Modern Transport in Hong Kong for the 21st Century

edited by

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Foreword

Hong Kong’s transport system has served us well over the years. Entering the new millennium, we face the challenge of maintaining a safe, efficient and reliable transport system to meet the ever-expanding transport needs of the community, and to facilitate sustainability and future development of Hong Kong.

This monograph has provided an opportunity for transport planners and regulators, service providers, academics and professionals to share their views on the past and future development of Hong Kong’s transport system, to review our transport policy and planning, to address the internal and external mobility needs of Hong Kong, and to draw up plans for Hong Kong’s sustainable transport development strategies. The views expressed will provide valuable input into Government’s transport policy formulation and planning.

Nicholas NG
Secretary for Transport
Hong Kong SAR Government
Introduction
1 Transport Development in 21st Century Hong Kong

Simon K W NG, Anthony G O YEH and Peter R HILLS

OVERVIEW

Hong Kong has enjoyed a prolonged period of economic success, dating back to the time when it functioned as a major entrepôt in the Far East before the two world wars. However, it was during the period after the Second World War when Hong Kong gradually emerged to become a significant economic entity, first as one of the newly industrialized economies (NIEs) in the 1960s and the early 1970s, and more recently as a regional financial and service centre, playing an all-important role for a liberalized Chinese economy since the late 1970s.

Over the same period, Hong Kong also witnessed sizeable population growth as well as tremendous urban development (and redevelopment). Population was estimated at 2.06 million in 1950 over a land area of 1,013 square kilometres\(^1\), and the corresponding figures became 6.76 million and 1,098 square kilometres in 1999\(^2\), the additional land area being created by reclamation. Other than to reclaim land and to build high-rise for our residents, and also for some of our industries, the Hong Kong government began to purposefully redistribute the growing population away from the old urban centres to designated new towns such as Tsuen Wan and Kwun Tong on the then urban fringe, and Tuen Mun and Shatin farther away in the New Territories. More and more commercial activities also followed the trend into new business districts such as Tsim Sha Tsui, Admiralty and Wanchai, while in the 1980s and 1990s many of our factories moved across the border to Guangdong for factors of production at a lower cost. According to the latest territorial development plan\(^3\), Hong Kong is heading towards a spatially more balanced development strategy, and gone are the days when all major activities were concentrated in the urban core, north and south of Victoria Harbour.

Without doubt, the timely expansion and improvement of our transport system has always been one of the key factors central to these
developments. It will remain so in the future as the Hong Kong Special Administration Region (SAR) Government is advocating “transport-led development” – with the transport system being planned and built before development actually takes place – as one of its future territorial development strategies. To support Hong Kong’s economic growth, the government has over the years placed a lot of emphasis on the development of our port and airport, as well as rail and road connections with mainland China, which helps to strengthen our linkages with the outside world and to facilitate the international movement of personnel and freight. As for our internal transport network, developments have mainly focused on road building, public transport improvement and road use management to build a system capable of satisfying the mobility needs of our residents for different purposes – work, school, business, social, and recreational. At the turn of the 21st Century, Hong Kong boasts a transport system which is reliable, efficient and safe by world standards: at Chek Lap Kok we have a state-of-the-art international airport which was the largest and the fifth largest in the world in terms of international freight and passenger throughput respectively in 1999⁴. In the same year, Hong Kong handled a total of 16.2 million TEUs to become the busiest container port of the world⁵. Internally, we have an extensive highway system and urban road network, and also a public transport system which comprises rail, buses, minibuses, taxis, tramway and ferry services, accounting for almost 90% of the 11 million passenger journeys made every day⁶. On that score, we have been doing very well.

However, there are reasons to believe that if Hong Kong is to remain successful in the new millennium, we have to at least double our effort to maintaining the same level of mobility – first, we will be facing enormous population pressure on our limited land resource, as our population is estimated to reach 7.61 million in 2011⁷. To cope with such increase, new housing and territorial development programmes will be launched by the government in the years to come, the success of which depends largely on the support of complementary transport facilities. Second, Mr. Tung Chee-hwa, Chief Executive of the Hong Kong SAR, has made public his dual intention to maintain Hong Kong as a competitive economy and to make the place a quality home for our residents⁸. Sustainability is to be treated on equal terms as prosperity. In this respect, the future transport strategy of the SAR has become a subject of heated debate as transport holds the key to both prosperity and sustainability – while it allows and promotes mobility and interaction, transport also creates negative externalities, such as congestion, pollution and fatalities. The
pace of economic development and urban growth in Hong Kong will continue to require the provision of new transport infrastructure and services, but the call for more roads and improved mobility will almost certainly be challenged by the ‘green’ members of our society who constantly raise their concern over traffic being a main source of pollution (Barron and Steinbrecher, 1999; Hills and Barron, 1996: 81-83), and also by our affluent population who is becoming more and more aware of the rising cost of transport on the environment, equity, and the quality of life in general. If we are to satisfy higher demands and expectations of our residents and the business community, we need total commitment as much as an open and innovative minds to look for and to experiment with new options. Are we ready for that challenge?

BLUEPRINT FOR THE NEW MILLENNIUM

Hong Kong can be considered as one of the more experienced cities in the world in transport planning and management (Wang and Yeh, 1993). Despite the fact that systematic studies of internal transport needs and problems only began in Hong Kong in the mid-1960s, in the three-and-a-half decades that followed a number of major transport studies have been completed and policy papers published (Table 1.1) that help shape Hong Kong’s present transport configuration. During that time, we have clearly defined, and subsequently refined, our transport policy objectives which in essence aim to achieve an acceptable level of mobility for both passenger and freight in order to satisfy the transport demand generated by economic growth and urban development in the territory. Three main principles – the improvement of the road system; the expansion and improvement of public transport; and more economic use of the road system – were also established to govern our approach to local transport problems (Hong Kong Government, 1979). Equally important, we have developed an administrative framework over the same period that shoulders responsibilities on transport policy formulation and co-ordination of internal transport issues, and on day-to-day transport operation and management. All in all, we have a well-established structure in Hong Kong to deal with transport matters.

However, many people raise doubts as to whether or not our current transport policy framework and our long-standing transport approach would lead us to a better transport system that satisfies the demanding requirements in a modern world. Their scepticism to some extent stems from the fact that after all these years of development, we are still short of a policy framework to tackle transport-related environmental issues
and cross-border traffic problems in an effective manner. Even more worrying is the way the government responded to such inadequacy in the past. Far-sighted advocates have long called for more attention to those issues cited above well before the 1990s, but the government thought otherwise as reflected in the second white paper on transport published in 1990. Strategies and recommendations suggested in that document confirmed a continuation of government's standing approach on transport matters laid down in the 1979 policy paper based on the three principles (Hong Kong Government, 1990). Unfortunately, such approach has failed from time to time to swiftly address emergent issues and their impacts on our transport system.

Table 1.1  A Chronology of Major Transport Studies and Policy Papers in Hong Kong, 1964-2000

<table>
<thead>
<tr>
<th>Year</th>
<th>Transport Studies and Policy Papers</th>
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<tr>
<td>1964-1966</td>
<td>Hong Kong Passenger Transport Survey</td>
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<td>1974</td>
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<td>1983-1984</td>
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<td>1983-1985</td>
<td>Electronic Road Pricing Pilot Scheme</td>
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<td>1986-1989</td>
<td>Hong Kong Second Comprehensive Transport Study</td>
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<td>1990</td>
<td>Moving into the 21st Century: The White Paper on Transport Policy in Hong Kong</td>
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<td>1991-1993</td>
<td>Update of Second Comprehensive Transport Study</td>
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<td>1991-1994</td>
<td>Freight Transport Study</td>
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<td>1991-1994</td>
<td>Railway Development Study</td>
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<td>1997-1999</td>
<td>Hong Kong Third Comprehensive Transport Study</td>
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<td>1997-</td>
<td>Crosslinks Further Study</td>
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<td>1997-</td>
<td>Feasibility Study on Electronic Road Pricing</td>
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<td>1998-1999</td>
<td>Study on the Implementation of ITS on Strategic Road Network (SRN) in Hong Kong</td>
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<td>1999-2000</td>
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<td>2000-</td>
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Transport Development in 21st Century Hong Kong

It is therefore quite appealing when the government refines its transport policy objectives in recent years, whereby the environmental dimension of transport has been accommodated. It is of course an encouraging sign and credit must be given to our government for they at least started looking at the issue. Indeed, government’s initiation is a measure of the growing size of the environmental issue itself and the civic support behind it. In 1997, the Hong Kong Third Comprehensive Transport Study (CTS-3) was commissioned, which aims “to provide a framework on which Government can develop a balanced transport strategy to facilitate the mobility of people and goods of Hong Kong in an environmentally sustainable manner up to 2016” (Transport Department, 1999:i). To this end, CTS-3 adopts the following guiding principles for the formulation of Hong Kong’s future transport framework:

- Integrating land-use, transport and environmental planning;
- According priority to railways;
- Co-ordinating and enhancing public transport services;
- Providing transport infrastructure in a more timely fashion;
- Managing transport with new technologies;
- Giving more emphasis to pedestrian needs; and
- Alleviating the environmental impact of transport to an acceptable level

Apparently, CTS-3 breathes some fresh air to our rather rusty and inflexible planning framework of old, to the extent that environmental elements of transport planning has been dealt with through greener policy objectives, a Strategic Environmental Assessment (SEA) exercise for the evaluation of transport development options, and a series of environmental improvement measures which aim to reduce transport-related pollution. Few would argue against the direction set out by CTS-3. We are on the right track, but are we really getting into our strides?

Towards Sustainable Mobility

While CTS-3 offers hope, it also pinpoints our current difficult situation and portrays a rather grim future picture as far as transport development and the achievement of our sustainability goals are concerned. In the final report of CTS-3 published in late 1999, it is clearly stated that implementation of many of the control measures on vehicle emissions recommended in CTS-3 could only arrest or decelerate the rate of damage
on the environment inflicted by traffic, rather than to reverse the trend. "The magnitude of [vehicle emission] reduction is not sufficient to bring the air quality in compliance with the Hong Kong Air Quality Objectives (AQOs). There will continue to be non-compliance with the AQOs for the recommended transport strategy under all considered scenarios for the year 2016..." (Transport Department, 1999:32).

Much as we would explore other feasible emission control measures to improve air quality and the noise environment, we really must realize that they are not the cure to our problem in the long term. Measures recently initiated by the government such as the switch to cleaner fuel and the retrofitting of sub-standard vehicle engines will certainly lead to reductions of traffic impacts on the environment, as will other technical and technological improvements in the near future. Unfortunately, such reductions are likely to be outweighed by traffic growth and people’s preference for private transport. In other words, if we do not try to control vehicle ownership and use, or to reduce the number of unnecessary trips at the same time as we implement remedial measures on vehicle emissions, the environmental problems we are facing today will still persist.

It is therefore absolutely appropriate for the government to suggest in CTS-3 an approach for our future transport planning in which land-use, transport and the environment are considered in an integrated manner. The government also intends to promote railways as the backbone of our future transport system, to promote pedestrianization at suitable locations, and to enhance public transport co-ordination. These are options that would lead to a gradual but long-term impact on people’s reliance on private vehicles and their trip-making behaviour, and would eventually lead us closer to achieving our sustainability goals. We should support these recommendations. More importantly, we must also make sure that government’s interest and support in these proposals is not short-lived and uncommitted.

Other than the issues already attended by the government, there are several key policy areas that have recently aroused public discussions and are worthwhile for further exploration by the government sooner rather than later.

First on the list is car ownership and car use. In Hong Kong, most of the residents are well-served by public transport, and the car ownership level of 57.2 per thousand people in 1999 is moderate by world standards\(^6\). However in Hong Kong, we are also talking about one of the highest vehicle densities in the world, with over 271 vehicles per kilometres of
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roads. Given the limit to road building in Hong Kong because of the lack of space, and given the argument that growing vehicular traffic could only further degrade the local environment and quickly erode the benefits brought along by emission control measures, it appears sensible for the government to exercise tighter control over vehicle ownership in the future, rather than to build new infrastructure mainly for the sake of accommodating additional traffic flow (as it is becoming evident that new roads attract new traffic). Fiscal measures were employed in the past to discourage car ownership, the effect of which diminished gradually as people are becoming more resistant to them over time and because of improving financial positions. Alternatively, we should call for more efforts to discourage unnecessary private car use as a complementary strategy to check the growing traffic.

Pricing is another heated topic in Hong Kong since the first day the idea of electronic road pricing was introduced in the territory. The government backed away from its effort to promote road pricing in the mid-1980s due to public opposition, but in March 1997 a feasibility study was commissioned in a bid to further explore the use of an electronic road pricing scheme as a means to regulate the use of vehicles in congested city areas. So far in Hong Kong, the true meaning of pricing in transport is overlooked by most members of the general public. Perhaps road pricing is the only measure they could relate to, but they tend to interpret it as an unfair tax imposed on drivers and other road users, rather than as a way to internalize external costs of transport, which is in this case congestion costs. There is renewed attention all over the world on the subject of pricing in transport, which is considered by many as a significant component of a sustainable transport policy. In Hong Kong, it is unlikely that transport users will in the near future pay the full social and environmental costs of their transport decisions, simply because asking people to start paying for things that were previously assumed free is an enormous task, and there will also be arguments and problems associated with the assignment of a right value for the externalities. In any circumstances, however, the government should try to make the external costs of transport more transparent, so that car users will be better able to make more informed decisions whenever they ponder to use their vehicles.

While we opt for the approach to discourage private car use, we must at the same time provide alternatives for the trip-makers or we are risking the immobilization of our population. For many years, it has been one of government’s priorities in transport to expand and improve public transport services, so that larger service area could be covered, more
choice could be provided, and more people could be mobilized. To this end, over 10 million public transport trips were made every day in 1999, of which some 38% carried by bus, 30% by rail, and the rest by the other modes. In the new millennium, however, we should be looking at the new dimensions of our public transport services – we are expecting attractive and quality services to dissuade car users from using their vehicles, greener services so as to enhance environmental and energy efficiency, and better modal co-ordination that emphasizes more passenger information, smooth connections and less waiting time. One good example of a transport mode under reform is the taxi industry. Recently, the industry has been working closely with the government to improve the quality of taxi service and to make it an environment-friendly mode. Taxi driver award schemes were launched and a self-learning language training programme was provided free-of-charge to drivers. The Legislative Council also approved in June 2000 a sum of HK$725 million for providing a one-off grant of up to HK$40,000 to taxi owners for the conversion of their diesel vehicles into the cleaner liquefied petroleum gas (LPG) taxis, with a target of complete conversion by 2006. As at October 2000, more than 2,000 LPG taxis were in service, representing over 10% of the entire taxi fleet of 18,138\textsuperscript{14}.

On modal co-ordination, the government has outlined a modal hierarchy in CTS-3 (Transport Department, 1999:16-18) which puts heavy rail system right at the top which is characterized by high capacity and low adverse environmental impact, and it is followed by light rail system and buses. We can see little objection to the idea of railway being the backbone of Hong Kong’s future transport system based on its relative efficiency and function. According to government, Hong Kong is to invest some HK$200 billion on railway projects in the next 15 years or so, adding 70% of the existing route length to a new total of over 250 kilometres, and putting over 70% of our population and 80%, of employment within walking distance from rail stations. By 2016, the rail share in public transport patronage will increase from the present 30% to about 45%. However, there are alarming concerns over the ambitious road infrastructure programme put forward in CTS-3\textsuperscript{15} (Transport Department, 1999:21-27) which proposes new highways along potential railway corridors (such as Route 7 along the western coast of Hong Kong Island which is outside the rail catchment at the moment). Under current practice, highways are constructed and maintained by the government whereas the rail operators have to pay for the land and tracks in any new construction. External costs of highway construction and the avoided
costs of railway construction are rarely fully assessed and considered. We accept that railway is no direct substitute for highway and they may serve different purposes. But if we really want to achieve sustainable mobility, should we move forward to a new rail financing framework and a cost-responsible project appraisal framework so that when we do have a choice between highway and railway, we are in a better position to choose?

The ‘predict and provide’ approach in transport planning has for long served Hong Kong well as an effective tool to first forecast and then match transport demand by providing enough road space for it. However, question arises as to whether or not we should persist with this approach in the future as we did in the past, without realizing that it is fast becoming unfashionable among transport planners all over the world, and more importantly without re-assessing its compatibility with sustainable mobility in the context of 21st Century Hong Kong. After all, we are no longer in a phase of development whereby a rapid expansion of road capacity is the only desperate need, but rather at a critical junction at which tiny Hong Kong could no longer concede much land resources to road space. If we accept that there is, or there should be, a limit to the supply of road space in Hong Kong, which in turn implies that we are unlikely to match it with the forecast demand, then we should try to influence or manage that demand in a way that acceptable and desirable traffic conditions would be achieved. It is becoming more of a ‘predict and prevent’ approach.

All the policy options discussed above are inter-related and should fall nicely into an overall transport strategy that would lead us closer to a truly sustainable transport system, a target that looks remote to us if we insist to rely on the piecemeal remedies we are having at the moment. There is a growing belief in Hong Kong that we need some fundamental policy changes and a new mindset – not only for the policy makers but also for all transport users – to live up with the challenge of sustainable mobility. In that process, concerted partnership among various government departments is also of paramount importance. After all, sustainability is an issue for all.

**Intelligent Transport System**

While sustainability and environmental issues are topics of the moment, we are also aware of the trend that advanced transport technology is receiving growing attention from all over the world as a means to achieve transport efficiency and safety. Western industrialized countries have
taken the lead in research, experiment and application of Intelligent Transport System (ITS). To a lesser extent in Hong Kong, ITS has been introduced in areas such as traffic control and surveillance, automatic toll collection and smart card ticketing system. Recently, not only are the private transport operators exploring the feasibility of ITS applications to bolster their fleet performance, the government is also vigorously turning to the latest technology in enhancing traffic management and road safety, and in providing real time travel information. For the years to come if we are to seek wider applications of ITS in Hong Kong in an effective manner, we need to quickly look into the formulation of an ITS strategy with objectives, priorities and evaluation criteria; the development of an institutional framework that oversees issues such as technical standards, legislature and funding arrangements; the fostering of a good working relationship between government and the private sector; and a supportive role played by local universities and industries in research and development.

Cross-Border Transport

Another topic of significant implication is cross-border transport and regional co-operation. Hong Kong’s internal transport network was very much a closed system before the 1980s. Since then, economic and urban development in Shenzhen Special Economic Zone immediately north of our border and later in other parts of the Pearl River Delta has led to the intensification of cross-border traffic (Yeh, 1995), including both the movements of personnel and freight. Lo Wu has become the busiest immigration control point in the world. In 1999, the average daily passenger traffic at Lo Wu was about 190,000, and the number could easily go up to as high as over 280,000 each day during major festivals and long weekends, such as the Chinese New Year and Christmas, causing serious congestion at the border and in railway stations. Similarly, congestion caused by the queueing of goods vehicles and container trailers at the border are not uncommon at the three border crossing points at Man Kam To, Sha Tau Kok and Lok Ma Chau. In this regard, the cross-border freight transport industry has been urging for more co-operation between the Hong Kong government and the Shenzhen authorities. In the early 1980s, the Annual Boundary Liaison Review Meeting and a system of Border Liaison Officials have been set up (Ng, 1994:130-133). However, it serves more as a platform for the review and discussion of all boundary issues that include transport, and the topics of discussion are more related to daily operation rather than long term planning. Quite clearly, the further economic and urban integration of Hong Kong with
its hinterland in the Pearl River Delta would demand even better and higher-level regional co-operation to tackle issues such as new cross-border road links, regional passenger movements, and cross-border vehicles emissions.

STRUCTURE OF THE BOOK

This book attempts to look into the various facets of Hong Kong’s transport system, with a view to understanding our current situation and to identifying credible transport options that we can explore in the new millennium. All but one of the following chapters are adapted from the revised conference papers presented at the Modern Transport in Hong Kong for the 21st Century Conference and Public Forum, held in Hong Kong on 30th April and 1st May 1999, and they are structured into three sections: Development and Challenges in the 21st Century; Transport Options for the 21st Century; and Advanced Technology and Modern Transport in Hong Kong.

Part One focuses on transport development and future challenges in Hong Kong. Kevin Ho in Chapter Two sets the tone for the subsequent chapters with a brief discussion of Hong Kong’s past transport development and future outlook. It is followed by Sam Chow’s account on CTS-3 (Chapter Three) which sums up all the key points of that important study. Discussions on Hong Kong’s internal transport system continue in Chapter Eight through Chapter Ten. In Chapter Eight, Mak Chai-kwong outlines Hong Kong’s future railway development with reference to the Second Railway Development Study. In Chapter Nine, Dorothy Chan turns her attention to our public transport services, and in Chapter Ten, Tsang King Man comments on the latest developments in traffic management and control. Also in Part One is an overview by Wang Liang Huew (Chapter Four) on Hong Kong’s external transport connections, which is supplemented by another three papers on specific nodes or modes of transport. In Chapter Five, the future of the port of Hong Kong is discussed by Richard Yuen, which is followed by a paper on rail connections with the mainland in Chapter Six by James Blake. In Chapter Seven, John Pashen and Maria Luk assess Hong Kong’s position as a regional aviation hub.

In Part Two, five contributors discuss possible options and necessary actions in the near future to respond to the emergent transport issues in Hong Kong. In Chapter Eleven, Tim Hau provides a detailed account on demand-side measures and road pricing in Hong Kong. In Chapter
Twelve, Hung Wing-tat raises his concern over environmental neglect in transport policy and argues that both transport and environmental demand must be met in the future. His call for a change in philosophy on the part of policy makers is echoed by William Barron in Chapter Thirteen who accuses transport planners of having a vision of the 1950s. With all the alarming indicators he provides on the level of pollution, he urges our transport planners to leave behind their business-as-usual approach in order to save our environment. On a different issue, Fred Brown offers and promotes a new approach to pedestrian planning in Hong Kong (Chapter Fourteen), which he believes is a deal that everyone would benefit. In Chapter Fifteen, Rex Luk touches on the issue of equity and social sustainability of transport by suggesting a fully accessible transport system in Hong Kong which caters for everybody including the disabled and the elderly.

Part Three is specially reserved for issues related to modern transport technology. Leo Lee in Chapter Sixteen addresses ITS development and experience in the United States, and he also summarizes initial findings of a study on ITS implementation in Hong Kong. Nelson Yung also adds his inputs on the background of ITS development in the world (Chapter Seventeen) with more examples from other countries and of course from Hong Kong. In Chapter Eighteen, Alex Au directs our attention specifically to civil aviation, and the implementation of satellite-based systems for air traffic control and management in Hong Kong. Finally, two overseas experts join our discussion in the last two chapters. In Chapter Nineteen, Paul MacCready shares his insights on mobility in general, on cars, and on his joy for "leap" solutions to the problem of mobility. In Chapter Twenty, Zhao Yilin discusses the potential use of location technologies in future intelligent transport systems.

NOTES


2 The figure provided by the government in early 2000 was 6.97 million, based on the so-called "extended de facto" method previously used by the Census and Statistics Department (CSD). Starting from August 2000, CSD replaced the old method with the "resident population" method to compile population estimates. Subsequently, the year-end population of 1999 was revised to 6.76 million. For details, see Press Release on "Method for compiling


In 1999, the Hong Kong International Airport at Chek Lap Kok handled 1.97 million tonnes of cargo and 29.1 million passengers. In terms of international cargoes and passengers, Hong Kong ranked first and fifth (after London Heathrow, Paris CDG, Frankfurt and Amsterdam) respectively in the world. If domestic cargoes and passengers are also considered, Hong Kong was the world’s second busiest cargo airport after Memphis (2.4 million tonnes), and ranked a distant 23rd in terms of passenger throughput (with Atlanta at the top, handling 78.1 million passengers in 1999). For more airport statistics, see the website of Airports Council International at http://www.airports.org/

Press release on 4 May 2000, Hong Kong Port and Maritime Board. The throughput recorded in 1999 represents a 11.2% increase as of 1998. Singapore came second in 1999, with a throughput of 15.9 million TEUs.

Figures based on the 2000 Policy Objectives in transport prepared and published by Transport Bureau, Hong Kong SAR Government.

Census and Statistics Department (2000), Hong Kong Population Projections 2000-2029. Hong Kong: Hong Kong SAR Government. The figure is mid-year population. This is the latest population estimates available from the government since the adoption of the “resident population” approach for compiling population estimates. See also note 2.

If we compare the policy objectives set out by the Transport Bureau in 1997 through 2000, there is a fourth objective in the latter years “to seek [or develop] and support environmental improvement measures in transport-related areas”.

Calculation based on 398,612 registered private vehicles (including motor cycles) and a population of 6,974,800 in 1999. According to World Bank, the 1998 car ownership rates (including motor cycles) for Australia (506 per thousand people), Canada (466), Germany (542), Japan (509), Malaysia (357), Singapore (150), the United States (497) and the United Kingdom (387) were much higher. The world average in 1998 (passenger cars only) was 91 per thousand people.

Hong Kong fact sheet on “Transport”, published by Information Services Department, Hong Kong SAR Government in 2000.

For examples, First Registration Tax (FRT) and Annual Licence Fee (ALF).

For details, see Tim Hau’s paper in Chapter Eleven, section on “Lessons from the Political Failure of ERP”.

For information on Hong Kong’s taxis, see the website of Transport Department at http://www.info.gov.hk/td/

The estimated cost of all the strategic highway projects (excluding the cross boundary links) amounts to around HK$250 billion at 1998 prices. From another source, Transport Bureau indicates that over 100 kilometres of strategic roads will be built or improved between 1998 and 2008.

In 1981, David Wilson (Governor of Hong Kong, 1987 –1992) as Political Adviser to Governor on Foreign Affairs led a delegation of government officials to Guangdong for discussions on establishing regular contacts between officials from both sides to deal with border issues such as smuggling, illegal immigration, and the movements of passengers and vehicles. Since then, the Annual Boundary Liaison Review Meeting (previously known as Annual Border Review Meeting) has been held once every year and a system of Border Liaison Officials has been set up for daily contacts on operational matters related to the border.
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Development and Challenges
in the 21st Century
2 Hong Kong – Moving into the 21st Century

Kevin HO

PAST DEVELOPMENT

At the turn of the 20th Century we had the peak tram operating, and Star Ferry was in its youthful years of service. The tramway system, which we now regard as part of our heritage, was brought in a few years later, and this was followed by the Kowloon-Canton Railway. Throughout this century, our transport system has taken huge strides one after another. We saw the growth of public transport, with the establishment of the Kowloon Motor Bus Company and the China Motor Bus Company in the thirties, and over the harbour the Hongkong and Yaumati Ferry Company started operations to provide some competition to the Star Ferry. With the rapid growth in population after the Second World War and the fast economic development in the last thirty to forty years, we have witnessed a rapid growth in the number of private cars, and consequently traffic congestion. We had to resort to building more and faster roads to meet this demand and to connect up our new towns, which mushroomed in the sub-urban areas. We also saw during this busy period the completion of one tunnel after another. First the Lion Rock Tunnel broke through the Kowloon Foothills, partly as a by-product of watermains connection. Then the cross harbour tunnels and other road tunnels opened up the communication routes between Hong Kong Island and Kowloon, and between development areas separated by geographic barriers. Our achievements in breaking barriers are of course not limited to tunnels. The trilogy of the Tsing Ma Bridge, the Ting Kau Bridge and the Kap Shui Mun Bridge is now a regular spot for tourists in addition to bridging Lantau Island and the airport with the urban areas. The expansion in the road network was matched by first the introduction and then the expansion of the Mass Transit Railway (MTR). In the last twenty-five years we have seen the MTR expand from one line to five, with one more line under construction, to capture now about one fourth of the public transport market. At the same time the Kowloon-Canton Railway moved from diesel to electricity, double-tracked its East Rail, commissioned the Light
Rail Transit service and is embarking on an ambitious plan to expand its network.

In the traffic field we have taken the first steps in using modern technology to help run our transport system. We have progressed at different speed in different areas. Automation and telemetry have been used in traffic management and control. Autotoll facilities are common to all our tunnels. We proudly have a unique innovation of our own, the Octopus card. The convenience of this contactless ticketing system applicable to the major modes of public transport proved to be so popular that the card went out of stock in the first year after introduction, not because of under provision, but because demand was so overwhelming. This smart card not only provides convenience to passengers but improves efficiency of public transport services by automating toll collection and dispensing with cash handling.

It will not be an overstatement to say Hong Kong possesses a good transport system. We achieve a peak hour average travel speed of 25 km/hour in the urban area and 44 km/hour in the suburban area. We provide no direct subsidy into public transport services which provide multi-modal choice, convenience and comfort. We have so far been able to improve the quality of service without an inordinate upward surge of charges. These may be the marvel of our competitors. Our reliance on market forces and private sector initiative has paid off handsomely.

FUTURE CHALLENGES

But we cannot be complacent. We will be facing new challenges. First, the cost efficiency of a transport system serving a compact population almost all concentrated in the urban area will no longer be there. The road and public transport networks are going to be more widespread and unit costs are going to go up. Secondly, we will need to take into account social costs. We will have to balance economic costs with other factors such as the cost of pollution. Thirdly, at no time in our history have we faced such dramatic forces of competition. The Southeast Asian economies are re-structuring very quickly. Our neighbouring regions are catching up even more quickly. To stay ahead, we will have to cut cost, increase productivity and find new opportunities. These endeavours will not be successful if we do not have an efficient transport system. Fourthly, we also face pressures in population growth. This will put pressure on housing, education, social welfare and health services, and also transport services. Taken together, these challenges demand that we find the means
to finance further improvements to our transport system amongst other highly competitive claims for investment and build a system which will meet the tests of sustainability.

We will not be able to determine sustainability of a transport system by looking at the system in isolation. Experience has taught us how important it is to integrate land-use and transport planning. Even more important is to get the integration on the right tracks to come up with plans which will meet the changing needs of the time.

The population pressure which we will face means we will have to expand our housing stock more quickly, if housing costs are not going to escalate, as it did several years ago, to erode our competitiveness. Increasing concerns on pollution and stronger desire on conservation mean we will have to tread very carefully on development anywhere, but even more so in the urban area. Economic pressure, both in the public and the private sectors, implies that we have to go for even more efficient ways of providing infrastructure and services. We will thus need to take a fresh look at how we plan our future. Integrating land use and transport planning has always been in place, but transport planners now need to be even more vigorous in trying to influence the planning of land use.

The Government has always relied on a three-pronged strategy to meet the transport needs of the community. We provide the transport infrastructure. We regulate the public transport services. We manage the use of the roads. This three-pronged approach will be valid in the future as it was in the past. But we need change to meet the new challenge.

For one of the clear facts is that we cannot, and should not, hope to satisfy transport demand just by building more and more roads. We do not have enough space even if we have everything else. Rail priority, both in terms of infrastructure development as well as public transport services, must be our aim.

We will need some new strategic roads. We will need to open the opportunities of new development areas and to improve our cross boundary transport. But we must also manage demand. To push as many trips to public transport is not enough. Even public transport on the road is a source of pollution. Almost ninety percent of our daily non-freight trips are now on public transport but this has not helped break through the back of pollution. We will have to plan so as to minimise trip generation, and to meet any such transport demand by the least polluting mode as far as possible.
Our experience has taught us that we will have to co-ordinate transport services. We will need to plan for sufficient capacity but it does not pay to have overprovision. Competition is healthy only if it is not cut-throat. Gross overprovision means inefficiencies which need to be paid for, both in financial terms and in social costs. Our challenge is to provide the proper co-ordination which maintains the right balance between competition and integration.

In managing road use we will need all the available tools to maximise the capacity of our roads. We will have a keen interest to use the latest information technology to maximise the benefits of use of road space. On the other hand we should not forget that there are simple and sometimes low cost solutions to apportion the use of valuable road and kerb space. For example, we have so far made very little use of time zones for moving traffic and can do with more. In the final analysis our investment into our roads is so heavy that we cannot leave any leaf unturned to find better ways of managing their use.

We will need technology not just to manage road use. We will need to be at the forefront of technology to combat the pollution concerns on transport. We will need to investigate and invest into alternative fuels. We will have to look at ways of reducing traffic noise. We will also have to find ways to ensure all transport vessels are properly maintained.

**CONCLUSION**

Even without the impact of the recent Court of Final Appeal ruling, our population is projected to reach 9, some say 10, million in the next 12 years. Realistically we must be looking at an increase of around 3 million in population in 12 to 15 years’ time. This means we have to build the equivalent of 6 complete Tseung Kwan O new town within this period. Clearly an impossible task! We will have to have a new approach to planning, and this will apply to transport planning as well. To meet the population pressures we will have to pile more people together in a smaller space, but preserving and improving the standard of the living environment. In terms of transport, we will have to look not only at how we move people and goods around the city, but also at mobility within the locality.
3 The Third Comprehensive Transport Study

Sam CHOW

BACKGROUND

The Third Comprehensive Transport Study (CTS-3), commenced in August 1997, is the third in a series of major territorial transport planning studies carried out by Government to plan Hong Kong’s transport system. In 1973 Government commissioned the first Comprehensive Transport Study (CTS) to prepare an infrastructure and policy programme for Hong Kong. CTS was "comprehensive" as it conducted combination analyses of the public transport system and the road network, and included other elements such as transport policies and land use alternatives to determine a desirable strategy for transport systems and policies.

The study carried out surveys, developed transport models and investigated the requirements to keep Hong Kong moving for the then foreseeable future. The decision to construct the Mass Transit Railway (MTR) system and the realisation that it would be necessary to restrain private car travel were the most lasting results of CTS.

The study made many other recommendations including the infrastructure like the Aberdeen Tunnel, the Island Eastern Corridor and West Kowloon Corridor. It also recommended that tolls at the Lion Rock Tunnel should be used to control traffic at acceptable levels, and that consideration should be given to the imposition of toll charges on major expressways. Overall, it formed the basis of transport planning for the territory up to the late 1980s.

The Second Comprehensive Transport Study (CTS-2) was carried out during 1986-89. It formulated a transport strategy up to the year 2001 for a population forecast of 6.3 million under a scenario of which the airport would be retained at Kai Tak. Due to the considerable uncertainties of transport planning at that time, CTS-2 recommended that the implementation of the transport development strategy should be closely monitored, and that the strategy should be updated at regular intervals, taking into account any new development plans.
As such, the *Updating of the Second Comprehensive Transport Study (CTS-2 Update)* was undertaken from 1990 to 1993. The study reviewed the CTS-2 Strategy, taking into account the recommendations of the *Port & Airport Development Strategy (PADS) Study*, which included the relocation of the airport to Chek Lap Kok, Metroplan, and various reclamation studies. The planning horizon was also extended to 2011 for a population forecast of 6.6 million.

CTS-2 was a key study in the development of Hong Kong’s transport policy and systems. Its recommendations formed the basis of the 1990 White Paper *Moving into the 21st Century*. Many of the road and rail infrastructure recommendations of the White Paper have now been implemented. These include: North Lantau Expressway, Lantau Fixed Crossing, Route 3, Hung Hom Bypass, Western Harbour Crossing and Airport Railway/Tung Chung Line. The broad policy directions have also been generally maintained.

Subsequent to CTS-2 Update, a number of major transport and planning studies have been completed or are in progress. Those most relevant to CTS-3 include:

- *Working Party on Measures to Address Traffic Congestion (1994)* – prepared a list of policies and package of measures that could ameliorate traffic congestion in Hong Kong;

- *Territorial Development Strategy Review (TDSR)* – completed in mid-1996, this major Study formulated an integrated land use strategy up to 2011;

- *Crosslinks Study* – completed in 1996, this Study assessed the ability of Hong Kong’s environment and transport infrastructure system to cope with additional traffic generated by additional road links with Mainland China. The *Crosslinks Further Study (CFS)* is currently being carried out by Planning Department;

- *Railway Development Study (RDS)* – this study led to the Railway Development Strategy of 1994, providing a rail infrastructure strategy to meet forecast rail demand up to 2011. *The Second Railway Development Study (RDS-2)*, commenced in 1998, will identify the next stage of railway construction for Hong Kong;

- *Feasibility Study on Electronic Road Pricing (ERPFS)* – this study, due to be completed in early 2000, will advise Government on the applicability of ERP to Hong Kong; and
Study on Sustainable Development for the 21st Century (SUSDEV21) – this study will provide Government with a tool to evaluate the sustainability of development.

CTS-3 differs from earlier comprehensive studies in that it has essentially been split into four parts, with some of the data collection and model development already carried out in separate studies for the first three parts:

- Travel Characteristics Survey (Final Report, 1993) – collected the data on which the person travel models are based;
- Freight Transport Study (Final Report, 1994) – collected data and prepared models for freight transport; and

CTS-3 forms the fourth part and has carried out model validation, adjustment and improvement, integrated the results, and prepared the transport programme, using inputs from the earlier three parts, as well as data collected specifically for the study.

CTS-3 also differs from the previous versions of the study in that the impact of transport on the environment has received much greater attention. A Strategic Environmental Assessment (SEA) has formed a key and integrated part of the analysis and strategy development process.

CTS-3 OBJECTIVES

In the past CTS studies, the captioned objective has been achieved historically through the three-pronged strategy:

- Improving the transport infrastructure;
- Expanding and improving public transport; and
- Managing road use.

The overall objective of CTS-3 is to determine what has to be done to achieve and maintain an acceptable level of mobility for passengers and freight by all transport modes up to the year 2016 enabling continued social and economic development in an environmentally sustainable manner as far as possible. Specifically, the study has addressed the following issues in developing the transport strategy:
♦ Budgetary constraints;
♦ Environmental issues;
♦ Public acceptability;
♦ Congestion levels; and
♦ Availability of alternative means of travel.

