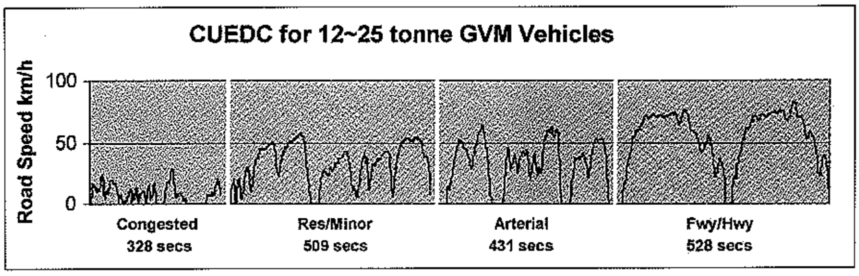


Figure 2 – Euro Series Emission Limits for Oxides of Nitrogen (NOx)

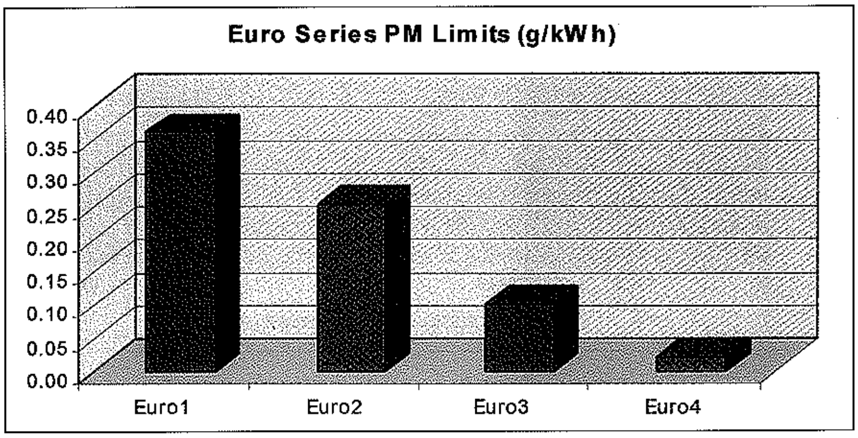
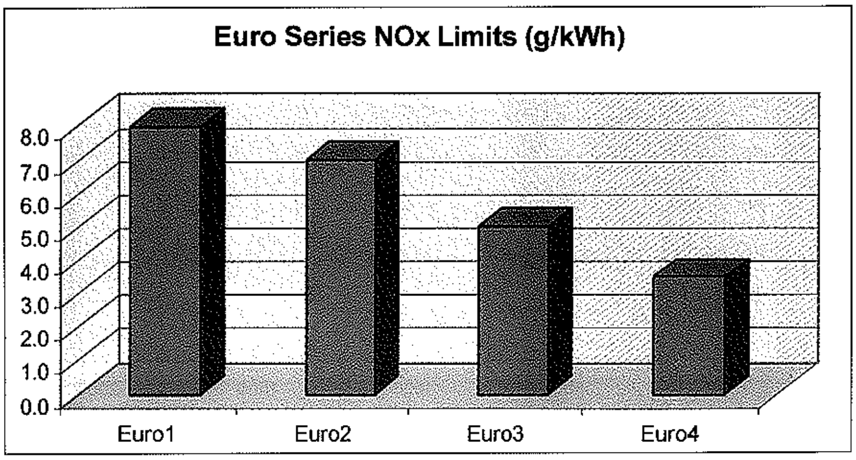


Figure 3 – Euro Series Emission Limits for Particulates (PM)



Figures 2 and 3 illustrate the huge emission reductions that will flow from the introduction of the new standards — currently targeted at Euro4 levels by 2006.

Emissions of NOx from diesel engines (one of the two key ingredients of photochemical smog) are quite intractable, so the reductions illustrated in Figure 3 present a major challenge to engine development. Proposed future standards for the USA go even further.

Fine particulate matter in diesel exhaust is a direct threat to human health and is a carcinogen.

To meet the Euro1 and Euro2 standards, virtually all diesel engines require turbochargers, direct fuel injection and computerised engine management systems.

Euro3 and Euro4 engines will almost certainly need catalysts and/or particulate traps in addition, which in turn require very low sulphur fuel (less than 50ppm sulphur compared with the 1200ppm typical of today's fuels).

Figure 4 – Correlation Between SAE J1667 Free Acceleration Opacity Test and Typical On-Road Emissions of Fine Particulates (PM)

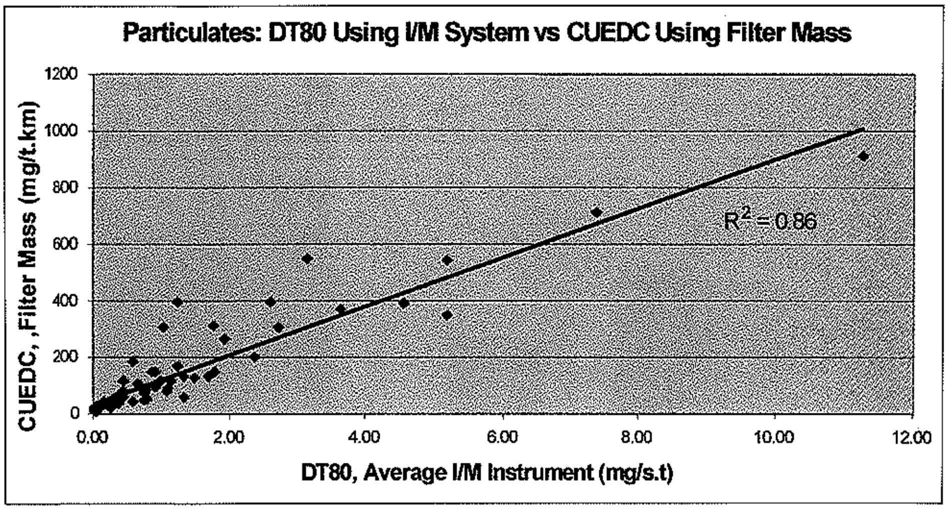
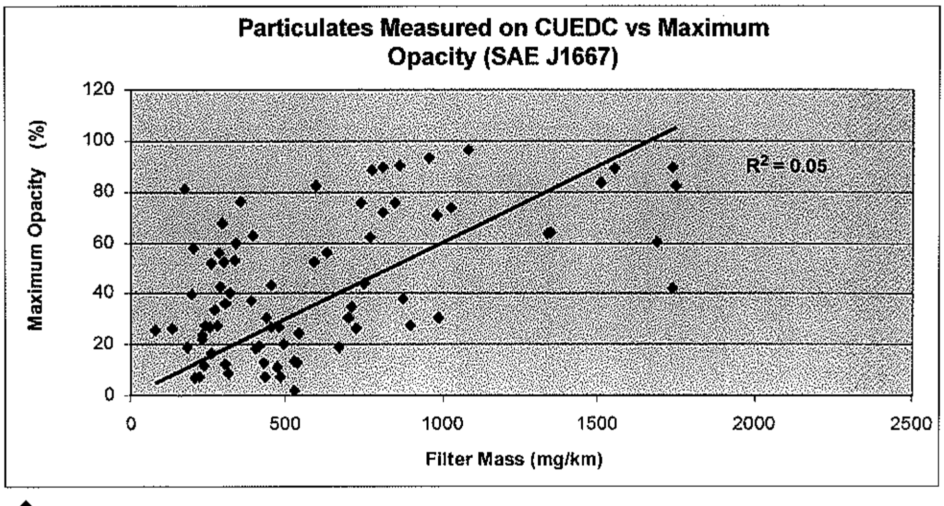


Figure 5 – Correlation Between DT80 Short Transient dynamometer Test and Typical On-Road Emissions of Fine Particulates (PM)



Keeping Them Clean

While new vehicle standards have been very effective in containing emissions from motor vehicles, reliance on this measure alone would result in outcomes falling a long way short of what can be realistically achieved through a more integrated "whole of life" approach.