Derived from this primary objective there are three general secondary objectives that must be met in a practical way:

♦ To establish the reasonableness or otherwise of the projects and policies proposed in recent strategic level studies;
♦ To provide a framework for the detailed regional and feasibility studies that will arise from the recommendations of CTS-3; and
♦ To provide a flexible framework to cater for different development and growth scenarios.

These objectives in turn lead to a series of key issues that must be addressed:

♦ The relationship between Hong Kong and Mainland China, in the sense of cross boundary supply and demand of passenger and freight transport;
♦ The development patterns in the New Territories, which form a dormitory for the urban area, and a corridor to be traversed by Mainland China traffic;
♦ The use that can be made of Lantau for new development and the opportunities it provides for transport infrastructure;
♦ The development of the urban area through variations of the reclamation programme;
♦ The need to maintain or create an acceptable environment for the people of Hong Kong, considering air quality, noise impacts and ecology;
♦ The need to provide infrastructure at a cost that is affordable in budgetary terms, and which can allow the transport operating companies to remain commercially viable;
♦ The need to define appropriate charges for transport infrastructure and services via acceptable and effective tolling and fare mechanisms;
The need to allow residents to make use of their increasing affluence, in their desire to make greater use of transport facilities, while not creating unbearable congestion; and

The need to move freight to satisfy the needs of Hong Kong and to maintain the affluence created by the port and airport trade.

STRATEGIC ENVIRONMENTAL ASSESSMENT

The impact of transport on the environment has received much greater attention in CTS-3. A Strategic Environmental Assessment (SEA) has formed a key and integrated part of the analysis and strategy development process. The incorporation of a SEA into the overall study process recognises the need for Hong Kong’s transport system to develop in a sustainable and environmentally-friendly manner as far as possible. It is an important objective of the study to identify a strategy that balances the principal aim of maintaining mobility with the damaging impacts of increased traffic volumes.

The main tools employed by the Study to assist in the development of the Strategy were the CTS-3 transport model and various noise and air quality assessment models. The CTS-3 transport model takes inputs such as assumptions on land use planning, economic growth, the size of the vehicle fleet, and network information to forecast demands on the transport system of Hong Kong. The model identifies constraints in the system, and can be used to test and evaluate alternative improvement measures. With appropriate adjustments, the model also provides input to a number of environmental assessment models, including noise and air quality.

DEVELOPMENT SCENARIOS

It is difficult to foresee events that will occur or conditions that will exist in 15-20 years time. CTS-3 therefore adopted an approach, which involved the examination of a wide range of development scenarios incorporating assumptions defining the key determinants of future travel demand. The intention was to address an envelope of assumptions and identify alternative combinations of infrastructure investments and demand management policies.

As Hong Kong moves forward, and levels of economic and other developments are better determined, Government can use the scenarios and packages to build a robust and flexible strategy that best meets transport
mobility, economic, financial, social, environmental and public acceptance objectives. This approach involves the examination of a wide range of growth scenarios defined by key elements. Key elements include:

- Land use planning scenarios;
- Economic growth;
- Port development;
- Vehicle fleet sizes;
- Value of time;
- Public transport fares;
- Transport infrastructure budgets;
- Cross boundary road and rail traffic;
- Airport trips; and
- International and cross boundary ferry trips.

SCOPE OF SEA

The SEA provides constraints on the preparation of possible infrastructure projects for examination and provides one of the main elements to be used in the evaluation of projects and policies. The SEA initially defines baseline conditions (1997) for Hong Kong, analysis procedures to evaluate environmental impacts, and a set of environmental performance indicators to be used in scenario evaluation, together with the operational, financial and economic outputs of the transport models. The SEA also assesses environmental impacts of transport strategy and recommends mitigation measures.

Air quality, noise and ecology are factors considered in SEA. Air quality assessment has been conducted in terms of emission inventories and detailed modelling. The emission inventories have compared transport scenarios on a district by district basis and identified districts where air quality could deteriorate. Noise assessment has been conducted in terms of noise conditions relative to the baseline (1997). Ecological appraisals were conducted when planning new infrastructure projects to identify proposed infrastructure projects.
CAPACITY DEFICIENCIES

The study has shown that the demand increase due to wide-ranging development scenarios have significant impact on the “existing plus committed” highway network. Person trips are forecast to increase at a faster rate than population. This is a result of higher personal incomes, higher private vehicle availability and smaller household sizes on trip making behaviour. Private vehicle trips are forecast to increase at an even higher rate. This higher growth rate reflects in the increased availability of private vehicles and a related shift in mode share from public transport to car. However, it should also be noted that private vehicle trip rates reduce through the design horizon as a result of increasing levels of congestion.

Widespread capacity deficiencies are forecast to exist in most major travel corridors. Rail boardings are forecast to increase at a higher rate than total public transport boardings. Increased use of rail is partially a function of rail system expansion, such as West Rail, included in the definition of committed projects. Also, severe congestion on the road system discourages bus use and diverts passengers to the rail system.

The severe deterioration in average road operating speeds is, of course, unacceptable on both transport and environmental grounds. Acceptable levels of mobility will not be achieved without additional infrastructure (both roads and rails) and new demand management policies.

Over the course of the Study, the outlook for many key factors affecting transport demand has altered. A series of sensitivity tests was carried out to examine the impacts of the following key variables:

- High development growth (high end), including a higher population, higher GDP, and a larger vehicle fleet;
- Reduced harbour reclamations with a bias towards development in the New Territories;
- Reduced harbour reclamations with a bias towards development on Lantau;
- Greater development at Tuen Mun Port; and
- Alternative cross boundary travel assumptions.

NEW INITIATIVES

In June 1998, a consultation exercise was conducted to allow the public
the opportunity to have their views taken into account in the findings of the Study. This represents an advance on previous CTS studies where any consultation was carried out at the end. This exercise found strong support for the new initiatives proposed:

- Integrated approach for land use and transport planning;
- According priority to railways;
- Better co-ordination of public transport;
- Timely provision of transport infrastructure;
- Managing transport with new technologies;
- Need to contain environmental impact; and
- Provision of safer and more convenient pedestrian facilities.

**Integrated Approach for Land Use and Transport Planning**

The demand for transport arises through the need for interaction between geographically separated land uses. These land uses may consist of “residential” from which workers need to reach their employment place, students their school place, or simply for the population to travel for shopping or entertainment. To these residences there is the need to deliver goods and services, and as land uses are rarely totally homogenous so that even residential land uses include some shopping, there would be the need to deliver produce to local shops. Similarly, for a “commercial” land use, there is the need for workers to travel, businessmen and customers to visit, together with the necessary deliveries and services. In the case of a “container port”, not only do loaded containers need to be taken to and from the port, but empty containers generally need to be taken away for storage until they are needed and the tractors required to move the container trailers must also find parking places. These ancillary land areas are termed port backup.

In the early days of urbanisation, land uses were closely integrated, with people living above their shop or close to their place of work. This meant that transport facilities largely dealt with the movements of goods, and to a far lesser extent with the mass movement of people. However, as person transport improved with railways and road-based vehicles, it became possible to improve the living environment through modern planning standards. These have largely separated land uses, so that residential neighbourhoods do not have the noise, air pollution and visual intrusions from immediately adjacent commercial and industrial areas. In
order to achieve and maintain a reasonable level of mobility, mass transportation has offered a solution but it also causes impacts to the environment. The extent of the environmental impacts can be reduced through land use planning that reduces the need to travel.

Firstly, by bringing together land uses that require major transport interaction, which can actually reduce the amount of travel needed. This principle can be applied on a wide variety of scales to achieve varying degrees of self-containment. The Territory as a whole is largely balanced, with some cross boundary differentials, but Hong Kong Island has a large excess of employment opportunities over labour force, and this state is likely to continue. This implies that most of the other regions have an excess of labour, and so could benefit from more employment to reduce travel demand. For example, in 1997 Tuen Mun had an estimated resident labour force of 220,000 as against employment of 107,000, and Sha Tin/Ma On Shan had 308,000 resident workers, as against 161,000 employment, in both cases roughly a ratio of 2:1. In the various planning studies of Lantau, where transport linkages are particularly difficult and expensive, there has been an attempt to maximise self-containment. These efforts should be continued in the various sub-regional studies although it is recognised that land reservation alone could not guarantee that the desired development would actually take place to provide the employment. It may be noted that in other countries, such as New Zealand, Government has taken the lead by moving major departments to developing areas to establish an employment base.

It is realised that integrating land use, transport and environmental planning are key objectives, which have guided planning in the Territory. Examples include NWNT and NENT Planning and Development Studies. However, this balancing principle can also be applied on a much smaller scale, such as the container port, where many efforts have indeed been made to allocate land for port backup close to the port itself. It is not proposed in general that residential and commercial/industrial areas should be re-integrated on a micro level, but developments such as the Cyber-port, where residential and compatible employment are in close proximity may help to reduce travel demand. Similar opportunities should be sought, and planning guidelines including Hong Kong Planning Standards and Guidelines could be reviewed with a view to more actively pursuing the goal of integrating land use, transport and environmental planning.

The other way in which land use planning can assist in solving transport problems is by the concentration of residential and commercial
land uses into small areas, which surround an actual or future rail station or other public transport interchange. This may not reduce the total travel, but rather allows it to be served by more efficient transport modes. One of the most important factors in determining people's usage of public transport facilities is the distance that they have to walk to get to the trunk service. Long walking distances, or the necessity to use a feeder service may reduce the share of public transport riders. Therefore, it would improve the usage of public transport if large numbers of both residential and commercial land uses could be planned close to such transport facilities. This would be further strengthened by the provision of good pedestrian access facilities.

These recommendations will have the effect of reducing the need for transport, and in particular, road transport, and so will act to improve environmental conditions.

**According Priority to Railways**

Wherever practical, CTS-3 has recognised the predominant role of railways in the movement of passengers. The new evaluation criteria incorporating economic, financial, developmental, and environmental considerations have also been adopted to assess rail projects, in conformity with the transport policy that railways will form the backbone of Hong Kong's future public transport network.

**Better Co-ordination of Public Transport**

The passenger carrying transport modes can be set out in a hierarchy depending on their relative efficiency and function. At the top of this hierarchy comes the heavy rail system, which is capable of carrying large numbers of passengers at low marginal cost, and with low adverse environmental impact. Coming next are the buses and LRT as the main providers of trunk services, with the rest of the other modes largely supplementing these services. The public light buses (PLB), especially in the form of green minibuses (GMB) may also act as carriers for lightly trafficked services. Ferries provide essential links to the outlying islands and ancillary services in the inner harbour.

Taxis provide a choice to travellers who are prepared to pay a premium fare in return for a personal, door-to-door service. However, in terms of road usage they are the least efficient type of public transport. Private cars impose a large burden on the community through their inefficient use of road space and their need for extensive parking facilities at both ends of their trips.
Hong Kong has one of the best public transport systems in the world, but there is always room for improvement. The current system serves around 11 million boardings everyday including taxis, and is under constant improvement. The rail system is under expansion and other modes will more and more act as feeders to the rail. A park-and-ride network will allow private vehicles to also act as feeders to the rail system. CTS-3 has examined the ways in which the co-ordination of public transport can be improved.

**Timely Provision of Transport Infrastructure**

Whatever infrastructure projects are selected in CTS-3, it is essential that they should not be constructed out of phase with actual demands. CTS-3 recommends the time of need for projects based on the best available forecasts of future developments, but the future is driven by too many variables to be accurately predicted. Therefore, CTS-3 has examined a range of future scenarios to give an envelope of possible needs, and has provided a trigger point mechanism (TPM) to allow Government to take into account changes in such matters as population and GDP forecasts.

The methodology adopted for the TPM isolates those factors that are most important in defining the traffic demand in the corridor of a new transport infrastructure project. The factors for highways will depend on the location of the project and are some or all of:

- Population (and/or employment) in the influence area of the project;
- Territory-wide GDP growth;
- Private vehicle fleet size growth;
- Goods vehicle fleet size growth;
- Port throughput demand;
- Airport throughput demand;
- Cross-boundary traffic; and
- Alternative off street transport modes.

**Managing Transport with New Technologies**

A balance is required between the need for transport and how that need is satisfied. Person movements can be made by different modes, which give different impacts on the transport system and so on the environment. The
way that transport is managed will drastically affect the results of any transport strategy, and new technologies can allow us to achieve a more optimal system. CTS-3 has considered various ways, means and effects of transport management through the application of these technologies.

Application of increasingly powerful in-vehicle computers linked to external information sources and traffic control centres by means of modern communications can provide a range of solutions to improve vehicle safety, to improve traffic management of the transport network and to provide travel information. These can be used to make more intelligent transport decisions.

These new technologies, which are also well known as Intelligent Transport System (ITS), can be applied to areas like area traffic control, highway surveillance, automatic incident detection, toll collection, speed enforcement, traveller information system, fleet management, driver navigation, and electronic road pricing.

**Need to Contain Environmental Impacts**

CTS-3 has examined the impact of transport policies and projects on the environment through ecological, noise and air quality evaluations. It has also identified a wide range of possible environmental mitigation measures to ensure that mobility of people and goods is achieved and maintained in a sustainable manner as far as possible.

**Provision of Safer and more Convenient Pedestrian Facilities**

The most environmental-friendly mode of transport is walking, but the congested street conditions and the unpleasant climate have often made this unattractive to most people. There are three main areas where pedestrian facilities can be used to increase the use of this mode of travel: access to public transport; direct pedestrian links; and pedestrianisation of local streets.

**ENVIRONMENTAL IMPROVEMENT MEASURES**

As stated in previous section, the environmental analysis forms an important component of CTS-3. Based on the findings of SEA, the environmental conditions will deteriorate if no further actions are taken to mitigate the potential environmental impacts associated with the expanding transport infrastructure necessary to sustain the mobility of Hong Kong. Some of the possible measures that can improve the environment are presented in the following sections.
Transport Measures to Improve the Environment include:

- Integrated land-use and transport planning to reduce the need for travel;
- More extensive rail network and promoting trunk and feeder services to maximise rail usage;
- Better co-ordination of different transport modes;
- Park and ride facilities;
- Application of new technologies in traffic management to relieve congestion;
- Pedestrianisation, possibly along with cycling facilities; and if necessary
- The more drastic measures such as restraining the growth and usage of vehicles.

Environmental Measures to Improve the Environment include:

- Alternative fuels such as diesel with low sulphur content for heavy goods vehicles and LPG for public light buses;
- Tailpipe emission reduction measures such as diesel catalytic converters and particulate traps;
- Limiting vehicle fleet age;
- Traffic demand management measures;
- Strengthen the inspection and maintenance programme for vehicles;
- More stringent noise emission standards;
- Engine encapsulation;
- Low noise road surface;
- Retrofitting existing roads (e.g. noise barriers);
- Putting new roads underground;
- Speed regulation;
- Expanded river trade terminal operation;
- Freight rail; and
Alternative vehicle types such as trolley buses and fuel-efficient vehicles.

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INTRODUCTION

The Hong Kong Special Administrative Region (SAR) has undergone a series of transportation infrastructure development since the 1970s. The building of the Mass Transit Railway, the improvement of the East Rail, the Hong Kong International Airport and related projects, the port development programmes, and the West Rail projects, to name a few, have all contributed significantly to the spatial reorganization of the territory in terms of population redistribution, landuse development, and socio-economic transformation, in addition to transport improvement.

Together with transportation infrastructure development is the improvement of traffic and transport operation and management, which is considered equally impressive. In short, one may conclude that with the adoption of optimizing landuse and transportation interrelationship as an urban planning approach since the 1980s, Hong Kong has gradually been transformed into one of the most efficient cities in the world as far as passenger and freight traffic and transportation movement is concerned. The high level of information traffic, though is a type of transport, falls outside the scope of the present discussion.

Perhaps other than airport and port development, most of the land transportation facilities, either completed or in progress, are mainly with an emphasis on internal efficiency. Emphasis on internal efficiency remains an essential objective of transportation development in any city. Notwithstanding, it must be recognised that land transportation development across the SAR border and beyond could generate significant impacts on our internal circulation and distributional logistics. Given the special position of Hong Kong in the Pearl River Delta Region and our recent reunification with the Mainland, a closer look at the cross border linkages appears to be relevant to our overall attempt in transportation development and traffic management.
The purpose of this short article is to provide an overview of our existing and proposed external transportation linkages, and at the same time to note the socio-economic and spatial implications of these linkages to the development of Hong Kong as a Special Administrative Region under the One Country Two Systems principle.

**CHANGES IN SPATIAL DEVELOPMENT POLICY**

Before entering into the discussion of transportation external linkages and the associated implications, one must first understand the spatial development strategies adopted by the past and present Governments in order to appreciate the link between transportation and development. It must be pointed out here that Hong Kong has never proclaimed any spatial development strategy preference. Conclusion can only be derived from our urban development trend. The refrainment from making a clear statement on spatial development preferences before the reunification was quite acceptable given our historical reality and the prevailing commercial sensitivity related to the issue. In contrast, our transport management policy has been relatively clear and precise.

Hong Kong has been actively creating a strong urban centre by concentrating most of the activities on both sides of Victoria Harbour. Obviously, this was a result of many factors, including infrastructure investment consideration, landuse constraints as well as geopolitical appraisal, among others. The strong urban centre attracted substantial international investment over the years that helped to turn Hong Kong into a great city and an international transportation hub in Asia Pacific.

The strong urban centre strategy certainly did not favour extensive development in the New Territories and the outer islands. In the past, all major transportation infrastructures were focusing on the urban centre, thus creating an efficient network for the enhancement of landuse intensification and landuse succession in particularly the central business district. Efficient transport facilities such as the mass transit railway and major trunk roads, were provided to link the urban centre and the new town residential areas at the urban periphery. In fact, new town development is an active vehicle in enhancing the establishment of a strong urban centre, as a result of relocating residential activities from the urban core.

The above-mentioned development strategy began to give way to a new approach that takes into consideration the potentials of the New Territories and beyond as the immediate sphere of influence of the city.
The reorientation of planning emphasis is gradually coming into existence with the transforming of Hong Kong as a Special Administrative Region within China. The introduction of the West Rail projects, the Deep Bay Bridges and the Zhuhai Bridge, to name a few, are recent proposals that could lead to a significant structural transformation of Hong Kong SAR with emphases on development outside the urban areas, and on the strengthening of spatial integration with the Pearl River Delta Region. One of the four proposed objectives of the recent Third Comprehensive Transport Study (CTS-3) also points to the need of using transport infrastructure as a stimulus to future spatial development of the SAR. With this change in development direction, Hong Kong is expected to play a new role which is different from that of the past.

Moving towards a stronger spatial integration is considered an important strategy in our future development. Healthy external transportation linkages are essential to this process. Notwithstanding, there are at least two relevant issues, which are equally important but occasionally not in line with each other, to be noted. First, improvement of transportation infrastructures should help to speed up further socio-economic cooperation between Hong Kong and other areas within the Pearl River Delta Region. Second, we must ensure that any such development should not lead to an increase of overall opportunity cost to the territory which may be not conducive to our future development as an SAR under the One Country Two Systems arrangement. How to strike a balance between the two objectives and at the same time supporting the continual growth of a robust Hong Kong economy remains one of the major planning challenges we are facing.

EXISTING AND PROPOSED TRANSPORTATION DEVELOPMENT PROGRAMMES

Based on the objectives mentioned above, we shall now proceed to examine some examples of external linkages in the various transport modes. The discussion below will focus on the opportunities as well as constraints available within the context of Hong Kong as an SAR under the Basic Law.

Air Transportation

The completion of the Chek Lap Kok airport projects has successfully re-established our leading role as a major air transportation hub in Asia Pacific. There are several airports in the Delta all aiming at the international
market, leading to possible serious competition among them. Notwithstanding, the Hong Kong International Airport will remain as the leading airport for many years to come given the special arrangement under the Basic Law and our past performance in the international air transport market. Coordination with other airports which was a major concern in recent years, especially on air traffic control, appears to be now in good order. Cooperation, as well as competition, in other areas such as passenger and ticketing sharing are issues in logistics to be sorted out. The present trend of strong cooperation among large airlines teaming up to provide a world wide network of services does not appear to be common among airlines utilizing airports in the Pearl River Delta Region. Obviously these airlines must first convince themselves that such a cooperation is conducive to their business operation. Perhaps the lack of efficient transport linkages among airports in the Pearl River Delta Region does not encourage such a service link up. Hong Kong may want to make use of its locational advantage by attracting potential passengers in the Pearl River Delta Region to utilize our airport for their international travel. Mainland airports may consider this an unfriendly threat to their respective market, inspite of the fact that the allocation of their international routes is within the control of the Central Government. To induce more direct transfer of passengers and cargoes between these airports and Chek Lap Kok, efficient direct travel links are required but lacking at the moment. Various modes of transport could be developed for this purpose.

Sharing of passengers and cargoes remains a sensitive issue among airports. One has only to recall the air cargo emergency arrangement during the early months of Chek Lap Kok operation for reference. Hence, some intelligent and innovative proposals are required to set up a workable programme from the beginning. The Hong Kong Airport Authority may take the lead to initiate workable programmes. There appears to be a need for these airports to coordinate and establish a hierarchical structure among them in order to avoid repetition in services and in resources allocation.

Discussion prevails on the possibility of using either Xian or Chengdu as a hub in China to cater for air traffic between Asia and Europe, in order to counter balance the position of Bangkok and to a less extent that of Singapore, which are all located along a similar longitude. A rescheduling of air traffic pattern may occur under such a programme. Although both Xian and Chengdu airports are at present not of the similar scale of Chek Lap Kok, the completion of the massive airport development and expansion programmes which involve a total of not fewer than a hundred airports in the country may make us re-examine our future positioning strategies.
With a mature air traffic market in the Mainland, the position of Hong Kong could be further enhanced, provided that we are able to continuously expand our sphere of business penetration.

**Port Development**

Our massive port development programmes indeed are based on a rather promising economic growth forecast of the region. The recent financial crisis in Asia and the existing port development programmes in South China outside the Hong Kong SAR may force us to consider technical adjustment in our growth estimates, and subsequent reassessment of our development programmes. Nonetheless, the urge for maintaining our position as the transportation and transshipment centre should be maintained.

Port management as an enterprise relies heavily on private participation in Hong Kong. The same trend will continue into the future. Port developers of Hong Kong have to date not only actively involved in large scale port business in the Pearl River Delta and elsewhere in China, but also in other major locations of the world. The globalization of the port business helps in strengthening Hong Kong’s position in the world market. The transformation into global operators allows Hong Kong’s port management companies to redress their investment strategy. Hence, how to maximize the inter-port links is a relevant question not only to the port operators, but also to Hong Kong as a major port. To the operators, this is a traffic logistics problem. To Hong Kong, it involves our long term spatial development strategy.

The position and size of a port is measured in terms of cargo volume. Whether to continue competing for volume leadership remains a business decision. We may encounter serious challenges in this area in the future if our port developers are attracted more and more to ports across the border. On the other hand, Hong Kong may in the future turn itself into the headquarters of operation for ports in the Pearl River Delta Region by coordinating the overall business in the area. In short, with the increase in operational and ownership integration among ports and port operators, there is a need for Hong Kong to extend its direct managerial and business sphere beyond the territorial boundary, rather than just to concentrate on port infrastructure expansion programmes within the SAR.

**Land Transportation**

Major traffic issues raised in the past are mainly related to land transportation, including highway and railway development. For reasons
explained, development in the past had been focusing on the urban centre and did not take into sufficient consideration in providing efficient linkages across the border. The recent change in territorial development approach demands our attention in this area.

The Hong Kong to Beijing railway service provides the long distance transport, while our West Rail projects concentrate more on the provision of efficient rail services to the New Territories, with possible extensions linking the urban rail development in Shenzhen. The Lok Ma Chau and Deep Bay Bridge are two major links, in addition to Lowu. With a planned facility to accommodate 400,000 passengers daily at Lowu by the Shenzhen Authority, we may also have to reconsider our traffic forecast and resources deployment at this exit point. We can envisage a close network link between Kowloon Canton Railway Corporation and Shenzhen in the future once the West Rail and Shenzhen mass transit railway are in operation. This in turn will create a rather significant impact on our population redistribution, landuse and urban development pattern, in addition to transportation demand changes.

The building of the Deep Bay Bridge may take place much earlier than the Zhuhai Bridge, because of its urgency and funding feasibility. The latter in fact was recently considered a low priority project on the national transportation development agenda. The construction of these two bridges demands the redesigning of our highway network in accommodating traffic from the two different directions. From Hong Kong’s point of view, we may have to carefully assess whether it is conducive to our overall development in having the Zhuhai Bridge landing in the New Territories, or to have it linking directly with Shenzhen, and later connected with Hong Kong through the proposed Deep Bay Bridge.

Highway traffic between Hong Kong and Shenzhen to date remains a difficult problem. Heavy container trucks to and from our ports over the years have created serious traffic congestion in Hong Kong as well as in Shenzhen City when passing through its urban area to other towns in the Pearl River Delta Region. Such traffic congestion may be viewed as negative economic externalities generated by our port expansion programmes. The society is asked to shoulder, for example, the said externalities of our privately owned port business as a social cost. A careful traffic management design to maximize inter-port linkages can reduce that part of our land traffic congestion caused by container trucks and cargo transport, and at the same time do not affect the revenue return of the port operators. At the cross border level the problem demands careful
coordination between the two Governments in searching for workable solutions.

The solving of the above cross border problems involves not only the vehicle traffic, but also the links between Hong Kong's roads and highways with those in Shenzhen and beyond. Many of the expressways from various Pearl River Delta cities meet at Shenzhen City without proper linkages among them. There exists no direct link with Hong Kong expressways either. In order to speed up land traffic links between Hong Kong and cities in the Pearl River Delta Region, it may be necessary to establish an expressway extension network linking Hong Kong's highways directly with these expressways. This serves at least two purposes. First, it provides direct venues for cross border truck traffic. This helps to reduce significantly unwanted traffic congestion in Shenzhen city centre. Second, it allows Hong Kong to link up directly with the expressway system of the country, enlarging our hinterland or sphere of influence.

If in the future we have to accept the Zhuhai Bridge, the network of expressway extensions mentioned above then can become the base for through traffic between both sides of the Pearl River Delta. It also serves as an efficient channel for diffusing our business influence to a wider market across the country. This positioning, unfortunately, is not being emphasized enough at the moment. An issue yet to be worked out is the management of traffic flows in view of the fact that vehicles are operated at the opposite lanes outside Hong Kong. Vehicles on these expressways could be restricted from mixing with the traffic of our local road system.

THE NEED FOR REPOSITIONING

The above illustration highlights only a few random thoughts on areas of concern and possible strategies facing Hong Kong. To implement any of them requires careful coordination between Hong Kong and our counterparts across the border. Existing channels could be but are yet to be fully utilized to enhance mutual cooperation. New venues can be created if necessary. More importantly we need to establish a set of guidelines and understandings between the public and private sectors within Hong Kong before taking up any new approach with other cities in the Pearl River Delta Region.

With the continuous open policy, the various cities in the Pearl River Delta Region are enjoying opportunities of direct links with the outside world which are not easily available in the past. Hong Kong therefore is facing direct competition from these cities. This inevitably will force us
to re-examine our future development strategy as a member city of the region. In fact, the Delta is transforming rather rapidly into an extended metropolitan region. In what role shall we play in the region in the future becomes so crucial an issue in our long term development plan. The development of transportation links is only one aspect of our overall development programme.

An equally challenging issue facing us is how to speed up our spatial integration process with centres in the extended metropolitan region without weakening our position as the transportation hub of the area. The solution lies beyond the transportation sector. It depends also on the success of our business operators by enhancing our services beyond the territorial boundary to capture the opportunities available as a result of the improved linkages. Otherwise, we could be challenged by the rapid urban development in the Pearl River Delta led by Shenzhen next door. There is an urgent need to coordinate our thought and vision on the repositioning of the SAR as a key player in the emerging metropolitan region of South China.
5 Future Development of the Port of Hong Kong

YUEN Ming-fai, Richard

INTRODUCTION

Hong Kong was founded as a port for China trade some 160 years ago. It has been in the entrepot role that the territory has flourished through its history. Today Hong Kong is the leading world port for China and is a major transhipment hub port for South-east Asia.

In 1998, the port of Hong Kong handled a total of 14.6 million TEUs (Twenty-foot equivalent units) representing a growth of 1.4 per cent over the previous year as shown in Figure 5.1 (HKPMB, 1999a). This makes Hong Kong one of the busiest container ports in the world.

![Figure 5.1 Hong Kong Container Throughput](image)

Source: Hong Kong Port and Maritime Board

The opening of China’s economy to the outside world in 1978 presented Hong Kong with new challenges and new opportunities. The Special Economic Zones established in the Pearl River Delta attracted huge investment from overseas and Hong Kong in joint ventures with Mainland manufacturers. Apart from playing the role of channelling investments
and managerial skills into the economic zones of southern China, Hong Kong, with its comprehensive link with the outside world, provides the main conduit for the movement of raw materials into and finished products out of the manufacturing plants in Southern China.

Since then, Hong Kong has become the gateway to China and the main international port for southern China as well as for much of the rest of the country. Last year the number of China-related container boxes shipped through Hong Kong amounted to around 9 million TEUs.

On the other hand, the shift of Hong Kong’s lower value-added labour assembly operations into the South-east Asian region, especially into southern China, has enabled us to develop into a manufacturing support base for the region.

Taking advantage of lower operating costs, ample supply of cheap land and a hardworking labour force, much of Hong Kong’s manufacturing developed during the 1960s and 1970s has relocated to Guangdong. At present, Hong Kong companies are said to have set up at least 40,000 factories, employing about 5 million workers in the province. To keep these factories running, raw materials and semi-finished products have to be imported and the finished products exported. The obvious choice is through the deep water port of Hong Kong, which is well known for its high efficiency, reliability and hassle-free customs procedure. Hong Kong and Guangdong have since benefited tremendously from this symbiotic relationship and Hong Kong has boomed as China’s economy expanded.

In the past 10 years, Hong Kong-China trade has been growing at an average rate of 14 per cent per annum. About 87 per cent of the cargoes in southern China are now imported and exported through Hong Kong port (HKPMB, 1999b).

PORT DEVELOPMENT POLICY

Hong Kong is unique in the sense that it is the only major international port in the world which is fully privately owned and privately operated. Most ports in the world are run by the Government, usually through a port authority. Hong Kong is not.

Since the development of the first container terminal in Hong Kong in 1972, the policy of the Government has been to provide new terminal facilities to match forecast demand. This policy encourages private investment, ensures high capacity and levels of efficiency, optimises the use of limited land resources and minimises waste. We rely on the private
sector to finance, build, own and operate new terminals in response to market demand. They assume the risk and take the profit. The Government provides the necessary back-up land, navigation channels, infrastructure and utilities.

Our system allows the private sector to finance, design and operate crucial parts of our port infrastructure, a system which has helped to make Hong Kong the world's ninth largest trading entity as shown in Table 5.1 (WTO, 1999).

Table 5.1  Top 10 Trading Entities in the World in 1998

<table>
<thead>
<tr>
<th>Economy</th>
<th>Trade Value in US$ billion</th>
<th>% Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. United States</td>
<td>1,627.6</td>
<td>14.9</td>
</tr>
<tr>
<td>2. Germany</td>
<td>1,006.3</td>
<td>9.2</td>
</tr>
<tr>
<td>3. Japan</td>
<td>668.5</td>
<td>6.1</td>
</tr>
<tr>
<td>4. France</td>
<td>594.2</td>
<td>5.4</td>
</tr>
<tr>
<td>5. United Kingdom</td>
<td>588.8</td>
<td>5.4</td>
</tr>
<tr>
<td>6. Italy</td>
<td>454.9</td>
<td>4.2</td>
</tr>
<tr>
<td>7. Canada</td>
<td>419.3</td>
<td>3.8</td>
</tr>
<tr>
<td>8. Netherlands</td>
<td>382.8</td>
<td>3.5</td>
</tr>
<tr>
<td>9. Hong Kong, China</td>
<td>362.8</td>
<td>3.3</td>
</tr>
<tr>
<td>10. Belgium-Luxembourg</td>
<td>330.5</td>
<td>3.0</td>
</tr>
<tr>
<td><strong>World Total</strong></td>
<td><strong>10,935.0</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

*Source: World Trade Organisation*

This private-sector led port development policy enables Hong Kong to take advantage of the commercial skills and flexibility of private operators, and keep to a minimum the bureaucratic red tape most disliked by business.

More importantly, this policy gives Hong Kong one of the world's busiest container ports at literally no cost to the public purse, except for the infrastructure such as roads and the dredging of channels which the Government must provide in any event.

The success of Hong Kong's port, and the increasing number of countries now seeking ways to privatisate their own port operations, of which
Singapore is a good example, are indicators that our system works and works well.

**MODES OF OPERATION**

Flexible operation is the strength of the port of Hong Kong. There are three main modes of container handling operation in Hong Kong, namely container terminals, mid-stream and river trade. They meet different customer needs and they compete with one another. The complementary characteristics of the three modes of container handling operation are highlighted in Figure 5.2. It is through the promotion of internal competition that Hong Kong succeeds in maintaining its competitive edge.

![Figure 5.2 Complementary Characteristics of the Three Container Handling Modes](image)

**Figure 5.2 Complementary Characteristics of the Three Container Handling Modes**

At present we have eight container terminals at Kwai Chung with a combined annual capacity of more than 11.5 million TEUs. In 1998, the Kwai Chung container terminals handled 9.56 million TEUs, about two-thirds of Hong Kong's total throughput as shown in Figure 5.3.

More than one-sixth of the port's container throughput is handled mid-stream. This involves the loading and unloading of cargoes from ships moored at buoys or anchorages in the harbour. Cargoes are taken from ship to shore by lighters which have their own derricks. The lower cost of this mode of operation provides a competitive alternative to container terminals and permits small to medium size ships, often engaged in intra-Asia trade, to handle containers more economically.
Figure 5.3  Pattern of Hong Kong Container Throughput in 1998

In 1998, 2.64 million TEUs were handled mid-stream in Hong Kong. If mid-stream operations here were to be considered as a single and separate entity, this throughput would have ranked it as the world's number 12 container port in the world.

The burgeoning trade between Hong Kong and the Pearl River Delta uncovered the potential of utilising the numerous waterways in the area as a natural highway to transport containers or cargoes to and from Guangdong. In 1998, some 2.39 million TEUs were handled by river trade vessels plying between Hong Kong and the delta area. The transportation of containers by river trade vessels provides a cheaper and environmentally friendly alternative to the increasingly congested road system.

Competition exists in these three modes of operation. There are four main container terminal operators, over 15 large and small mid-stream operators, and numerous companies operating in the river trade. On the whole, different modes of operation catering for different needs can complement one another and operators of different services are encouraged to co-operate to provide a better overall customer choice. The internal competition helps us cope with constantly changing cargo and shipping patterns.

Competition among the container terminals and from alternative modes of container handling drives the operators to improve efficiency and quality of service. Sea-Land Orient Terminals, a one-berth terminal operator at the Kwai Chung container port now handles over 1 million TEUs a year. This is more than twice the world standard.

Competition does not rule out co-operation. Today co-operation among rival container terminal operators in the same port is a trend. With the
restructuring of major shipping alliances, Hong Kong's terminal operators will have to co-operate more closely in the future to serve these mega alliances. Otherwise a single operator might have difficulty in servicing big alliances on a regular basis. In fact, there are already overflow arrangements among operators at Kwai Chung. The four operators at the Kwai Chung container port have set up the Hong Kong Container Terminal Operators Association (HKCTOA) on 30 June 1999. The main mission of the Association is to promote the port of Hong Kong as the Container hub for the region providing premier service to the shipping industry.

PEARL RIVER DELTA PORTS

Hong Kong is not the only port in the area. There is wide-spread port development in the Pearl River Delta which gains momentum each year. The Shenzhen ports alone handled close to two million TEUs last year — more than 10 times their total throughput five years ago as shown in Figure 5.4.

![Figure 5.4 Shenzhen Ports Container Throughput](image)

Source. Shenzhen Municipal Port Authority

Most of the Pearl River Delta ports do not have deep water access or deep water anchorages; the constant dredging necessary is either prohibitively costly or geographically impractical.

The ports in Southern China which represent the greatest challenge to Hong Kong are Yantian in the eastern coast of Shenzhen and Shekou in
the western coast of Shenzhen. There is no doubt that Yantian, which has open deep water access, and possibly Shekou, with an improved channel access, will develop into successful and busy ports.

Yantian is separated from the Pearl River waterways by Hong Kong, but it has an ample supply of backup land for developing an in-dock rail terminal to connect to Mainland’s rail network and serve the central and western inner provinces. It can also extend its catchment area up to eastern Guangdong and Fujian.

REGIONAL PORTS

While we are not complacent, we do not foresee regional competition on a scale which would pose a threat to our growth in container throughput. In the region, Singapore and Hong Kong have a friendly rivalry over the title of “the world’s busiest container port”, but that is as far as it goes. Singapore is a hub for South East Asia. Hong Kong provides alternatives for transhipment from Vietnam, the Philippines and to a gradually greater degree the ports of Fujian Province.

Korea has its own established market and has handled transhipment cargo from Eastern and Northern China. Japanese ports, particularly Kobe, have always handled large volumes of Northern and Eastern Chinese transhipment cargo. But Kobe is considered very expensive in the shipping world and is not likely to attract transhipment cargo from Hong Kong. Shanghai handled more than 3 million TEUs in 1998. It will certainly develop - but is likely to concentrate on its own vast hinterland.