To fully realise the benefits of tighter new vehicle standards, there must be some way of ensuring that emissions control systems remain effective throughout each vehicle's operating life.

Research in Australia by the Federal Office of Road Safety (Anyon et al 1995) has shown that deterioration, abuse and tampering over the life of a light-duty petrol vehicle can result in emissions being many times higher than typical new vehicles. Parsons is currently engaged on a similar project to characterise the deterioration of diesel vehicles over their working life (Anyon et al 2001).

Fortunately, recent developments in vehicle emission testing technology have dramatically reduced the cost of routinely and effectively testing in-use vehicles to "weed out" the high polluters that are responsible for a disproportionate amount of pollution.

In-service emission reduction programs (frequently referred to as Inspection and Maintenance programs) can play vital role in reducing overall pollution from motor vehicles. It is also very important that these programs are designed and operated in a way that delivers the best outcome.

For diesel engines, it has been clearly shown that testing the vehicle under load on a "rolling road" dynamometer, which simulates actual driving conditions, is the only way to reliably evaluate in-use emission levels. Idle or "free acceleration" tests, while very convenient and inexpensive, are virtually useless for evaluating the diesel emissions of greatest concern — fine particulate matter (PM and oxides of nitrogen or NOx).

Figures 4 and 5 illustrate the correlations of a "free acceleration" smoke opacity test (SAE J1667) and a short, transient dynamometer test (DT80) with the reference "real-world" composite urban emissions drive cycle (CUEDC).

Figures 4 and 5 clearly illustrate the vastly superior discrimination and effectiveness of a simple, transient dynamometer test, compared with the free acceleration smoke opacity check. The opacity check provides virtually no reliable indication of fine particulate emissions.

Until recently, it would have been out of the question to consider routine dynamometer testing of in use vehicles, because of prohibitive equipment costs. This situation is now rapidly changing and cost-effective equipment is now becoming available for this work.

Retro-Fitting Exhaust After-Treatment Systems

Recent developments in exhaust after-treatment systems have made it possible to substantially reduce particulate emissions from existing diesel engines. The two most common technologies are:

- diesel oxidation catalysts, and
- particulate traps (filters)

Oxidation catalysts are most effective in reducing visible smoke and particulate levels, and also substantially reduce hydrocarbon and carbon monoxide (though diesel engines are not a major source of the latter two compounds).

Conveniently, oxidation catalysts can be packaged together with a muffler, in a canister the same physical size as the vehicle's existing muffler. This makes installation quick and economical.

Typical particulate reductions are in the order of 25-40 percent, and their durability in normal service is claimed to be several hundred thousand kilometres. To work effectively, low sulphur fuel (less than 500 parts per million, ppm) is required.

Particulate traps filter the fine particulate matter from diesel exhaust, using ceramic, fibre or metallic filter media. For vehicle use, these devices are increasingly combined with catalysts that incinerate the accumulated particulate matter when exhaust temperatures exceed the "light-off" temperature of the catalyst coating — typically around 280°C. Some older units utilise electric heating, on a periodic basis, to burn off the accumulated particulates.

The latter type of trap, commonly referred to as continuously regenerating traps (CRTs) require much lower sulphur content fuel, typically not exceeding 50ppm and preferably below 30ppm. These devices are extremely efficient and can remove in excess of 95 percent of all exhaust particulate matter. They also are typically packaged as a direct muffler replacement.

Unfortunately, neither of the above after-treatment systems have any effect on reducing diesel engines' high emission levels of oxides of nitrogen (NOx) — one of the two principal ingredients of photochemical smog. To convert NOx into harmless nitrogen, carbon dioxide and water requires a reducing atmosphere — quite the opposite of a diesel engine's oxygen-rich exhaust stream.

Selective catalytic reduction (SCR) systems for reducing NOx levels in diesel exhaust are just starting to become commercially available. These systems typically utilise chemical coatings in a catalyst monolith to store NOx during normal engine operation.

Periodically, a reducing atmosphere is created by injecting excess fuel or urea solution into the exhaust, upstream of the SCR unit. During these brief periods, the stored NOx is reduced and converted. This process is repeated cyclically.

SCR can be installed as an Original Equipment (OE) system and integrated with computerised engine management controls, or retro-fitted with a separate controller and on-board tank for the reductant (unless diesel fuel is used as the reductant). They can be combined with oxidising catalysts and/or particulate traps to control all of the pollutants of concern from diesel vehicles. Typical NOx reduction efficiency is 30-40 percent and, again, fuel with less than 50ppm sulphur is required.

The benefits of retrofitting exhaust after

"... very low sulphur fuel enables the use of highly effective exhaust after-treatment technologies, such as continuously regenerating particulate traps and selective catalytic reduction systems."

treatment systems can be factored on top of the benefits deriving from improved repair and maintenance initiated by an inspection and maintenance (I/M) program. For example, a 20 percent I/M improvement in particulate reductions could be factored by an additional 33 percent from an oxidation catalyst. Hence the overall PM emissions can be reduced by: (1-(0.8 x 0.67)) x 100 percent = 46.4 percent PM reduction.

To maximise the effectiveness of this "doubling up" approach, I/M cut points would have to be set carefully to ensure that the existence of the catalyst is not regarded as a substitute for effective maintenance and repair practices.

Fuel Issues

Most buses in Australia are diesel powered. Diesel engines are economical, rugged and reliable, so they continue to be widely used, although compressed natural gas (CNG) is rapidly making inroads and LPG, when properly commercialised for heavy vehicle use, has potential to match CNG.

Much discussion has taken place on the need to reduce sulphur levels in diesel fuel, as well as improving other characteristics of the fuel to minimise emission levels. Although there is certainly a trend towards lower particulate emissions from lower sulphur fuels, reducing fuel sulphur levels for this reason alone is only part of the story.

As we have seen above, very low sulphur fuel enables the use of highly effective exhaust after-treatment technologies, such as continuously regenerating particulate traps and selective catalytic reduction systems.

In fact, some engine manufacturers are now planning to deliberately increase engine-out emission levels and rely on after-treatment technologies to clean up the exhaust in order to meet regulated emission levels. They argue that only in this way can they avoid significant fuel consumption penalties in future engines designed to meet ever more stringent emission regulations.

From an urban air quality perspective, compressed natural gas (CNG) and liquefied petroleum gas (LPG) have very similar credentials. As very simple chemical compounds they burn very cleanly and have inherent emission levels of fine particulate matter and other dangerous air toxics that are typically an order of magnitude lower than diesel.

Because of its lower carbon to hydrogen ratio, CNG has potentially lower greenhouse gas emission levels than LPG. However, unless carefully controlled, high levels of methane in the exhaust can offset this advantage.

This latter point is often overlooked in consideration of CNG as a greenhouse-friendly fuel, particularly in the case of non-OE conversions where other engine characteristics may not be optimised for operation on gaseous fuels. Indeed, until direct injection systems become available for gaseous-fuelled heavy-duty engines, there is little likelihood of either fuel realising its full potential in automotive applications.

From a practical standpoint, CNG and LPG are very different. In most countries there is virtually no commercial infrastructure for the sale of CNG, so its use is mostly confined to large urban fleets that can sustain the cost of establishing their own refuelling depot(s). In addition, for a given operating range, the size and weight of CNG tanks are typically around three times that of LPG. This can result in reduced passenger space and/or revenue-generating payload.

Unfortunately, however, the engine manufacturers and conversion equipment suppliers have so far failed to successfully promote LPG as a viable alternative to CNG and it therefore remains very much on the margin. This situation may change in time.

Report card

From all the above, there is a smorgasbord of options available to enhance the environmental credentials of urban bus operations. Fortunately, all are complementary and most are additive — the more you adopt, the bigger the environmental and economic gain. Moreover, they can be applied in two ways:

- to ensure that future bus purchases deliver the best outcomes, and
- to get the most out of existing fleets.

Careful consideration of the current bus fleet make-up and realistic planning for the future should encompass:

- optimal new vehicle purchasing decisions
- retro-fitting the most cost-effective exhaust after-treatment technologies
- realistic assessment of fuel choices (not necessarily driven by fashion)
- implementation of targeted and measurable maintenance practices.

These strategies, if linked to the inherent economic, social and environmental benefits of a well-designed busway system can very easily lead to a 35 percent reduction in fuel use and at least a ten-fold reduction in harmful particulate and air toxic emissions from the urban bus fleet. ❖

For details on breakthrough technology on emissions measurement, see page 27.

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Latest Developments in Public Transport Passenger Information Systems in Australia and New Zealand

By David Panter, JRC Consulting Pty Ltd, Brisbane Australia

The delivery of passenger information is rapidly gaining acceptance as a mechanism to increase the visibility of bus services and to encourage patronage. An embryonic technology five years ago, there has since been rapid growth in the number of systems available.

These systems are now more accurate, have greater reach and are more widely accepted than at any time in the past. Despite this there is a strong feeling that we are only at the beginning of a journey into real time information and that the best is yet to come.

Concentrating on passenger information systems as implemented in Australia and New Zealand, the focus is on what is on the street rather than on concepts and plans.

In order to put the application of passenger information systems into context it is worthwhile reviewing the different funding mechanisms underlying public transport in the region. In general there are three models that seem to apply in funding.

The primary differences are not in what gets implemented but in who pays for the implementation and how soon a system gets implemented.

Who Pays for What?

Metropolitan governments, local governments and operators all provide funding for various initiatives. Generally though, metropolitan government is the only body that operates across an entire city and across multiple private operators.

A consequence of this is that almost all of the funding that involves infrastructure comes either directly or indirectly from the government.

There is no national policy in either New Zealand or Australia on moving towards a public transport emphasis. As a result each state and each capital city must go it alone. This has the effect of maximising competition and providing a fertile ground for innovation.

It also means that a lot of work is duplicated and there is little scope for reductions in costs due to standardisation or improvements in scale.

Much of the duplication in research and planning is slowing down the overall delivery of real time information to the public.

New Zealand authorities operate with a strong emphasis on commercial operations. The government's role is seen as setting overall transport objectives in accordance with the community good.

It delivers a framework for the private initiatives to work within and meeting community service obligations by contracting services where it is not profitable for private operators to operate a service.

Passenger information systems fit into the framework for delivery of the overall transport objectives.

There is broad agreement amongst the Regional and City Councils in New Zealand that a shift in travel patterns away from private vehicles towards public transport is required. There is however, some debate on whether bus priority measures, passenger information or both are the way to achieve this.

Auckland Regional and City Councils and Stagecoach bus lines decided to utilise both priority and passenger information in concert and worked together to deliver a holistic approach to this issue along two corridors. The Regional Council paid for the on bus equipment, the City Council created priority bus lanes and implemented traffic signal intervention and the bus operator delivered new, low floor buses and revised services.

The results were significant reductions in travel times with variability in travel times reduced by half. Patronage increases were 16-30 percent over the first two years compared with an average patronage increase for the city of just over four percent. Auckland's other local governments or councils are now looking at extending this concept to the rest of the city.

In the rest of the country similar funding models apply with Christchurch currently implementing a passenger information system and Wellington recently calling for tenders for a real time information system.

It is interesting to note that while the funding comes from each Regional Council, they are not allowed to own any infrastructure and so

> **"These systems are now more accurate, have greater reach and are more widely accepted than at any time in the past."**

WEB LINKS

For more information see the following web links:

http://www.stagecoach.co.nz/timetables/routeframeA.html

for an example of a system sponsored by both Stagecoach NZ (the operator) and the Auckland Regional Council (purchasing authority); and

http://www.transperth.wa.gov.au/framesets/mf_journey.htm

for an example of a system sponsored by Transport West Australia.

Similar systems also exists in **Brisbane** at

http://www.transinfo.qld.gov.au/iptisnet/Timetables.htm

Sydney at

http://www.131500.com.au

and **Melbourne** at

http://www.victrip.com.au

must work with the city councils and operators to ensure that the service levels they set are maintained.

In a recent tender put out by Wellington Regional Council the equipment was to be owned by the supplier of the system and the Regional Council would only pay for the supply of information to passengers.

In Australia each state has a number of government bodies responsible for various aspects of the provision of passenger information systems. In addition to local councils, New South Wales have the Department of Transport, State Transit Authority (STA), Roads and Traffic Authority (RTA) and State Rail.

Similarly, Queensland have Queensland Transport, Main Roads, Queensland Rail, Brisbane City Council and the other local governments.

The metropolitan scope of the Brisbane City Council means it is able to develop and deliver services within the City of Brisbane that are beyond the scope of most other local governments.

Outside of Brisbane the rest of the State is managed in a similar way to that of the other states with the State government delivering the infrastructure and private operators delivering the services.

Passenger information is provided by the operators with some assistance from the State.

Types of Information Available

Passenger information can be delivered using a broad range of media. Many of these media are traditional but technology is significantly widening the options available to the public. Austin (2000) gives a very good run down on the types of information available in the United Kingdom and local developments are not too different. A quick summary of these options allows us to place the newer system in context.

Printed Paper Booklets and Timetable Leaflets

These are used extensively by all operators. In some cities such as Auckland they are consolidated for a route so that the customer is presented with a single timetable for a route regardless of the operator that is running a single service. The information contains expected arrival times at every stop (Brisbane) or just key timing points (Melbourne).

At Stop Printed Arrival Times

Information displayed at stops would appear to vary depending on the type of stop and the philosophy of the controlling body.

Generally if a stop hierarchy were in place only high level stops would be considered for the display of information.

The information varies from the display of the printed leaflet to specific stop based information generated either directly from the scheduling system or manually assembled and printed for a small range of stops (eg, Wellington Central Business District).

Online Timetables and Trip Planning

There are large numbers of web based timetable displays throughout the region with most capital cities having on-line systems. In general these are complemented by a trip planning system such as Australian firm OPCOM's IPTUS system.

The data is often provided by the operators and either published directly or through cooperation between the Transport funding authority and the operators.

Technologies

LED

The dominant display technology has been LED displays delivering high visibility in red or amber. Most existing systems use individual lines for the display. This helps keep the cost of these systems down, however recent tenders for passenger information displays for Brisbane's South East Busway called for signs capable of full graphical displays.

LCD

While LCD signs represent about half of the installed display base in Europe they have not been utilised to any great extent in Australia. A stable and proven technology, passive LCD displays are now being offered as alternatives on some real time systems.

A new development can be seen in flat panel LCD displays offering multi-line and full screen capability with a touch screen interface. The first examples of these screens are now appearing on the streets of Melbourne as the SmartGuide system.

Plasma

The cost of plasma displays is limiting their wide application in public transport and the author is not aware of any systems that use these displays to convey public transport passenger information.

Flip Dot

Flip dot display systems have seen wide application for use as route destination indicators on the front of buses and for conveying information to drivers.

However the large minimum pixel size has tended to preclude their use for most passenger information display systems.

Information Displayed

Almost all systems display the route, destination and time that the bus is due (either as an absolute time or as a countdown in minutes).