Kaohsiung will certainly take some of our business as and when the process of direct trade between the Mainland and Taiwan becomes established. With full liberalisation of direct shipping links between the Mainland and Taiwan, it is anticipated that about 80 to 90 per cent of the cargoes (about 1 million TEUs) which are currently shipped between the Mainland and Taiwan via Hong Kong will be affected.

However, current indications are that this development will take several years, and the actual impact is likely to be less serious. Indeed liberalisation so far has not had a very appreciable effect. We must not underestimate the positive side of the liberalisation, which is expected to bring more investment in the Mainland and increase trade flow between the places which in turn will generate more cargoes and more port traffic for everyone in the region.
PORT CARGO FORECASTS

The policy of our Government has always been to provide new port facilities to match forecast demand. A key element of this policy is the accurate forecast of future port cargo demands. The Port and Maritime Board engages experienced and reputable international consultants to assist us in undertaking a major review of the Port Cargo Forecasts once every two to three years. This is to ensure that these forecasts, which covers a span of up to 20 years ahead, are as accurate and up to date as possible.

According to our latest forecasts published in February 1998, the throughput of the Hong Kong Container port is forecast to grow on an average of 5.8 per cent a year in the next 10 years. Exports from South China will continue to be the driving force behind the growth of the port of Hong Kong.

The forecasts have taken into full account projected port developments in South China and the possibility of direct shipping links between the Mainland and Taiwan. In more specific terms, the forecasts predict that the throughput of Hong Kong container port will increase to 24 million TEUs in 2006 and 33 million TEUs in 2016 as shown in Figure 5.5 (HKPMB, 1998). The forecast figures show that Hong Kong needs more new terminals beyond Container Terminal 9 to meet demand in the next 20 years. We will of course need to review these figures in the light of the impact of the Asia financial turmoil and China’s accession to World Trade Organisation. The next forecasting exercise will be conducted in spring 2000. But the important message is with the continued and rapid growth of the Mainland economy and manufacturing sector, we can expect a strong demand on Hong Kong’s container handling facilities in the long term.

FUTURE PORT DEVELOPMENT

The new Container Terminal 9, on Tsing Yi Island opposite the eight existing terminals at Kwai Chung, will occupy an area of 70 hectares and consist of four deep sea berths and two feeder berths. The latter are designed to cater for the interchange of containers between large ocean-going vessels and regional carriers. The first berth of CT 9 will come on stream in mid 2002, and, when fully developed, the terminal will provide an additional capacity of at least 2.6 million TEUs.
Figure 5.5 Hong Kong Container Cargo Traffic Forecast

In order to provide improved facilities for mid-stream operators, the Government has leased two permanent mid-stream sites on Stonecutters Island comprising 6.7 hectares with some 460 metres of quay length.

To encourage river trade and to promote the use of Pearl River waterways to transport containers, we are building Hong Kong’s first dedicated river trade terminal at Tuen Mun. The first phase of the terminal came into operation in October last year and the whole terminal is expected to complete by the end of 1999.

The river trade terminal will collect and consolidate cargoes brought down by small river trade vessels before feeding them, in large dedicated shuttle barges, to the Kwai Chung container terminals and mid-stream operators. This will improve the efficiency of the terminals and mid-stream operations and cut down the actual amount of water-borne traffic in Hong Kong harbour.

ROLE OF HONG KONG PORT

According to our latest Port Cargo Forecasts published in 1998, which included extensive interviews with key and experienced industry players and port operators in Hong Kong and the Mainland, cargo from South China will grow sufficiently fast to support the planned expansion of the ports in the region, including Hong Kong and Shenzhen.
We need to increase co-ordination on regional port development to avoid excessive short term competition detrimental to everyone. And to this end the Port and Maritime Board Secretariat is working closely with the Mainland port authorities.

We make frequent visits to Pearl River Delta ports to assess their development and better understand the role we shall have to play in the future. Our talks with their management suggest that nearly all of them, with the exception of Yantian and possibly Shekou, are likely to develop as feeder ports with Hong Kong as the hub. The important point is that these ports and Hong Kong need to co-ordinate developments to serve and support the needs of Southern, Central and Western China’s economic growth.

The picture we see emerging is of Hong Kong developing more and more as a hub port for Southern China, with feeder services to smaller ports in the Pearl River Delta. Apart from building river trade terminals, we are also encouraging container terminal operators to step up liaison and co-ordination with river trade terminals in the Pearl River Delta area. In some ways this co-operation is enhanced by common commercial interests being involved through joint ventures in port ownership and management.

Given the large size of Hong Kong’s container port and the critical mass of shipping lines calling here, the Mainland market must continue to rely on the port of Hong Kong to handle a major share of its imports and exports. At present, Hong Kong operates 400 shipping services a week compared to Shenzhen ports 107 scheduled services per month. Hong Kong has ships providing services to over 170 ports in 60 countries worldwide. In Asia alone, we have regular services to more than 80 ports.

CONCLUSION

Competition in any industry is a necessity. We have already discussed the internal competition we have in Hong Kong as well as competition in Southern China.

Both the Hong Kong Port and Maritime Board and the Shenzhen Municipal Port Authority realise that our future lies in co-operation and interdependence rather than in competition. Consequently we have developed close liaison with our counterparts on the Mainland to ensure that our ports are well equipped both operationally and commercially to accommodate the various cargo flows and patterns emanating from Southern China.
On a grander scale new links with the Pearl River Delta are scheduled. The first from Shekou across Deep Bay will be in place by 2006. To complement this road infrastructure we are conducting feasibility studies for two new container terminals at Tuen Mun port. In the longer term a bridge across the Pearl River Delta is planned.

Cargoes and trading routes are volatile and will change over time. We hope that our system, with its built-in monitoring through the Port and Maritime Board, will enable us to update regularly our strategic plan to cope with local and international changes.

Hong Kong is building a port to serve not just its own economy and that of southern China, but the whole region. Hong Kong is dependent on economic events well beyond its own borders, and is only too aware how vital co-operation is in order to achieve accurate forecasts for future strategic planning.

Hong Kong has long experience. We are efficient, non-bureaucratic and reasonably priced and are technologically at the leading edge. I have no doubt that our growing port will enable the territory to maintain its leading world position as a prime trading economy. We are only too happy to share our experiences in running a port as well as port planning with others, because we believe that co-operation is the way forward.

NOTE

1 The four container terminal operators are Cosco-HIT, Hongkong International Terminals, Modern Terminals and Sea-Land Orient Terminals.

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INTRODUCTION

East Rail is the southern most section of the north-south Jiangjiu strategic railway corridor connecting Hong Kong with Beijing. Since 1910, East Rail, formerly known as the British Section of the Kowloon-Canton Railway, has been playing its role in moving people and goods between Kowloon, the New Territories and the Mainland.

The history of East Rail dates back to 1898 when the British Chinese Corporation obtained concession from the Imperial Government of the Qing Dynasty to build a railway between Canton (now known as Guangzhou) and Kowloon. An agreement was signed to the effect that the railway should be divided at the Shenzhen River into the British and Chinese sections and the two governments should be responsible for the construction of their own section.

The Hong Kong Government was responsible for the operation of the British Section of the railway until the inception of the Kowloon-Canton Railway Corporation (KCRC) in 1983 that took over the train operation from the Government. The Government is the sole shareholder of KCRC.

Today, KCRC is one of the world’s most successful railways, carrying over one million passengers a day and being profitable over the past 14 years. It operates without any Government subsidy.

Its net profit has been growing steadily to reach HK$1,640 million last year. A HK$956 million profit was posted in the first half of 1999. Its return on average next fixed assets has increased 2.5 times from 4 per cent in 1990 to 10.4 per cent in 1998.

KCRC is committed to quality and productivity and the efforts made gained wide recognition. In 1998, it was chosen as one of Hong Kong’s top ten companies in the Far Eastern Economic Review’s Review 200
Survey and was the winner of the Grand Award of the Hong Kong Awards for Services: Productivity. In terms of productivity, the cost of carrying each passenger for one kilometre has fallen from 63.9 cents in 1990 to 40.5 cents in 1998 and the number of employee per million passenger-km has dropped from 0.77 in 1990 to 0.45 in 1998.

EAST RAIL

East Rail has undergone a lot of changes since the early days when steam-powered locomotives operated on a single track system. It advanced from steam to diesel-powered locomotives in 1955. The Government’s new town programme in the New Territories marked the beginning of the modernization of East Rail. In the ensuing two decades, the system was double tracked and electrified, transforming East Rail into a fast and efficient commuter system.

Improvement continued after KCRC took over the operation from the Government. To achieve the mission of providing quality transport, the Corporation re-invested profits in further improvement of the services. Railway stations were expanded with the provision of more elevators and exits. A new extension was added to the Hung Hom Station. A new signalling system, known as the Automatic Train Protection, was put in place to enhance safety and to increase train frequency. Train cars have been undergoing a major refurbishment leading to an increase in carrying capacity. With the arrival of new train cars and completion of the refurbishment in 2000, the overall carrying capacity of East Rail will increase by 38 per cent to cope with the passenger growth. East Rail is now the most predominant transport mode in east New Territories, commanding 52 per cent of the market share. This trend will continue in the future.

The opening up of the Mainland market in the 1970s brought new opportunities to develop rail links with the Mainland. Through train to Guangzhou was resumed in 1979 after a 30-year break. To meet the needs of the travelling public, primarily in the Mainland, the inter-city service was extended in 1997 to Shanghai and Beijing. There is potential to develop these long-haul routes into attractions for tourists.

For inter-city services within Guangdong Province, KCRC in collaboration with Mainland railway authorities operates routes from Hong Kong to Changping, Foshan and Zhaoqing. The speed and comfort of through train service to Guangzhou was upgraded in 1998 with the launching of the double-deck \textit{ktt} trains which provide passengers the
service equivalent to jetliner travel and cut journey time to about 100 minutes.

To cope with the increasing demand, the number of through trains to Guangzhou was increased from four pairs a day to seven pairs when Phase I of the Guangzhou metro system opened in early 1999. By providing passengers a direct access to Guangzhou’s metro system, the through train ridership increased by 30 per cent since the metro.

Cross-boundary passenger flow also increased significantly. Last year there were 65 million passenger crossings via Lo Wu or 180,000 daily. The figure represents an 18 per cent growth when compared with 1997. In terms of market share, it grew from 75.3 per cent to 76.9 per cent. The increase continued in the first six months of 1999 with the average daily crossings reaching a record high of 202,000, representing a 20 per cent year-on-year increase, or 77.4 per cent of the market share.

The role of East Rail as a strategic link in the Pearl River Delta region is growing each day. When the metro system in Shenzhen opens in 2004, it will serve as a landbridge connecting metro systems in Hong Kong, Shenzhen and Guangzhou.

As a multi-modal system, East Rail operates freight services between Hong Kong and major freight distribution centres in the Mainland including Xian, Wuhan, Chengdu and Changsha. However, freight development is constrained by keen competition from other freight operators and by the lack of a direct access to the container port at Kwai Chung. At present, transshipment by rail from the Mainland has to rely on on trucks to perform the last leg of their journey to the container port at Kwai Chung.

To overcome this handicap, KCRC has put forward a proposal to build a freight tunnel from Tai Wai to the container port at Kwai Chung which will enable re-exports from the Mainland to reach the portside directly.

To complement this, KCRC is also looking into the feasibility of participating in the development of a freight storage and distribution centre in Pinghu, 15 km north of Shenzhen. Implementation of this proposal will enable exports from the inner provinces to route via Pinghu to Hong Kong.
LIGHT RAIL

Light Rail is a local closed commuter system serving the new towns of Tuen Mun, Yuen Long and Tin Shui Wai in northwest New Territories. The system opened in September 1988. Since then, more routes were added to meet the needs of these strategic growth areas. Light Rail now has a length of 32 km which is 36 per cent longer than the original alignment.

With an average daily ridership of 314,000, Light Rail is the most predominant transport mode in northwest New Territories. The system is now undergoing a HK$2.3 billion improvement programme which, upon completion by 2004, will transform it into a feeder system for Phase I of West Rail. Major improvement includes the construction of two new extensions in Tin Shui Wai; upgrading four Light Rail stations into interchanges with West Rail; installing a new signalling system and separating Light Rail and road traffic at busy junctions.

THE WAY AHEAD

KCRC is committed to developing a comprehensive railway network to meet the growing transport needs. In the next five years, it will invest HK$80 billion on four new railway projects which will change the face of Hong Kong.

Phase I of West Rail, which will link up northwest New Territories with West Kowloon, is now under construction. When this railway opens in December 2003, it will cut journey time from Tuen Mun to Nam Cheong Street to 30 minutes.

West Rail will be one of the quietest railways in the world. It will comply with the very stringent noise control law in Hong Kong. During early morning and late night, the train will be operating below a noise level of 55 dB(A) over a 30-minute interval in rural areas. This is made possible by a multi-plenum noise attenuation system specially developed for this railway. The system uses a number of devices to trap at source the noise of a running train. These include the use of side skirts and underbody noise absorption material to attenuate noise emitting via the contact of train wheels and tracks, floating slabs with rubber support to mitigate noise of vibration and noise barriers on both sides of the tracks as an added protection to attenuate noise.

West Rail is a fully electrified system operating in an environmentally friendly manner. It will help clean up air by reducing
emission from vehicles which is a major source of air pollution in Hong Kong. With an estimated daily patronage of 340,000 in the initial phase of its operation, West Rail will save the need for about 2,500 bus trips a day and hence a substantial amount of harmful pollutants emitting from diesel-powered buses.

For the convenience of the travelling public, KCRC sees the need to develop West Rail as a strategic east-west railway corridor. We could make this happen by extending West Rail via the Southern Loop and Hung Hom Station to terminate at Diamond Hill in East Kowloon. This extension will bring shorter travelling time between East and West Kowloon and reduce road congestion and hence air pollution in the heavily built-up areas of central Kowloon.

To complement the west-east corridor, there is a need to beef up East Rail’s role as a strategic north-south corridor. Such need was confirmed in the Railway Development Strategy which has been accepted by the Government as the blue print for developing the railway network up to 2004. The Government has invited KCRC to proceed with detailed design for the construction of three East Rail extensions. They are the Ma On Shan Rail to serve the new growth area in North East New Territories, the Tsim Sha Tsui Extension to provide a second interchange with MTR and the Sheung Shui to Lok Ma Chau Spur Line to relieve congestion at Lo Wu.

Ma On Shan Rail will provide a fast and efficient service to the growing population in the area which is expected to double in 20 years. The 11.4-km railway will have nine stations and will interchange with East Rail at Tai Wai.

The railway will be on viaduct for most of its length and the stations are located for most part within easy walking distance of large residential developments in the area. The railway will adopt the same multi-plenum system developed for West Rail to attenuate train noise. It includes extensive use of noise absorbing devices on tracks and underneath train cars that will enable train operation to meet the stringent statutory noise control requirements in Hong Kong.

The Tsim Sha Tsui Extension will extend East Rail southwards by one kilometre from Hung Hom Station to East Tsim Sha Tsui. The extension will run underground below Salisbury Road to terminate at a new station below Wing On Plaza and the Middle Road Playground. There will be pedestrian subways to link up the station with the nearby
commercial developments and the MTR station at Tsim Sha Tsui. With this extension, cross-boundary passengers can travel all the way to the main business and tourist centre in Kowloon.

The Sheung Shui to Lok Ma Chau Spur Line will provide a second boundary crossing for rail passengers. This extension is urgently needed to relieve congestion at Lo Wu. The 7.4-kilometre rail line will branch off from East Rail north of Sheung Shui and run westwards to a new station at Lok Ma Chau.

The Lok Ma Chau station will have facilities similar to those at the existing Lo Wu station. There will be shops and accommodation for customers and immigration clearance. The new station will be linked by a pedestrian bridge across Shenzhen River with Huanggang where boundary-crossing passengers will have direct access to Shenzhen’s metro system and easy transfer to other land transport for journeys to other parts of the Mainland.

CONCLUSION

The four KCRC new projects are due for completion between 2003 and 2004. They are crucial to the development of a comprehensive railway network which will support Hong Kong’s economic growth and the overall land development strategy.

Hung Hom will become the mass transport centre of the east to west and north to south corridors. However, this role is incomplete without extending East Rail across the harbour to Hong Kong Island. In a feasibility study in the 1980s KCRC identified there was a strong demand from East Rail passengers for a direct rail link with the main business centre on Hong Kong Island. A proposal was put to the Government in 1989.

In the ensuing years, infrastructure development shifted to the west side with road and rail projects associated with the new airport. With the completion of these projects and West Rail now under construction, the focus is back to the east side. In the light of this, KCRC has recently revised its original proposal and has expressed a strong interest in extending East Rail to Hong Kong Island.

By building the fourth railway harbour crossing as an East Rail extension, it will give the 1.8 million population living in the East Rail catchment area a direct access to the main business centre on Hong Kong Island. At the same time, it will give the 1.4 million population living on
Hong Kong Island a direct access to the mass transport centre in Hung Hom where the east-west and north-south corridors meet and the inter-city services begin.

REFERENCES


7 Hong Kong International Airport as an Aviation Hub

John B PASHEN and Maria LUK

INTRODUCTION

Since the opening of Kai Tak in 1925, Hong Kong has developed from a barren island into one of the predominant financial centres in the world. Hong Kong has been building and expanding its economy and its position as a "hub" for the Asia-Pacific region and the world based on its geographical advantage – its central location in South East Asia, and its natural harbour.

Since the first flight at Kai Tak Airport, the aviation industry has gained momentum and its successor at Chek Lap Kok is now one of the most important and recognised airports in Asia and in the world. In recent years, a number of studies have discussed the significance of Hong Kong as a regional aviation hub in a macro sense including Rimmer (1992), Yeung (1997), Enright, Scott and Dodwell (1997), Berger and Lester (1997). However, very few studies have examined what a hub is in aviation terms.

In aviation terms, hubbing is the process which enables airlines to carry passengers from one airport to another airport by stopping at a third airport en route between the departure and destination airports. At the en route airport, passengers/cargo may either be transferred to another flight with the same airline, or to another flight with a different airline (likely to become more common within the airline alliances), or reboard the same aircraft for the last leg of the journey to their destination airport.

In the last years of Kai Tak, it was operating at well above its design capacity. It attained substantial economies of density in handling more passengers and cargo per square metre of land than any other international airport in the world. In July 1998, the new Hong Kong International Airport was opened with a terminal to handle a capacity of 35 million passengers and cargo facilities to accommodate up to 3 million tonnes of cargo. It was planned to have an ultimate capacity of 87 million passengers
and 8.9 million tonnes of cargo. The planned capacity can thus accommodate a significant progressive growth in air traffic for many years to come.

The recent 1999 HKSAR Policy Address put forward initiatives to enhance Hong Kong's position as an aviation hub by making commitments to liberalise air cargo services and progressively to liberalise air services agreements in general. In addition, the Airport Authority's initiatives to provide a marine cargo terminal and logistic centre at Hong Kong International Airport were recognised.

The purpose of this paper is to present an overview of the evolution of hubbing in the airline industry, to summarise the potential implications of hubbing on the future development of Hong Kong's International Airport (HKIA) and to outline the needs of the airport to accommodate increased hubbing activities.

BACKGROUND

Aviation is a complex, interactive and evolving industry which comprises activities involving human resources, multi-modal transportation systems, material handling systems, manufacturing systems, complex telecommunication systems and service industries. Airports provide facilities and services to meet the needs of its customers including airlines, air passengers, and the air freight industry to provide for the safe, efficient and regular movement of passengers and goods by air.

The three key global revolutions in the aviation industry in the last 50 years were:

- the introduction of wide body aircraft in the 1960s;
- the US Airline Deregulation Act of 1978 and all its aftermath; and
- the internet and its transformation of the industry both on the cost side and revenue side (for instance, many airlines can now sell their tickets via the internet instead of relying on travel agents. It is envisaged that this may lead to the restructuring of airlines' marketing strategy and the travel industry. In addition, E-commerce may generate more time-definite shipment of goods by air).
Airline Deregulation and Development of Hubbing in the USA

The USA is the world’s largest and most dominant country in aviation. Its development has a predominant and continuous impact on the aviation industry worldwide. As such it is important that the historical development of domestic hubbing in the USA is considered in any examination of future strategies for hubbing at airports.

In 1977, the US domestic all-cargo service was first deregulated. In 1978, the Congress enacted the Airline Deregulation Act which dealt primarily with domestic air transportation in the US. The main theme of the Act was to encourage competition between airlines with the objectives of efficiency, innovation, low prices and price/service options.

In the twenty years since deregulation, the US domestic airline industry has undergone rapid expansion with the appearance of a number of new entrants immediately after the deregulation in 1978 followed by several mergers and acquisitions since the late 1980s.

Deregulation has allowed airlines to move towards a market-oriented pricing and route system. This has led to the expansion of hubbing operations, not only at major traffic attraction and generation centres, but also at inland cities where there is more room for airport expansion to meet the increasing air traffic demand. This has enabled the airlines to achieve considerable economies of scope (increased market coverage) and scale (lower cost). On the other hand, the experience of domestic deregulation in USA suggests that full deregulation may lead to monopoly or duopoly scenarios which will inhibit competition and actually increase fares. In essence, some level of regulation might be necessary to monitor mergers and acquisitions, to ensure a competitive environment and market, and to promote low cost and high quality service. This is enforced through anti-trust legislation controlled by the US government. In addition, regulation of airline’s operating procedures and their pilots should always be enforced to ensure that safety standards are not compromised.

The US airline deregulation has had a significant impact on the strategic development of civil aviation all over the world. The Canadian deregulation legislation was enacted in 1988. In view of the maturing aviation industry in the US, the Bush Administration in 1989 promulgated an “Open Skies” policy so as to promote liberalisation of the international civil aviation market in order to expand its market penetration in the
global arena. Full privatisation of the Australian airlines took place in 1993. In 1997, the European aviation industry was liberalised. Subsequently, many EU airports have been competing to be the “EU HUB”. A comparison of the percentage of transfer passengers at EU airports between 1990 and 1998, as shown in Table 7.1, demonstrates the significance of the evolution of hubbing in Europe.

### Table 7.1 Comparison of Percentage of Transfer Passengers at Some EU Airports

<table>
<thead>
<tr>
<th>EU Airports</th>
<th>% Share of Transfer Passengers at Each Airport</th>
<th>1990</th>
<th>1998</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frankfurt (FRA)</td>
<td>45.0%</td>
<td>47.0%</td>
<td></td>
</tr>
<tr>
<td>Munich (MUC)</td>
<td>7.0%</td>
<td>26.1%</td>
<td></td>
</tr>
<tr>
<td>Amsterdam (AMS)</td>
<td>27.1%</td>
<td>42.2%</td>
<td></td>
</tr>
<tr>
<td>Zurich (ZRH)</td>
<td>29.3%</td>
<td>39.8%</td>
<td></td>
</tr>
<tr>
<td>Brussel (BRU)</td>
<td>5.0%</td>
<td>29.3%</td>
<td></td>
</tr>
<tr>
<td>Vienna (VIE)</td>
<td>14.6%</td>
<td>26.4%</td>
<td></td>
</tr>
<tr>
<td>London Heathrow (LHR)</td>
<td>28.0%</td>
<td>32.0%</td>
<td></td>
</tr>
<tr>
<td>Charles-De-Gaule (CDG)</td>
<td>10.0%</td>
<td>38.0%</td>
<td></td>
</tr>
</tbody>
</table>

*Source: With courtesy from Prof. Jaap de Wit, Head of Aviation Economics, Ministry of Transport, The Netherlands*

### Growth of Hub-and-Spoke Networks

An important early stage in the restructuring process following deregulation involves the trunk carriers re-orienting their route networks into hub-and-spoke systems. This was clearly demonstrated in the US deregulation exercise discussed earlier. With the new freedoms that flow from deregulation, the airlines can expand or create new hubs to counter the lower overall cost structure of new entrants. By concentrating resources in this way airlines are able, through the better utilisation of their aircraft and flight crews, to derive considerable economies of density. This also enables economies of scope through the carriage of passengers with different origins or destinations on the same aircraft, resulting in 5-10% higher load factors on routes radiating from a hub. As demonstrated by Kanafani (1981), the most efficient way of overcoming production indivisibilities in the use of large aircraft is to develop route systems based on the hub-and-spoke principle (William, 1993).
Advantages of Hubbing

The main advantage of a highly developed airline hub-and-spoke operation is that it provides an enormous "multiplier" effect and enables airlines to experience economies of scale, scope and density. This allows carriers to provide service to a larger number of city pairs with a given size of aircraft than do point-to-point networks and leads to increases in the number of departures at these airports.

Another major advantage of a hub network is the savings in the number of direct flights necessary to connect all nodes on a network. In this way the operators with larger aircraft are able to compete in less dense markets. By increasing the number of destinations served from a traffic hub, the airline can increase the size of aircraft and/or service frequency that could be operated to any one point in the network. As shown in Figure 7.1, it requires a total of fifteen routes to link up six cities with direct flights while the hub-and-spoke system only require five routes (Goodavitch, 1996).

![Point-to-Point vs Hub-and-Spoke](image_url)

**Figure 7.1 Illustration of Point-to-Point and Hub-and-Spoke Network**

In this way it becomes easier for operators with larger aircraft to compete in less dense markets. By increasing the number of destinations served from a traffic hub, the airline can increase the size of aircraft and/or service frequency that could be operated to any one point in the network. As a result of the extensive networks created by hubbing, individual airlines are able to achieve a more extensive coverage over much more expansive geographic areas. Also, a larger proportion of flights from small communities can be scheduled for large and medium cities. Hence
small community residents can take advantage of an increasing array of connecting services. Thus the carriers are able to attract passengers and, with tight scheduling, are able to meet passengers’ preference for single-carrier service. Consequently, this also gives the hub carrier a marketing advantage. By operating a higher frequency of services from traffic hubs than their competitors, airlines are able to gain higher proportions of the total traffic.

Disadvantages of Hubbing

There are, however, some negative aspects of hubbing. The very objective of minimising minimum connection time between flights forces acute peaking, and potentially highly congested simultaneous flight arrivals and departures. The intense peaking requires extra facilities and personnel that may be redundant during off-peak periods. These extra resources are costly and inefficient. Hubbing also involves inconvenient transfers and lengthy routes for passengers, extra ground handling for cargo, and additional processing/securing screening of passengers’ bags. The increasing market concentration of hubbing might deter competition in the long term. As experienced in the US, too many hubs clustered together (hub saturation) may create an excessive number of flights for the same routes resulting in empty seats/cargo space and declining yield for the major carriers. The increasing concentration of flights during the peak hours also cause substantial delays and decrease the efficiency/utilisation of airline fleets.

LIBERALISATION AND HUBBING AT INTERNATIONAL AIRPORTS

In Asia-Pacific, there has been considerable discussion on the possible relevance of the deregulation experiences in the US and EU to the region. However, in comparison with the US, Canada, Australia, and the European Union, the Asian nations are each very different in terms of their cultural, economic, financial, legal and political systems.

The majority of the large Asian airports are international ones and many of the countries only have one airport. International civil aviation is regarded as a high priority second only to national defence in many of these countries. It appears unlikely that the form of US domestic deregulation would be acceptable within the Asia-Pacific region. A number of factors indicate that hubbing at international airports is somewhat different from domestic hubbing at US airports. One of the most fundamental differences is the institutional factor. Deregulation in
the US has allowed unfettered competition amongst domestic services and many airlines have established multiple hubs. However, airlines that hub at international airports have to operate within the limits set by bilateral air service agreements. Unlike many US mega carriers that have more than one hub in the US and some who have already established hubs in Europe and Asia, Asian carriers are predominantly based at their home airports and do not have a second hub outside their country.

In the last two years, the industry in the region has been developing in the direction of code sharing, global alliances and global multilateral agreements. With the intensified competition in Asia and the increase in capacity at many Asian airports (including Singapore, Taiwan, Korea, Japan, Malaysia and Hong Kong), Singapore, Taiwan, Brunei, New Zealand, Korea, Malaysia and Japan have agreed an “Open Skies” accords with the US (Oum, 1998) to liberalise the air services with an objective to compete as “The Asian Hub”. This has also forced the other Asian airports to address the “Open Skies” regime more ardently.

In September 1999, APEC agreed to consider liberalisation measures towards an open market in air services. The APEC Air Services Group recommends actions to encourage more competitive air services with the objective to provide fair and equitable opportunities for all member economies.

The four priority actions endorsed by APEC economies are:

- eliminating restrictions on air-related services, such as ground handling and computer reservations;
- removing barriers to air freight service providers, whose capacities and rates are currently set by governments;
- allowing multiple airline designation, increasing competition in domestic and international markets; and
- allowing airlines to co-operate with each other through ventures such as code sharing.

**OPPORTUNITIES FOR HKIA AS A PASSENGER HUB**

**Background**

With the economic growth in the Asia-Pacific region, many Asian airports including Hong Kong have experienced substantial growth in demand. A number of these airports can not cope with this increase in demand. In addition to the range of opportunities and options provided by the
introduction of longer range wide body aircraft and more direct air services, the consumers have been benefiting from the consequential lower travel cost and this has effectively attracted more marginal air travellers.

HKIA is a major international airport in the region and acts as a major gateway to the Mainland as well as a focus where east meets west. The air service agreements in Hong Kong have been progressively made more open in the last 10 years encouraged by the rapid growth in demand. However, due to the capacity constraint at Kai Tak, this led to a situation where the air carriers flying in and out of Hong Kong were mainly wide-body aircraft which enjoyed high load factor during the “late” Kai Tak era.

Airlines access to HKIA is controlled by the air service agreements (ASA) between the Hong Kong Government and the respective governments of other countries. In the Kai Tak era, the entry of new airlines or services was fundamentally constrained by airport capacity, the curfew and the regulatory environment. Generally speaking, where new services were approved, it was on the basis that there was no existing service or route, or there was insufficient capacity on the route.

If airlines wish to hub at HKIA and they have the right through an ASA to fly to Hong Kong, then they could apply to the Schedule Co-ordinator for particular slots during the day or night to optimise their hubbing activities or their origin-destination strategies at HKIA or other airports. With the recent formation of the Star Alliance and OneWorld Alliance, intensive co-ordination activity between member airlines of each Alliance to develop opportunities within each alliance can be expected.

An airport’s main function is to facilitate the movement of passengers and goods by air, but in order to do this it must not only provide adequate airport facilities to accommodate the efficient transfer of traffic from surface transport to air transport, but must also actively encourage the safe operation of aircraft and surface vehicles involved. Thus the planning of an airport is a complex process encompassing a wide range of activities which have different and often conflicting requirements.

During the New Airport Master Plan (NAMP) 1990-1992, facilities such as those at the passenger terminal building were planned based on the specific airline requirement at the time which was essentially to provide facilities to accommodate on origin-destination passenger demand. The design objective was therefore to develop facilities for an
origin/destination airport. However the Airport Authority, as a safeguard, planned for facilities that would also achieve a reasonable level of service to serve transfer passengers. A comparison of the airport facilities between Kai Tak and HKIA at Chek Lap Kok is presented in Table 7.2.

Whereas the selection of the terminal concept for the passenger terminal building as it now stands was based on a number of criteria, it was foreseen at the time that it would be more convenient for transfer passengers to move between aircraft gates without the need to change terminals, as is the case at Singapore, Heathrow, etc., and this was one of the reasons that a single large terminal/concourse building was selected at the time. A substantial number of frontal stands were provided as depicted in Table 7.2 so that the majority of the passengers can be facilitated under one roof and the need for passengers to use airside buses to remote gates can be minimised.

In the last years of Kai Tak, the government had to turn down many applications for new services due to the capacity constraints at Kai Tak. Since the operation of the new airport, the airline industry has also entered a new era of alliances with the objective to expand their network penetration in the global market.

Under these circumstances, in common with other major airports the base carrier (Cathay Pacific or Dragonair in the case of HKIA) can introduce and maximise opportunities for hubbing, without compromising existing air service agreements, by bidding for slots so that the arrival and departure times for specific routes can be arranged to promote hubbing. Cathay Pacific has already embarked on this exercise since airport opening to utilise its third and fourth freedom rights (Cathay Pacific Airways Limited, 1998).

**Air Passenger Demand**

In the last twelve years, the total annual air passenger throughput in Hong Kong increased from 12.1 million trips in 1987 to 29 million trips in 1999, giving a compound annual growth rate of 7.6%, while the world average was only about 5%. These statistics include the impact of the Asian economic downturn since 1997. This overall strong growth was attributable to the strong economic growth in the Asia-Pacific Region, easing of travel restrictions between Taiwan and the Mainland since October 1987 and the significant increase in overseas visitors, particularly from Japan and Taiwan.
Table 7.2  Comparison of Airport Facilities at Kai Tak and Chek Lap Kok

<table>
<thead>
<tr>
<th>Facilities</th>
<th>HKIA at Kai Tak</th>
<th>HKIA at Chek Lap Kok</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Airport Site Area</td>
<td>333.8 hectares</td>
<td>1,255 hectares</td>
</tr>
<tr>
<td>Annual Passengers</td>
<td>29.5 million</td>
<td>35 million</td>
</tr>
<tr>
<td>(excluding transit) at PTB</td>
<td>(actual in 1996)</td>
<td>(Phase 1a design capacity)</td>
</tr>
<tr>
<td>Air Cargo Tonnage</td>
<td>1.78 million tonnes</td>
<td>3 million tonnes</td>
</tr>
<tr>
<td></td>
<td>(actual in 1997)</td>
<td>(design capacity at airport opening)</td>
</tr>
<tr>
<td>Airfield</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Runways</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Runway length</td>
<td>3,393 m</td>
<td>3,800 m</td>
</tr>
<tr>
<td>Taxiway system</td>
<td>7.1km</td>
<td>35 km</td>
</tr>
<tr>
<td>Apron Area</td>
<td>1.03 km²</td>
<td>1.33 km²</td>
</tr>
<tr>
<td>Total Area of Passenger</td>
<td>66,000 m²</td>
<td>550,000 m²</td>
</tr>
<tr>
<td>Terminal Building</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retail Area</td>
<td>13,600 m²</td>
<td>31,300 m²</td>
</tr>
<tr>
<td>Retail Outlet</td>
<td>40</td>
<td>120</td>
</tr>
<tr>
<td>Number of Aircraft Gates</td>
<td>69</td>
<td>88</td>
</tr>
<tr>
<td>Frontal</td>
<td>8</td>
<td>48</td>
</tr>
<tr>
<td>Remote</td>
<td>56</td>
<td>27</td>
</tr>
<tr>
<td>Air Cargo</td>
<td>5</td>
<td>13</td>
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<tr>
<td>Check-in Counters</td>
<td>210</td>
<td>288</td>
</tr>
<tr>
<td>Immigration Control Desks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arrival</td>
<td>170</td>
<td>224</td>
</tr>
<tr>
<td>Departure</td>
<td>92</td>
<td>128</td>
</tr>
<tr>
<td>Customs Inspection Positions</td>
<td>78</td>
<td>96</td>
</tr>
<tr>
<td>(arrival)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Security Screening Positions</td>
<td>52</td>
<td>76</td>
</tr>
<tr>
<td>(departures)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baggage Reclalm Units</td>
<td>6</td>
<td>12</td>
</tr>
</tbody>
</table>

Source: Based on Airport Authority Annual Report 1996-97
In terms of passenger mix, the proportion of transfer/transit passenger traffic to total throughput in Hong Kong increased from 19.3% in 1987 to 27.8% in 1998, and further to 29.9% in 1998/99. This increasing trend has become more apparent following the opening of the new HKIA, such that the transfer/transit traffic represented 30.2% of the total passenger throughput during the period from July 1998 to March 1999. It is anticipated that this trend will continue with further gradual liberalisation of aviation policy and the further development of airline alliances.

**The Impact of Hubbing on Passenger Facilities at HKIA**

Changes to the type and pattern of traffic through increased hubbing could affect the requirement for new facilities and the capacity of certain facilities could come under pressure considerably earlier than currently predicted.

The impacts on traffic pattern would include:

- further distribution of flight schedules and potential acute peaking during the peak hours;
- an increasing proportion of transfer passengers; and possibly
- a decrease in transfer passenger dwell time within the terminal.

The impacts on airport facilities are highlighted as follows:

- capacity of runways and aircraft parking facilities during peak periods could be compromised;
- a review on gate assignment policies will be necessary;
- need for specialised facilities to accommodate fast turnaround transfer bags;
- demand exceeding the capacity of ramp handling equipment and other ground services during peak times; and
- possible need for additional or enhanced facilities at the transfer passenger lounges including expanded lounges, more seats, relocation and/or expansion of retail areas, retail shops, washrooms, etc.

From the airport's perspective, the service providers, the Authority, and all the business partners who provide ground handling services and airport support services would be concerned about:
extra facilities and personnel to meet the acute demand;

- the tendency for an increase in hubbing to increase the frequency and use of smaller aircraft than in the past, that is, a progressive change in the fleet mix towards smaller aircraft; and

- costs/benefits of the Authority’s investment in additional facilities.

**The Need for Additional Facilities for Transfer Passenger at HKIA**

The APEC’s four priority actions on air services and the SAR Government’s policy to progressively liberalise air services agreements will magnify the demand for hubbing sooner rather than later. Additional facilities may be required to enhance the airport’s attraction as a hub.