The information is presented as text and little use has been made of graphics, perhaps more as a result of the available displays rather than through lack of desire.

Typically train systems use graphics and make extensive use of colour and this may well be the path that bus systems will use in the future.

Significantly more work has been done on this area in Europe, with the report of the CODE task force into introducing Real-Time information at bus stops providing some insights.

For more information see **http://www.cordis.lu/telematics/tap_transport/library/code_real_time_info.html**

Next Stop Information On Vehicles

It is now common for train systems to using GPS and/or track circuits to identify the location of the train and then display next stop information on an LED display in each carriage. Many operators are implementing this type of passenger information display on all of their rolling stock.

Buses are somewhat further behind. In part this is because the detection technology has only just become of age but also because the cost per passenger carried is much higher and presents a more difficult business case.

Where information on the next stop is displayed it is on high capacity inner city circle routes such as installed on the Perth CAT service and planned for the Auckland LINK services.

Intermodal Information

Gradually there is a move to deliver inter-modal information on the displays at stops. This can be seen in the SMART BUS system in Melbourne where the signs must also display information on trains obtained from the PRIDE system.

While there is a large scope for displaying information at stops and stations the efforts made to date have centred around displaying the information from different systems on the one display. The issues of improving the interconnections between services and delivering information that can assist passengers with trip planning have not been addressed.

This functionality is left to the on-line trip planning applications supported by call centres and kiosks.

Kiosks

Many cities have some form of kiosk that enables trip planning and viewing of timetables. These do not reflect real time running of the vehicles.

Mobile Applications

There are not known to be any Wireless Application Protocol (WAP) capable applications delivering real time information in the region although some suppliers claim that they are developing this capability.

Due to the personalised capability of this delivery mechanism, it can be expected that this type of application will be in much demand in the next five years. We should see a number of WAP capable system rolled out within the next two years.

Installed Systems

Perth, Western Australia

The highly successful CAT services operating within the Perth central area utilises GPS to track vehicles. It then displays arrival times in minutes at the dedicated CAT stops using a seven segment countdown display. This system is restricted to CAT services only.

> "... the early days of public transport information experimentation are nearly over. The availability of technology and wider acceptance of the use of this technology to deliver information, is bringing this concept into the main stream."

Sydney, New South Wales

Real time information was running for some years on the city to airport route using the ANTTS system embedded in the well known SCATS traffic control system. While the vehicles are still being tracked this system is no longer displaying passenger information. A wider trial using 10 VMS and 250 buses is currently delivering passenger information in Sydney's northern beaches using PTIPS. A number of major projects will be looking at real time information in the next couple of years.

Christchurch, New Zealand

The Christchurch real time passenger information system was locally developed by Connexionz, a New Zealand firm, and delivers arrival information to passengers at the central bus exchange via seven line LED displays located within the exchange and in nearby shop windows. Although suffering initial teething problems the system is now delivering accurate information for most buses using the station.

Brisbane, Queensland

The RAPID system continues to deliver real time information on over 700 buses within the city of Brisbane. Information is displayed on around 100 displays located at key stops in major corridors. The system also delivers real time priority at signalised intersections. Recently RAPID was upgraded to support GPS based detection of vehicles, as well as substantial improvements in the management of data and delivery of information via a web browser.

Auckland, New Zealand

At the time of writing Auckland had installed the RAPID system on two corridors and have now gone to tender to deliver real time information to the rest of the city.

Melbourne, Victoria

The Smartbus project in Melbourne was developed by Tyco and uses GPS and ferrite tags imbedded in the road surface to track the vehicles. Priority and passenger information are then delivered to 10 Passenger Information Displays (PID) and 20 intersections along the two cross town corridors.

Transfield have developed a predictive system for Yarra trams. This utilises location data from the ageing AVM system and presents predictions on a number of LED signs within the CBD.

Pixeltech developed their SmartGuide system for tracking Swanston Trams. Real-time information is derived from the existing AVM system and is currently being delivered at six locations in the CBD.

Trains

Most train networks in Australia and New Zealand now have electronic displays on train departures and most of these systems update the information in real time. Typically these systems include entry concourse presentations as well as platform specific departure information.

Funding for these systems generally is by the operators. One such system is the PRIDE system running in Melbourne and the PIDS system developed by Q-Rail and running in Brisbane. Passenger information display systems also operate in Perth, Wellington and throughout the NSW rail network.

Studies

Funding authorities have undertaken a number of studies to define the best method and presentation format for meeting the needs of passengers waiting at stops.

The Queensland Transport "Real-Time Passenger Information — General guidelines for real time passenger information content and display" is one such document.

However, while outlining what is required there is no direct connection with the capabilities of the existing systems to derive and then display the needed information.

In a similar vein there have been developments in ITS and Real-Time Passenger Information System (RTPIS) architectures with a view to sharing data and standardising on a delivery framework.

To date none of these architectures have come to much and more work is required before any system reaches a critical mass and gains wide acceptance.

The Future

It is clear that the early days of public transport information experimentation are nearly over. The availability of technology and wider acceptance of the use of this technology to deliver information, is bringing this concept into the main stream of public transport initiatives.

In spite of the various funding arrangements, most governments are looking at real time passenger information, trip planning and technology as a part of their solution and are working with bus operators to deliver these solutions.

New communication delivery mechanisms will be adopted at a faster rate and web based interfaces will become even more prevalent.

A number of capable suppliers have emerged and are competing to deliver systems in most capital cities. Some rationalisation of these suppliers could be expected in the next five years as critical mass implementations are made and this in turn will help resolve architectures and standards for equipment and data sharing.

In short we are moving into an interesting time with passenger information delivery and the real winner will be the passenger. ❖

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A Webb, Queensland Transport.

Bangkok Mass Rapid Transit

By Philip Sayeg Director, Policy Appraisal Services and Transport Roundtable Australasia – Brisbane, Australia

Mass Rapid Transit (MRT) has been recommended as part of a suitable transportation system for Bangkok since 1975. Bangkok's first MRT, the Bangkok Transit System (BTS) system, was officially opened on December 5, 1999 as part of Thailand's King Bhumibol Adulyadej's 72nd birthday celebrations.

Reportedly having cost US $1.3 billion, BTS consists of two elevated MRT lines totalling 23.5km, has 23 stations and traverses some of Bangkok's busiest streets and activity centres.

The project was promulgated by the Bangkok Metropolitan Administration (BMA) in the early 1990s. In 1992, BMA signed a contract with the Bangkok Transit Systems Corporation (BTSC) to deliver the project as a Build Transfer Operate scheme in 1992. The infrastructure has now been transferred to BMA while BTSC will operate the system for the balance of its 30 year concession.

Two other MRT schemes are presently under construction. The second system is the 20km underground Blue Line system which is being constructed by the Mass Rapid Transit Authority (MRTA). The system will open in 2003.

Negotiations for the supply of rollingstock and operation of the system were completed during early 2000.