Examples of facilities that may be provided within the passenger terminal building are – a recreation area for children, a mini movie theatre, short term accommodation units, cyber-café, retail facilities, etc. However, in view of the expenditure required for these facilities, one would need to be quite confident of the continuation and success of hubbing, as there are many examples of airlines who are successful in convincing an airport operator to provide facilities, only to change their strategy within a comparatively short period, leaving the facilities unused or under utilised.

One of the strategies in planning the airside areas was to provide as much flexibility as practicable in respect of the facilitation of a wide range of commercial aircraft. In this context, all of the frontal stands at HKIA have the capability to serve a wide range of aircraft from the B747-400 down to the A320. Therefore, the airport has a considerable advantage over other airports in terms of hubbing because the complete range of commercial aircraft currently used by airlines can be accommodated at any of the frontal stands.

In the longer term, for the development of the midfield concourses, the need to provide facilities specifically for hubbing will need to be carefully considered in the planning stage, as the preliminary work carried out to date has focussed on the need to provide concourses, aprons, etc. with the overall objective to maximise opportunities for origin and destination traffic as a priority over transfer traffic.
OPPORTUNITIES FOR HKIA AS A CARGO HUB

Background

Air cargo at most airports in the world is “self-handled” by airlines and the major airlines usually have their self-handling terminals at the airport. In fact, before 1976, air cargo was self-handled by major carriers in Hong Kong. However, the operation was not structured and there was no standardised procedure to monitor the performance and efficiency of the operation. In the mid 1970s, the government decided to introduce a single operator with the objective to standardise the air cargo operation and to ensure more efficient land utilisation within the vicinity of Kai Tak for expansion to meet the anticipated demand. Consequently, in 1976, Hong Kong Air Cargo Terminals Ltd (HACTL) commenced operations at Kai Tak. Since the early 1980s, HACTL has adopted an automation strategy. The application of mechatronics and information technology enabled Kai Tak Airport to handle more capacity per square footage than any other major airport in the world. Terminal 2 at Kai Tak was uniquely designed in the late 1980s to have a multi-storey and common storage system for both import and export cargo to meet the demand in the 1990s. The 1992 New Airport Master Plan therefore took forward the multi-storey vertical storage concept in terms of allocating land for cargo facilities at the new airport.

However, even with the apparent constraints of the physical infrastructure, limited land, and the regulatory environment at Kai Tak, the air cargo industry developed at an astonishing rate notably in the last ten years. This was largely due to the strategic geographical location of Hong Kong in the Asia Pacific region and the mature route structure for air passenger services which was essentially in place many years before capacity constraints were introduced at Kai Tak (the majority of air cargo is shipped in passenger aircraft). Hong Kong has been for some time a gateway airport for international transportation of both air cargo and passengers to and from the Mainland.

With the lifting of the physical constraints after opening of the new HKIA, the increased runway capacity and cargo terminal capacity and round-the-clock operations, there should be considerable potential for new carriers to enter and further develop Hong Kong as a significant air cargo centre. From a consumer’s perspective, the entry of new airlines should provide competing services which should over time, drive costs down and increase the size of the air cargo market. From the Authority’s
perspective, increased services would result in additional revenue, and a more extensive and mature route network thereby enhancing the airport’s reputation for air cargo and passengers.

**Air Cargo Demand**

The total annual commercial air cargo (direct and transhipment) in Hong Kong increased from 559,000 tonnes in 1987 to 1,660,000 tonnes in 1998, representing a compound annual growth rate of 9.4%, with 9.6% for direct traffic and 8.4% for transhipment traffic. About 55% of the air cargo in 1998 was carried by passenger aircraft and 45% by freighters. Although the air cargo throughput is only about 1% of the total cargo throughput in Hong Kong, its trade value is about 20% of Hong Kong’s trade value in terms of imports and exports⁷.

Even with the economic downturn and the problems encountered at airport opening, total air cargo throughput at Hong Kong has remained strong amongst the major air cargo markets in the Asia-Pacific region as shown in Figure 7.2. In addition it retained its status as the world’s leading international cargo centre in 1998 with Narita second and Miami in third position.

![Major Airports in the Pacific Asia Region](Source: ACI)

**Figure 7.2** 1998 Air Cargo Throughput at Major Air Cargo Markets in the Pacific Asia Region
The air cargo flow between Hong Kong and major air cargo markets in the Asia/Pacific as shown in Figure 7.3 constitutes over 50% of the total air cargo throughput of Hong Kong.

**Hong Kong as an Asian Air Cargo Hub?**

The dynamic change towards globalisation in manufacturing and sourcing is demanding more time-definite door-to-door services. The growth of air cargo in the Asia-Pacific is expected to be over 5% per annum up to 2017 with the Mainland contributing the strongest growth of over 7% per annum. Express shipments are growing in volume by 20% annually in Asia, compared with 5% in North America and 9% in Europe. Boeing (1999) has projected that the express market will constitute about 37% of the air cargo demand in Asia by 2017 with double digit growth per annum. If this forecast should materialise, this would have a significant impact on the future design of air cargo terminals.

![Figure 7.3 Air Cargo Throughput between Hong Kong and Major Air Cargo Markets in Pacific Asia Rim](source: CAD Annual Report, 1997-98)
Rapid growth of the air cargo market in Asia has prompted the need for development of a major air cargo hub, in particular an express hub, in the region. Hub-and-spoke (hubbing) systems improve the efficiency of air cargo services in several ways. By consolidating freight onto a single aircraft en route to many destinations, hubbing enables airlines to achieve an economy of density by using larger, more efficient aircraft. Large aircraft would be particularly suitable for an inter-Asian hub operator because of the relatively long travel distances between cities. Air Cargo is carried by passenger aircraft, all cargo carriers, and integrators. The integrators are key operators in the express cargo sector worldwide.

The major air cargo markets in the Asia-Pacific are shown in Figure 7.4. The potential hub sites include Hong Kong, Manila, Shenzhen, Singapore and Taipei. The optimal location would be dependent upon at least five technical criteria: geography, capacity, local market size, terminal services (in respect of operational efficiency and effectiveness) and route authority.

Figure 7.4  Major Air Cargo Markets in the Asia/Pacific and the Preferred Hub Location

Of the potential sites evaluated, a hub at HKIA could serve the Asia-Pacific with the lowest number of flight hours, whereas a hub in Taipei, Taiwan could serve the region with the lowest tonne kilometres
of service. Hong Kong offers convenient ground access to the Mainland where large numbers of manufacturing plants and one-fourth of the world's population are located.

Based on the limited research undertaken to date, the major competitor for Hong Kong in the medium/long term would therefore appear to be Taipei which offers an immense local market, liberal air service agreements, and available airport capacity, although it does not have Hong Kong's convenient ground access to the Mainland. Singapore is not seen as necessarily competitive, due to its relatively remote geographic location in the region\textsuperscript{11}. However, it should also be noted that Heathrow is not at the best geographical location to be the key hub in Europe, and nevertheless continues to enjoy considerable success as a major hub.

With the commissioning of the second runway and the HKIA's current cargo handling capacity of 3 million tonnes per year the major barrier to accelerating air cargo growth in Hong Kong would appear to be the restrictions contained in existing air services agreements. The recent policy statements of the HKSAR government to liberalise the all cargo air services market will be a catalyst to the air cargo industry. In addition, the initiative to have a marine cargo terminal at the airport will provide an alternative means of transport to facilitate the marine transportation of air cargo between the Pearl River Delta region and HKIA and could over time prove to be more efficient in terms of travel times and costs than the ground access alternatives.

\textit{Benefits to HKIA as Asia's Premier Express Hub}

The benefits to HKIA as Asia's premier express hub would include:

\begin{itemize}
  \item improved cargo delivery schedules and consequently more attractive closeout times and additional non-stop services to shippers. (It is understood that shippers located in hub cities should be able to deliver express cargo to their carriers by as late as 10:00 p.m. for overnight shipments, compared with deadlines of around 5:00 p.m. in cities that are merely spokes for offshore hubs);
  \item possible reduction in air cargo rates\textsuperscript{12} by at least 5% as suggested by Schweiterman (1993);
  \item substantial new revenues for the Authority through additional landing and parking fees; and
\end{itemize}
the lower cost, more extensive network and frequency of operations at the hub would also stimulate air cargo growth, and boost commercial revenues and franchise fees for the Authority.

Factors which could constrain the development of HKIA as a cargo hub include:

- airport curfews (should not be an issue providing the current policy to sustain the round-the-clock operation of HKIA remains in place);
- restrictive air service agreements (should not be an issue assuming the recent statements on liberalising policy on air services are enacted in practical terms);
- seasonal fluctuations in demand;
- possible incompatible flight schedules between HKIA and European and North American routes, even with 24 hour operations at HKIA;
- border congestion for cross-border trucks (alternative transportation by marine transport between ports in Pearl River Delta and airport would help to alleviate this impact);
- security requirements for transhipment cargo (this would depend on the security policies of the government); and
- although there is an overall cargo terminal capacity of 3 million tonnes, only about 5-7% is currently allocated for express handling. A change in the cargo mix could reflect the need to commission new specialised (express) facilities faster than additional general cargo facilities. Timely provision of facilities to meet changes in the market will be necessary. For example, in the medium/long term, there may be potential capacity constraint to the provision of express cargo handling facilities to accommodate the expected double digit growth of express cargo.

SUMMARY AND CONCLUSIONS

Hong Kong has been a hub in the region in the macro sense for many years. In aviation terms, there are still considerable opportunities for Hong Kong to develop further as an “aviation hub”. The US deregulation and EU liberalisation experiences have shown that hubbing is a derivative and direct consequence of deregulation/liberalisation of the airline industry. The increased hubbing activity at HKIA since airport opening
has already accelerated the proportion of transfer passengers and trans-shipment cargo through the airport. As a result, more frequencies and services to and from the airport which has no capacity constraints, will be required to generate more origin-destination passengers and cargo.

The key opportunities to promote and enhance hubbing at international airports flow from the liberalisation of air services agreements. With the opening of the new HKIA, the infrastructural constraints inherent at Kai Tak have been removed. Airlines should have considerable flexibility to optimise the utilisation of their fleets more effectively. With the APEC’s recent initiatives and the SAR government’s new policy to further liberalise the air services, it is expected that hubbing will grow in importance and magnitude even in the short term. These new developments in aviation in Hong Kong should have a rippling effect on regional aviation developments and on the mainland which has also been undergoing considerable infrastructural changes in the industry in the 1990s.

From the airlines perspective, further liberalisation would enable home based carriers to establish codeshare agreements with their alliance members. Non-home based carriers should have a greater opportunity to establish a non-home based hub at HKIA. Hubbing should enhance the airlines’ opportunities to achieve economies of scope and scale in their operations. By providing more frequencies and services, the airlines can enhance their market dominance and extend their global network penetration through alliance and codesharing arrangements. However, the experience in the US also demonstrates that market concentration by one or two dominant carriers may in the long term hamper competition.

From the passengers and air cargo shippers perspective, the more extensive network of hubbing would provide more coverage and frequencies at a lower cost. However, passengers may also experience long transfer waiting periods, inconvenient transfers and extra handling of bags that could increase the probability of delays and mishandling.

From the Authority’s perspective, as the facilities were planned based on a set of assumptions, including policies, design criteria and levels of service, the recent changes in policy and airline operating structures will by their very nature drive variations in market characteristics and facilities requirements. The very objective of hubbing will induce acute peaking and potentially highly congested peak periods with simultaneous flight arrivals and departures in many cases. The intense peaking would lead to the early need for extra facilities and personnel
even though they would be under utilised during off-peak periods.

Last but not least, from the regulator’s perspective, it appears that some form of anti-trust regulation would be required to ensure as far as practicable, a continuing competitiveness of the market. As safety is the primary concern in air transport, the regulation of the airline’s operating procedures, their pilots and aircraft should always be enforced to ensure that safety standards are not compromised.

On a final note, it is important to note that airport planning is a continuous process and is necessary to constantly review the adequacy and form of facilities. The planning process is essential to ensure that the facilities are appropriate to accommodate the changes in market conditions, customer’s expectations and at the same time provide reasonable levels of service and rates of return. The status of HKIA as a major international airport will be enhanced by continued recognition of this planning process.

NOTES

1 Bootsma, Pieter D. (1997)

2 Four basic principles of Open Skies are: (a) complete territorial openness/access; (b) use of unarmed aircraft for observation flights; (c) an advanced sensor suite with sensors commercially available to all Parties; and (d) annual quotas for reciprocal overflights.

3 Bilateral air service agreements specify services and routes to be operated between the two countries, designated airlines and capacity to be provided by each airlines, stipulate foresetting mechanisms, and specify conditions under which passengers may be taken or picked up in each country and flown to third country (Oum, 1998).

4 APEC Secretariat (1999). Hong Kong is a full and separate member in APEC using the name “Hong Kong, China”.

5 United Airlines, Air Canada, Lufthansa, SAS, Ansett Australia, Air New Zealand, Thai Airways International and Varig Brazil

6 Cathay Pacific, British Airways, Qantas, American Airlines, Canadian Airlines, Iberia

7 TDC publication

8 Boeing (1999)
9 Schwieterman (1994)

10 The average flight distance for most North American hubs is less than 1,800 km, compared with an expected average distance of 3,200 km at an Asian hub.

11 Schwieterman (1993)

12 Studies by Gellman Research Associates (1990) and Schwieterman (1993) show that the entry of US cargo airlines into concentrated intra-Asian markets could lower prices by at least 5 percent.

DISCLAIMER

The views presented in the paper represent the opinions of the authors, and do not necessarily reflect the views of the Airport Authority Hong Kong.

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8 Development of Hong Kong’s Urban Railways – The Second Railway Development Study Highlights

MAK Chai-kwong

"... the future successful growth of the area hinges largely on the ability of its people to make it a place where all can live and work together pleasantly."

– Jean Gottmann on Megalopolis (1961)

INTRODUCTION

This paper focuses on the development of Hong Kong’s domestic railway network and discusses some of the key considerations in the further expansion of the railway system. The observations presented in this paper are based on the initial findings of the Second Railway Development Study (RDS-2) currently undertaken by the Government. The purpose of RDS-2 is to update the recommendations of Government’s first Railway Development Strategy published in 1994.

THE TRAVEL DEMAND

The main driving force for railway development in Hong Kong springs from both internal development and the economic integration with the Mainland. The need to travel, both for business and for leisure, and the public’s perception on the relative cost and convenience of travel are the factors governing the choice of the travel mode, as well as the travel pattern and habit. In 1998, the Hong Kong citizens made an average of 12 million trips each day of which 80% was by public transport means. Rail trips had accounted for more than 25% of the total transport.

The domestic travel demand is linked to the size of the population and the economic activities. Hong Kong has at present a population of about 6.5 million. This is expected to grow to some 8.9 million by the year 2016. Whilst increase in the population size will result in increase in the total traffic, the travel demand in particular transport corridors is

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largely influenced by the distribution of population and job locations.

Besides the domestic demand, the cross-boundary passenger traffic resulted from closer economic and social ties with the Mainland has important bearings on Hong Kong's railway network expansion. Hong Kong has four land-based boundary crossings, viz., the rail passenger crossing at Lo Wu and three road crossings at Lok Ma Chau, Man Kam To and Sha Tau Kok. The Lo Wu Crossing has traditionally been the preferred choice for the cross boundary passengers. In recent years, there has been a significant growth in the demand as can be seen from an increase from a steady growth rate of 6-8% in the early 1990s to 16-18% as from the second half of 1996. In the first six months of 1999, the average daily trips at Lo Wu reached 200,000. During festival periods, high daily flows at Lo Wu were well over 220,000.

Now an affluent society, Hong Kong is moving towards the development of an efficient and comfortable transport system that not only will meet the travel demand, but is itself environmentally friendly. For this reason, rail-based mode of transport, which has the advantage of causing much less air and noise pollution than motor cars, is the favoured mode of transport. According priority to railways has become an important policy in Hong Kong's transport infrastructure development.

In planning for the future railway network expansion, the ability to establish a reasonable range of travel demands corresponding to different scale and patterns of development is central to the planning process. In this regard, the land use/transport interface has been, and will continue to be, a key factor in demand forecasting. In formulating an optimal railway network development strategy, the Government planners have adopted a scenario approach, when the relative performance of possible network expansion options are tested through an iterative process. Fundamental to this process is to develop a comprehensive and responsive planning methodology with which sensible choice and the right balance in decision making can be made.

**HONG KONG'S RAILWAY SYSTEM**

Hong Kong is fortunate to have two financially sound Railway Corporations – the Mass Transit Railway Corporation (MTRC) and the Kowloon-Canton Railway Corporation (KCRC). They deliver high quality rail service and have been able to fund service and network expansion largely out of the income from the fare boxes. Over the years, with the expansion of the rail network, the daily rail patronage has grown to more than 3 million.
The MTR System

The planning and development of Hong Kong’s MTR system dated back to the 1960s when the first Mass Transit Railway Study for Hong Kong was carried out. Following decision to proceed with the construction of the MTR, the first section of the Kwun Tong Line (KTL) (between Kwun Tong and Shek Kip Mei) was completed and opened to public on 1 October 1979. In the two decades that followed, Hong Kong saw the successive completion of four new MTR lines, viz., the remaining phase of the KTL (1980) which was subsequently extended to Quarry Bay via the Eastern Harbour Crossing (May 1989), the Tsuen Wan Line (May 1982), the Island Line (May 1985) and the Airport Railway (July 1998) which provides two services to the public: the Tung Chung Line (TCL) and the Airport Express Line (AEL).

With a railway network comprising 5 services and a total route length of 77 km, the MTR system is now one of the most heavily utilized urban railway system in the world. The MTR now carries more than 2 million daily passengers in a normal weekday.

The KCR System

The KCR is a conventional main line railway that can accommodate a mix of traffics: passenger and freight. The 34-km system was completely electrified and modernized in the 1980s. It provides the key transport link with the Mainland and serves also as the main commuter corridor for the 1.4 million population in the Northeast New Territories for travelling to and from the urban area. The system is now carrying some 700,000 daily passengers and is connected to the MTR system at Kowloon Tong where passengers can interchange between the two networks.

Although the two railway systems in Hong Kong are different in terms of their traffics and technology, the increasing urbanization of the outskirts has made the previous distinction between them as sub-urban and urban railways no longer appropriate. With Hong Kong proceeding with massive railway expansion, the entire railway network will be greatly expanded with much wider penetration of the rail services to almost all parts of the Territory. It would be more appropriate to consider the MTR and KCR systems as Hong Kong’s domestic railway network. Planning for the expansion or enhancement of the railway service is to develop an integrated railway network with the ultimate objective of facilitating the convenience of travel. In this connection, it is important that the Railway Corporations would establish new operating relations, with which it will enhance the usage of the rail services by the public in what must be an enlarged overall system.
THE NEXT PHASE OF RAILWAY DEVELOPMENT

It was against the background of high economic growth and recognition of the importance of railways that the Hong Kong Government commissioned a comprehensive study on railway development in 1991. The findings and recommendations of that study formed the basis of Government’s Railway Development Strategy (RDS) of 1994. The RDS has provided the blue print for expanding Hong Kong’s railway network. Today the priority projects recommended in the 1994 RDS are already in different stages of implementation (Figure 8.1).

The Second Railway Development Study

Whilst completing the new rail projects will provide additional capacities, we are perceptive that as Hong Kong recovers from the recent down turn in the economy, we will be faced with new challenges as we move into the 21st Century. We are also mindful of the increase complexity in planning for the railway system expansion, the long lead time required for project approval and delivery, the heavy capital investments as well as the strong controls demanded by society. In order to sustain Hong Kong’s development, we need to plan ahead — to determine the next phase of railway development and to complete all the necessary planning and preparation so as to enable the timely provision of adequate railway services.

In March 1998, the Government commissioned the Second Railway Development Study. The objective of the Study is to determine optimal network configurations to enable the formulation of a railway network expansion strategy that can cater for the changing demands in the future. The Study includes also a Strategic Environmental Assessment to ensure that environmental considerations are fully integrated into the network expansion strategy so that environmental benefits are maximized and adverse environmental consequences avoided.

Besides the network elements, the institutional aspects of railway planning, implementation and operation are important elements that will affect railway network expansion. The study includes investigations into the various funding method and the institutional arrangements for implementing railway projects that would be appropriate to Hong Kong’s situation. It covers also a review of the fare structure and considerations on possible approach to fare integration, and on ways for fast-tracking the railway development planning and implementation process. The diagram in Figure 8.2 shows the study framework.
Figure 8.2  RDS-2 Study Framework
Employing transport modelling techniques, the Study has completed the assessment of a large number of possible network expansion options. Amidst the diversity of potential options, the focus is to determine an optimal network that can meet both the short term needs as well as the longer term requirements. Whilst detailed analysis is still on-going, the initial findings of RDS-2 have identified a number of potential new lines which individually or in combination, would greatly relieve bottlenecks in the railway network and which could support development of new growth areas in the territory. They are shown diagrammatically in Figure 8.3.

The Fourth Rail Harbour Crossing

The network assessment has shown that the existing and projected future demands for rail transport is very closely influenced by the locational distribution of population and employment. This is particularly so in the urban area where the peak hour loading on the principal rail routes, notably the harbour crossings and the rail corridors in the urban area, is governed by the employment level in the Central Business District.

The assessment further identified that a Fourth Rail Harbour Crossing (FHC) would have the strategic function of relieving major bottlenecks in the system, enhancing the rail capacity across the harbour and at the same time bringing about a more even distribution of the flows on the network. A number of options for the FHC have been identified:

- extensions of the KCR East Rail from Hung Hom to either Victoria Park or Tamar;
- extensions of the KCR West Rail from West Kowloon to Tamar;
- extensions of the MTR Kwun Tong Line (KTL) from Yau Ma Tei to either Victoria Park or Tamar; and
- a new EKL that runs from Diamond Hill via Hung Hom to either Victoria Park or Tamar.

Preliminary studies suggest that the most promising options for the FHC involve either the East Rail or the EKL extension options, which are shown respectively in Figures 8.4 and 8.5. These options have advantages and disadvantages that need to be assessed further in the context of the longer term network development on either side of the harbour and the different planning and harbour reclamation scenarios.
Figure 8.5  East Kowloon Line Extension to Hong Kong Island
In the final stage of the Study, the FHC options together with other domestic corridors will be combined into strategic network systems for a comprehensive evaluation. The evaluation will assess the performance of the options covering both the transport, environmental, economic and financial criteria. The findings would work towards identifying the common components of a “Core Network”. Depending on future development and other external factors, the priority, sequence and timing for implementing the various component parts of the network will then be decided.

Other potential new lines with a longer term potential will also have to be assessed. The purpose is to ensure that their route alignments are not frustrated by other developments and advanced works may be necessary for some parts of these routes so as to achieve cost effective implementation in future. All in all, these identified longer term options will need continuous review even though they are not required for immediate development.

SUMMARY

The overall objective of developing Hong Kong’s domestic railway system is to formulate a railway network expansion strategy that will be able to remove bottlenecks in the existing and planned railway system; to facilitate timely accessibility to strategic growth areas; to meet cross boundary passenger traffic demands and to increase the rail share in the overall transport system.

The outcome of the RDS-2 would include:

(a) a comprehensive demand forecasting tool capable of responsive analysis of different input assumptions due to rapidly changing external factors;

(b) a comprehensive evaluation framework to assess the relative merits and performance of potential network expansion alternatives based on which an network expansion strategy could be formulated;

(c) identification of the key components of the preferred railway network in terms of the priority and sequence of development of new lines, and the appropriate timing for their implementation; and

(d) the institutional aspects of railway development covering the project implementation programme, the funding methods, as well as the agent to deliver the new rail projects.
In sum, an updated railway development strategy for Hong Kong will be a proactive planning framework for railway network expansion that is robust and adequate to react to external changes, and which will encompass indicators that would trigger the various steps in the implementation process of these projects.

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INTRODUCTION
Transport is of vital importance to our economic activity and social life. It affects everyone of us who use public transport services either regularly or occasionally for different trip purposes. In terms of volume, over 10 million trips a day are made on our public transport network which comprises the railways, buses, minibuses, ferries, taxis and non-franchised buses.

Hong Kong is probably unique in the world in terms of variety and choice of public transport modes. It is also one of the few countries in which public transport services are provided without direct government subsidies. This paper will examine the circumstances which have made public transport operation a success in Hong Kong and discuss our future challenges in maintaining and developing the strengths of our existing system.

TRANSPORT SUPPORTS HONG KONG’S GROWTH
Over the past 30 years, we have witnessed a remarkable growth in Hong Kong’s economy. Hong Kong which was once a barren land is now a major financial centre. Apart from the dense and entrepreneurial nature of our population which have contributed to our growth, Hong Kong’s economic growth is supported by a well planned and developed road and public transport system.

Development of Road Infrastructure
In terms of road length, our total road kilometres has doubled over the past 30 years. In 1965, we had about 870 km of roads which was increased to 1,838 km in 1998. Figure 9.1 shows the growth in our road network.

Our 3 cross harbour tunnels are carrying over 230,000 vehicles a day compared to 19,000 vpd carried by our vehicular ferries in 1972 just
before the opening of the first cross harbour tunnel linking Wan Chai and Hung Hom. With the completion of West Kowloon Expressway, Tsing Ma Bridge and the North Lantau Expressway, we can now travel by road to Tung Chung and to the new airport from Central Business District in less than 45 minutes. Our annual expenditure on road construction for Financial Year 1999/2000 is now just over HK$3,910 million reflecting a commitment on the part of government to keep Hong Kong moving.

![Figure 9.1 Total Road Length, 1965-1998](image)

**Public Transport Services**

Hong Kong is well served by a variety of transport modes. The following sections will focus on the main bus and rail modes which carry over 7 million passengers a day, or 70% of the total public transport patronage as illustrated in Figure 9.2.

**Development of Rail and Bus Services**

Beginning with an initial section in October 1979 between Kwun Tong and Shek Kip Mei, the Mass Transit Railway (MTR) has since extended its network to cover Tsuen Wan, Hong Kong Island, Tung Chung and the new airport utilizing three rail cross harbour crossings. The system now comprises 77.2 km underground railway system with 44 stations and carrying about 2.4 million passengers a day compared with 400,000 in 1980.
Figure 9.2  Public Transport Services in Hong Kong

The Kowloon-Canton Railway (KCR) with its electric trains serves the eastern part of the New Territories connecting the new towns in New Territories to 3 urban stations in Kowloon. The electrification of the system was completed in 1983. Today, the railway with 13 stations is carrying about 71,000 passengers daily on its 34 km of track. Also under the management of the Kowloon-Canton Railway Corporation is the light rail system serving Tuen Mun, Yuen Long and Tin Shui Wai. It is carrying about 380,000 passengers a day on its 31.75 km of track.

As for buses, we have introduced more franchised bus operators. Prior to 1993, the Kowloon Motor Bus Company (KMB) and the China Motor Bus Company (CMB) were the only two franchised bus companies providing bus services more or less on a geographical basis serving Hong Kong Island, Kowloon and the New Territories. A small operation exists on Lantau Island under the New Lantao Bus Company.

Now we have five franchised bus companies with different sizes, a fleet of 5,836 franchised buses and carrying nearly 4 million passengers a day. The latest tender exercise for a new bus franchise was conducted in March 1998. In this exercise, New World First Bus was successful in getting most of the CMB’s network. CMB also ceased to be a franchised operator after 65 years of operation. Figure 9.3 gives the market share between the bus and the rail modes.
The Regulatory Framework for Buses

The Government encourages the private sector to provide and operate bus services by offering an environment which provides a reasonable return on investment. For nearly 20 years, a profit control scheme applied to KMB and CMB. The scheme assessed fare increases based on a percentage return on the average net fixed assets. This had encouraged bus operators to expand in acquiring and updating their fleet and in providing depots for bus maintenance.

The Profit Control Scheme was criticized for having encouraged expansion without due regard to efficiency and as profits are more or less guaranteed, there is no incentive for the companies to improve services, to cut cost and to respond to market demand.

The Profit Control Scheme was abolished in 1993 for CMB and 1997 for KMB. While this scheme is abolished, fare adjustment applications are considered based on a ‘basket of factors’ which takes into account operating expenses, inflation, investment requirements, public acceptability and the need to provide a reasonable rate of return to the bus companies.

A closer look at the structure of the bus industry today will find it moving towards greater competition on a district basis. The Public Bus Service Ordinance allows franchises to be granted on a route by route basis. Restricted by the availability of maintenance depots and servicing areas, both KMB and CMB had in the past restricted their operation to each side of the harbour with CMB serving Hong Kong Island and KMB serving Kowloon and the New Territories. With the completion of more cross harbour links and a generally better bus fleet with fewer breakdowns
and larger fuel tanks, it is possible for operators to go outside their
traditional operating base albeit on a smaller scale and for a limited number
of routes.

On Hong Kong Island we have 2 franchised operators. While
commuters benefit from a more competitive network of services, extra
efforts have to be made to regulate the use of roadside space especially
along the common corridors as both operators have the tendency to
maximize the utilization of the bus fleet throughout the day including
peak and off-peak hours. Given the high density in the use of our roads
and the limited kerb space available for bus stops, we would need to be
careful in planning the routes and stopping places when new bus operators
are introduced into a district.

Excessive duplication of bus routes must be discouraged and
regulated. Our experience in regulating 2 bus operators on Hong Kong
Island shows that unless well justified by demand, new routes which
duplicate a large part of an existing bus route, or which connect two
points where travel demand is not high and could be conveniently served
by one interchange would not be necessary as this will decrease the
occupancy of existing services and the extra buses put on the new service
will not be fully utilized. We do not envisage major growth in the bus
network on Hong Kong Island and Transport Department will be closely
scrutinizing any proposals for new services.

New Roads and Railway

We have a well-defined programme for road and railway construction
into the next millennium. Major roads (Figure 9.4) which will be
completed between 1999 and 2006 include the Hung Hom Bypass and
Princess Margaret Road Link (in 1999). Improvements to Tuen Mun Road
(in 2000), widening of Tolo Highway between Island House Interchange
and Ma Liu Shui Interchange (in 2001), Tsing Yi North Coastal Road (in
2002), improvements to Castle Peak Road, Kam Tin Road (1999-2002),
widening of Fo Tan Road, Island Eastern Corridor (2002-2003) and the
completion to the section of Route 5 between Shek Wai Kok and Chai
Wan Kok. Major roads under feasibility study and detailed design include
Route 9 between Sha Tin and Cheung Sha Wan, Route 10 section between
North Lantau and So Kwun Wat, Central Kowloon route, Western Coast
Road, Central–Wan Chai By Pass and Island Eastern Corridor Link. The
Third Comprehensive Transport Study will also map out new roads that
will be required for Hong Kong over the next 15 to 20 years.
Figure 9.4  Major Road Projects up to 2006

Road development alone cannot satisfy our travel demand and there are questions on the impact to our environment with increase vehicular traffic on new roads. As in other urban cities, railway is an important mass carrier and between now and 2004, we will add to our existing rail network (Figure 9.5) new railways for Tseung Kwan O, Ma On Shan, the West Rail, extension of the KCR East Rail to Tsim Sha Tsui and a spurline to Lok Ma Chau. The Second Railway Development Study will contain proposals for new railways.

Figure 9.5  New Railway Development by 2004
CHALLENGES FOR THE TRANSPORT SECTOR

All these improvement measures will improve the accessibility of our urban population and open up new growth areas. These developments will have considerable effects on our public transport services and the relationship of various modes under an improved railway scenario.

In the Short Term

In the short term, both rail and bus operators will be watching and guarding their market share closely. Inevitably, bus operators will need to adjust to the availability of new railway lines close to and conveniently sited to major population centres.

The new railways to be commissioned between 2002 and 2004 will stretch out the railway network and increase the railway patronage. However, these areas are served by existing franchised buses. KMB is now operating 236 buses in Tseung Kwan O, 297 buses in Ma On Shan and 640 buses in Tuen Mun and Yuen Long on a daily basis. It would be difficult (but not impossible) as experience tells to withdraw direct bus routes against strong public wishes. In addition, population in these areas is expected to grow significantly just before the new railways are ready and not only will we be faced with a well developed network of bus services in these areas, more new bus routes are needed to meet interim growth in demand.

Study on the Co-ordination of Public Transport Services with the Three New Railways

Earlier in 1999, Transport Department commissioned a consultancy study on the co-ordination of public transport services with the new railways. The study in short, called SCOPTS, will examine the impact of the new railways on existing public transport services which operate along the future rail corridors. The study will conduct an assessment of the implications of a coordinated network plan with details on planned changes to bus routes. The plan will also include feeder services from all likely catchment areas and these services should be provided at the most attractive frequency possible and economical. The rationale behind the study is an appropriate co-ordination of different public transport modes whilst encouraging some degree of competition among public transport providers, optimising road use, but avoiding excessive duplication, surplus capacity and congested road traffic conditions. The study will be completed by mid 2000.
Future Challenges

It is our policy to provide commuters with reasonable choices and this is achieved by providing a range of transport modes which differ in speed, comfort and fares and to encourage healthy competition among operators. For public transport services to remain efficiently operated, we will be looking for closer integration at an operational level among different transport modes. This may include better facilities at interchanges, provision of information on timetables, routes and fares and interchanges of all sorts including bus-rail or bus-bus interchange.

The wide variety of our public transport services gives the Transport Administrator an important and challenging job in co-ordinating and in designing the service network. The well-patronized bus services from the New Territories West to Central reflects the strong public demand and popularity for quick, direct and comfortable bus service with a seat for every passenger in a fully ventilated bus. It will be a major challenge to re-organize our bus services in a way acceptable to commuters and yet encouraging appropriate bus-rail connection. While I would not promise that SCOPTS will give us a new model on intermodal co-ordination, it will certainly provide insights into how rail, buses and other modes could be planned and interwoven to form an effective network of services. We may have to go through some difficult adjustment process in balancing the interests of various stakeholders especially the public transport users in the areas, the bus, green minibus and rail operators. This is not easy as Hong Kong does not offer a favourable environment towards a fully integrated public transport system as we have separate bus and rail operators with different fare structure and ownership. With foresight, determination and effective communication, I am confident that we can move towards a more interesting public transport system.

To be more effective in tapping and in competing positively for commuter support, bus operators will find themselves moving away from the traditional approach in responding to public complaints to a more proactive one in promoting and marketing their services. Bus operators may also find it necessary to increase efficiency further through better fleet management, ensuring higher fleet availability and introducing more bus-bus interchanges schemes. A recent bus-bus interchange scheme introduced by KMB making use of concessions through the Octopus ticketing system on three New Territories bus routes is a good case in point. In addition to through ticketing which is made possible by Octopus, bus operators would be able to benefit from latest technological
developments such as satellite tracking and improved mechanical system which will make our buses increasingly environmental friendly.

CONCLUSION

The Government has demonstrated its support for the public transport sector by providing an environment which encourages investment, restraining itself from unnecessary intervention and in exercising flexibility in our role as regulator and co-ordinator. As we move into the next millennium, we should build on the co-operation and confidence that operators and the Administration have developed over the past 30 years to continue to excel in our roles as service providers and planners. We want to create partnerships at all levels to respond to changes and challenges.

As the railway expands, buses would not be the single mode which carry the largest volume of passengers as it is today. It is not difficult to foresee the growth in rail ridership with new railway lines. Changes in the existing mode of travelling would be inevitable and to meet these changes, it is all the more important that a close working relationship should be established among operators in establishing priorities, in service planning and in promoting the use of feeder bus services.

Lastly but not least, it is necessary to put emphasis on research. With 30 years of success behind us, it is suggested that the public transport sector should consider establishing comprehensive data on the local transport industry. We should also seek to develop our research ability, to promote the skills we have developed in managing a complicated transport network and to record the experiences of those who have served the industry well over many years. Our major rail and bus operators have reached the maturity to be able to influence the development of meaningful research programmes. This may include initiatives involving the universities in encouraging the development of appropriate skills in supporting our transport industry in enhancing operational efficiency, in promoting safety and in initiating researches and studies. It is hoped that the common objective of bringing the best transport system of even higher quality will help to blend operators together towards this common goal.
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INTRODUCTION

While the road network has been expanding by 27% in the past decade, the number of vehicles is also increasing considerably by 57%. Such unbalanced growth results in traffic congestion problems particularly in the urban built-up areas. Serious congestion would incur heavy economic, environmental and social costs to the community. Apart from building more roads, effective traffic management is essential to keep Hong Kong moving. In this aspect, various management tools have been employed, ranging from advance technologies to conventional traffic engineering techniques. This paper reviews the applications of advanced technologies to utilize the road space more efficiently in Hong Kong.

TRANSPORT POLICY IN HONG KONG

The vision of the Transport Department is to provide the world’s best transport system, which is safe, reliable, efficient, environmentally friendly and satisfying to both users and operators. Transport today is increasingly busy and complex and there is a growing pressure on infrastructure and resources. We need to moving towards direction of introducing more advanced technologies to control traffic better, maximize use of road network capacity and provide real time information to road users.

The main objective of Hong Kong’s transport policy is to maintain a reasonable level of mobility of people and goods necessary to support economic growth and to meet social, commercial and recreational needs of the community. This has been achieved historically through three main principles laid down in the White Paper on Transport Policy in Hong Kong (Transport Branch, 1990):
(a) improving the transport infrastructure;
(b) expanding and improving public transport; and
(c) managing road use.

Improving the Transport Infrastructure

The efficient working of the transport system depends on the provision of an adequate infrastructure. It is the Government's mission to expand and improve the transport infrastructure to support and enhance economic and housing development. Continuous proactive planning is essential to ensure timely provision of facilities. We are currently conducting the Third Comprehensive Study to formulate an integrated transport strategy, to achieve and maintain an acceptable level of mobility for passengers and freight by road, rail and ferry over the next 15 to 20 years. The focus is on expanding the strategic road network and high capacity, environmentally friendly rail systems.