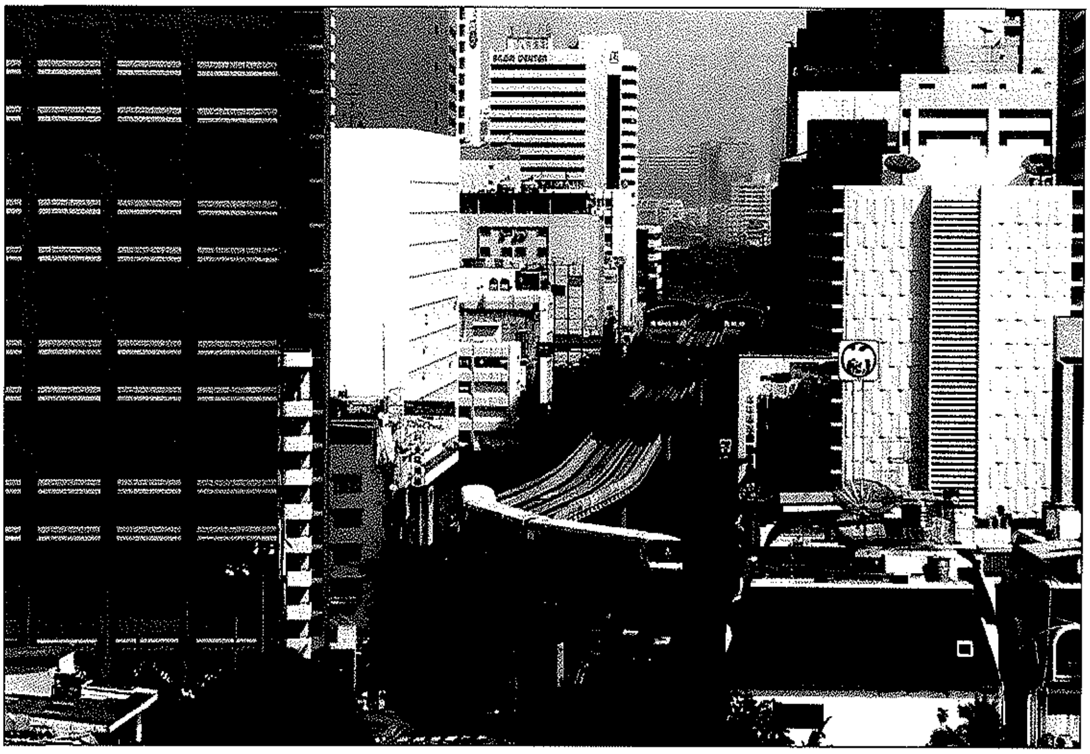
The third system is the failed elevated rail and expressway system promoted by Hopewell of Hong Kong. While the project was probably overly ambitious (it included elevated expressways above the railway infrastructure) it had excellent alignments through making use of the main long distance rail rights of way which pass centrally through much of Bangkok. There are attempts to revive the project although it is highly unlikely to be operating within the next decade.

These three systems potentially form a logical backbone network on which to extend the MRT network in future.

BTS — now popularly known as Skytrain — has been operating successfully now for 22 months. The quality of its rollingstock provided by Siemens of Germany, cleanliness of stations and reliability of operations are all first rate.

It is a heavy rail system with a peak capacity of some 45,000 passengers per hour per direction (pphd). BTS presently operates 27 three-car, 800 passenger capacity trains.

They can be operated in the future as six



WEB LINKS ASIA-PACIFIC MRTS

HONG KONG

Hong Kong Mass Transit System Corporation

Since operations began in 1979, the MTR Railway has become one of the most important elements of Hong Kong's transportation network. With effective and efficient management in planning, design, operations, maintenance and continuous improvement of our railway services, we have achieved a world-class performance in safety, efficiency and service quality — becoming Hong Kong's fast track to a world-class city.

http://www.mtr.com.hk/eng/homepage/index.html

SINGAPORE

The Land Transport Authority (LTA)

A statutory board under the Ministry of Communications and Information Technology, was established on 15 September, 1995 with the aim to build a world-class land transport system in Singapore. We spearheaded improvements to the land transport system through integrated planning, development and management of land transport policies and infrastructure.

http://www.lta.gov.sg/Menu_SiteMap.htm

Singapore Mass Transit Corp

http://www.smrt.com.sg/smrt/index.htm

Singapore LRT

On 10 February 1996, PM Goh Chok Tong announced Government approval for the building of the Bukit Panjang LRT system. It would be the first fully automated LRT system to be built in Singapore — providing a modern and convenient feeder service that links Bukit Panjang New Town to the MRT system at Choa Chu Kang.

http://www.slrt.com.sg

THAILAND

Bangkok Transit System

Home page (Thai language)·

http://www.bts.co.th

also see

http://www.student.chula.ac.th/~00005221/home_content.htm

more over page

WEB LINKS

MALAYSIA

PROJEK
Usahasama Transit Ringan Automatik Sdn Bhd (Putra) was recently awarded the ASEAN Outstanding Engineering Achievement Award 2000. This award was given away to Putra during the Conference of The ASEAN Federation Of Engineering Organisations (CAFEO), which was held on 22-24 November, 2000 in Hanoi Vietnam.

http://www.putra.com.my/profile.htm

INTERNATIONAL

Light Rail, Tramway, and Urban Transit Links
Our goal for the LRTA links page is to create a comprehensive compendium of links to other sites concerned with light rail, tramways, urban transit, transport policies, transit heritage, as well as museums, tramways, metro systems, light rail systems, and other urban transit systems worldwide.

http://www.lrta.org/links.html

American Public Transit Association — US LRT Website

http://www.apta.com/sites/transus/lightrail.htm

US Heavy Rail Web site

http://www.apta.com/sites/transus/heavyrail.htm

Routes International
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http://routesinternational.com/index.html

Janes
Welcome to Jane's Online — your subscription service to the complete portfolio of Jane's defence, transportation and security information online.

http://www.janes.com/

car trains. Presently, the trains are operated at 3 to 5 minute headways (the interval between trains) but as demand increases the headway can be shortened to 2 minutes. Regular passenger operation is between 0600 and 2400 hours.

Passenger information is minimal and relies on direction and information signs. As BTS consists of only two lines, passengers do not need timetables or real time information on train arrivals. Imminent train arrivals are announced on platforms and trains. Cubic-supplied, single trip and stored value magnetic stripe tickets are presently available.

The typical BTS station's platform is some 12 metres above the ground (or about level 5 in a typical building). Below the platform level (at about 7 metres above ground) is a concourse in which passenger circulation can occur and in which the paid and unpaid areas are laid out. Escalators are at present only provided between the concourse and the platform level. Following persistent lobbying by disability groups special lifts are being provided initially at a limited number of stations.

Patronage has been a disappointment but is improving. After the opening patronage stabilised at some 160,000 per day. It has since grown to above 200,000 a day. But this is still only one-third of the forecast. But BTS is not alone here. Similar experiences have been recorded by the recently opened:

- Star and Putra MRTs in Kuala Lumpur, Malaysia;
- Metrostar, Manila, Philippines; and
- Sydney airport rail link, Australia.

Shortly after the initial operation, Mr Suraphong Laoha-Unya, Vice President of Strategy and Planning of BTS, said that "Getting passengers to try the system is the most important thing". This is still very true as there is still believed to be a large number of potential passengers who have yet to try the system out.

A principal reason for the poor patronage performance is the lack of complementarity of bus services and the associated fare structures.

BTS' present full fare levels of Baht 10 to Baht 40 (about US $0.25 to US $1.00) are up to two times more expensive than the various types of air conditioned bus and many times more expensive than standard buses.

Proper integration of bus services has failed to take place. The major monopoly bus operator, the Bangkok Mass Transit Authority (BMTA), is not operated along commercial lines.

Despite the major impact congestion has on BMTA's operations it has failed to see the passenger and commercial advantages of re-orienting their services to be more complementary to BTS.

In the absence of any concrete moves by the government to develop integrated bus feeder BTS now separately operates limited feeder services provided by air conditioned mini-buses.