The building programme is continuing. Recently completed major projects include the Tai Lam Tunnel, Ting Kau Bridge and Airport Railway while on-going projects include the West Rail and Mass Transit Railway Tseung Kwan O Extension.

Expanding and Improving Public Transport

Public transport carries 90% of all person trips in Hong Kong. It will continue to carry the bulk of person trips since our highly concentrated development pattern and limited road space do not allow extensive use of private cars. It is therefore our commitment to improve the availability and quality of public transport services. We will enhance monitoring of franchised bus, light bus, ferry, taxi and tram services and co-ordinate demands on and interchange among various modes of public transport.

Managing Road Use

Along with expanding the road and rail networks to accommodate the traffic demand, traffic management measures have played an important role in maintaining mobility, especially in the urban built-up areas. These tools enable us to make more effective use of the road space and give priority to the more efficient and essential road users such as franchised buses and emergency vehicles. As a result of these efforts, we have been able to maintain a reasonable level of mobility in the past ten years despite considerable increase in both the numbers of vehicles and trips.

Technology offers the prospect of making more efficient use of our
roads while making road transport safer and more environmentally acceptable. This leads to the development of Intelligent Transport Systems (ITS), the application of modern telecommunications and information technologies to traffic and transport fields.

ITS can contribute to the achievement of our vision. Applications that manage traffic better are making more effective and safer use of our existing road network. Applications that provide better information to passengers and better management of bus fleets can increase the attractiveness of public transport as an alternative to car.

We are all road users – drivers, public transport passengers or pedestrians. Our economy and all of us depend on road transport to deliver goods and services. The proper deployment of ITS will benefit our life.

**AREA TRAFFIC CONTROL**

We have a long history in deploying ITS in Hong Kong. Hong Kong installed its first computerised area traffic control (ATC) system in 1977. This fixed-time traffic control system, which initially controlled about 80 road junctions in West Kowloon, was expanded gradually to control 320 junctions in other parts of Kowloon by 1990.

The SCOOT (Split, Cycle, Offset, Optimisation Technique) system with real time adaptive traffic control capability was installed on Hong Kong Island in 1989. The system now controls 308 junctions there.

The Kowloon ATC system was replaced by the SCATS (Sydney Co-ordinated Adaptive Traffic System) in 1995, employing up-to-date technology and traffic control concept. This new system now controls about 518 junctions in Kowloon, 127 junctions in the Tsuen Wan New Town and 86 junctions in Sha Tin. We have plans to provide ATC in other new towns in the coming years.

The ATC systems have generated significant benefits to the traffic by good co-ordination of traffic signals. With the use of advanced computer technology to co-ordinate the control of traffic signals, motorists are given a green wave to go through junctions without stopping. Detectors are installed at the junctions to record real-time traffic conditions to allow the traffic signals to be adjusted accordingly. Special computer plans are also developed to give priority to emergency vehicles so that they can arrive at their destinations more quickly. Studies revealed reductions in journey time by 30%, number of stops by 28%, and stop time by 52% after the installation of ATC systems.
OTHER ITS APPLICATIONS IN HONG KONG

We also used ITS in the following areas:

(a) traffic control systems in tunnels and bridges;
(b) emergency telephone;
(c) Close Circuit Television (CCTV);
(d) automatic toll collection;
(e) electronic smart card for parking and public transport;
(f) Red Light Camera System (Figure 10.1); and
(g) Speed Monitoring Camera System.

Figure 10.1  Red Light Camera

TRAFFIC CONTROL AND SURVEILLANCE

We installed a sophisticated traffic control and surveillance system at the important Tsing Ma Control Area to facilitate traffic management and control for the complex 17-km network of open highway, road tunnels and bridges providing access to Hong Kong’s new airport at Chek Lap Kok.

The system includes emergency telephones, automatic incident detectors, closed circuit television cameras, overhead vehicle detection and many variable signs and signals. Other sub-systems include radio communication systems for the operational and communication staff, the Police and the Fire Services. Radio re-broadcast system with break-in capability and a public address system will be also provided.

We intend to extend such provision to manage the rest of our
Traffic Management and Control in Hong Kong

Strategic Road Network (SRN). The SRN warrants special considerations for ITS implementation because of its high travel speeds, large traffic volumes and more severe traffic safety concerns. Incidents on the SRN are generally more severe than on local roads. They take longer to clear and hence may cause more severe traffic congestion, if not chaos, over a widespread area.

Existing SRN covers a total length of 190 km. Significant traffic congestion was observed along several major corridors including Cross Harbour Tunnel, Tolo Highway, Gloucester Road, etc. Recurrent congestion creates an estimated delay of 186,000 pcu-hours per day. The other cause of congestion is due to accidents and incidents on the SRN. It is estimated that there are on average 27 incidents and accidents on the SRN per day. This created an additional non-recurrent delay of 345,000 pcu-hours per day.

By 2011, the SRN will expand to 320 km. Recurrent delay caused by traffic congestion is estimated to increase to 258,000 pcu-hours per day, a 39% increase over 1997 conditions. Analysis of accidents/incidents indicates that there will be, on average, over 49 incidents and accidents on the SRN per day by the year 2011, nearly doubled the 1997 conditions. Non-recurrent delay due to incidents and accidents on the SRN is estimated to give rise to an additional delay of 701,000 pcu-hours per day by 2011. This represents an increase of 104% from 1997 conditions.

In view of the anticipated problem, we commissioned a study on the provision, management and operation of traffic control and surveillance facilities for the SRN (SRN Study) in July 1998. The study will be completed in late 1999.

The objective of the SRN Study is to investigate the feasibility and cost-effectiveness of deploying ITS for the management of the SRN. The aim is to improve safety and efficiency, and reduce environmental cost associated with congestion.

Overseas experience proves that proper management of the SRN could

(a) improve traffic flow by

♦ implementing suitable traffic management schemes especially when an incident has occurred, e.g., lane use signals (Figure 10.2);
Figure 10.2 Dynamic Message Sign

- providing motorists with real time traffic conditions to allow them making rational decision on transport mode, time to travel, route and destination, e.g., radio broadcast, dynamic message signs;
- smoothing traffic flow using ramp meters and variable speed limit signs; and
- reducing time for identification, verification and clearance of incidents by means of automatic incident detectors

(b) improve road safety by
- providing motorists with real time information on incidents to avoid driver frustration and secondary accidents, e.g., dynamic message signs;
- enhancing enforcement by police, e.g., installation of speed enforcement cameras; and
- reducing time for identification and verification of accidents and faster access to the accident site by CCTVs, automatic incident detection and service patrol.

(c) reduce pollution by
- smoothing traffic flow thereby reducing pollution caused by stationary vehicles; and
- reducing time for clearance of incidents and hence duration of delay.

Implementing the SRN Management System also lead to other benefits such as reducing gasoline consumption; reducing driver frustration; and improving the image of Hong Kong’s road transport system.
In the Study, we established a set of SRN strategies including:

(a) Traffic Management Strategy;
(b) Traveller Information Strategy;
(c) Incident Management Strategy; and
(d) System Integration Strategy.

We identified options for each strategy and carry out cost benefit analysis to identify the most cost-effective options. Following the formulation of the SRN Management Strategy we continue to develop an operation plan and conceptual design for implementing the Strategy. The implementation programme outlines our plan of implementing SRN Management Strategy over the next ten years.

We plan to establish a Traffic Management and Information Centre (TMIC) to manage the SRN activities (Figure 10.3). The TMIC will serve as a central processing and co-ordination centre for traffic management, traveller information and incident management of all SRN roads. The TMIC would communicate with the tunnel/bridge control centres, the Police Regional Command and Control Centres (RCCCs), the Area Traffic Control (ATC) Centres, the Transport Department Emergency Transport Co-ordination Centre (ETCC) and other control centres.

We also plan to install a variety of ITS facilities including CCTV cameras, dynamic message signs, lane use control signals and speed enforcement cameras on our new highways and retrofit such facilities on our existing highways in conjunction with road works. All these facilities will be connected to the TMIC through fibre-optic cables.

Figure 10.3 Traffic Management and Information Centre
TRANSPORT INFORMATION SYSTEM

ITS applications in Hong Kong so far mainly focus on traffic management. There is limited information flow, be it static or dynamic, to road users, including motorists, fleet managers, passengers and pedestrians.

We are now conducting a Feasibility Study of Transport Information System (TIS Study). The purpose of the Study is to assess the business, technical and financial feasibility of a TIS and to recommend an implementation plan. This 7-month Study commenced in August 1999.

The proposed System will be based on commercially available Geographic Information System (GIS) technology for storing, analysing and display of transport information. It should enable transport information to be assembled in a readily available digital form and to facilitate dissemination to the public via established distribution channels like variable message panels, electronic mass media and commercial publication/services, etc.

By providing reliable and comprehensive transport information, the System enables commuters to make conscious choice on modes of transport and routes to take, thereby minimising productivity loss due to road congestion. In the end, ready provision of transport information contributes towards efficient use of road, better traffic flow, greater safety on the road network and improved accessibility in our city.

The initial system will only handle static information but future expansion into dynamic transport information system will be included.

PRIVATE PARTICIPATION

The development of TIS is an essential first step and indication of our commitment towards adopting a strategic approach to manage and disseminate transport information. It also contributes to our objective to achieve a customer friendly transport system in Hong Kong.

With the setting up of the GIS based Transport Information System, transport information will be readily available in digital form. It will open up opportunities for services provision, which otherwise are not available, or at least not cost effective to do so. Private sectors can participate and develop their commercially viable products and services. For example, car navigation system (Figure 10.4) can be easily tailored for use in Hong Kong. Motorists and public and private organisations managing vehicle fleet can use such software to optimise their trips by planning ahead.
In addition, information service providers can improve their existing service, or even develop new service with digital transport information available from the Government. For example, Interactive TV (Video On Demand) can set up a transport channel. Viewers can enter their choice of origin and destination, the suggested route with associated traffic condition will then be displayed on screen. Such service will add value to existing service and will attract customers not only limited to those for home entertainment.

With the joint effort of the Government and private sectors to develop products/services based on digital transport information, commuters will be better informed and their journey time will be more predictable. The business community will therefore benefit from the improved transport efficiency.

CONCLUSION

Hong Kong already has a wide range of ITS in use. Examples include Area Traffic Control System, Traffic Control and Surveillance System, Automatic Toll Collection System and Red Light Camera System, etc. Clearly, however, an important aim for us must be to take advantage of wider ITS developments so far as they are consistent with our transport and other objectives.

Experience elsewhere shows that ITS is a multi-billion dollar business for the electronic, telecommunications and automobile industries. However, the Government must take the lead in promoting ITS and, in so doing, must provide the vision, a strategy and the necessary facilities to guide and develop the relevant services and industries.

Besides the technical aspects, we also need to sort out the institutional
arrangements, such as liaison and co-operation with international and Mainland authorities and legislative issues, such as proprietary and intellectual property rights over data and infrastructure, personal privacy, etc.

We also need to explore the potential of enabling technologies such as Global Positioning System and Optical Character Recognition, etc.

Lastly, it is important to point out that applications of ITS cannot be successful without the active participation of all the related parties. This may include initiatives involving the universities in encouraging the research and development of enabling technologies; consultants in bringing in overseas experience; industries in rolling out innovative products; service providers in providing user friendly value added services and contractors in carrying out system integration. It is hoped that everybody would contribute to the further deployment of ITS in Hong Kong to make our Transport System safer, more reliable, efficient and environmental friendly and satisfying to the users.

REFERENCE

Transport Branch (1990), *White Paper on Transport Policy in Hong Kong*, Hong Kong: The Hong Kong Government.
Transport Options for the 21st Century
11 Demand-Side Measures and Road Pricing

Timothy D HAU

INTRODUCTION AND SUMMARY

The purpose of this paper is to demonstrate that the use of demand-side measures via fiscal measures – even crude ones – constitute an indispensable tool in transport for urban development that pre-empts gridlock. The paper begins with a brief comparison of Hong Kong vis-à-vis other countries in terms of its transport characteristics, paying particular attention to rival Singapore and Japan. It gives a brief historical sketch of urban transport policy as it relates to demand-side measures in Hong Kong and proceeds to analyze the Transport Branch’s Report of the Working Party on Measures to Address Traffic Congestion, November 1994, as well as the newly named Transport Bureau’s Third Comprehensive Transport Study Consultation Document, June 1998. The main lesson to be drawn is that the most effective and sustainable way of tackling the urban transportation problem is with a set of demand-side measures alone – despite the bluntness of simple tools such as first registration taxes and annual license fees on private vehicles – or a combination of demand-side measures and positive supply enhancements (in the form of road construction and public transport provision).

Per contra, note that the pursuit of supply measures alone by transport planners would be inefffectual in dealing with the congestion problem over the long haul in the absence of differential pricing of road use via peak/off-peak charges. This is because space in urban areas is scarce and construction costs are high, continued road capacity expansion and transport improvements without demand-side restraint is an unviable solution on both financial, physical and environmental grounds. Congestion pricing of roads turns out to be a potential win-win strategy in that it curtails congestion and mobilizes public revenues for any cash-strapped government. In addition, it lowers environmental externalities and conserves energy as by-products. Traffic will converge on preferred times and places until there is congestion and delay – due to the fundamental law of traffic congestion – resulting in both inefficient trips
and economic activities undertaken unless there is some form of peak/off-peak pricing. Newly industrializing economies such as Hong Kong with increasingly tight fiscal resources cannot afford to waste them on largely unsuccessful attempts to ease congestion by constantly expanding facilities. When the existing infrastructure is efficiently priced and utilized, marginal transport projects could then be shown to fail the cost-benefit test. Costly projects could then be averted or deferred. Economically efficient prices can also signal the optimal level of road capacity to be invested. Efficiently pricing for the external effects of road use in the short run and optimally investing in road capacity over the long run should be the transport planner’s dual objectives. Setting the right road use price via a finer demand-side measure such as electronic road pricing obviates the need to rely on crude and relatively indiscriminate instruments like first registration taxes, annual license fees, and even fuel taxes (which could be used instead for tackling other externalities such as pollution and road damage, for instance). In short, dealing with the fundamental law of traffic congestion at the higher end calls for differentially pricing for congestion.

COMPARISON OF SOME RECENT CROSS COUNTRY ROAD TRANSPORT CHARACTERISTICS

Hong Kong’s transport characteristics place her in a unique position of being one of the leaders in combatting the congestion conundrum. Although Hong Kong has only a quarter of Tokyo’s population, Hong Kong emerges with the second highest population density in the world after Macau (see Table 11.1). As a leading Asian hub, Hong Kong (like Singapore) is ranked among the top 16 wealthiest countries and her citizens can increasingly afford the luxury of owning private automobiles. Further, Hong Kong has six-tenths of Japan’s real income (GDP) per person but a seventh of Japan’s car ownership: Hong Kong has only 5.2% car ownership per capita compared with Japan’s 37% figure (and Singapore’s 11.6% figure) for the year 1996, the latest year for which data across countries are readily available in The Economist Pocket World in Figures, 1999 edition. With an average household size of 3.3, Hong Kong has a low household car ownership level of 18%. Economic prosperity in the postwar period allows the Hong Kong Government to increasingly afford capital-intensive infrastructure programs; the wealth helps explain the fact that Hong Kong possesses one of the denser road networks per unit of land area around — about half that of Japan’s (and a third that of Singapore’s). Yet because of Hong Kong’s diminutive size,
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<th>Position</th>
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**Note:** GDP and population data are as of 1996. Economic growth is measured as the average annual % increase in real GDP from 1996 to 1998. Car ownership data are per 100 people as of the latest available year.
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Source: The Economist Pocket World in Figures 1999 Edition
the physical amount of road space is small in magnitude. So it should not come as a surprise to find that Hong Kong's road network is five times more crowded than Japan's (and twice as crowded as Singapore's), with citizens squeezing ten times more usage out of its small road network as compared to Japan's. Hence we appear to achieve the dubious honor of having the world's most crowded road network, as measured by the number of vehicles per unit of road length, as well as the most heavily used road network, as measured by the number of vehicle-kilometers per kilometer of road network.

In a separate paper, I constructed an internationally comparable data set from the figures of Table 11.1 for the year 1993 to examine the statistical relationship between car ownership and income for the 22 wealthiest countries for which car ownership data was made available. I found that car ownership per capita is not as strongly determined by income per head as is commonly believed. Other variables such as spatial road density, road availability, the number of vehicles per kilometer of road and population density yield a greater statistical influence on car ownership per capita than GDP per head. The income elasticity — or GDP per head elasticity rather — on car ownership is 0.3 when evaluated at the variables' sample means, which says that a 10 percent increase in GDP per head results in 3 percent increase in car ownership.

Next, I ask how Hong Kong and Singapore fares, in terms of cars per million US dollars of GDP in 1996, compared to the top 30 wealthiest economies (see Table 11.2). In 1996, both Singapore and Hong Kong have incomes above the average income per capita of US$23,975 for the 30 countries. Yet both Singapore and Hong Kong possess very low car ownership levels of 11.6% and 5.2% respectively, well below the average car ownership figure of 38% across countries. It is quite clear from looking at the scatter plot of car ownership per capita versus GDP per capita in Figure 11.1 that Hong Kong and Singapore are outliers. Hence both these city-states possess the lowest car per million US dollars of GDP (see Figure 11.2). This bar chart hints that the potential to motorize for these two fast-growing economies appears to be robust, suggesting that traffic demand management ought to be pursued to counteract the negative external effects. A stronger statement cannot be made because I do not have data relating the growth of income and growth of car ownership across countries. However, there is data published by the Transport Department which is readily accessible both in print form and from the Government's home page.
### Table 11.2 Car Ownership of High Income Economies, 1996

<table>
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<tr>
<th>Rank</th>
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<th>Car Ownership per Head</th>
<th>Car Ownership per million US dollars of GDP **</th>
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</tr>
<tr>
<td>7</td>
<td>Austria</td>
<td>27,940</td>
<td>45.8</td>
<td>16.39</td>
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<td>27,590</td>
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<td>25,770</td>
<td>41.1</td>
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</tr>
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<td>15</td>
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<td>24,760</td>
<td>5.2</td>
<td>2.10</td>
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<td>16</td>
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<td>16.27</td>
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<td>37.0</td>
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<td>35.9</td>
<td>19.54</td>
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<td>New Zealand</td>
<td>15,850</td>
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<td>Cyprus</td>
<td>13,230</td>
<td>34.8</td>
<td>26.30</td>
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<tr>
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<td>Taiwan</td>
<td>12,800</td>
<td>19.3</td>
<td>15.08</td>
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<tr>
<td>30</td>
<td>Bahamas</td>
<td>12,480</td>
<td>16.1</td>
<td>12.90</td>
</tr>
</tbody>
</table>

Average: 23,974.7, Standard deviation: 8,899.83

** Only the top 30 wealthiest economies with car ownership figures reported are included here (with Bermuda and United Arab Emirates excluded).**

** Car ownership per million US dollars of GDP is obtained by dividing car ownership per head by GDP per head.**
Figure 11.1 Car Ownership per Capita of High Income Economies, 1996
Figure 11.2  Cars per Million US Dollars of GDP, 1996 (in Descending Order)
GDP GROWTH AND AUTO OWNERSHIP

Since motorization is correlated with a country's wealth, the same can be expected to occur in Hong Kong, especially with such a low car ownership level at present (of 5.4% in 1998). With the real GDP growth rate averaging 5.9% over the past two decades (1979-98), the incessant demand for auto ownership cannot be allowed to grow unchecked without imposing some form of disincentive. After all, despite heavy investments in transport construction and maintenance by the Government, the length of public road has only increased by a little over 2½ percent annually in the same twenty-year period. Unless one plows large amounts of resources into road building - to the extent that it becomes uneconomical - a small urban area such as Hong Kong could not afford to forgo managing the demand side. Yet with such low household car ownership - at least for the time being - one may mistakenly think that it must have been public acquiescence that results in the Hong Kong Government's passage of several major car taxation restraint measures. In actuality, it is the Government's strategy of combining a package of supply enhancements and traffic management measures to date that facilitates the successful integration of and continued reliance on demand-side measures as part of a comprehensive transport policy. The use of demand management is achieved despite it being politically unpalatable with a newly emerging 'sandwich class' of aspiring car owners. Therefore, given that fast economic growth is generally associated with high motorization levels and travel demand, Hong Kong's low car ownership figures in fact belie a lack of political obstacles to the Government's success in introducing and maintaining reasonably effective demand management policies aimed primarily at the private car (as we shall see later on).

DEMAND-SIDE MEASURES ON AUTO OWNERSHIP

The level of motorization in Hong Kong began to gather momentum in the sixties. With trade being Hong Kong's lifeline, export-induced economic prosperity resulted in the growth of road transportation and an increase in motor vehicle acquisitions. Despite massive postwar infrastructure investment, it was recognized by authorities even back then that Hong Kong's topography prevented traffic from growing without bound and that priorities had to be determined among road user types. Such concern led to the commissioning of studies such as the first Comprehensive Transport Study (1976) by the Public Works Department in 1973. The Comprehensive Transport Study (hereafter CTS-1) revealed a startling finding: three-quarters of the road space were being used by
only a quarter of the travelling population, namely motorists and taxi occupants. Transport consultants' recommendations helped launch the Government's first Green Paper on internal transport policy in 1974. That green paper, whose purpose was for public information and discussion, was the first to propose establishing the tripartite principles of transport policy for Hong Kong, namely to: i) improve the road system, ii) expand and improve public transportation, and iii) make more economic use of road space.

One effective means to enhance traffic flow – albeit a blunt one – is a fiscal measure that curtails private car ownership. A first registration tax (FRT), i.e., a purchase tax on the value of a vehicle, can serve as a crude proxy for vehicle usage. Thus the FRT for both the private car and the motor cycle were increased in March 1974 by a half to the level of 15% of the cost-insurance-freight (c.i.f) value of a vehicle. Concurrently, annual vehicle license fees (ALF) were approximately trebled, with the high levels targeted primarily at private cars. As expected, such a combination of FRT and ALF measures contributed to an immediate decline in the number of private cars for three years (and the number of motor cycles for the same number of years, the curve of which is not shown for now in Figure 11.3 to avoid clutter). Note further that private cars (and motor cycles) did not attain their previous highs until five years (and seven years respectively) after the restraint measures' implementation (see Table 11.3). Because goods vehicles were not initially charged in 1974 with respect to their contribution to freight transportation's external effects, the year-on-year increase in the number of goods vehicles helped account for the fact that the total number of all registered vehicles exceeded its pre-FRT peak in just four years instead of five. The next adjustment to the FRT occurred in December 1975, when the Government doubled the existing first registration taxes for private cars and motor cycles to 30% and decided to also charge goods vehicles and taxis at the rate of 15%. Aside from this tax hike, the Hong Kong stock market crash of 1973 and the world-wide energy crisis of the early 1970s helped dampen the growth in freight traffic. As can be seen in Figure 11.4, goods vehicles continued to rise throughout the 1970s and indeed the 1980s. The observed high correlation of real GDP and freight traffic buttresses my point that it is the severity of the combined FRT/ALF fiscal measure of 1974 on private autos and motor cycles rather than the contemporaneous impact of the recession that significantly lowered car and motor cycle registrations. Even though subsequent minor adjustments to the FRT were made in February 1978 and March 1979 in the form of a higher FRT tax rate on high-valued private cars vis-a-vis low-valued ones, the trend in automobile registrations continued upwards.
Figure 11.3  Time Series Plot of the Number of Registered Private Cars versus Real GDP for Hong Kong, 1961-98
### Table 11.3 Number of Registered Private Cars, Goods Vehicles and Real GDP in Hong Kong, 1961-98

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Registered Private Cars</th>
<th>Growth of Registered Private Cars</th>
<th>Number of Registered Goods Vehicles</th>
<th>Real GDP (in HK$ million) (1990=100)</th>
<th>Growth of Registered Goods Vehicles</th>
<th>Growth of Real GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961</td>
<td>35,778</td>
<td>-</td>
<td>10,270</td>
<td>61,750</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1962</td>
<td>40,216</td>
<td>12.4%</td>
<td>11,460</td>
<td>70,488</td>
<td>11.6%</td>
<td>14.2%</td>
</tr>
<tr>
<td>1963</td>
<td>45,210</td>
<td>12.4%</td>
<td>14,170</td>
<td>81,557</td>
<td>23.6%</td>
<td>15.7%</td>
</tr>
<tr>
<td>1964</td>
<td>51,073</td>
<td>13.0%</td>
<td>16,931</td>
<td>88,547</td>
<td>19.5%</td>
<td>8.6%</td>
</tr>
<tr>
<td>1965</td>
<td>53,515</td>
<td>4.8%</td>
<td>17,058</td>
<td>101,364</td>
<td>0.8%</td>
<td>14.5%</td>
</tr>
<tr>
<td>1966</td>
<td>56,911</td>
<td>6.3%</td>
<td>17,384</td>
<td>103,111</td>
<td>1.9%</td>
<td>1.7%</td>
</tr>
<tr>
<td>1967</td>
<td>60,949</td>
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<td>17,673</td>
<td>104,859</td>
<td>1.7%</td>
<td>1.7%</td>
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<td>1968</td>
<td>69,062</td>
<td>13.3%</td>
<td>18,470</td>
<td>108,334</td>
<td>4.5%</td>
<td>3.3%</td>
</tr>
<tr>
<td>1969</td>
<td>80,209</td>
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<td>18,017</td>
<td>120,588</td>
<td>-2.5%</td>
<td>11.3%</td>
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<tr>
<td>1970</td>
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<td>15.8%</td>
<td>21,298</td>
<td>131,656</td>
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<td>9.2%</td>
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<td>105,874</td>
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<td>25,790</td>
<td>140,977</td>
<td>21.1%</td>
<td>7.1%</td>
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<td>1972</td>
<td>120,725</td>
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<td>28,794</td>
<td>155,541</td>
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<td>10.3%</td>
</tr>
<tr>
<td>1973</td>
<td>129,651</td>
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<td>31,473</td>
<td>174,765</td>
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<td>12.4%</td>
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<tr>
<td>1974</td>
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<td>2.3%</td>
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<tr>
<td>1975</td>
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<td>32,034</td>
<td>179,453</td>
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<td>0.3%</td>
</tr>
<tr>
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<td>113,665</td>
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<td>37,108</td>
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<td>16.2%</td>
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<td>11.7%</td>
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<tr>
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<td>47,405</td>
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<td>8.5%</td>
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<tr>
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<td>51,780</td>
<td>281,954</td>
<td>9.2%</td>
<td>11.3%</td>
</tr>
<tr>
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<td>58,801</td>
<td>310,499</td>
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<td>10.1%</td>
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<tr>
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<td>211,556</td>
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<td>64,214</td>
<td>359,044</td>
<td>9.2%</td>
<td>9.2%</td>
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<tr>
<td>1982</td>
<td>214,849</td>
<td>1.6%</td>
<td>67,606</td>
<td>348,764</td>
<td>5.3%</td>
<td>2.7%</td>
</tr>
<tr>
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<td>200,923</td>
<td>-6.9%</td>
<td>69,057</td>
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<td>5.7%</td>
</tr>
<tr>
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<td>182,985</td>
<td>-8.9%</td>
<td>72,469</td>
<td>404,872</td>
<td>4.9%</td>
<td>10.0%</td>
</tr>
<tr>
<td>1985</td>
<td>168,200</td>
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<td>77,918</td>
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<td>86,347</td>
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<tr>
<td>1987</td>
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<td>3.5%</td>
<td>101,970</td>
<td>508,565</td>
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<td>12.9%</td>
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<tr>
<td>1988</td>
<td>178,234</td>
<td>6.7%</td>
<td>114,451</td>
<td>549,344</td>
<td>12.2%</td>
<td>8.0%</td>
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<tr>
<td>1989</td>
<td>195,818</td>
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<td>123,329</td>
<td>563,325</td>
<td>7.8%</td>
<td>2.5%</td>
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<tr>
<td>1990</td>
<td>215,709</td>
<td>10.2%</td>
<td>130,270</td>
<td>592,549</td>
<td>5.6%</td>
<td>3.4%</td>
</tr>
<tr>
<td>1991</td>
<td>236,747</td>
<td>9.8%</td>
<td>134,285</td>
<td>612,259</td>
<td>3.1%</td>
<td>5.1%</td>
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<tr>
<td>1992</td>
<td>265,755</td>
<td>12.3%</td>
<td>140,755</td>
<td>650,125</td>
<td>4.8%</td>
<td>6.2%</td>
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<tr>
<td>1993</td>
<td>291,913</td>
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<td>144,093</td>
<td>690,321</td>
<td>2.4%</td>
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<td>1994</td>
<td>311,929</td>
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<td>141,876</td>
<td>727,604</td>
<td>-1.5%</td>
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<tr>
<td>1995</td>
<td>318,223</td>
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<td>4.6%</td>
</tr>
<tr>
<td>1996</td>
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<td>3.8%</td>
</tr>
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<td>1997</td>
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<td>135,267</td>
<td>831,319</td>
<td>0.4%</td>
<td>5.2%</td>
</tr>
<tr>
<td>1998</td>
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<td>3.2%</td>
<td>133,242</td>
<td>788,677</td>
<td>-1.5%</td>
<td>-5.1%</td>
</tr>
</tbody>
</table>

Average 164,775.1 6.7% 67,338.2 354,229.0 7.4% 7.2%
Besides the car ownership fiscal restraint measure on private cars and motor cycles imposed in March 1974 (and minor increases in 1978 and 1979), the second noteworthy fiscal restraint measure was the hefty increase in first registration taxes and annual license fees in May 1982. Indeed, it is the two drastic car ownership fiscal measures of 1974 and 1982 that were primarily responsible for the interruption of the rising trend in the private vehicle fleet of cars and motor cycles in postwar Hong Kong. The major fiscal restraint measure of May 1982 has its roots in the White Paper on Internal Transport Policy of 1979, which enshrined the green paper’s tripartite transport policy – a policy which has in fact been adopted ever since. In turn, the White Paper was based on the technical work and policy recommendations of the first Comprehensive Transport Study, which demonstrates that the preferred option of combating growing congestion is – after ruling out the instruments of parking controls, supplementary licensing and physical restraint – a fiscal measure of auto ownership restraint. Such an impetus was precipitated by the continued growth of private automobiles, which by the early 1980s, reached two-thirds of the total vehicle stock. The drastic fiscal restraint measure on the ownership of private cars and motor cycles involved: i) a doubling of the FRT to 70%-90% of a vehicle’s c.i.f. value; ii) a tripling of the ALF; and iii) a doubling of the petrol tax. Despite the stock and property market crashes of 1982 and a decline in real GDP growth in 1985, freight traffic continued to grow unabated and in fact accelerated after 1985. Hence the large drop found in the number of private cars and motor cycles could reasonably be traced to the sharp increase in FRT and ALF. The relative effectiveness of the FRT and ALF can be further seen by having a close look at the number of registered versus licensed private cars and motor cycles in Figure 11.5. Here we see that the number of private cars plotted with data based on year-end registrations from the Transport Department declined from its peak in 1982 for 4 years until it reaches its trough in 1986. Thereafter, the downward trend reversed itself and it was only until 1990 – fully 8 years after the fiscal restraint measure of 1982 – did total private car registrations exceed the past peak of 1982. Similarly, with the level of motor cycle registrations exhibiting the same humped-curve characteristic as that of the private car, the level of motor cycle registrations declined for 6 years and the level did not exceed its previous peak of 1981 until 13 years later in 1994. Such is the potency of adopting FRT and ALF as transport policy instruments for sustainable urban development.
Figure 11.5  Number of Registered and Licensed Vehicles, Private Cars and Motor Cycles for Hong Kong, 1977-98
ECONOMETRIC ANALYSIS OF GDP AND PRIVATE CARS AND GOODS VEHICLES REGISTRATIONS

Lest the reader is not convinced by the arguments advanced above, elsewhere I have performed a rigorous time series analysis of the number of private cars and the number of goods vehicles as well as real GDP using 1961 to 1993 data, the results of which are summarized here. First, I found that, as expected, national income determines the total number of registered cars using time series data (but not cross section data). The effect of the important fiscal measures of private car first registration tax and annual license fee rises in reducing the net change in the private car fleet in March 1974 and May 1982 is found to be (statistically) significant using dummy variables, holding constant important economic factors such as the real income level. This suggests that public policy to control traffic should be increasingly directed towards the use of finer instruments such as annual license fees, then fuel taxes and ultimately road use pricing.

Second, the evidence indicates that the impact of an increase in first registration tax and annual license fee on goods vehicles in March 1990 and March 1991 is (statistically) significant. Fiscal measures, although politically unpopular, are considerably more effective in curtailment of the number of vehicles than conventional traffic management measures. Fiscal measures enhance efficiency in part by mobilizing valuable resources to be reused by increasingly lean governmental authorities.

FIRST REGISTRATION TAXES VS. ANNUAL LICENSE FEES

It is useful to differentiate between registered vehicles and licensed vehicles. For instance, the fraction of registered private cars and motor cycles that was licensed was 89% and 88% respectively in December 1998, which explains the discernable gap between the number of vehicle registrations and vehicle licenses in Figure 11.5. Note that the first registration tax is a one-time tax: once paid for by a motorist, the FRT can be regarded as a sunk cost. On the other hand, annual license fees can be paid on an annual or quarterly basis (and vehicle owners can even request for a refund if the vehicle is out of commission when undergoing repairs). Hence the ALF is akin to a variable charge, albeit on vehicle ownership and not usage. Thus one would expect that motorists would respond more quickly to ALF increases by behaving accordingly. My hypothesis that motorists bear the brunt of an ALF increase right away is confirmed by noting that the number of licensed private cars and motor cycles already began to decline in 1982. Thus the number of licensed private cars and motor cycles both declined for 5 consecutive years and did not respectively exceed the previous peak until 9 years and 15 years afterwards! Lest one thinks that it is the trebling of the ALF— as opposed
to the *doubling* of the FRT – that caused the relative responsiveness of licensed vehicles over registered ones, a closer look at the dollar magnitudes of each instrument indicates that the ALF should have had a much smaller impact vis-a-vis FRT given the ALF’s lower fee increases.

**ELECTRONIC ROAD PRICING (ERP)**

Given that past experience has shown that the combined FRT/ALF increase is effective albeit for the medium term of only several years before the onslaught of inflation erodes its bite, the Government appeared to use the FRT/ALF increase in May 1982 as a stopgap measure. By 1985, private cars had fallen to a half of the vehicle fleet, with the taxi fleet equivalent to a tenth of the private car fleet size. However, private car *use* had declined by only a tenth, with three-quarters of traffic flow generated half-and-half by private cars and taxis for most of the day. In fact, during the morning peak period, private car use represented half of the total vehicle flow. The then Secretary for Transport Alan Scott announced in 1983 that Hong Kong would embark through 1985 on the world’s first technical feasibility study of electronic road use pricing with automatic vehicle identification technology. By pricing the difference of the social and private costs of road use, ERP can charge flexibly the external effects of vehicular traffic by time and location. By comparison, the FRT/ALF ownership restraint measure is regarded as a sledgehammer approach to the curtailing of congestion externalities since it tackles vehicle usage in a very indiscriminate manner. (Still, it allows the Government to collect revenue for the public purpose, rather than letting the revenue be dissipated under queuing.) The major disadvantage in terms of economic efficiency of this FRT/ALF restraint measure is that it suppresses socially worthwhile trips in uncongested areas. In terms of equity, it prevents aspiring middle-class households from the acquisition of private automobiles. Since the fiscal restraint measure resulted in a relatively quick and dramatic improvement in traffic speeds, it is likely that pre-existing (and perhaps better off) vehicle owners would intensify their vehicle use by naturally converging on their most preferred times and routes, thereby defeating the initial gain in travel times engendered from the crude demand-side measure. Thus unless differential pricing is carried out by pricing road use higher during peak demand and lower during off-peak demand – as is commonly practised by telecommunications companies both in Hong Kong and abroad – the congestion problem will persist.

**THE BENEFITS AND COSTS OF ERP, 1983-85**

Since the Hong Kong SAR Government’s current plan (as of this writing
in 1999) is to consider whether or not to go ahead with Electronic Road Pricing (ERP) in Hong Kong, it would be useful to review briefly the Hong Kong Electronic Road Pricing System experiment of 1983-85. That demonstration project involved fitting a sample of 2,500 vehicles with electronic number plates on the underside of a vehicle. This video-cassette sized transponder permits radiowave communication with the electronic loops embedded below the road surface. Roadside microcomputers installed at selected charging points in turn relay the vehicle’s identification code to a control center. Car owners (only) are then sent monthly billing statements (similar to telephone bills) listing the actual amount of road use subject to ERP. Noncomplying vehicles either without electronic number plates or with defective ones are photographed by closed-circuit television cameras just as radar technology is used to catch speedsters. Based on a true subset of the full ERP system, the ERP pilot experiment proved to be an overwhelming technical success at 99.7% reliability, which well exceeded the 99% accuracy requirement specified by the Government. Five charging periods were initially tested: the morning and afternoon peaks, the interpeak and the shoulder peaks, with the prices reflecting the level of travel demand. Three different zoning schemes which vary in the number of toll sites and in the degree of complexity were simulated, with the benefits reported in Table 11.4. The benefits include the savings in travel time to those who stay and pay under ERP and the vehicle operating cost savings from less congestion as well as the disbenefits to those who are priced off the route to avert the ERP charge. The distributional benefits and other issues are discussed in the author’s paper entitled “Congestion Charging Mechanisms for Roads: An Evaluation of Current Practice,” World Bank Policy Research Working Paper Series WPS 1071, The World Bank, December 1992. For any of the three ERP schemes, four-tenths of the benefits are reaped by those on public transport, whereas about a quarter of the benefits each is realized by those in private cars and goods vehicles respectively, with taxis obtaining the rest of the benefits (of less than a tenth). The aggregated benefits for all vehicles under various schemes are summarized in Table 11.4. For comparative purpose, the optimal charge for the true external cost of road use was also simulated. ERP Schemes A, B and C, which more or less rise in zone-to-zone charge levels and in the degree of complexity, each reap six-tenths, seven-tenths and three-quarters of the benefits of the theoretical optimum. Each year on average the benefit-cost ratios are respectively 14.7, 17.8, 17.8 and 24.1 whereas the revenue-cost ratios are respectively 7.9, 9.5, 10.4 and 18.9. Time wasted in traffic congestion is gone forever whereas the revenues collected can be (re)used to finance more public goods and services.
### Table 11.4 Benefits, Costs and Revenues of Various Road Pricing Schemes (Compared to 1991 Reference)

<table>
<thead>
<tr>
<th>Option</th>
<th>Car ownership Restraint Measure</th>
<th>Area Licensing Scheme</th>
<th>ERP Scheme A</th>
<th>ERP Scheme B</th>
<th>ERP Scheme C</th>
<th>Optimum Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average peak-hour charge</td>
<td>-</td>
<td>HK$70</td>
<td>HK$8</td>
<td>HK$9</td>
<td>HK$9</td>
<td>HK$10.5</td>
</tr>
<tr>
<td>Annual Benefits, B</td>
<td>301</td>
<td>338</td>
<td>734</td>
<td>871</td>
<td>919</td>
<td>1250</td>
</tr>
<tr>
<td>As a Share of the Benefits of the Theoretical Optimum</td>
<td>24%</td>
<td>27%</td>
<td>59%</td>
<td>70%</td>
<td>74%</td>
<td>100%</td>
</tr>
<tr>
<td>Gross Revenue Generated, R</td>
<td>1200</td>
<td>188</td>
<td>395</td>
<td>465</td>
<td>540</td>
<td>976</td>
</tr>
<tr>
<td>Annualized Capital and Operating Costs of Charging Mechanisms, C</td>
<td>0</td>
<td>10 - 15</td>
<td>49.8</td>
<td>49</td>
<td>51.7</td>
<td>&gt; 51.7</td>
</tr>
<tr>
<td>Benefits less System Cost, NB = B - C</td>
<td>301</td>
<td>323 - 328</td>
<td>684</td>
<td>821</td>
<td>869</td>
<td>1200</td>
</tr>
<tr>
<td>Benefit-Cost Ratio, B/C</td>
<td>8</td>
<td>22.5 - 33.8</td>
<td>14.7</td>
<td>17.8</td>
<td>17.8</td>
<td>&lt; 24.1</td>
</tr>
<tr>
<td>Revenue-Cost Ratio, R/C</td>
<td>8</td>
<td>12.5 - 18.8</td>
<td>7.9</td>
<td>9.5</td>
<td>10.4</td>
<td>&lt; 18.9</td>
</tr>
</tbody>
</table>

Notes: Figures are in millions of 1985 Hong Kong dollars
HK$1 = $US1 and HK$10 = £1 (1985 figures)
The conversion factor to adjust the 1985 dollar figures to 1998 is 2.665 using the (Composite) Consumer Price Index

AREA LICENSING

The Hong Kong ERP study also simulated a 12-hour manual-based area licensing scheme of the type that operated for over two decades in Singapore between June 1975 and August 1998. Since September, 1998, Singapore has automated its former road pricing system with a fully electronic road pricing system using smart card that protects citizens’ privacy. (Singapore’s Area Licensing Scheme, the foremost example of road pricing in the world, requires that private cars and motor cycles display prominently a color-coded area license on their windshields as they enter the Restricted Zone in the central business district during the hours of operation. Between 1989 and 1998, the charges for the morning and afternoon peaks were S$3 per day whereas the charge for the interpeak is S$2 per day\(^2\). Enforcement between 1975 and 1998 was carried out straightforwardly by traffic wardens eyeballing the nonstop traffic moving past the gantries at city speeds.) Similar to those of the car ownership restraint measure, this daylight period charging scheme achieves a quarter of the benefits of the theoretical optimum but at a fraction of the cost of the ERP schemes. Because of the simplicity and low cost of the area licensing scheme, the benefit-cost ratio and the revenue-cost ratio range from 22.5-33.8 and 12.5-18.8 respectively.

LESSONS FROM THE POLITICAL FAILURE OF ERP

Yet despite the tremendous benefits to be obtained from this first-best demand-side measure, the proposal to implement a full-fledged ERP System based on the 1983-85 pilot scheme was rejected by the public. When confronted with the fact that eight-tenths of the population travel by public transport, a tenth by private cars and a tenth by taxis, it appears that Hong Kong possessed the ideal climate for the successful implementation of ERP. There are several reasons for ERP’s failure in 1983-85, the main ones of which are summarized here\(^3\). First, the enormous revenues to be obtained from ERP – with its 8 to 1 revenue-cost ratio – aroused some to question the Government’s true intentions and to regard ERP as the conception of a revenue-raising device. This despite the fact that the Hong Kong Government promised – but only at the eleventh hour – revenue neutrality: that ERP revenues were to be offset by lower first registration taxes and annual license fees. This historical experience suggests that the earmarking of the revenues from ERP is an important prerequisite for the political implementation of road pricing. The author has shown elsewhere that motorists are fully rational when they vote against road pricing\(^4\). (Briefly, those who continue to
use a road when a road use price is introduced will find that the toll payment exceeds the time savings on average. Those who are tolled off the road are naturally worse off. Hence unless motorists are compensated for by the recycling of the proceeds from congestion toll revenues in the form of a transport fund, say, or via a rebate that does not distort travelers’ choice of mode, route, time-of-day, etc., road pricing is destined to fail politically.) Second, the mounting of a transponder underneath a vehicle enables authorities to track citizens’ movements, a most unwise decision in light of the signing in 1984 of the Sino-British Joint Declaration on the future of Hong Kong after July 1997. This fear of a ‘big brother’ government helped defeat ERP in 1985 when the Government sought public consultation for the implementation of a full system. In fact, even with the outdated technology, cash accounts without a paper trail could easily be set up (as is done in many places including Oslo, Trondheim, Dallas, Oklahoma as well as in Hong Kong) with the use of one-way transponders. Since then, technology has advanced to the stage where smart cards are used in electronic toll collection (as in Italy since 1989 on the autostrada). Smart cards are simply electronic purses similar to stored value rail and phone cards. Invasion of privacy can no longer be seriously used as an excuse to defeat road pricing schemes, as had been done in many places following Hong Kong’s 1983-85 public relations disaster. Third, only private cars were charged, which created much ill-will on the part of motorists. After all, goods vehicles generate sizable congestion (as well as road damage) externalities.

THE SECOND COMPREHENSIVE TRANSPORT STUDY, 1989

As economic growth over time reduces the impact of the 1982 fiscal measure, private car acquisitions plainly rise along trend after 1986. In order to establish what needs to be done to attain a sustainable level of mobility for passenger and freight in Hong Kong up to the year 2001, the Second Comprehensive Transport Strategy was initiated in 1987 by the Transport Department. Thereafter, the Second Comprehensive Transport Study (hereafter CTS-2) was released jointly by Transport Department and Wilbur Smith and Associates in 1989. CTS-2 reports that the value of highway investment projects which had already been committed in 1980 totalled HK$23 billion. Even so, the CTS-2 Study recommended a HK$20 billion road construction program. Yet road construction alone could not solve the congestion problem. After all, with the car and goods vehicle fleet growing at ten percent per year, the fleet was forecasted to triple from 280,000 in 1988 to 880,000 by 2001. Assuming that both the
committed and recommended highway programs were undertaken as planned, road space would only increase by a third, from 3,650 lane-km to 4,900 lane-km, within the same time span\textsuperscript{15}. Further, the demand for road space by all vehicles would double from 1986 to 2001 (see Figure 11.6). Road use by private cars would rise from a fifth of total traffic in 1986 to a quarter in 2001 whereas goods vehicles would increase from four-tenths to a half over the same period, when measured as a share of total passenger car unit-kilometers (see Figure 11.6). The demand for road space by public transport – which includes public light bus (i.e., 14-seater minibus), omnibus and special purpose bus – would shrink from two-tenths to a tenth. The share of taxis, categorized as a personalized form of public transport, would decline from a fifth to an eighth. When rail is included, however, CTS-2’s Figure 8.1 states that rail would rise from 26\% in 1986 to 41\% in 1996. The fact is that rail – important though it is as a public transport mode with reliable line-haul travel times – constitutes only 31\% of all public transport boardings as of December 1998\textsuperscript{16}.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure116.png}
\caption{Demand for Road Space in Passenger Car Unit-Kilometers, 1986 and 2001}
\end{figure}
Additional positive supply-side measures are plainly needed. Indeed, a $9 billion rail investment program (in 1988 prices) including rolling stock for railway projects is recommended in CTS-2. Another major urban rail line costing HK$20 billion is also recommended for consideration for the late 1990s. Nevertheless, even with the growth of rail passenger services, CTS-2 states that road-based transport would still be expected to carry two-thirds of all public transport services by the turn of the century, compared with three-quarters in 1986. Clearly this scenario calls for demand management.

TRAFFIC FLOW OR GRIDLOCK: THE CHOICES WE FACE, 1994

In November 1994, the Secretary for Transport Haider Barma unveiled for public consultation a set of policies contained in the Report of the Working Party on Measures to Address Traffic Congestion (hereafter the Report) and its synopsis Traffic Flow or Gridlock: The Choices We Face, 1994. Noting that the annual increase in the number of private vehicles is close to 10% a year in 1992-93 and that traffic is moving slower than bicycles in some places, the Report estimates that the value of lower productivity from traffic congestion is about HK$15 billion a year. The problem that Hong Kong was (and still is) faced with is a universal one, namely how to prevent travel times in an already congested transport network from deteriorating into gridlock. In the Report, the Government reaffirms the tripartite principles of the previous White Papers and, in a bold move, to charge for road use via electronic road pricing over the long term. Pending the public acceptance and implementation of ERP using smart cards that fully protects privacy, simpler demand-side measures were proposed to restrict the growth of private car and motor cycle ownership to 2% a year. This low growth rate is required given the fact that the annual rate of growth of private cars and motor cycles has been around 9-10% for the period 1987-93. Proposed demand-side measures for the short term include: i) an increase in the first registration taxes for private cars and motor cycles from the current range of 40% to 60% of a vehicle’s retail price to a uniform rate of 70%; ii) an increase in annual license fees of 40% to offset the erosive effects of inflation; and iii) increases in tunnel tolls at key blackspots. For the medium term, a vehicle quota system for private cars and motor cycles that patterns after Singapore’s Vehicle Quota System is proposed as an alternative to FRT increases should these recommended increases for the short term prove unpopular. Initial problems encountered in Singapore since its
introduction of the Vehicle Quota System in 1990 included speculation and price uncertainty.

In a pathbreaking step from the conventional British budgeting practice of nonhypotheication of funds, the Report states that the additional revenue generated from the increase in FRT is to be channelled into a transport fund for the improvement of public transportation facilities such as bus terminals. A proposal such as this would help overcome the primary objection to the ERP scheme of 1983-85. Instead of letting road tax revenues go directly into the treasury as in the past, the Transport Branch’s proposal to earmark road tax increases and/or road use charges is crucial in ensuring that road charging schemes be publicly accepted (as is successfully done in the toll rings of Bergen, Oslo and Trondheim). Dedicating the collected funds for the purpose of improving public infrastructure turns a road tax into a road user fee by linking revenue and expenditure. Thus I would argue that earmarking would serve as a likely precondition to – although not a sufficient condition of – the public acceptance of any future ERP scheme. The other viable alternative worth investigating is to grant a nondistortionary rebate.

As part of the task of carrying out the recommendations of the Updating of CTS-2 in 1993, the Report recommends that traffic management measures be continued where appropriate (e.g. more priority lanes for buses, stricter enforcement of illegal parking and tighter control over road work and (un)loading activities). In addition to expanding the off-road rail transport mode to relieve the pressure on the road system, the Government promises to spend HK$30 billion on new roads over the following five years. The Report also states that Hong Kong cannot afford to build its way out of congestion despite the combination of heavy investments in supply enhancements and traffic management policies discussed above.

The three-month public consultation period on the Report of the Working Party on Measures to Address Traffic Congestion lapsed in February 1995. Public reaction thereafter has been strongly against car ownership fiscal restraint measures and the Singapore-type vehicle quota scheme. According to the Deputy Secretary for Transport John Telford, public opinion at the time was favorable to electronic road pricing since people felt that ERP would indeed be the most fair and flexible way of curbing gridlock18. After processing the consultation submissions, the Secretary for Transport announced on June 23, 1995 that: i) the proposed increase in first registration taxes and annual license fees would be delayed until Hong Kong’s recession had waned and private vehicle growth had
resumed; ii) the vehicle quota scheme would be dropped from further consideration due to its unpopularity; iii) a HK$30 million feasibility study of electronic road would be initiated by the end of 1995, to be followed by a technical demonstration project of ERP; and iv) a proposed tripling of the Cross Harbour Tunnel Toll from 7 a.m. to 9 p.m. daily (except Sundays and public holidays) was dropped due to motorists’ objection.

We follow the Report’s focus of confining our attention here to congestion externality (as opposed to the pricing of other externalities from road use such as pollution). Since the private (average) cost is borne by the motorist in the form of time cost (and vehicle operating cost), the Government’s task is to charge for the external (congestion) cost so that quasi-market measures can be established and the “right” prices emitted. If free-flowing traffic happens, then road pricing (or congestion pricing, rather) would call for a zero charge; if congested traffic occurs, it is the presence of excess demand that justifies charging the difference of the social and private costs of a trip. Simply stated, congestion merely reflects excess demand. Thus one could either increase the supply side (in the form of positive supply measures of road construction and public transportation improvements) or strengthen demand management. As we have seen, these stand-alone supply-side measures are ineffective over the long haul. We have also seen that even the demand-side measures used in Hong Kong are effective over a medium period of several years because of economic growth and inflation. However, with differential pricing, the congestion toll revenues collected are bona fide resources which can then be ploughed back to improve people’s well-being by providing more public services and/or tax/fee rebates. Otherwise, enormous waste results from travel time lost in congested traffic on the part of both passengers and freight.

THIRD COMPREHENSIVE TRANSPORT STUDY
CONSULTATION DOCUMENT, 1998

The Third Comprehensive Transport Study (CTS-3) was commissioned by the SAR Government in August 1997 and scheduled for completion in 1999. In the interim, the Transport Bureau responded to rising community expectations by issuing the Third Comprehensive Transport Study Consultation Document in June 1998 to solicit broader professional input. The Consultation Document states that the Government is committed to the three-pronged strategy of: a) improving the transport infrastructure; b) expanding and improving public transport; and c)
managing road use. The Document further pays special attention to our environment. To achieve sustainable development, it is important that expanded road infrastructure and public transport provision should be pursued in tandem with managing road use – the last policy of which was given short shrift in the Consultation Document, a point I shall elaborate below.

First, giving high priority to rail – a grade-separated mode – appears to neglect the crucial role that other public transport modes serve in a balanced multi-modal transportation system. As of December 1998, the combined public transport modal share of rail is 31%, which falls short of CTS-2’s forecast of a rail modal share of 41% for the year 1996 as discussed earlier. After all, the primary beneficiaries of rail are those who reside near the railways, not to mention developers and Hong Kong’s only two rail corporations. In order to better utilize rail it is important to provide adequate feeder public transport services using different-sized buses to the trunk rail lines. In that regard, the trunk-feeder concept for both passenger and freight movement explored by the Transport Department is worth investigating. Second, despite tolling being widely recognized by transport professionals as an indispensable demand management tool for efficiently redistributing traffic – as a starting point – among the three cross-harbour tunnels and at the entrances therein, it did not even earn a mention in the CTS-3 Consultation Document itself. (Ironically, the perceived political opposition to tolling was overcome without any apparent objection when the Financial Secretary Donald Tsang unwaveringly announced in his annual Budget Speech in March 1999 a doubling of the Cross Harbour Tunnel toll come September 1st upon the expiration of the Cross Harbour Tunnel Co.’s 30-year Build-Operate-Transfer project19. The doubling of the Cross Harbour Tunnel toll was successfully done despite the economy being in the doldrums, or possibly because of it.) Recall that the former Transport Secretary Haider Barma’s proposal for the Cross Harbour Tunnel toll increase met much resistance back in 1994-5 when the economy suddenly turned soft. Yet surprisingly the toll increase passed political muster at a most trying time for Hong Kong in 1999. It appears that the alternative revenue sources are even more difficult to exploit politically. All this seems to suggest the importance of considering (congestion) tolling – a negative externality-corrective toll-tax – for public finance and efficiency purposes.

Third, both road expansion and improvements and mass (rapid) transport provisions – the first two prongs of the CTS-3 strategy – are far from low-cost propositions for society. Pursuing supply enhancements
without pricing them properly would mean that quasi-market measures would not be established and the wrong prices emitted. Carrying out only the first two prongs of the strategy is unlikely to be sustainable in the long run on both fiscal, physical and environmental grounds in and of themselves. Why? “An iron law of economics states that demand always expands beyond the supply of free goods to cause congestion and queues. Drivers caught in traffic jams on the freeways in and around major cities of the world regularly run afoul of this law.” This is a quote by Nobel Laureate Gary Becker of the University of Chicago. Travel demand management – currently on the political agenda of many city governments – is understandably unpopular amongst motorists and many career government officials but is necessary to avoid dishing out too many free lunches. The third strategic prong of “managing road use” in the CTS-3 Consultation Document sounds rather innocuous. It appears to me that the Government has backtracked from its third policy commitment of making “more economic use of the road system”, the latter of which was espoused by Government in the first White Paper of Internal Transport Policy in 1979.

It is worth explaining why continuous expansions of road infrastructure is likely to be unsustainable if no restraint is in place; it is due to the fundamental law of traffic congestion. An increase in traffic capacity on commuter expressways in urban areas results in an increase in travel demand that erodes much of the capacity-enhanced traffic improvement. (Expressed in colloquial terms, Down’s law of peak-hour traffic congestion says that ‘if you build them, they will come’.) This phenomenon arises because demand that has heretofore been suppressed as a result of peak-hour congestion – otherwise known as latent demand – is released as soon as the traffic situation is improved. After all, everyone opts to travel at his or her most convenient time via the most favored route and mode were it not for the presence of queuing delay. Hence any improvement in travel time due to capacity enhancements will induce hitherto early birds, for instance, to commute later and closer to their official work start time. Traffic will hereby rise until congestion worsens to a tolerable level (such as that of the inferior local arterials) unless traffic restraint is imposed.

The Transport Branch’s 1994 Report of the Working Party on Measures to Address Traffic Congestion, p. 22, in fact gives several pieces of evidence on the fundamental law, although it was not stated as such:

“We will spend $30 billion on new roads in the next five years. However, building new roads alone will not eliminate

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Traffic congestion. In fact, new roads can encourage travellers to switch to personal forms of transport especially private cars. A clearcut recent example of this occurred with the completion of Route 6 (Tates’ Cairn Tunnel and Kwun Tong Bypass). With the opening of the new tunnel [in June 1991], the daily volume of traffic using the Tates’ Cairn, Lion Rock and Shing Mun Tunnels increased by about 30 per cent within a year from 133,000 to 178,000 vehicles [a day]. In the same period, there was a 14 per cent fall in the peak hour use of the Kowloon-Canton Railway (KCR) as people turned to private cars. Initially, the level of traffic through the Lion Rock Tunnel reduced by more than 20 per cent. Within 2½ years (by the end of 1993) both the Lion Rock Tunnel and Tate’s Cairn Tunnel were operating at their design capacity and long traffic queues are now a regular feature in peak hours. Private vehicles now account for 66 per cent of the daily throughput of the Lion Rock and Tate’s Cairn Tunnels. The impact on the adjacent road network proved even more severe. In the same 2½ year period, the number of private vehicles on the Tolo Highway increased from 27,000 to 43,000 per day, representing a growth of about 60 per cent. Tolo Highway is now operating beyond its design capacity during the morning peak hours.”

Thus capacity expansion appears to generate even more than its own demand, filling the newly increased capacity right away as well as dwindling both ‘public’ coffers: the public’s and the public transport operators’. This phenomenon is consistent with the Transport Department’s observation that within two or three years, roads built become full.

The most viable solution to the above problem is, unsurprisingly, to pursue travel demand-side measures. Fiscal measures in the form of first registration fees and annual license fees are an administratively simple and powerful form of restraint on vehicle ownership – albeit a crude one as mentioned earlier. Clearly, fiscal restraint on private car ownership is less equitable and flexible than fiscal restraint on car use. An example of the latter instrument is the fuel tax. Unfortunately, as Hong Kong has experienced recently with minibus and taxi operators, diesel taxes have become an increasingly politically difficult instrument to mount for demand management purposes. Compared to all these travel demand management measures, the less onerous tool appears to be the introduction of road use charging over the long haul in line with the user pays principle.
Indeed, the free-marketeer Nobelist and Stanford’s Hoover Institution affiliate Gary Becker gave his backing on road use charging as follows: “A vastly better solution than building highways through dense urban areas would be to charge for the right to use congested roads with electronic toll collectors. Tolls could vary with the time of day and day of week, the degree of traffic congestion. Electronic tolls can relieve these bottlenecks and also provide revenue, a win-win situation for all.” (op. cit., p. 26). The benefits of market-based strategies via road pricing include not only congestion reduction but air quality, energy conservation and transit productivity goals. Without these market-based measures, it would be very difficult to meet Chief Executive Tung Chee-Hwa’s policy objective of improving the environment of the SAR, achieve international protocols on air quality let alone achieve sustainable development.

Alas, one of the lessons we learnt from the failure of introducing electronic road pricing in 1983-5 – despite it being a resounding technical success and it being cost-effective – was that ERP was perceived to be a revenue-raising device by the public. Pricing is generally resisted by motorists simply because no one wishes to pay more than before. This suggests that a corresponding lowering of the high annual license fees would therefore be welcome by motorists and would go some distance towards alleviating their hardships and softening their positions. Be that as it may, the vast majority of the traveling public would benefit greatly from the implementation of pricing restraints on excessive traffic since 80% of all trips undertaken are made on public transport vis-a-vis only 10% by private cars and 10% by taxis. The divergent objectives of motorists and public transport users suggest that ERP should be sold as part of a carrot-and-stick transport policy package together with the first two strategic prongs of infrastructural capacity expansions and mass rapid transit provisions, for instance. Were ERP to be proposed as a separate public consultation exercise following the impending submission of the final feasibility study report of ERP (supposedly in 1999-2000), it is doubtful that ERP per se would be embraced by the public, especially in the present political climate. After all, motorists would embrace the free lunches offered in the form of supply enhancements in CTS-3 but would most likely reject something that they believe would cost them more money. I am afraid that this finer fiscal restraint measure of ERP (supposedly in 1999-2000) would turn out to be a case of the (low-income) silent majority being overrun by a minority of the (better off) motorists.

Of the on-going pricing experiments in North America and Europe, a primary lesson emerges for garnering public support: congestion pricing,
also called value pricing, needs to be introduced as part of a larger transportation package. Indeed, Bergen, Oslo and Trondheim used a road financing strategy to win public acceptance of their toll rings. For instance, the success of the manual-based Bergen Toll Ring, operating since 1986, was due to the Toll Ring being sold as a road financing scheme, with 80% of the revenues earmarked for road construction and 20% for busways. The citizens of Bergen were offered a choice of either accepting a road infrastructure program to be delivered in the normal 30 year’s time or accepting a road expansion program to be delivered in half the time on the condition that they embrace the Bergen Toll Ring. This requires users entering the city to pay a toll of 5 Norwegian kronos (approx. HK$5) during Monday to Friday from 6 a.m. to 10 p.m. In this way, Norway has successfully implemented a total of three toll rings via road financing since 1986 in Bergen, 1990 in Oslo and 1991 in Trondheim, with the Oslo and Trondheim Toll Rings being electronic ones. These and other international experiences suggest that an integrated transport policy package could be put together to the public by combining both the infrastructure and rail solutions in CTS-3 and the pricing disincentives in the overdue ERP report. A packaged carrot-and-stick approach would be sustainable fiscally, physically and environmentally in the long run.

Lastly, the use of information technology in the CTS-3 Document to manage the road network is worth evaluating; it dovetails with the technological side of ERP. Recently developed information technologies can indeed help enhance the capacity of our transport system, as with the heavily-utilized and now familiar Area Traffic Control System. Where there are social benefits due to the non-rival public good attribute of information, a public transport information system ought to be established – preferably from earmarked ERP surpluses – so that public transport riders could be notified in real time of the imminent arrival or delay of the next bus or train. Where the benefits are more private and excludable in nature, the establishment of an automatic route guidance system, for instance, could be provided on a commercial basis by the private sector, as has already been done elsewhere. In order to facilitate the coordination and integration of different transport modes, all public transport operators should ideally be required to install Octopus card readers for the convenience and benefit of the travelling public (who are perhaps tired of making unwanted donations to the fare boxes).

OUTLOOK FOR THE FUTURE
The outlook on the road transport front for Hong Kong does not appear to be rosy given the severity and persistence of the Asian financial crisis
since 1997. Vocal, unyielding and competing demands for public revenues and resources continue unabated. We can examine the pattern of motorization in the last decade, the data of which is summarized in Table 11.5 and shown in Figure 11.7. A picture speaks a thousand words, so we can easily observe whether or not Hong Kong society is able to satisfy the suppressed demand of aspiring motorists. As her income, i.e., real GDP, rises steadily along trend of about 3.3% annually over the past decade (even taking into account the negative economic growth of 1998), the number of licensed private cars has risen at 6.4% per annum. As a rough approximation, the Government has appeared to partially meet the travelling public’s "need" for additional road infrastructure. One way of looking at this is to note the trend growth of the lane length of public roads, which serves as a better proxy for the road capacity produced than does the length of public roads per se\(^{23}\). If not for the 5% negative growth encountered in 1998 – which was almost unheard of in Hong Kong’s several decades past – real GDP has slightly outpaced the lane supply of public road length. However, real GDP is out-distanced by the trend growth of licensed private cars *despite* the recession. The slow rise of licensed goods vehicles, at below 1%, perhaps reflects the changing structure of the Hong Kong economy as the manufacturing base moves northwards. While from a public finance viewpoint, it appears that the Government is spending prudently by providing additional road infrastructure at about the trend growth of real GDP, it may not be serving the best interests of society. The reason is the operative fundamental law of traffic congestion which releases latent travel demand inherent in a city-state such as Hong Kong. The trend growth in the number of licensed automobiles in Figure 11.7 and the rising private car per million US dollars of GDP in Figure 11.8 are both consistent with the point that a positive supply-side measure such as infrastructure provision alone is clearly unsustainable over the long haul. (The private car per million dollars of GDP variable is obtained by simply dividing the number of licensed private cars by real GDP and the official exchange rate of 7.8. This variable serves to capture car ownership controlling roughly for economic growth.) The private car per million US dollars of GDP variable over time for Hong Kong obtained in this way can then be compared with the car ownership per million US dollars of GDP figures across countries obtained earlier in Table 11.2 and Figure 11.2. It should be clear that there is much suppressed demand for owning a private car in Hong Kong. This state of affairs suggests that the pursuit of demand-side measures – no matter how crude – to address traffic congestion is crucial in dealing with the vexing urban transportation problem.
<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Licensed Private Cars</th>
<th>No. of Licensed Goods Vehicles *</th>
<th>Real GDP in HK$ million (1990 = 100)</th>
<th>Lane Length of Public Roads in km</th>
<th>Private Cars per million US dollars of GDP**</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>160,579</td>
<td>105,072</td>
<td>549,344</td>
<td>3,650</td>
<td>2.28</td>
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<tr>
<td>1989</td>
<td>180,184</td>
<td>112,363</td>
<td>563,325</td>
<td>3,742</td>
<td>2.49</td>
</tr>
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<td>1990</td>
<td>197,852</td>
<td>117,745</td>
<td>582,549</td>
<td>3,801</td>
<td>2.65</td>
</tr>
<tr>
<td>1991</td>
<td>212,017</td>
<td>118,061</td>
<td>612,259</td>
<td>3,925</td>
<td>2.70</td>
</tr>
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<td>1992</td>
<td>237,035</td>
<td>119,790</td>
<td>650,347</td>
<td>4,090</td>
<td>2.84</td>
</tr>
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<td>1993</td>
<td>259,874</td>
<td>120,661</td>
<td>690,223</td>
<td>4,503</td>
<td>2.94</td>
</tr>
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<td>1994</td>
<td>279,420</td>
<td>121,581</td>
<td>727,506</td>
<td>4,610</td>
<td>3.00</td>
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<td>1995</td>
<td>285,467</td>
<td>118,205</td>
<td>755,832</td>
<td>4,744</td>
<td>2.95</td>
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<tr>
<td>1996</td>
<td>293,381</td>
<td>117,107</td>
<td>789,753</td>
<td>4,788</td>
<td>2.90</td>
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<tr>
<td>1997</td>
<td>314,833</td>
<td>118,649</td>
<td>831,319</td>
<td>5,142</td>
<td>2.95</td>
</tr>
<tr>
<td>1998</td>
<td>318,137</td>
<td>115,457</td>
<td>788,677</td>
<td>5,227</td>
<td>3.15</td>
</tr>
</tbody>
</table>

Average: 248,979.9 | 116,790.1 | 685,557.6 | 4,383.8 | 2.80

* The number of all licensed goods vehicles include light, medium and heavy goods vehicles, as well as special purpose vehicles (which consists of less than half a percent of all goods vehicles).

** Private cars per million US dollars of GDP is obtained by dividing the number of licensed private cars by real GDP and the linked exchange rate of 7.8 to the US dollar.
Figure 11.7  Trend Growth of the Number of Licensed Private Cars, Goods Vehicles, Real GDP and the Lane Length of Public Roads for Hong Kong, 1988-98

Figure 11.8  Private Car per Million US Dollars of GDP for Hong Kong, 1988-98
NOTES

1 The similar rankings of Hong Kong and Singapore in Table 11.1 suggest that more striking comparisons can be made between Hong Kong and Japan – the Asian lion. Nevertheless, Hong Kong has twice the population of Singapore’s and six-tenths larger land area, resulting in a higher population density. The 1999 edition of *The Economist Pocket World in Figures* reports data for the year 1996 unless otherwise indicated.

2 Her 1,865 kilometers of public road length is still a tiny fraction of the over 1.1 million kilometers of roads that Japan has in 1998.


4 The car per million US dollars of GDP variable is obtained by simply dividing Table 11.1’s car ownership per head by GDP per head. Further, since *The Economist Pocket World in Figures*, 1999 edition, does not report car ownership figures for Bermuda and United Arab Emirates, the next two high income countries on *The Economist* list were included to form a total of 30 wealthiest economies.

5 Statistically speaking, for both the car ownership per head and car ownership per million US dollars of GDP variables, Hong Kong is more than two standard deviations below the mean. In other words, Hong Kong lies outside the 95% confidence interval of the sampled distribution across countries. We can therefore infer that Hong Kong, possessing a higher than average GDP per head, has much (at least statistically significant) suppressed demand for private car ownership.

6 A 6% GDP growth rate means that the economy’s gross domestic product doubles every twelve years.

7 Note that the Road Traffic Ordinance requires that a registered vehicle must be licensed before it can be driven on public roads. Thus one could view the FRT as a fixed charge and the ALF as a variable charge on vehicle ownership.

Conference of the Hong Kong Society for Transportation Studies, Hong Kong Society for Transportation Studies, Hong Kong, December 7, 1996, pp. 284-315. Granger causality tests allow one to address the question of whether motorization — in the form of increased auto ownership and use — necessarily follows from economic development, and vice versa.

9 Time series analysis issues of serial correlation and heteroscedasticity are tackled therein. High first registration taxes do not affect the existing vehicle fleet directly since these vehicles have already been purchased.


11 Licensing records published by the Transport Department are available from 1977 onwards only.

12 From June 1, 1994, a charge of S$1 ALS charge was imposed at the East Coast Parkway approach to the city, which has since been superseded by the Singapore ERP System.


15 The lane length of public roads of 4,900 km was already achieved at the end of 1997.

16 Transport Department, Monthly Traffic and Transport Digest, December 1998.
Effective August 1, 1994, the tax base for the FRT was changed from the cost-insurance-freight (c.i.f.) value to the retail price. In order to maintain the same tax payment/proceeds, the corresponding FRT rates for private cars and motor cycles were rescaled downwards to the range of 40% to 60% of a vehicle’s retail price.

I surmise that it is perhaps a choice between choosing the least of all evils.

Unfortunately, the one-year reduction on taxes on diesel – a “green tax” – were given another year’s lease on life by the Financial Secretary ostensibly due to the lobbying activities of minibuses and taxis.

This is akin to giving travellers a free lunch at taxpayers’ expense.


For public roads in Hong Kong, the average number of lanes is 2.7 for the last decade.
12 Environmental Neglect in Transport Policy

HUNG Wing-tat

INTRODUCTION

The roadside air pollution index reading of Hong Kong has been at an alarming level, exceeding 130, in the early months of 1999. According to the classification of the Environmental Protection Department (EPD), the air pollution level is very high and people, especially those with respiratory illnesses, are warned to avoid prolonged exposure in areas with heavy traffic. Mr. Rob Law, the EPD Director, reckoned that the air pollution level in Hong Kong accounts for at least 2,000 premature deaths each year and diesel vehicles are the main causes for roadside air pollution.

To tackle this problem, Mr. Law suggested limiting the growth of diesel vehicles. To this end, he proposed to put forward a number of policy measures, namely, (a) to build more rails, at least as extensive as Tokyo and London, instead of roads; (b) to pedestrianise the roadside air pollution blackspots; (c) to increase drastically the penalty for smoky vehicle offences; (d) to control emissions from idling vehicles; (e) to retrofit large diesel vehicles with diesel catalytic converters; and (f) to introduce toughest international emission standards for new petrol and diesel vehicles. He did not mention a timetable for implementing these measures nor how much the air quality can be improved when all these measures are fully implemented. It may be beyond his ability to predict.

Indeed, the problem of vehicle exhaust emissions has been deteriorating for the last two decades. From the first day of setting up the air quality monitoring station in 1984 onwards, the Government has already been aware of the problem of air pollution; in particular the contribution of vehicle emissions to air pollution. This problem, together with many other pollution problems, induced the birth of EPD in 1986. Ironically, this problem does not diminish with the birth and growth of EPD but grows along with the controlling authority. Now, the EPD is bigger and the problem is bigger.
Of course, some would argue that without the EPD, the situation could have been much worse and the premature death toll might have been a lot higher. This might be the case. However, as time cannot go back and real life cannot be massaged like experiments in the laboratory, it is impossible to prove one way or the other. It is not the purpose of this paper to assess the performance of EPD. This paper will point out that policy measures proposed by EPD to curb road transport exhaust emissions will have little effect if they are not integrated into the overall transport policy.

FORMULATION OF TRANSPORT POLICY

The development of transport policy in Hong Kong is travel demand-led and resource-restrained. Increase of population and growth of economy generate the travel demand. The primary objective of transport policy is to satisfy the travel demands of people and goods. Only when the travel demand and resources requirements are satisfied, the authority may look into other aspects such as efficiency, safety, equity, environment and ecology.

In the early stage of development in the 1950s and 60s, Hong Kong was faced with huge impetus of people from the Mainland, Government had to, by all means, sort out basic problems such as housing, employment and transportation. The urban areas of Hong Kong were developed spontaneously and basically unplanned. The early roads of Hong Kong, in the current eyes, are narrow, bendy, steep and sub-standard.

Until the end of the 1960s, when the community accumulated adequate wealth and Government started to think about longer term administration in Hong Kong, the Government initiated the process of urban planning, including transportation system planning. The first industrial new town at Tsuen Wan was built in 1965. The first transport study was carried out in 1964 and the Transport Department (TD) was established in 1968 (Transport Department, 1999).

The formulation of transport policy, under the administration of the Transport Bureau and managed by the Transport Department, has been driven by the comprehensive transport study (CTS). The CTS-1 and 2 were conducted in 1974 and 1986, the first and second Transport White Papers were published in 1979 and 1990 respectively. The CTS-3 was commissioned in 1997 and shall be completed by the end of 1999. It is expected that the third Transport White Paper will then be announced.

The process of CTS is such that the TD collates sets of population,
economic as well as land use and development data from various Government departments. They then pass these data to the Consultant, who will produce figures of travel demands and options of transport infrastructure expansion to meet these demands using mathematical models. Policy options are tested using the CTS Model package. The final evaluation of the effectiveness of the policy options is the traffic flow and speed.

The CTS-led transport policy formulation process emphasises strongly on the “supply-demand” inter-relationship. The “supply” means the road and public transport networks and the “demand” means the passenger and freight transport demand.