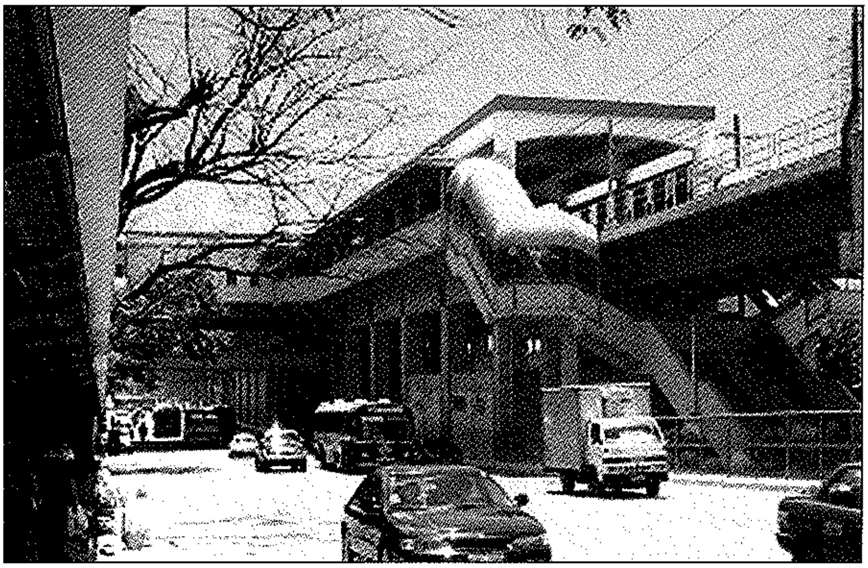
What has been the impact of BTS on Bangkok's badly congested traffic? Diversion to BTS by car drivers appears to be fairly high at about 10-15 percent of total patronage. Because of the high levels of congestion there is believed to be fairly high levels of suppressed trips which would quickly replace cars taken off the road. Nevertheless, for a given level of congestion, there will be a much higher level of person capacity in relevant corridors.

BTSC has been recently given the go-ahead to extend the system by 11km and it is hoped that these extensions will assist in boosting patronage. The viability of these extensions is on people's minds however. Irrespective of the fortunes facing the operating company, the people of Bangkok and its visitors are the beneficiaries of this high quality rail MRT system. ❖

No Up Ramp

By Philip Sayeg, Director, Policy Appraisal Services and Transport Roundtable Australasia — Brisbane, Australia

Recently constructed urban rail systems in Australia and the balance of the Asia — Pacific region have, almost without exception, performed well below expectations. Almost all have been funded in one way or another by the private sector. Quantifying the time lag to achieve forecast patronage levels is on many an investor's mind. But it is not that simple.


Manila's Metrostar Elevated Station

Disappointing patronage performance, typically at levels one quarter of that expected, is a serious issue for investors, and governments, for many new urban rail systems or Mass Rapid Transit Systems (MRTs).

An issue of concern is "ramp up". Ramp up appears to be best defined as the time to bridge the gap between forecast patronage (ie expected) and actual for a given fare structure, network, demographics and income. In other words, investors want to know when their revenue stream will get on track.

While patronage will presumably eventually rise in response to population and income growth these effects are not truly those that underly the ramp up issue which should largely be concerned with individual perception by potential passengers and their resultant travel behaviour.

Transport planners are normally engaged by investors to forecast the patronage for new MRTs but where there is no previous such system the 50 year science of transport modelling remains more of a black art.

There is a surprising lack of ability to correctly model the behavioural response of patronage to a new high quality transit system where none presently exists in that city.

Recent experience in the following cities has been very similar:

- Bangkok (23.5 km Bangkok Transit System opened December 1999);
- Kuala Lumpur (27 km Star and 29km Putra MRTs; December 1996 and 1998 respectively);
- Manila (17 km Metrostar; December 1999);
- Sydney (10km Airport Rail; June 2000); and
- Hong Kong (34 km Airport Express Rail; mid 1997).

Of the systems referred to the Star MTR has the longest operating history. Star's patronage appears to have languished at its initial low level of 20-25 percent of the forecast patronage.

The other more recent systems have only performed marginally better. Apart from the Asian economic crisis that commenced in mid 1997 (which all the countries considered faced) Star's fares are expensive, land use along much of its alignment is low density, bus integration did not occur and car ownership is believed to have grown strongly.

The Putra experience is similar. Metrostar which is built along EDSA, a major circumferential road in Manila, also performs badly. It suffers from difficult pedestrian access, a lack of affordable fares and integration with bus and jeepney (small bus-like vehicles) services.

Both Putra and Metrostar have improved their patronage performance recently but only after significantly reducing fares. The effect on revenue is probably negative.

The Hong Kong Airport Express Rail link also struggled with a first year patronage of some 25 percent of the forecast as does the new privately funded Sydney, Australia Airport link.

Although the Hong Kong Airport Line has improved its position in response to a rapid increase in Airport traffic at the new Chek Lap Kok airport the Sydney airport rail link is now in receivership with services being operated for the administrator by the government's State Rail Authority. Similarly, the assets of the two Kuala Lumpur MRTs were taken over by the Malaysian Finance Ministry in early 2001.

But overall Hong Kong and Singapore MRTs have largely achieved their expected patronage levels.

Why? Apart from having very high population densities, both cities have for many years, actively promoted public transport as central to their integrated approach to transport strategy.

Hence, fares of their MRT are much more affordable than in the other Asian cities referred to. When relative income is taken into account, their fares are about one

"No Up Ramp" continued from previous page

quarter as expensive as those in Bangkok, Manila and Kuala Lumpur.

They are set at a similar level to that of air-conditioned bus services which along with integrated ticketing systems provides a good base upon which to integrate the operations of the entire public transport system.

Overall there is little firm guidance that can be drawn on the ramp up issue from recent experience.

Each situation appears to be quite unique although the integrated approach of Hong Kong and Singapore and their unique characteristics no doubt are very influential factors that contributed to the achievement of MRT patronage forecasts in both of these cities. ❖

Mass Rapid Transit Policy Issues

By Philip Sayeg, Director, Policy Appraisal Services and Transport Roundtable Australasia — Brisbane, Australia

"Even when extensive MRT networks are in place the MRT lines may only carry up to 15 percent of the total person trips within cities."

Rail based mass transit seems almost universally desired for urban applications even when the economics of new rail based infrastructure is not favourable.

Busways can achieve most of the benefits claimed for rail based systems at a far lower cost and permit easier integration with the ordinary bus system which typically carries over half of daily person trips in developed and developing cities.

A recent study carried out for the UK Department for International Development (DFID) and the World Bank by Consultant, Halcrow Fox, considers the appropriate role of Mass Rapid Transit (MRT) in developing economies. MRT or metro is defined to include bus and rail-based systems — busways, Light Rail Transit (LRT), metros and suburban rail.

The study entitled "World Bank Urban Transport Strategy Review — Mass Rapid Transit in Developing Countries" was published in July 2000.

It was commissioned to provide input into the World Bank's recent review of urban transport policy. It was intended to provide guidance on two key decisions:

- The choice of MRT system; and
- Given this decision, how to approach the issues which should be considered during the project development process, to maximise the prospects for success.

The role and form of MRT depends on its city context, its size, income level, asset base, institutions and the characteristics of its public transport system.

MRT investment decisions impact upon the following areas of public policy:

- Macro-economic effects where the MRT represents a disproportionate share of city and national resources;
- Economic growth;
- Poverty alleviation, and impacts upon the travel disadvantaged;
- The environment; and
- Land use and development.

How should all these potential impacts be balanced to secure the best overall policy effect?

While rail based MRT has very high potential capacity (30,000 to 60,000 persons per hour per direction (pphd) busways may have capacities reaching 20,000 pphd (at good levels of service) which is more than enough for all but the largest of cities.

Rail systems can provide high quality of ride although new bus technology is making bus transport potentially more comfortable. Rail systems have less ability to segment the market than bus systems which can offer basic, air-conditioned, guaranteed seat, express and limited stop services.

The four types of MRT are considered to perform slightly different roles and ideally should be developed in a complementary way. Hence, the study concludes that in medium-sized and low income cities busways may provide the basis of the MRT system for many years.