CTS-1 assumed a given set of population and land-use scenario and predicted the traffic demands in the form of trip matrices. It then proposed new road links and public transport services to satisfy those demands. The CTS-2 saw a change of emphasis from demand-based planning. It took as input the land-use development strategy recommended by the Territorial Development Strategy and determined an implementation programme of transport infrastructure and policies to cope with the predicted travel demand, taking account of the likely financial constraint. Transport policies to reduce travel demand to within the capacity of the proposed transport networks were also examined. CTS-3 will introduce two new major elements, namely a strategic environmental assessment and a cross-boundary traffic assessment. These new elements intend to ensure that the transport proposals would be environmentally acceptable and the impact on the boundary crossings would be assessed (Transport Department, 1999).

There are many limitations in this policy formulation process. Firstly, using only mathematical models to help formulate transport policy has intrinsic limitations because a number of important considerations such as comfort, safety, equity, convenience and ecological damages simply cannot be evaluated in terms of numbers and figures. Secondly, the CTS Model package basically looks at vehicular flows. Little consideration is given to other road users such as pedestrians, cyclists and the handicapped. Thirdly, the CTS process cannot address the broader issues such as the value of transport provision. In this policy formulation process, there is no forum where we can raise the questions such as what are the goals and objectives for further expanding our transport system? Is expanding our existing transport system the only way to cater for the predicted travel demand? Do we want more roads or do we want more open spaces? Do
we want a clean healthy walking environment or an easy vehicle accessible but dirty environment?

In the very beginning of the consultation document on CTS-3, the authority states that:

"Transport policies must evolve over time. They need to respond to community aspirations and cater for economic and population growth. In 1990, the Government published a White Paper on transport policies entitled "Moving into the 21st Century". This was based on the recommendations made in the Second Comprehensive Transport Study conducted in the late 80s. Since then, there have been many developments and community expectations have risen. While many of the transport policies in the White Paper remain valid, others need to be updated and refined."

Clearly, the intention of the authority is to update and refine the current policies owing to changing community aspirations. However, the authority has not elaborated their understanding of changing community aspirations. There is no intention to re-visit the goals of transportation. No revolutionary proposal deviating from the current policies is expected to be put forward. Indeed, the CTS-3 simply carries on what has been implemented in CTS-2.

ENVIRONMENTAL INTERVENTION

The environmental intervention in the whole process of transport policy formulation and implementation process took place at two levels in CTS-1 and CTS-2. Environmental considerations could be taken into account at the Territorial Development Strategy Study (TDS) and at the individual road and rail project levels (Figure 12.1).

At both levels, environmental factor was considered as one of the many constraints rather than a goal to be enhanced on its own merits. And, it is not unusual that environment is the one to be sacrificed in the event of enhancing the growth of economy. The large scale reclamation proposed in the TDS for enhancing economic growth, especially with the scenario whereby Guangdong Province and some other inner provinces of China are assumed to be the major economic hinterland of Hong Kong (Planning Department, 1995), is a typical example. Some even suggested that Maipo should be relocated to give way to property development. At the project level, the situation is even worse.
Figure 12.1 Transport Policy Formulation Process in Hong Kong
Environmental impact assessment is now statutorily required for major road and rail projects. However, the law has never been strong enough to compel the road or rail to change route when the environmental and ecology impact is found to be huge and even exceed the statutory allowable limits. The law only requires the project owner to try their best practical means to minimize the impact. If traffic noise is concerned, the project owner, at the most, will compensate the sensitive noise receivers with minimal money to install double-glazing at the windows of those seriously affected. Once the alignment of a road or a rail is fixed, there is no way to change the route solely on environmental and ecological grounds. There are too many such examples. Mei Foo Park has to give way to the West Rail. The Tai Lam Country Park has to give way to Route 3 and now the bats and hundreds of old indigenous trees will soon have to give way to a Queen’s Link connection between Admiralty and Kennedy Road.

The environmental intervention has never been effective to protect the environment. Now, one of the major elements introduced into the CTS-3 is the strategic environmental assessment (Transport Bureau, 1998). It sounds a good idea but it really arouses too high an expectation to the public than what it will be achieving. The strategic environmental assessment merely produce a once and for all evaluation of the converged transport network proposals generated in the CTS (Figure 12.1). It will simply give an idea to the authority the level of pollution with the converged proposal. There is no requirement for the Consultant to change the converged proposal on environmental ground. In other word, nothing will be changed simply on environmental ground.

Now comes SUSDEV21². The Government gives people an impression that it will guide Hong Kong to develop a splendid sustainable city. In the information digest of SUSDEV21 in April 1998, it says, “a fundamental principle of sustainable development is that activities arising from decisions taken today should not compromise the quality of life or economic well-being of the future. The Government’s intention to embrace sustainable development is driven by a commitment to enable Hong Kong to continue to prosper and allow the economic, social and environmental aspirations of the people of Hong Kong to be fulfilled.”

It is expected that all development policy including transport policy will be guided by SUSDEV21. From the information available today relating to the study², it does not appear to be the case. The recent consultation document on environmental indicators, in particular, reveals
how far apart is the expectation from reality. These environmental indicators are supposed to put benchmarks and footprints for our past and future developments. Nevertheless, as far as transport is concerned, it fails to demonstrate how the Study can guide a sustainable transport policy formulation. There are three proposed indicators for transport development, that is, average travel distances to work; average network speed and cost of freight transport. The beauty of these proposed indicators is that the values of these indicators can be easily output from the CTS Model. However, none of them can give a clear direction to transport policy formulation. Are we seeking high or low values of these indicators? What are the optimum values? It appears to be logical to seek for decreasing values for travelling distance and freight transport cost but increasing value for network speed. If that is the case, are we going to stop moving people from near the existing business centres to new towns in the New Territories? Are we going to build more highways and railways to improve the network speed and lower the freight transport costs? If these are the intentions behind the transport indicators, how do they help reduce traffic pollution and subsequently achieve sustainability?

CONSEQUENCE OF ENVIRONMENTAL NEGLECT

The consequence of weak environmental intervention to transport policy formulation is obvious. The traffic induced environmental pollution, mainly noise and air pollution, deteriorates over time. Traffic induced air pollution becomes increasingly more critical when the industrial pollution subsides owing to the fact that most industries move to the North across the border for cheaper land and labour costs.

There is no lack of data and figures to show how dirty our air is. Citizens can even feel it by themselves. The EPD times and again, constantly makes the following comment: "Vehicle emissions are now our major air pollution problem, especially in the urban areas. Because of our high diesel vehicle usage, we have higher levels of air pollution associated with diesel emissions, i.e., particulates and nitrogen dioxide. For years, most of our monitoring stations have been recording particulate levels violating our annual Air Quality Objectives. The situation is worse at busy roadsides in the urban areas."44

The EPD, having little collaboration with the TD, presses on its own alleviation program starting from the announcement of the First Environmental White Paper in 1989. Their strategy is five-prong: (a) clean alternatives to diesel vehicles; (b) stringent new vehicle emission
standards and fuel specification; (c) strengthened in-use vehicle emission inspection; (d) strengthened enforcement against smoky vehicles; and (e) education and publicity. Leaded petrol was banned from 1 April 1999. LPG vehicles are being introduced. Vehicle exhaust emission standards are being upgraded to Europe, Japan and US standards (Ha, 1999). EPD has made considerable headway as long as fuel and vehicle technology is concerned.

Despite the huge effort of EPD in the last decade, the results are not at all satisfactory. The air quality of Hong Kong is not getting better but worse. EPD should have received praises for their efforts but instead, condemnation. The efforts of EPD have been totally nullified by the continuously increase of road traffic.

The reason is clear. The key result of the CTS is to build more roads and railways. The total length of roads in Hong Kong increased from 1,484 km in 1990 to 1,831 km in 1997 (an increase of 23%) but the average daily road traffic increased from 21.99 million vehicle kilometer travelled (vkt) to 32.84 million vkt (an increase of 49%) in the same period. The total traffic intensity, that is, volume of traffic on every kilometer of road has been on the increase all the time (Figure 12.2). These figures reveal a universal fact that the rate of increase of road surface can never bid the rate of increase of road traffic. It is, in an ironic way, fortunate for Hong Kong that we do not have adequate space for road expansion. Otherwise the competition of road length and traffic could have been more vigorous. It is because road length was bidden by traffic volume, we therefore have been forced to suppress the growth of the road traffic.

![Figure 12.2 The Average Daily Traffic Intensity on Hong Kong Roads](image)

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The lack of powerful environmental intervention in the transport policy formulation process led by CTS-3 currently being undertaken by Consultant will again follow the footstep of the past. No doubt, one of the key results of CTS-3 will be a splendid proposal of road expansion plan for the next decade and beyond. Traffic volume will compete with it again. Assuming the traffic volume increases at the same rate as in the past decade, that is, around 50% in the coming decade, we can roughly see the following emission scenario, with particulate emission as an example. The EPD, after switching all taxis to LPG vehicles will achieve a roughly 17% of particulate emission reduction. Thereafter, in order to counteract the effects of traffic volume increase, the enforcement of stringent emission standards to other vehicles will have to achieve another 33% emission reduction. Can it be done? The particulate emission standard of diesel trucks in Hong Kong is now at 0.13 g/kWh (Ha, 1999). There is very little room to go further down.

CONCLUSION

Everybody knows that transport policy has great impact on the use of road transport and subsequently on vehicle emissions and air pollution. EPD has identified vehicle emissions, in particular nitrogen oxides and particulates, as the major causes of urban air pollution. In order to improve the air quality, the most straightforward answer is to reduce the road traffic. This simple logical answer does not appear to be understood by transport policy makers. In the past two decades, the transport policy formulation process has been led by CTS, which bases on a set of mathematical models. The key output of CTS is an enlarged road and rail infrastructure to meet with the given population, land-use and economic growth scenarios. Environmental intervention in this process is weak and air quality and other environmental factors have never been important considerations.

The consequence of environmental neglect in transport policy is that the air pollution aggravates over time to an alarming level now. Although EPD has tried all possible means to reduce emissions from vehicles through specifying the most advanced low emission vehicle models, it appears that they can only beat about the bush. The emission reduction anticipated to achieve will highly unlikely be able to balance the emission increase owing to road traffic volume increase.

It is a plain fact that in order to achieve a reduction in road traffic emissions, transport policy makers have to change their philosophy; from
simply meeting the transport demand to meeting both transport and environmental demands. There appears a sign of change in the CTS-3, which specifies a strategic environmental assessment to the converged transport infrastructure. However, the change is too minor and not adequate. At least, the CTS-3 can have a target. Can we compare the total emissions of the proposed future transport network with the current one and ensure, at least, no increase in emission?

I think we can take a bigger leap. We can specify a gradual reduction on the reliance of road transport. I believe there is ample room that we can think of as practical substitutes. Walking is one. In a small compact city such as Hong Kong, facilities can be accessed quite easily within walking distance. With good design of pedestrian walkway system, a whole new town, say Tung Chung, can be a decent walking town. Even the old Central and Wanchai districts, with dedicated effort and thought, can become comfortable walking commercial and business centres. Electronic communication is another. Working at home, for a number of trades, is not a too remote event to happen.

NOTES
2 A study on Sustainable Development of the 21st Century in Hong Kong commissioned by the HKSAR Government in 1997.
3 Information in SUSDEV21 web-site http://www.info.gov.hk/planning/susdev/venue-e.htm
5 According to data from Transport Department, taxi runs about 17% of the total vehicle kilometer travelled.

REFERENCES


Re-Thinking Transport in Hong Kong –
A Fundamentally New Vision is a
Necessity, Not an Option

William F BARRON

INTRODUCTION

Recently, transport planners in Hong Kong emphasized the importance of rail transport for moving people. And indeed they indicate that rail will be the priority means of meeting future transport needs. For example, one of the 1998 Policy Objectives for the Transport Bureau notes that:

"Railways, will form the backbone of the public traffic network serving major corridors which have the heaviest traffic flow."

An indicator of this commitment is the planned expansion of the rail system from 143 km in 1998 to 200 km in 2004. Nearly a 40% expansion (Transport Bureau, 1998, p.5). Meanwhile the Bureau also notes its aim to complete the construction and improvement of over 100 kilometres of strategic roads in the next 10 years, that is, up to 2008.

Hong Kong 1998 (Hong Kong SAR Government, 1998), the Government Yearbook, provides some cost estimates. It notes that government plans to invest a total of HK$ 110 billion in rail between 2002 and 2004. While it does not say how much will be invested in roads for the coming 10 years, it does note that up to only 2002 a total of HK$25 billion will be spent. It is expected that several major new roads will be started not long after 2002, for examples, Route 7 (Kennedy Town to Aberdeen) and Route 10 (Green Island to Lantau). In addition, there are detailed design studies for a number of other major roads to be completed between 2001 and 2005 (Transport Bureau, 1998).

It is the contention of this paper that while the government is increasing the role of rail, such efforts are inadequate in light of the environmental challenges Hong Kong faces in the coming decade and beyond.
Further, the potential of electric road systems (trams, electric trolley buses) in place of internal combustion engine buses in high density areas has to-date received little active consideration. As suggested below, there seems too little appreciation among Hong Kong’s transport planners about their responsibility with regard to their fundamental contribution to the air pollution problem.

The Transport Department’s 1996 Digest Section 8, “Concerns over Environment”, reads (Transport Department, 1997, p.86):

“Impact on the environment is always a key factor in the Department’s planning and provision of new transport infrastructure and terminal facilities. Transport Department together with the Environmental Protection Department continued to monitor closely the air quality inside government and private tunnels, as well as covered bus termini. Advice and assistance are provided to the Environmental Protection Department on schemes to reduce emissions from motor vehicles, the proposal of using cleaner fuel for light passenger vehicles.”

This is essentially an end of pipe view without any note of the advantages of controlling the growth of the source of the problem, that is, internal combustion engine vehicles.

For its part, the Transport Bureau’s 1998 Policy Objectives do not mention the environment.

The 1998 Government Yearbook does note the environmental impact of road construction:

“The environmental impact of new road projects is carefully examined at the planning stage. Where practical, measures, such as landscaping, artificial contouring of surrounding hillsides, and the installation of noise barriers are considered. Consideration is also given to providing air-conditioning units and double glazing in domestic premises where noise levels cannot be brought within required standards through other means”.

FORWARD TO THE 1950s

Missing from the above is any evidence of an awareness that the expansion
of the road system itself facilitates (and indeed may even be seen to encourage) the growth of polluting motor vehicles.

The appropriate solution need not involve utopian dreams of truly pollution-free transport or even a call for going as far as possible to keep Hong Kong’s air relatively clean. Rather, what is needed is practical off the shelf cost effective proven technology to bring our air quality back within safe levels. There are practical alternatives which can and should be applied in Hong Kong but are given little more than lip service of that.

Considering the population densities, high air pollution levels and the extensive exposure to concentrated vehicle exhausts and the often short travel distances, Hong Kong can and should be exploring a leading role in more environmentally friendly transport options.

Yet, Hong Kong’s transport planners, far from offering visions of the future as we move into the next millennium, seem stuck in the visions of the 1950s – that is, to focus on adding more and more highways, many of which usurp shorelines and prime sites (for example, Kai Tak) from other potentially high valued uses as well as breeding more noise and air pollution.

Until Hong Kong’s transport planners come to accept fundamental responsibility for air quality of the decisions they made, they are likely to continue to lead us down a path of ever more serious air pollution with major effects on the economic well being of the SAR as well as on the health of its population.

ACCEPTING RESPONSIBILITY FOR THE PROBLEMS YOU CAUSE

The planned 54-kilometre extension of the rail system and the 200-kilometre expansion of the strategic road system as Hong Kong approaches the next millennium is taking place in the context (see Figures 13.1 through 13.6) of street level pollution which are chronically unhealthy and where projections (Barron and Steinbrecher, 1999) are for street level air quality to become far worse under the pressures of continuing population growth and increases in road goods transport.

A simple way to view this situation is as follows. First, air quality must be improved if Hong Kong is to become a safe place for people to live and work and especially in which to raise children.
Figure 13.1 Average Annual Concentration of RSP for Urban Areas and Street-Level Monitoring at Mongkok (and Causeway Bay) in μg/m³

Note: The latest data available from EPD at the time of this assessment was for the month of April 1998
Source: Barron and Steinbrecher (1999) p. 23

Figure 13.2 Average Annual Concentration of NO₂ for Urban Areas and Street-Level Monitoring at Mongkok (and Causeway Bay)

Note: The latest data available from EPD was for the month of April 1998
Source: Barron and Steinbrecher (1999) p.19
Figure 13.3  BAU Projections for the RSP Indicator

Figure 13.4  BAU Scenario for the NO$_2$ Indicator
Note: TSP emissions from the Power Sector were assumed to be 50% RSP.
Source: Barron and Steinbrecher (1999) p.85

Figure 13.5 Baseline Projections for RSP Emissions

Source: Barron and Steinbrecher (1999) p.86

Figure 13.6 Baseline Projections for NO$_x$ Emissions
Second, the major source of street level pollution in Hong Kong is road traffic, in particular taxis, mini-buses, buses and at some times and places light goods vehicles. Heavy goods vehicles and pollution imports from Guangdong add to the background levels of pollution.

Third, population is projected to increase by about 30% by 2012. With a roughly proportionate increase in demand for passenger transport.

Fourth, if that demand is met two-thirds by internal combustion road vehicles as it is today, then pollution emissions would increase proportionally (Hong Kong SAR Government, 1998). Further, this increase would take place in the context of growing good transport and increasing cross border pollution imports.

The pollution source potentially most subject to effective government control is passenger transport. Unless far more of this (for example, over 50%) is met by electric systems within the next decade or so, street level air quality will be far worse, potentially to levels which undermine the SAR’s appeal to residents with the skills to live elsewhere, as well as to tourists and to international business (Barron and Steinbrecher, 1999). Even more of concern is that such pollution levels will threaten the health and well being of virtually all residents.

Let us consider a very simply abstract formulation of the sources of air pollutant concentrations in Hong Kong:

\[ \text{Ambient Pollutant Concentration in congested areas} = f(CF, PT, GT, [PI - PE], LNTE) \]

where

- CF = climatic factors (e.g., winds),
- PT = passenger transport emissions,
- GT = goods transport emissions,
- PI = pollutant imports from the rest of China (which would be positive in winter and low in summer),
- PE = pollutant exports, and
- LNTE = local non-transport emissions (e.g., from the power sector, industry).
While we have to await the Third Comprehensive Transport Study (CTS-3) to get current projections of demand for future levels of passenger and goods transport, we can preliminarily assume that the increase in each case would be proportional to population growth, and if incomes rise, it would likely increase more than proportionally, especially for goods transport. Most large vehicle goods transport takes place in the Northwest New Territories away from the core urban areas. Hence while such emissions contribute to street level pollutant concentrations in the core urban area, they are not a major factor. As for the non-transport sources (NTS), the SAR’s power plants are located in the West of the Territory and have high smoke stacks so that their emissions do not come down in concentrated form within Hong Kong. As for industrial emissions, these have been steadily decreasing as industry moves across the border. Nonetheless they do contribute to localized pollutant concentration in such places as Kwai Chung and Kwun Tong.

Returning to this very general model, if we assume that climatic factors will remain more or less unchanged over the next decade or two, then the model will reduce to one of

\[ \text{Ambient Pollution} = \text{largely } f(\text{[PT+ GT]}, \text{[PI-PE]}) \]

If, as noted above, the changes in PT and GT are roughly proportional to population growth, then as shown in Figure 13.6 according to government’s population projections both PT and GT would increase by about 22% from 1999 to 2011 (Barron and Steinbrecher, 1999). While there are no reliable figures publicly available, it seems likely that pollutant imports from nearby parts of China will continue to increase for at least the next several years and probably for the next decade or more.

Hence, under a business-as-usual approach (that is, electric systems providing about one-third of passenger transport and little goods transport), air quality in urban Hong Kong is likely to become worse, and perhaps far worse.

One simple way to envision the issue is as follows:

- assume for the moment that goods transport and pollutant imports remain constant over the next decade and that goods transport accounts for about 50% of Hong Kong’s transport related emissions (Barron and Steinbrecher, 1999);
- if passenger journeys increase by about 20% in the coming decade there need to be an overall average improvement of about 20% in the emissions from each passenger transport journey simply to keep air quality from becoming more unhealthy; and

- even if EPD is successful in its fuel switching and emission improvements program (hard to be too optimistic here given the record), it still would be difficult to attain such an improvement in the next decade and then keep on making further improvements decade after decade as population increases and other sources of pollution increase.

Probably the only realistic way to attain the needed gain is to shift much more of the transport journeys from internal combustion engine vehicles to electric powered ones. The basic options are rail (underground or surface, trams) and electric trolley buses.

In reality, of course, goods transport will increase as will pollutant imports from nearby parts of China during the winter period, adding to the ‘background’ pollutant concentrations to which localized emissions are added to result in the street level concentrations to which much of the population is exposed each day.

**IS THIS THE WAY TO RUN A RAILRAOD?**

Hence, if Hong Kong is to be able to offset the increases in levels of pollutant emissions from goods transport and from emissions from across the border, there must be an aggressive program to reduce emissions from passenger transport through greater access to rail and provision of modern trams and electric trolley buses.

As shown in Figure 13.7, a transport related increase in electricity demand would add somewhat to the evening peak, but overall would probably help to level the load of the Hong Kong power companies, thus improving overall efficiency. Figure 13.8 shows the emissions levels per passenger journey from different modes of transport.

Clearly, to make far greater use of rail, there need to be a fundamental change in the way rail is financed. Route 7 and related road upgrade in southwestern Hong Kong Island illustrate the problems with current thinking. In order to provide transport to the planned cyber port and other
Figure 13.7 Comparison of Passenger Peak Load from Rail Systems with Peak Demand of Utilities

population centres in the area, the government is building Route 7, a 14-km link from Aberdeen to Kennedy Town and then Central. It is also undertaking a massive upgrading of Pokfulam Road to handle road traffic increases until Route 7 is open. Needless to say, all of this being done entirely at public expense. Meanwhile, the Mass Transit Railway (MTR) cannot justify a 3-km link from Wan Chi to Aberdeen because the government continues to argue that it is not prudent to ‘subsidize’
Figure 13.8 Present and Future Emissions per Passenger Journey for Public Transport

rail systems in Hong Kong (except of course for ad hoc adjustment like West Rail when it sees fit).

Further, the Mass Transit Railway Corporation is not allowed to take credit for the possibility that a rail extension might be able to offset the need for additional road expenditures. **Is this a sound way to finance transport infrastructure in today's Hong Kong?**
NOTE

1 While the exact contribution of 'local' and 'background' sources varies from place to place, we can note that on a typical winter day RSP levels at Tap Mun in Mirs Bay are about 50% of those at Causeway Bay. If approximately 50% of the Tap Mun readings come from 'background' sources, then RSP levels at Causeway Bay contributed by 'background' sources would be approximately 25%.

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INTRODUCTION

We are all pedestrians – we all possess a free and universally available mode of transport – walking. Since man invented the wheel and learnt to ride a horse, pedestrians have been continuously relegated down the pecking order and with the advent of the motorized vehicle were firmly placed as third class travellers allocated residual space after more important travellers had been provided for (Figure 14.1). An extreme view perhaps.

Figure 14.1 The Pecking Order

Why does the community treat the one mode we can all use so badly and give so much to other modes, especially the motor car, which few people use? The answer is both simple and complex. The simple answer is that it must be the general will – we all think cars, buses, taxis and trucks are more important – do we?

The complex answer is that pedestrian networks and space are part of an overall urban system involving land use, building disposition and design, active and passive use of space, environmental quality, social and economic needs, as well as being a fundamental component of the transport system. We, the community, have not comprehensively addressed the vital role that pedestrian movement networks and space have in contributing
to the functioning and quality of life of our community. Worse, even when comprehensive ideas have been developed they have become fragmented and lost as other more pressing needs prevent integrated networks being implemented.

In this paper the case is presented for giving pedestrians – ourselves – a better deal which achieves so many of the ‘buzz’ words often carelessly used in defining community objectives:

- environmentally friendly;
- resource efficient;
- equitable – available to all;
- affordable;
- socially cohesive/community oriented;
- cost effective;
- healthy;
- promotes public transport usage; and of course
- sustainable.

Walking uses human energy and does not need fossil fuels and can benefit individuals through exercise. Walking does not emit pollutants of any kind. Walking is available to all who care to walk within their mobility abilities. Since it is free it is equitable, and places no social barriers. Furthermore walking can create a community spirit and atmosphere of mingling and sharing the city compared to the adverse behavioural transformation often created by driving a car – at the extreme, road rage. Walking is also cost effective, large numbers of people can move through space at densities much higher than any other mode, requiring no car parks, stations or stops. Pedestrian access facilities can promote the use of public transport.

**PEDESTRIAN REQUIREMENTS**

Pedestrians come in many shapes, sizes and abilities – children, elderly, people with mobility, visual or hearing impairments, luggage laden persons, pregnant women, and so on – namely everyone. In general they can be divided into pedestrians with or without mobility problems. Pedestrians with mobility problems are considered to represent 10-20% of the total population.
Pedestrians, as well as being diverse in type, are diverse in needs and purpose. The use of space allocated for pedestrians can be classified as follows (Figure 14.2):

- **Functional**: used to walk from one place to another, space/path is used only as medium for movement to reach an activity location; e.g., to the workplace, to catch a bus – like a road or railway provides for cars or trains;

- **Active**: space used when walking is seen as an end in itself or part of an activity, rather than a means to get to a place; e.g., window shopping, strolling in city streets; and

- **Passive**: characterized by standing, chatting, sitting and watching, e.g., watching the world goes by, street cafes, sitting out areas.

Notwithstanding the diversity in people and activities, all pedestrians need a safe, convenient and comfortable environment. These general requirements of pedestrians are briefly discussed below:

- **Safety**: pedestrians are physically vulnerable. Cars should be tamed, not people. Some pedestrians are more vulnerable than the others, so more care should be taken of children, the elderly and those with impairments. Pedestrians also need security. This can be improved by open and socially active space with good
lighting, which encourages ‘public watch’. At least, people should be allowed to see far enough to anticipate potential danger and take avoiding action;

- **convenience**: pedestrian paths should provide direct and continuous routes with minimal level changes. Delays should be minimized and congestion eliminated, especially at junctions. Useful facilities such as public phones, bins, kiosks, waiting and stopping areas should be provided as appropriate. Good orientation should be provided through network design, including signs. The pedestrians should be guided such that they know where they are, and how to proceed further for their destinations. In short, pedestrian paths should be easy to follow; and

- **comfort**: the desire to walk is heightened by the provision of a pleasant environment. Crowding, noise, polluted air, weather exposure, high or low temperatures should all be avoided or screened from pedestrians.

**A COMPREHENSIVE APPROACH**

**Comprehensive Networks and Space Usage**

We are all used to the idea of hierarchies of transport networks. The same applies to pedestrian systems but become more complex as there is shared use between functional, active and passive spaces. The major elements are:

- **trunk corridors**: major corridors of movement; e.g. elevated walkways and subways (being analogous to limited access expressways with no frontage activity);

- **primary routes**: supporting functional movements as well as activities and frontage access (e.g., Hennessy Road); generally a busy, heavily trafficked environment;

- **local access**: side streets often with kerbside activities and a quieter atmosphere; and

- **pedestrian areas**: shopping streets, parks, sitting out areas.

In Hong Kong, our strategic networks are incomplete and ill defined. Walking from Wanchai to Central involves in-street in Wanchai, possibly segregated through Admiralty; back onto in-street in Central, then possibly elevated structures in Central. The route is indirect, includes diversions
Pedestrians: The Need for a New Approach

through curves of parks, has many at-grade signalized and unsignalized crossings, and poor orientation.

The use of primary and local access routes have benefited from a concerted effort to make road crossing safe by signalization and grade separation. However it has to be admitted the allocation of ‘green’ time and introduction of isolated footbridges and subways are largely controlled by the needs of road traffic not those of pedestrians, leading to inconvenient and indirect pedestrian routes.

Hong Kong lags behind much of the world in terms of outdoor pedestrian street space. General resistance from certain sectors in business and the administration has held back the development of in-street pedestrian areas. Only now is pedestrianisation being promoted, largely as a means to reduce the impacts of traffic-related pollution. However, pedestrianisation has much broader social and economic objectives.

On the other hand, Hong Kong has developed certain extensive indoor pedestrian areas which are a great success. However these are usually internalised and not part of the network, with deliberate discontinuities to discourage through traffic or movement to adjacent buildings. How often do you get lost inside a shopping mall? These need to be opened up and integrated with the overall network. Mass Transit Railway (MTR) and Kowloon Canton Railway (KCR) stations and interchanges provide excellent opportunities for this and are key nodes in the network.

The component parts of developing comprehensive pedestrian networks and space include a range measures, treatments and facilities. Figure 14.3 shows some past examples developed in Hong Kong, but only partially implemented.

Segregated Facilities

The high density of Hong Kong makes it ideal in demand terms to develop fully segregated pedestrian networks to concentrate flows and create a strategic network. Many plans have been prepared — the Central/Mid Levels study as long ago as 1981 put forward an extensive network which has only been partially implemented; the many reclamation plans and District Traffic Studies put forward extensive networks — how many will survive? It is not a breakthrough in new ideas which is needed — rather a breakthrough in implementation (Figure 14.4).
Figure 14.3  Examples of Area-Wide Schemes

Figure 14.4  Walkway Systems
Mechanised Pedestrians

Escalators, travellators, lifts and bicycles all improve the mobility of pedestrians. With these aids, pedestrians can move more quickly and more comfortably over greater ranges. These aids allow pedestrians to move in a way closer to vehicular travel in terms of speed, distance and comfort. However, such mechanised pedestrian facilities are more environmentally friendly (Figure 14.5).

![Figure 14.5 Central Mid-Levels Escalator](image)

The Central/Mid Levels escalator has proved to be successful and generated adjacent urban renewal. It was planned as part of a network not fully implemented. Other similar bold schemes can reduce vehicle usage and extend public transport catchment areas, especially in hilly areas.

At-grade moving walkways have had limited impact but can on longer haul segregated networks extend pedestrian ranges. Their use as feeders to major transport nodes should be considered as an option to road-based modes.

Traffic Calming

Traffic calming aims to change the way street space and the environment is managed to improve:

- the safety and convenience of pedestrians;
- the built environment in terms of noise, air and ambience;
- improve road safety generally; and
- improve amenity.
It can be interpreted as a type of ‘soft’ pedestrian/vehicle separation through regulating traffic speed and priority in using the road. Traffic calming tries to rationalize the balance between pedestrians and cars in using road space. Methods of traffic calming include the redesign of local streets by kerb re-alignment, speed restriction, landscaping and road humps. Residential areas in Hong Kong already have some facilities, however a complete treatment is needed to change the environment and the relationship between motorist, pedestrian and frontage usage (Figure 14.6).

![Traffic Calming and Pedestrianisation](image)

**Figure 14.6  Traffic Calming and Pedestrianisation**

**Pedestrianisation**

A pedestrianised street is a place for social gathering and economic activity. It means far more than a traffic-free area. It means a complete change in socio-economic use of the space involved. Pedestrianisation hands back street space to people and humanizes it. It can bring a wide range of socio-economic benefits, including:

- a better walking environment, more opportunities for quality landscaping, and less traffic-related pollution;
- reduce the inconvenience for elderly and disabled to go out;
- a place for children to gather and play around;
more patrons and business for the nearby shops;

new business opportunities such as street-side cafes, pubs and markets;

encourage social and cultural exchanges by inducing social gathering and interaction; and

help tourism by creating a more tourist friendly environment for shopping, absorbing the local culture and general leisure activities.

In cities around the world including Paris, Florence, Dalian, Singapore, Newcastle, Düsseldorf, Dortmund, Dublin, Macau and many others pedestrianisation has added a cohesiveness and focus to city life. Such areas are a feature of the city and provide a place for the gathering of locals and tourists and become a feature remembered by visitors.

Implementation

Schemes have been floated in Hong Kong in the past but have often failed to reach implementation due to many fears and prejudices such as:

- road traffic impacts – it will cause congestion;
- policing – street crime;
- hawkers and refuse collection – hard to control;
- servicing of buildings – no vehicular access;
- impact on adjacent businesses – lose customers; and
- management and responsibility – whose?

None of these are insurmountable and are usually lame excuses to stop change. If hundreds of cities can do it why not Hong Kong? We already have Temple Street, Lan Kwai Fong, to name two. Schemes have been proposed for Mong Kok, Causeway Bay, Tsim Sha Tsui, Stanley, and others in the past. Whilst reducing pollution is an important benefit, such area-wide schemes bring much wider rewards to the community.

Hong Kong already has extensive indoor pedestrian areas in Taikoo Shing, Pacific Place, Harbour City, Festival Walk, New Town Plaza, etc. With our climate these will continue to be popular. Outdoor pedestrianisation will add another dimension and environment. A key objective will be to link together ‘people’ areas, indoor or outdoor, with a hierarchical pedestrian network.
PEDESTRIAN PLANNING AND DESIGN – WHOSE RESPONSIBILITY?

Who plans and designs the facilities for pedestrians? Planners, architects, traffic engineers, urban designers, or engineers?

Planners allocate land uses which govern the volumes and desire lines of pedestrian and traffic flows. Architects design buildings, determine the access/egress points of pedestrians and vehicles, and the width and configuration of footpaths and carriageways. Urban designers define the pedestrian framework in an urban setting and allocate urban space for local pedestrian use, but may not fully appreciate the whole range of demands by all types of pedestrians: functional, active and passive, and the interactions between these demands. Traffic engineers assess and meet the requirements of vehicular (and pedestrian) traffic on the roads. These requirements are mostly quantified, although many are not so quantifiable. Civil engineers are concerned with physical layouts and implementation and constructability issues. These professionals all contribute to the planning and design for pedestrians.

But who takes the lead in securing well-planned pedestrian networks and environments? It can be everybody or nobody. Hence, there may be a place for a new profession: Pedestrian Planners or Pedestrian Engineers.

If designated, Pedestrian Planners would do the following:

- identify the full range of pedestrian requirements involved in a planning/design context;
- design space, corridors and networks to meet the demands;
- co-ordinate with other professionals to provide the required pedestrian space and facilities;
- plan and design pedestrian environment and system as a whole, rather than as a group of fragmented bits; and
- monitor the performance and quality of these facilities after implementation.

Public/Private Partnerships

The government, through studies and plans and also planning permissions, can and does induce the evolution of pedestrian networks and has some tools to hand:
Pedestrians: The Need for a New Approach

- infrastructure programmes;
- Outline Development Plans;
- site lease conditions;
- plot ratio bonus for provision of public space for circulation;
- building access locations; and
- premium reductions for provision of infrastructure.

On the other hand Government cannot always force developers to make provision on new sites, and many existing buildings are unsuitable for the incorporation of new links. Nevertheless a Master Plan for each area should be developed and pursued vigorously. It was sad to see a pedestrian congestion and blackspot like Pedder/Queens Road/Wyndham Street have new buildings being completed and still no grade separation for pedestrians right next to an MTR station. Although we now hear that a scheme is to be developed to redress this which is most welcome.

Comprehensive pedestrian network plans need to be developed for each district and taken forward into ODPs to be implemented in an integrated and phased manner. Detailed plans need to be prepared specifying segregated systems, access points, links to buildings, redevelopment needs, lease conditions, compensation responsibilities and so on. This needs detailed planning and engineering studies and should not be left to ad hoc studies attached to highway or development schemes which may have other objectives. It is also true that 'the devil is in the detail' and many practical, legal and administrative hurdles need to be overcome.

If we are serious about developing pedestrian facilities then the public and private sectors need to join forces and develop partnerships to work towards comprehensive networks. It will take time, but Hong Kong reinvents itself nearly every 10 or 20 years.

SUMMARY

Hong Kong already does a lot for its pedestrians – but it is fragmented, not always well integrated, and frequently well thought out plans fail to be implemented in a comprehensive manner (Figure 14.7).
First in the Pecking Order

Master Network Plans

Institutional Strengthening

Public Private Partnerships

Enabling Measures

Community Involvement

Area-wide Pilot Projects

EVERYBODY WINS

Figure 14.7 Pedestrian – A New Deal

The arguments for a comprehensive approach are overwhelming and meet every criteria of sustainability. Key success factors will be:

- placing pedestrian needs at the forefront of planning, financing and implementation;
- developing network plans which have the same position in infrastructure planning and implementation as roads and railways;
- using and enhancing incentives for public and private organizations to build, extend and coordinate facilities;
- institutional strengthening and reorganization to secure the needs of pedestrians in a comprehensive way and enable Government to implement and manage different types of pedestrian facilities;
- using planning permission/lease conditions to ensure networks are fully implemented and not blocked by individual developers;
- community research and involvement in planning the use of pedestrian space to meet the public’s needs; and
- development and implementation of pilot projects on a meaningful scale – bold experiments are needed.

As with the environmental revolution we need a change in hearts and minds ‘to think pedestrian’. It ought to be easy since everyone wins.
INTRODUCTION AND HISTORY OF SPECIALIZED TRANSPORT IN HONG KONG – THE REHABUS

Rehabus was started in 1978, with the aim to provide transportation services to people with disabilities who found it difficult or impossible to use public transport services in Hong Kong. Rehabus was started twenty years ago because the ‘social action’ to try to make the Mass Transit Railway (MTR) accessible by a group of people with disabilities at the planning phase was unsuccessful. As a result the MTR proposed to donate some adapted vehicles, specialized in carrying wheelchair users to operate the Rehabus service.

We started with two 7-seater vans and have since expanded to a mixed fleet of some 80 vehicles, mostly light buses (Figures 15.1a and 15.1b). Our patronage has also increased from 8,000 to 440,691 passenger trips in 1999 (Table 15.1). The increase in service is 55-fold in twenty years. While this may seem a trivial patronage for most public transport operators, majority of the people with mobility difficulties have been relying solely (perhaps occasionally on taxi) on Rehabus service to get to and from work, training, school, treatment, social and recreational activities.