"If affordability increases or environmental concerns become critical, then LRT may perform a similar role.

"In the largest corridors of major cities, metros may be required, and when affordable may be justified. The secondary corridors may then justify busways or LRT lines, which may also feed the metro."

The study found that MRT has had only a limited impact on traffic congestion through attracting car drivers (less than 10 percent) — initially most patronage comes from existing bus users.

Even when extensive MRT networks are in place the MRT lines may only carry up to 15 percent of the total person trips within cities. Buses normally retain their majority market share. However, MRTs provide the ability to allow city centres to grow.

A central policy issue in developing cities (and many developed cities) is the structure and levels of fares.

Even the name Mass Rapid Transit implies that MRT should carry large numbers of passengers, rapidly. Fares must not be too high.

Given public funding constraints fares cannot be too low. Overall, a good compromise appears to be MRT fares set about the same level as air conditioned bus fares.

Fares set at reasonably modest levels will maximise MRT usage and to the extent there is diversion from other modes, reduce traffic congestion and pollution.

A second critical issue is integration of fares of MRT and buses — even in developed cities this sometimes does not occur due to institutional and associated revenue sharing concerns.

Where integration cannot be achieved then bus fares (especially basic bus service fares) set lowish appears to be a good compromise.

The study sees that there are great opportunities for future innovation.

Technological advances provide the opportunity to improve services or reduce costs. A particularly prominent example is in the area of busway system design.

There are considerable opportunities to raise the image of busways by creating "greener" systems using landscaping, clean-engine technology buses, and better urban design.

New ticketing and passenger information systems will benefit bus and rail based systems. There are also considerable opportunities for incremental development of MRTs over time.

The study found that MRTs did little for the poor. The opportunity cost of MRT may have significantly impacted on the poor however through reduced provision of other services excluded by the MRT investment decision.

Project development issues were examined carefully by the study. It found that there were 14 critical issues organised under three key headings: process; the options and procurement strategy.

The issues are extremely complex and cannot be done justice in this article. However, the study concluded that the government has a crucial role in developing MRT in an appropriate way.

Informed government must establish the environment in which the project can best be executed and the most appropriate role for the private sector.

"To be effective the private sector needs the government to carry out its core functions …" including "first and foremost … determine the project development process". ❖

"… busways may have capacities reaching 20,000 pphd (at good levels of service) which is more than enough for all but the largest of cities."

Australian Breakthrough in Mobile Emissions Measurement

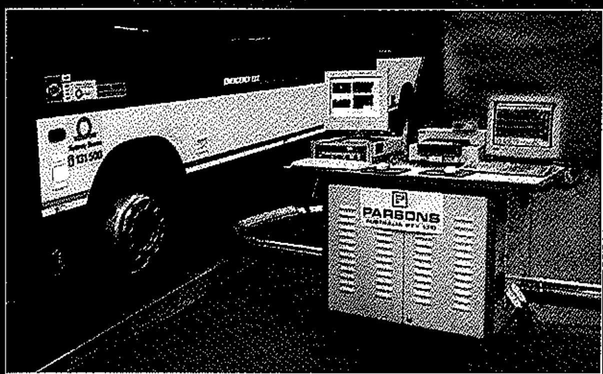
Responding to a worldwide need for accurate, on-site or roadside measurements of exhaust emissions from diesel vehicles, Parsons Australia Pty Ltd has recently developed an advanced, mobile system designed to fill this need.

With a tightly integrated system design that harnesses advanced laser technology and high-speed data acquisition systems, as well as more conventional measuring technologies, Parsons has effectively produced a "laboratory in a box".

Delivering real-time measurements of key pollutants from diesel, petrol and alternative fuelled vehicles while they are "driven" on a rolling road dynamometer, the system is capable of accurately simulating any traffic situation from stop-go inner city congestion to high-speed freeway cruising.

The Australian-designed and developed system handles a range of emissions unmatched by most large laboratories, yet can be up and running at any remote site in less than an hour. The following parameters can all be measured, logged and integrated on a second-by-second basis:

- Oxides of Nitrogen (NO_x)
- Total Hydrocarbons (THC)
- Methane (CH_4)
- Fine Particulates (PM10, PM2.5 or PM1.0)



- Carbon Dioxide (CO_2)
- Carbon Monoxide (CO)
- Oxygen (O_2)
- Smoke Opacity (%)
- Exhaust mass flow (g/sec)
- Vehicle speed and acceleration(m/s and m/s^2)
- Power (kW)

The whole system is completely self-contained (including its own power generator) and can be easily transported to any level site for rapid deployment. For further information contact Philip Sayeg, Smart Urban Transport magazine. ❖

Public Transport Reform and Development in China

By Zong Yan, Transport Specialist, World Bank Beijing Office, PR China

Public transport mode shares have declined precipitously in many cities across China during the past 15 years.

In some cities, municipal governments have to provide operating subsidy to state-owned bus operators.

Shanghai, Beijing and many other cities have initiated public transport reform during the last five to ten years. This article reviews the factors underlying this trend, the goals and strategies of public transport reform, and challenges for further public transport reform in China.

> **"As trip lengths continue to increase with city growth and development, and as motorisation threatens the accessibility of cities, municipalities are faced with many challenges in developing public transport."**

Public Transport Then and Now

Historically, China's public transport sector was characterised by a single state-owned operator, providing regular bus services with simple fare structures.

Typically, these state-owned enterprises (SOEs) exhibited labour intensive operations and low-technology management and operating methods, common characteristics of monopoly operators.

To some extent, this reflected the use of planning targets rather than efficiency benchmarks for staff planning, capital planning and operations. For example, staff to bus ratios in Louyang, Shanghai and Tianjin were 9.4, 10 and 10.5:1 in 1995 respectively.

Other than fare revenue, municipal budgets were the only source of finance for public transit, and large subsidies were needed for both operating and capital expenses. In terms of mode share, public bus operators held a steady 25-35 percent share of trips until around the mid-1980s when they began losing shares to non-traditional operators and other modes.

Today, several years into reform, the public operator is still the dominant provider of public transport services.

But we are seeing more diversified ownership arrangements for municipal bus companies which are now corporatised and increasingly commercialised.

As a result, operating efficiencies are much improved with staff to bus ratios having reduced from 10:1 to near or below 6:1 in some cities (although progress on this is uneven across cities).

Public operating subsidies are reducing, and there is more private participation in the sector, in particular in the finance of vehicles (short term bank loans, private investors).

Over time, this will allow cities to redirect public investment to other investments to support public transport, such as terminals and bus priority measures.

Trends Underlying Need for Public Transport Reform

In the mid-1980s, in an attempt to protect public transport mode shares, the government of China (GOC) established a policy that public transport should be the dominant mode of urban passenger transport.

The policy emphasised development of

public transport systems and containment of growth of privately-owned vehicles.

Despite increased public investment between 1985 and 1994 however, public transport lost mode share.

Table 1 shows recent mode shifts for Shanghai (urban population 13 million) and Shijiazhaung, the capital city of Hebei Province (urban population 1.5 million).

Public Transport Reform Agenda

In an effort to retain and expand public transport mode share, while decreasing public subsidies to transit, the goals of many cities' public transport reform programs were two-fold:

- In the near term, raise operating efficiencies and lower costs, eg via operating subsidy regulation; and
- In the longer-term, the goal is to improve and expand services with minimum public finance, thereby reversing mode share losses in a sustainable way.

Early public transport reform efforts tended to focus on operators themselves and the problem of labour redundancy or inefficiency. Increasingly, cities are also recognising the value of commercialisation, competition and liberalisation of supply to increase efficiencies and expand the choices for users.

Early Reforms

The major problem facing most public transport companies is labour inefficiency and redundancy.

One early strategy to reduce costs, commonly employed by many Chinese government enterprises, was to spin off excess staff to "tertiary enterprises", in the hope that these would generate supplemental income for unprofitable bus operations.

However, these tended to divert management attention from core operational issues.

Moreover, the heavy social obligations associated with employment were often too difficult to overcome, an unsurprising outcome of transferring inefficiency from one industry to another.

Another strategy aimed at both reducing operating inefficiency and expanding services was to retrain conductors and other staff as bus drivers.

While the move to single-operator buses reduces costs, given the lack of modern fare collection equipment, a potential disadvantage is the trade-off in lower average speeds. Operators are learning that bus priority measures, proper scheduling and modernised fare payment systems can help mitigate this problem.

Economic Reforms

Consistent with general State Owned Enterprise (SOE) reform, corporatisation emerged as a major strategy to commercialise bus operations and attract private investment.

Typically, this involves organisational restructuring into a main "head" company which manages several operating companies distinguished by function or lines of business.

One big bus company has been split into several companies and the new companies compete among each other including with any new comers. This first model has less aggressive variations such as in Beijing.

The second model requires a strong initiative by the government such as in Shanghai.

In terms of the first model, those companies in earlier stages of reform are choosing a tighter internal structure and early commercial relationships between units as a means to prepare them for competition.

Various incentive and penalty systems are used to improve performance rather than subjecting units to external competition,

FACTORS CONTRIBUTING TO PUBLIC TRANSPORT MODE SHARE LOSS

Urbanisation.
The number of cities increased to 622 from 225 (2.7 x) in the period 1981 to 1994 with major growth (1.5 x) of large cities (over 1 million population). As cities grew in size, and public transport services were not able to meet demand.

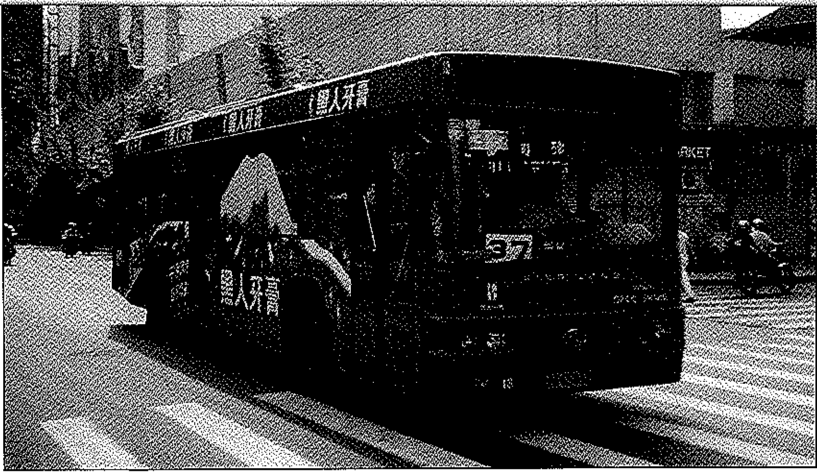
Motorisation.
More importantly perhaps, the growing affluence of households and demand for private modes of transport was being met by government industrial policies supporting motorisation.

Congestion.
Cities were not well equipped for the problems associated with motorisation. As a result, traffic congestion grew rapidly, and in the absence of priority measures, caused lower bus operating speeds (8-10 km/hr in Guangzhou and Shanghai, 1998).

Inadequate Public Transport.
Poor route efficiency, deteriorating vehicle conditions, and underdevelopment of passenger facilities worsened public transit levels of service and added to travel times.

Table 1 – Public Transport Mode Share Loss

Mode Share / Year	Shanghai		Shijiazhuang	
	1986	1995	1985	1998
Non-motorised	73%	78%	53%	88%
Walk	41%	33%	34%	34%
Bicycle	31%	45%	58%	54%
Motorised	27%	22%	8%	13%
Auto/Motorcycles	3%	7%	2%	5%
Taxi				2%
Company Car			1%	2%
Transit	24%	15%	5%	3%
Other				2%
Total	**100%**	**100%**	**100%**	**100%**



although internal competition for route-concessions may not be far off.

One reason for this is that regulation of "private" public transport services is extremely weak as yet.

In Shanghai, for the second model, there has been more deregulation with the result that operating companies are independent in both management and finance and actually compete for service contracts.

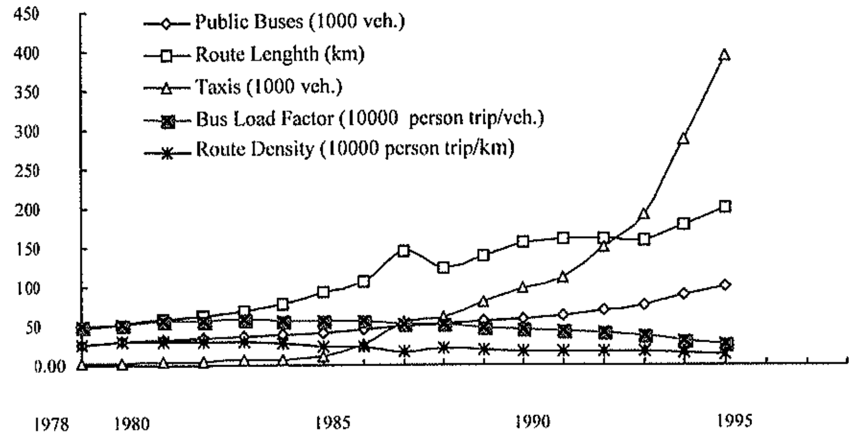
More recently, municipalities have begun to experiment with various forms of concessioning in an effort to manage subsidies and expand services without additional public finance.

Remaining Challenges

As trip lengths continue to increase with city growth and development, and as motorisation threatens the accessibility of cities, municipalities are faced with many challenges in developing public transport.

Policy/Vision: First and foremost, intermodal policies need to be sharpened, especially with respect to motorisation in all of its facets (licensing, user charges, cross-subsidies, road development and traffic management, land use policy).

Figure 1 – China Public Transport Trends



Planning and Economic Regulation: City functions in planning and regulation need to be strengthened and integrated significantly. Policies to liberalise supply and capacity to regulate competition policy should improve as lessons of experience are disseminated.

Clarify Responsibilities: The responsibilities between government and operating companies should be clearly identified. The government should restrict its role in administration. Regulations and procedures for operation should be set up to promote fair competition and social services.

Any subsidies for social services should be clearly defined in advance. Any operating company should have managerial and financial independence for its operations under the regulation and framework set up by the government.

Franchise Regulation: Cities need to invite external experts who should understand both the government and operating companies to help to draft this regulation which will need to be approved by the People's Congress.

Finance and Investment: Fare and subsidy policies should be clarified and adequate provision made for public transport infrastructure and facilities, including priority measures. Investment in new technologies should be considered carefully in terms of cost-effectiveness and local capacity.

Increase integration: Cities should find ways to improve the coordination and integration of the various sub-sectors of public transport.

Public transport operators also must continue to prepare themselves to operate in a market environment.

This requires better understanding of financial management, cost-effective investment in technology to improve management and operations, and improved knowledge of customer preferences and the markets in which they operate.

Residents and public transport users could also play more active roles as consumers and planners of services.

Citizens already do provide views and feedback via "hotlines" and in some cities, participate in "price" committees reviewing fare increase proposals.

New technologies should be experimented with for both operational efficiency and bus priority measures. ❖

All views, findings, interpretations and conclusions expressed in this paper are entirely those of the author and should not be attributed in any way to the World Bank, its affiliated organisations, members of the Board of Executive Directors or the countries they represent.

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