As we approach the new millennium, we have seen changing public attitudes toward people with disabilities. Our public transport system is certainly becoming more friendly to people with disabilities and the elderly. Yet, it is still far from being fully accessible.

With the increasing participation of people with disabilities in work, education and social activities as well as an aging population, we have seen an upsurge in the demand for Rehabus service. In spite of the 55-fold increase of service in the last 20 years, demand still far exceeds supply by 1.3 times. The unmet demand for our service exceeds 10,000 passenger trips per month. Unlike commercial public transport operators, as Rehabus
is a Government-subsidized service for a targeted clientele, it has never been easy to get enough resources to meet the demand.

Figure 15.1a  Rehabus (Side View)

Figure 15.1b  Rehabus and its Rear Platform
Table 15.1  Rehabus Service Statistics for 1998/99

<table>
<thead>
<tr>
<th>Type of Service</th>
<th>Scheduled Routes</th>
<th>Off-peak Dial-a-ride</th>
<th>Full-day Dial-a-ride</th>
<th>Feeder Service</th>
<th>Weekend Recreational Routes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Rehабuses</td>
<td>53</td>
<td>52</td>
<td>14</td>
<td>2</td>
<td>159</td>
</tr>
<tr>
<td>Number of Routes</td>
<td>52</td>
<td>52</td>
<td>14</td>
<td>2</td>
<td>--</td>
</tr>
<tr>
<td>Average Number of Daily Passengers</td>
<td>515</td>
<td>260</td>
<td>185</td>
<td>54</td>
<td>56</td>
</tr>
<tr>
<td>Total Number of Passengers Trips Carried</td>
<td>175,258</td>
<td>131,832</td>
<td>85,725</td>
<td>13,373</td>
<td>2,076</td>
</tr>
</tbody>
</table>

Whilst all public transport operators would be far too pleased to see an increase in patronage and are keen also to compete for patronage, it is most unfortunate that these operators are never keen in competing for Rehabus riders. Only until recently have our public transport operators been avoiding such patronage because of ‘efficiency and safety concerns’. Henceforth there are still a large number of elderly and disabled people who are frustrated, day in and day out, of not being able to fully participate in society because of the lack of transport services provided for them. This phenomenon is quite difficult to comprehend for people who can travel freely everyday in at least three or four alternative travelling modes.

Rehabus was started because of a failed social mission to turn one of our largest transport systems into an accessible one. It has always been Rehabus mission to provide ONLY a complementary or supplementary service to ‘mainstream’ public transport services.

A FULLY ACCESSIBLE TRANSPORT SYSTEM FOR ALL IN THE NEW MILLENNIUM

Public transport cannot be called public transport unless it caters for every sector of the community who so wishes to utilize the services. Public transport is not just for the majority. It is for ALL. The public transport system in Hong Kong ought to be fully accessible to all.
It is every citizen’s right to be able to travel freely to and from places. Elderly and disabled people should not be deprived of this right. The wide choices and convenience that are open to the general public should also be enjoyed by them.

Specialized transport service is not the solution. It forbids the integration of disabled people into the community. It is also not as readily available as public transport modes. Specialized transport should be seen as a complementary mode of transport for travelers who are less capable of self-care or for those with more severe mobility problems. Majority of the wheelchair users can travel freely on their own and/or with escorts given an accessible transport means.

Specialized transport is subsidized by Government and is seen as welfare. It is uneconomical to operate purely specialized transport service because of the limited market segment. People with disabilities do not want welfare. They are very happy to travel on the Kowloon Canton Railway (KCR) because it is fully accessible.

There is a potential market for every transport operator. The increasing number of Rehabus riders, which stood at over 440,000 in 1998 and the unmet demand of nearly 110,000 have proven that the market is growing everyday. As long as your service is accessible, these people can be your potential riders as well. The existing problem is that not all transport modes are fully accessible, making it difficult for riders to make use of the accessible modes, such as KCR, because there is no feeder services.

An accessible transport mode is not only necessary for the people with disabilities. It also proves to be more convenient and safe for other users such as the elderly, pregnant women, passengers with luggage and young children.

**FACTORS AFFECTING THE ACCESSIBILITY OF PUBLIC TRANSPORT SERVICE**

Access is not just limited by the physical design of the system. (Mitchell, 1995). The lack of information, resources and public education can all inhibit access.

**Physical Design**

It is often easier to incorporate accessibility at the planning and designing stages rather than making changes and modifications later on. For example,
MTR has to overcome substantial technical difficulties in order to modify its existing system to become an accessible one. Whereas the Airport Express is designed and planned with accessibility in mind.

A low floor bus is of no use if the bus stops and pavement conditions do not allow the ramp to open freely. The infrastructures are an integral part of any accessible transport system and requires the concerted effort of both the Government and public transport operators to make it work. It is not uncommon to hear complaints from transport operators regarding the lack of coordinated effort from various Government departments in this area of work.

Standards and Information

The Government has always been reluctant in working out a general set of guidelines and standards for transport operators to observe. Operators have spent huge sums to purchase low-floor buses, which are still not accessible to wheelchair users, though these buses are admittedly, more users friendly to most riders.

The lack of information also means that many potential riders are not able to make use of the service. The Government should take a more active leading role in promoting the services to the community.

Affordability

While taxis are generally more accessible to wheelchair users, it is also the most expensive mode. A survey by the Hong Kong Society for Rehabilitation (HKSR) indicated that 40% of the respondents expressed that taxis are not affordable at all. Bus fares are certainly more affordable, but buses are not as accessible.

Capital Input

Elsewhere, research has indicated that the capital input for more accessible transport mode can be compensated by the gain in patronage income over the years. It is certainly less expensive to incorporate an accessible system at the planning stage rather than performing modifications later on.

Public Education

Both operators and the public need to be educated about the needs of people with disabilities. They need no sympathy but opportunity. It takes very little to care for others, to be a bit more patient when a person with disability is boarding the bus, to allow a person in wheelchair to use the lift at the MTR, or to give up a seat for an elderly person.
Drivers should also be given sufficient training on the use of the various devices in facilitating the disabled traveler as well as having the right attitude in servicing them.

CONCLUSION

From both the social and economic point of view, public transport system should be fully accessible to ALL. For those who have severe mobility difficulties, specialized transport can certainly complement or supplement public transport. Like all riders, people with disabilities should have the right to choose the forms of transport they need, at an affordable price, and with as much freedom and flexibility as possible.

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Advanced Technology and Modern Transport in Hong Kong
16 Intelligent Transport Systems
Implementation in the United States and Hong Kong

Leo K LEE

INTRODUCTION

Through the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), the United States government has launched a program to promote Intelligent Transportation Systems (ITS). ITS applies advanced and emerging technologies in such fields as information processing, communications, control, and electronics to solve transportation needs. The objective is to effectively integrate and deploy technologies in order to realize and maximize the benefits from more efficient use of our infrastructure and energy resources, and significant improvements in safety, mobility, accessibility, and productivity.

ITS is a multi-facet approach for addressing transportation needs. Some of these approaches are already commercially viable and are here today. Others represent long-term research. Some ITS systems will be implemented by the private sector, others by the public sector, and yet others will be implemented through public/private partnerships.

The key program areas that comprise ITS are classified into the following:

**Advanced Traffic Management Systems (ATMS)** provide the surveillance and control functions of traffic management. Historically, ATMS has been implemented in the form of traffic signal systems and freeway management systems. Loop detectors and advanced techniques such as video surveillance obtain the necessary data. ATMS processes this information to determine traffic flow, measure congestion, and detect incidents. Many agencies have implemented ATMS, including the Area Traffic Control (ATC) Systems in Hong Kong.

**Advanced Traveller Information Systems (ATIS)** disseminate information to the travelling public over a variety of distribution channels.
Among these are cable TV, digital broadcasts, the Internet, kiosks, in-vehicle navigational receivers, and personal hand-held devices. ATIS can assist in pre-trip planning as well as in providing guidance while the traveller is en-route. Multi-modalism between the personal automobile and transit is a constant theme of ATIS.

Commercial Vehicle Operations (CVO) improve motor carrier (goods vehicles) safety and productivity. The use of technology for improved and targeted inspections addresses the safety goal. To enhance productivity, mitigation of the regulatory burden at border checkpoints is accomplished by reducing paperwork through electronic transactions, weigh-in-motion, and automatic vehicle identification technologies. State and international boundary crossings are a particular focus area for this. For CVO to be successful, information links must be established among various entities including regulatory agencies, dispatch centres, roadside facilities, and in-vehicle devices.

Advanced Public Transportation Systems (APTS) apply ITS technology to the needs of public transit. This includes fixed route systems as well as route deviation and demand-responsive modes. Systems include bus, rail (heavy, light and commuter), vans, carpools, and shared-ride taxis. Some APTS systems are directly visible to the travelling public (e.g., transit information systems), while others are associated with transportation management (e.g., transit dispatch systems).

Advanced Rural Transportation Systems (ARTS) are a collection of ITS technologies (ATMS, ATIS, etc.) applied to the rural environment. The diverse rural environments have distinct needs from urban environments and even from each other. As a result, the reasons for, and the nature of, rural applications often differ from those found in the urban areas.

Advanced Vehicle Control Systems (AVCS) focus on safety devices in vehicles that prevent accidents. This is in contrast to traditional vehicle safety systems (seat belts, air bags, etc.) which mitigate the harmful effects of accidents that occur. AVCS facilitates safety by enhancing driver performance. Reducing the number of accidents results in fewer injuries and fatalities, and in lower societal costs. Roadside and in-vehicle devices are used to facilitate safety, with initial systems self-contained within the vehicles. AVCS can give drivers better awareness of their surrounding (e.g., blind spot situation displays), warn the driver of hazardous situations, or eventually even compensate for driver errors. AVCS depends heavily on private sector (i.e., vehicle manufacturers) investment.
Automated Highway System (AHS) would involve “hands off” driving. It combines infrastructure embedded in the roadway and equipment installed in the vehicle to achieve a “driverless vehicle”. It could result in both safety and capacity improvements through reduced headway between vehicles and automated driving. A National AHS Consortium has been established to demonstrate and co-ordinate long-term research in this area.

Through the past 7 years of ITS planning and development, the Federal Highways Administration (FHWA) has initiated programs to develop ITS Strategic Plans for over 75 cities, regions and states, as well as providing funding for operational tests, researches, 5 pilot corridor implementation, and developing a National ITS System Architecture.

This paper discusses the key lessons learnt in the planning, development, implementation and operation of ITS in the USA in the past 7 years, as well as summarising the initial findings of the ITS Master Plan Project for the Strategic Road Network (SRN) in Hong Kong. Each section that follows address a specific area as follows:

- Section 2 address the development of ITS Strategic Plans in the USA
- Section 3 summarises the development of the USA National System Architecture
- Section 4 provides an overview of the potential benefits of ITS.
- Section 5 summarises the initial findings of the SRN ITS Master Plan Project in Hong Kong.

**ITS STRATEGIC PLANNING**

The objective of ITS Strategic Planning is to provide guidance for developing action oriented plans which lead directly to the deployment of integrated ITS.

Historically, ITS has been implemented in a piecemeal, ad-hoc manner. Agencies often do not have clear roles, responsibilities, funding, and mandate for the design, implementation, procurement, operation and maintenance of ITS. This has led to deployment of ITS in a “disjointed” manner, which resulted in higher costs, inefficiencies and ineffectiveness. Another side effect is that, oftentimes, agencies procure equipment from vendors in individual contracts that do not facilitate overall system integration. Through a coherent approach, the ITS Strategic Plan is
intended to serve as a roadmap to guide the public agencies towards cost-effective and integrated ITS deployment that will serve their individual needs properly.

An ITS strategic planning process is developed based on systems analysis, a planning process developed specifically for large, complex, multidisciplinary systems. Systems analysis can be described as a top-down planning approach. It begins by considering the overall goals and objectives of the system, and progresses to examine more specific initiatives to achieve these goals and objectives. This approach is often used in planning for high-technology systems to prevent the pursuit of technological approaches which, while often very interesting, may have little ability to solve problems at hand.

An important point is that an ITS planning study cannot take place in a vacuum. ITS planning should be an integral part of the regional transportation planning effort. Linking ITS planning to the ongoing transportation planning process in a region is essential in realising a successful ITS planning study. One way of achieving this is through involving the necessary people in the study. There must be significant input from policy makers and other stakeholders in the transportation system.

The ITS strategic planning process involves the following 10 steps:

1. Establish Core Stakeholder Coalition
2. Develop Vision
3. Define Problems and Goals
4. Screen Market Packages
5. Develop Market Package Plan
6. Identify Desired Functional Capabilities
7. Define System Architecture
8. Define Operational Strategies
9. Develop Strategic Deployment Plan
10. Monitor/Evaluate Strategic Plan

Each one of the above steps is discussed in the sections that follow.
Establish Core Stakeholder Coalition

Building a coalition of key policy makers and stakeholders is a critical part of ITS planning. The success of the plan depends on how well it is being received by the stakeholders. A strong coalition of stakeholders from the beginning will promote “ownership” of the resulting plan, and promotes its chances of being implemented.

The ITS stakeholders are many and varied. In fact, one could argue that the entire population of the region are stakeholders because ITS will impact all modes of transportation. Therefore, the challenge of this step is to identify a group of individuals and agencies that represent the larger body of stakeholders. This group, the core coalition, will then serve to steer the study to ensure that ITS plans will directly address the needs of the region. Possible core coalition members is listed below:

- Local Transport Agencies
- Private ITS Industry
- Local System Operators
- Automobile Association
- Transit Agencies
- Fleet Operators (trucking, taxi, etc.)
- Transit Operators
- Transit Riders
- Regulatory Agencies
- Business Owners
- Emergency Services (Fire, HAZMAT, etc.)
- Media
- Police
- Interested private citizens

A small working group of core coalition members should be selected to serve as the Steering Committee. The Steering Committee must play an active role in order for the study to be successful.
In many cases, core coalition members will not be able to devote the level of effort required of the Steering Committee. In order to ensure that their input is included in the study, the establishment of task forces is suggested.

**Develop Vision**

The vision defines conceptually how ITS is expected to function in the regional transportation system. It plays a critical role as the document that sets the direction of the planning effort. There are many ways in which the vision should be used in the remainder of the planning process. First, the vision provides an opportunity to describe the potential of ITS without delving into technical details. Not only can the vision be used in educating policy makers, it also provides an opportunity for their early involvement in the planning effort.

**Define Problems and Goals**

One important premise of ITS planning is that it needs to be a needs driven process. Therefore, this step links the ITS planning effort directly to established regional transportation goals. It seeks to identify specific transportation problems which may be addressed by ITS.

The identification of problems should not require an extensive, time-consuming data-collection or inventory effort. Rather, it is recommended that system problems be identified through interviews with key transportation providers. This allows regional expertise to be used to improve the efficiency of the planning effort.

**Screen Market Packages**

The purpose of this step is to identify ITS elements (market packages) which are best suited to meeting regional transportation goals and have the highest potential for successful implementation. A market package is defined as “a collection of equipment capabilities that satisfy a market need and are likely to be deployed as a group.” Market packages are particularly useful in ITS planning in that they are linked directly to elements of the ITS architecture, allowing for a quicker progression from concepts to projects. The USA National ITS Architecture defines 53 market packages.

**Develop Market Package Plan**

This step takes the high priority market packages that have emerged from the screening process and examines them in more depth. This is done by
selecting performance criteria for each market package, and then conducting a preliminary analysis to measure the market package’s performance using the criteria. While detailed simulation modelling may provide excellent estimates, the scope of a planning study often prohibits devoting the needed resources. In many cases, simple sketch planning provides a sufficient level of analysis for the market package plan.

**Identify Desired Functional Capabilities**

The purpose of this step is to move beyond the generic descriptions of ITS capabilities, market packages, to a more detailed description of the functional capabilities of the region’s ITS vision. In this step, the equipment packages are mapped to the high priority market packages. An equipment package contains the functional capabilities required to implement a market package.

**Define System Architecture**

The purpose of defining a system architecture is to provide a framework for the delivery of the market packages. A system architecture allocates the desired functional capabilities, or equipment packages, to subsystems, and defines the flows of information and the interfaces between the subsystems. Effort spent in defining the architecture will provide a way to identify how regional organisations, both public and private, may work together to deliver market packages. In addition, it will help to identify integration opportunities.

A critical aspect of defining the system architecture is selecting interface standards. In developing the architecture, it becomes clear where interface standards must exist to support the interoperability of the ITS system.

**Define Operational Strategies**

One key element of ITS planning involves the operation and maintenance (O&M) of the system. Whereas technology may offer a wide range of possibilities, its operation and maintenance costs and constraints must be considered in the planning process in order to realise the full benefits. Effectiveness of high technology is dependent on the people who use it.

The operational strategies evaluate the level of O&M needs, which generally fall under two basic categories: staffing and budget. Different means of achieving maximum effectiveness should be explored, including forming public/private partnership and sharing resources among agencies.
Institutional issues are the main barrier to implementing ITS. In the USA, the various domain experts said that there are no technology showstoppers that must be tackled before progress can be made in their areas. The technology is viewed as being “easy” when compared to the magnitude of institutional problems that are faced. The definition of operational strategies must tackle the institutional issues in order to achieve an integrated ITS system.

**Develop Strategic Plan**

This step pulls together the efforts of the planning process to clearly document an action-oriented ITS implementation plan. As a roadmap towards implementation, the ITS plan needs to contain well-defined projects, including capital acquisitions and construction activities, as well as operations and maintenance costs.

**Monitor/Evaluate Plan**

The last element of the ITS planning process is not a step, but rather an on-going effort to learn from the experience gained in planning for, and implementing ITS projects. This effort will uncover lessons which will assist in future ITS planning, and in the efficient deployment of ITS projects.

Another important aspect of this element is to evaluate the effectiveness of ITS projects. Sketch planning is used in the planning process to estimate project benefits. In this step, actual data can be collected to determine actual project benefits. Documented benefits of deployed projects will be of benefit in obtaining support and funding.

**ITS SYSTEM ARCHITECTURE**

ITS is basically all about information – the collection, sharing, processing, and redistribution of information – to help move people and goods better. Information lets travellers make better decisions, and helps improve the efficiency and safety of the various elements of our transportation infrastructure. Management of information to control an operation – and better serve its customers – is an idea that is very familiar to any major organisation that has to streamline its operations and get better performance at lower cost.

A system architecture, then, is a framework that lays out the boundaries, players, and strategies for that process of information
management. It has to have an intimate knowledge of the way
transportation works in order to get the new systems to work well with
the existing ones. The framework can then guide the development of
standards and making deployment decisions that will result in efficiency,
economies of scale, and interoperability.

Started in 1993, the National ITS System Architecture for USA was
a three year effort to map out an organised approach to implementing, in
a consistent manner across the United States, the various ITS services
envisioned for the next 20 years or more.

Throughout 1993 and 1994, the Architecture Program examined in
detail four alternative architectures – four very different concepts for
creating the nation-wide ITS infrastructure, developed by four independent
teams – and held them up to the scrutiny of a broad range of technical
experts and various ITS stakeholders. Out of this process emerged the
two teams that have subsequently jointly completed the development.

ITS relies on interactions among three layers of infrastructure:

**Communications Layer** – This is the information infrastructure that
connects elements of the transportation layer and allows co-ordination
and sharing of information among systems and people. The system
architecture carefully lays out: (1) what types of information and
communication are needed to support various ITS services; (2) how data
should be shared and used by which physical entities (subsystems); and
(3) what types of standards are needed to facilitate this sharing.

**Transportation Layer** – This is the physical ITS infrastructure that
includes traveller, vehicles, management centres, and roadside equipment.

**Institutional Layer** – This includes the socio-economic infrastructure
of organisations and social roles, reflecting jurisdictional boundaries and
including agencies at all levels of government, private companies, and
those that may be impacted by ITS services. Activities on this level include
developing policies, financing ITS, and creating partnerships to guide
ITS deployments.

Figure 16.1 shows the contents of the USA National System
Architecture, and Figure 16.2 shows the physical architecture component.
ITS BENEFITS

Empirical tests performed by the US Department of Transportation (USDOT) have demonstrated that ITS services can meet a wide range of community needs, enhance capacity and improve efficiency, safety, and quality of life. Some of the documented benefits are summarised in the following sections.

Efficiency and Enhanced Use of Existing Capacity

The USDOT estimates that deploying the intelligent transportation infrastructure in 50 of the largest metropolitan areas will reduce the need
for new roads while saving taxpayers 35% of required investment in urban highways. Better management of transportation systems is central to achieving efficiency. However, managing any part of the system – transit, highways, or streets – more efficiently is nearly impossible unless system managers have access to information, such as the location of a traffic incident. And information does little good if there is no means to respond and make adjustments to the system or to communicate with travellers. ITS field tests and deployments have shown that strategic application of information and control systems can significantly improve efficiency for system managers:

- ITS infrastructure in 75 of the largest metropolitan areas is estimated to have a benefit-cost ratio of 8.8 to 1;
- Freeway management systems can reduce accidents by 15% to 62%, while allowing the system to handle 8% to 22% more traffic at 16% to 62% greater speeds in comparison to congested conditions;
- Incident management programs have reduced incident-related congestion and delays by 50% to 60%;
- Electronic toll collection has increased throughput by 200% to 300% compared with traditional attended lanes; and
- Automated traffic signal systems have shown the capability to decrease travel times by 14%, reduce delay by 37%, and increase travel speeds by 22%.

Preventing Accidents and Saving Lives

Today, ITS technologies are making it easier for emergency response teams to locate incidents and reach victims quickly, dramatically improving the chances of survival. Freeway management systems, such as ramp meters that help smooth traffic flow, have reduced accidents by 15% to 20%. New information technologies for commercial vehicles are allowing more efficient and accurate safety inspections, increasing access to safety information for inspectors, and automating hazardous materials incident response systems. In the near future, better incident information and warning systems will reduce the high number of accidents at intersections and improve safety at highway-rail crossings. More startling, the National Highway Transportation Safety Association estimates that 1.2 million crashes – 17% of the 6.4 million nation-wide – could be prevented each year if all vehicles were equipped with three ITS crash avoidance
countermeasures currently under development: rear-end crash warning systems, roadway departure warning systems, and lane change/merge crash avoidance systems. These systems would also save $26 million annually in accident-related costs.

Reducing the Cost of Government Operations and Services

In the October 1995 report, *High-Tech Highways: Intelligent Transportation Systems and Policy*, the Congressional Budget Office states that “ITS research may enable highway and transit authorities to provide better service at lower cost, possibly reducing the need for public subsidies.” In an environment of limited budgets and cuts in public sector subsidies, the components of ITS infrastructure can dramatically reduce the costs of transit management, toll collecting, and truck safety inspections:

- Advanced public transportation management systems in 265 actual or planned deployments have been estimated to save transit operators from $3.8 billion to $7.4 billion (1996 dollars) in operating costs, without diminishing quality of service;
- In Oklahoma, operating costs dropped from $176,000 to $16,000 per year per toll booth when booths were equipped with electronic debit systems, a cost reduction of 90%; and
- Commercial vehicle administrative programs have reduced compliance-related labour costs (licensing, permitting, registration, fuel-tax reporting, and credentialing) by 9% to 18% through the use of enhanced information technologies.

Enhanced Quality of Life

Because ITS can enhance capacity using the existing physical infrastructure, it can lessen disruptions to wetlands, parks, open spaces, and neighbourhoods caused by new construction. Also, ITS and its supporting infrastructure can increase mobility – giving people more information and greater control over their transportation choices. In greater Boston, for example, a majority of travellers change their routes, times of travel, or mode when they are given up-to-date information through advanced information services. National focus group research indicates high interest among all income groups in travel products that provide personal security and safety services, location assistance, advanced traffic notification, and alternative route advisories. Equally important as the population age, in-vehicle safety and information technology could enhance the capabilities of older drivers.
INITIAL FINDINGS OF THE ITS STRATEGIC PLAN FOR THE SRN IN HONG KONG

In June 1998, Transport Department commissioned a 12-month consultancy study to evaluate the feasibility and develop the most cost-effective means of implementing ITS on the Strategic Road Network (SRN) in Hong Kong, and to develop a strategic plan for such implementation over the next 10 years. This section outlines the early findings that establish the need for ITS on the SRN.

The Strategic Road Network (SRN)

The SRN, as defined originally in the Comprehensive Traffic Surveillance and Control Study (CTSCS) conducted in 1980, consists of those trunk roads which have been defined as being of particular economic and social importance, and which are designed to carry high volumes of traffic with minimum disruption. This concept of a system of trunk roads is formally adopted through recommendations of the Transport Policy Co-ordination Committee (TPCC) Paper 12/84, and is subsequently included in Section 2.2.1.2 of Transport Planning and Design Manual (TPDM) Volume 10. Figure 16.3 shows the current SRN in Hong Kong.

The SRN comprises a roadway network that has expanded from about 122 km envisioned in 1980 to about 195 km in 1997. By 2011, according to the Third Comprehensive Transport Study (CTS-3) maximum infrastructure scenario, the SRN would be expanded to about 302 km.

The SRN consists of primarily higher speed segregated roads with limited frontage and access. Some sections (e.g. Waterloo Road) are of arterial street classification only to provide connectivity of the network. The SRN warrants special attention in terms of traffic management strategies because of the following key reasons:

- It typically carries larger volumes of traffic than arterial streets. Therefore, it has significant impacts towards the mobility of people and goods in Hong Kong;
- Because of the higher speeds of travel, accidents are typically of more severe consequences;
- Most of the SRN roads do not have a hard shoulder. Any minor incidents such as vehicle breakdowns would block travel lanes, hence impacting traffic flow and causing congestion;
Figure 16.3 Existing and Planned SRN in Hong Kong, 1998
Due to the segregated nature of the roadway, traffic congestion due to accidents/incidents cannot easily find detour, and the resulting traffic queues would take a longer time to clear;

Emergency access to the accident scene is more difficult due to its limited access nature and lack of hard shoulder;

When congestion occurs, travellers who may wish to take alternative routes would need to make such decisions further upstream than on a street network;

The SRN typically caters for longer trips. Therefore, its operation has a more profound impact on the trip time and on travellers’ perception of the transportation network’s reliability as a whole; and

Some sections of the SRN have no suitable alternative routes, and hence it warrants special attention and disaster planning.

Although the SRN is adopted by the TPCC, there is currently no formal mechanism for its establishment and updating. It is recommended to formalise the establishment of the SRN through:

(a) Identifying a lead agency for evaluating any roadway to be included in the SRN;

(b) Establishing the criteria for evaluating any roadway to be included in the SRN;

(c) Formalising an SRN Management Strategy for maintaining a high level of operational efficiency on the SRN; and

(d) Developing a set of operational criteria and ITS infrastructure for all roadways within the SRN.

Traffic Conditions on the SRN

Existing conditions on the SRN indicate significant traffic congestion along several major corridors, notably Route 1, Route 2 and Route 8. Recurrent congestion creates an estimated delay of 186,000 pcu-hours per day. The other cause of congestion is due to accidents and incidents on the SRN. Based on accidents statistics provided by Transport Department, and extrapolating using tunnel operation data to estimate unreported incidents, it is estimated that there are currently on average 27 incidents and accidents on the SRN per day. This creates an additional non-recurrent delay of 345,000 pcu-hours per day.
Using model run projections of CTS-3 furnished by Transport Department, future traffic conditions on the SRN were evaluated for 2001, 2006, and 2011 respectively. Despite the expansion of the SRN to more than 150% its current size by 2011, recurrent delay caused by traffic congestion is estimated to increase to 258,000 pcu-hours per day, an increase of over 39% over existing conditions.

By extrapolation, it is estimated that there will be, on average, over 49 incidents and accidents on the SRN per day by the year 2011, almost doubled over 1997! Non-recurrent delay due to incidents and accidents on the SRN is estimated to give rise to an additional delay of 701,000 pcu-hours per day by 2011. This represents an increase of 104% from 1997 conditions.

Table 16.1 below summarises the key travel statistics on the SRN:

<table>
<thead>
<tr>
<th>Key Parameters</th>
<th>1997</th>
<th>2001</th>
<th>2006</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Distance (km)</td>
<td>195</td>
<td>208</td>
<td>248</td>
<td>302</td>
</tr>
<tr>
<td></td>
<td>(7)</td>
<td>(27)</td>
<td>(55)</td>
<td></td>
</tr>
<tr>
<td>Total Modelled VHT (pcu*hr)</td>
<td>783,000</td>
<td>1,028,000</td>
<td>1,091,000</td>
<td>1,323,000</td>
</tr>
<tr>
<td></td>
<td>(31)</td>
<td>(39)</td>
<td>(69)</td>
<td></td>
</tr>
<tr>
<td>Total VKT (pcu*km)</td>
<td>17,516,000</td>
<td>21,134,000</td>
<td>23,753,000</td>
<td>28,841,000</td>
</tr>
<tr>
<td></td>
<td>(21)</td>
<td>(36)</td>
<td>(65)</td>
<td></td>
</tr>
<tr>
<td>Recurrent Delay (pcu*hr)</td>
<td>186,000</td>
<td>193,000</td>
<td>193,000</td>
<td>258,000</td>
</tr>
<tr>
<td></td>
<td>(4)</td>
<td>(4)</td>
<td>(39)</td>
<td></td>
</tr>
<tr>
<td>Accident/Incident Delay (pcu*hr)</td>
<td>345,000</td>
<td>573,000</td>
<td>599,000</td>
<td>701,000</td>
</tr>
<tr>
<td></td>
<td>(66)</td>
<td>(74)</td>
<td>(104)</td>
<td></td>
</tr>
<tr>
<td>Total Delay (pcu*hr)</td>
<td>530,000</td>
<td>765,000</td>
<td>792,000</td>
<td>958,000</td>
</tr>
<tr>
<td></td>
<td>(45)</td>
<td>(49)</td>
<td>(81)</td>
<td></td>
</tr>
</tbody>
</table>

*Note: Figures in parentheses indicate percentage growth between 1997 and future years.*
The increase in travel delay on the SRN, both recurrent and non-recurrent, despite having made major investment towards building roadway and railroad infrastructure, indicates a strong need to promote the operational efficiency of the available roadway network. Hence the need for an SRN Management Strategy.

The consultancy study currently on-going has developed a set of SRN Management Strategy that is classified into:

- Traffic Management Strategy;
- Traveller Information Strategy;
- Incident Management Strategy; and
- System Integration Strategy.

Other tasks of the consultancy study includes:

- Developing an Operational Plan that recommends an institutional framework for implementing the SRN Management Strategy. The institutional framework includes an organisational set-up, roles and responsibilities, policies and procedures, required legislation, and operational and maintenance arrangement for ITS;

- Developing a conceptual design of the ITS infrastructure on the SRN. Such infrastructure includes out-station equipment on the SRN, associated civil works, communication system, and a Traffic Management and Information Centre (TMIC) infrastructure; and

- Developing an implementation programme that lays out a logical and cost effective manner of implementing the SRN Management Strategy.
INTRODUCTION

Since the invention of wheels and engines, surface transportation has evolved into different forms catering for different needs. Commonly, there are buses, trains and rails that are designed for mass transit with fixed routes and pre-schedules. They are most efficient and economical in terms of transporting groups of people to specified destinations. However, they are also the least satisfying to individuals because of the fact that fixed routes and pre-schedules are far from being personalized. On the other hand, there are private cars and taxis designed for more personal use. This is most satisfying to individuals because schedules are determined according to demands, and routes can be personalized. However, they are the least efficient, and probably the most expensive.

As the costs of traveling and private cars become more affordable to many nowadays, the demand for travel is no longer just a matter of necessities, but also of leisure and entertainment. For this reason, the number of vehicles in the world has been on an increasing trend, especially for private vehicles, and much money has been spent on building and maintaining the supporting road infrastructure (Transport Department, 1998). For example, in Hong Kong, there were just over 370,000 registered vehicles in 1990, compared with over 500,000 in 1998 (Transport Department, 1992; 1998), as depicted in Figure 17.1. Although more roads have been built, the number of vehicles per kilometer has actually been increased from 250/km in 1990 to 272/km in 1998 (Government Information Services Department, 1997), as depicted in Figure 17.2. With traffic normally unevenly distributed, this adversely stretches our road network, which consequently worsens the problems of congestion and pollution.

Of all the problems created by the increase in the number of vehicles and traffic volume, congestion perhaps has the greatest impacts that are
most far reaching. It impinges on the precious little time that modern city dwellers have. Moreover, it indirectly affects our economy through loss of productivity, absentees, delay of shipments and goods, among many others. As estimated, the loss of productivity may cost Hong Kong billions of dollars in the years to come (Transport Department, 1994). While recent survey in Japan indicated that an estimated economic loss of 12 trillion yen, and time losses of 5.6 billion person-hours per year are due to traffic congestion (Highway Industry Development Organization, 1996). Furthermore, congestion also increases the level of pollution due to the start-and-stop traffic that severely impacts on our environment. At its worst, congestion induces aggressive driving that manifests itself as speeding, improper overtaking, careless lane-changing, tailgating and disobeying traffic signals, which could have grave consequences (Hong Kong Police Force, 1997).

Figure 17.1  Total Number of Registered Vehicles in Hong Kong from 1990-1998

Figure 17.2  Registered Vehicles per Kilometer in Hong Kong from 1990-1998
To tackle the congestion problem, many argue for expanding our existing road network at a faster pace. This sounds a logical solution. However, more roads imply larger maintenance cost. According to the U.S. House of Representative Subcommittee on Technology hearing in 1997, the roads and highways in the U.S. cost over US$80 billion to maintain annually (Morella, 1997). With an anticipated 50% increase in traffic in the next decade, they reckoned it is not practical to simply build more roads and highways. Therefore, a practical solution has to come from somewhere else. For this reason, others have argued for restricting the number of vehicles on the road. In fact, various quota, tax, and road pricing regimes have been introduced in different countries or cities, trying to do just that (Transport Branch, 1994; Wachs, 1981). So far, none of these has achieved real success in reducing the number of vehicles on the road.

Since expanding the road infrastructure, or reducing the number of vehicles on the road have both met with some major barriers, it would perhaps be natural to consider increasing road utilization through applying Information Technology (IT) appropriately. As argued by Morella (1997), it is apparent that research and development in transportation systems that offer shorter traveling time, safer and more environment friendly, is the best step forward in meeting our transportation needs in the 21st Century. This argument is further supported by the decade-long Research and Development (R&D) experience in the U.S., Europe and Japan in applying IT to solve some of the transportation problems. Driven by the success of earlier programs (e.g., IVHS, PATH, Prometheus, Drive), many countries are now seriously funding R&D projects, deployment of systems and building of infrastructures under the broad heading of Intelligent Transportation Systems (ITS).

For instance, Japan has budgeted over US$100M for ITS R&D (Figure 17.3) and over US$400M for deployment and infrastructure just in 1998 (Highway Industry Development Organization, 1998). The U.S. Federal Government has budgeted a total of close to US$1.3 billion (not including ITS spending by individual states) from 1998-2003 for their TEA-21 program (Highway Industry Development Organization, 1998; ITS-US, 1996) (Figure 17.4). Similar ITS programs have also sprouted in Europe (e.g., T-TAP, TEN-T) and Asia in response to these programs. They broadly cover areas such as navigation systems, traffic/traveler management/information systems, public transportation systems, vehicle control and safety systems, and commercial vehicle operations. In these areas at present, research is being actively pursued, and some early versions of systems have already been tested and deployed for sometimes. However,
as ITS covers a wide spectrum of areas in transportation and is multi-disciplinary in nature, more are planned to be deployed in the next few years and more R&D efforts are still needed. As for Hong Kong, this presents great opportunities as well as challenges.

![Graph](image1.png)

**Figure 17.3** Japan’s ITS Research and Development (R&D) Budget

![Graph](image2.png)

**Figure 17.4** US ITS Budget under TEA-21

From the R&D point of view, the outdoor road environment is often noisy and hostile, where traditional image/video processing and sensing techniques previously developed for in-door applications will likely fail. More robust and real-time methods are thus required. Moreover, research is further constrained by the expensive and restrictive nature of conducting experiments, tests or trials on the road, which in other cases, can be easily performed in laboratory environment. Therefore, realistic and extensive simulations must be conducted under such circumstances. This demands an accurate modeling of each problem, which is not always possible but will enable us to understand the practical issues better eventually. In
essence, research in ITS would have to be more application oriented, and
relied more on modeling and simulations, and less on experimentation.

From the technology and deployment point of view, ITS can
potentially create new industries and generate huge revenue. To illustrate
the enormity of the ITS market and application, for instance, it is
understood that for car navigation systems in Japan alone, total sales are
expected to reach 2 trillion yen in the near future. Apart from this, there
are plenty of opportunities in developing other ITS technologies, some of
which may be transport information acquisition and delivery services
through the Internet or various fixed/mobile communication channels,
in-vehicle autoPC/info-tainment/navigation, personal mobile computing
and navigation aids, and traveler/transit/tourist information services. The
extent to which this ends is only limited by our imagination.

Therefore, how Hong Kong positions itself in respond to the ITS
development worldwide would be critical. It would determine the way in
which this technology may be utilized to reduce congestion and pollution,
and how best we may capture the market and develop a new high value-
added industry.

WHAT IS INTELLIGENT TRANSPORTATION SYSTEMS
ANYWAY?

In general, ITS can be broadly considered as applying Information
Technology to solve transportation problems. The word intelligent
highlights the difference between the transportation systems with the IT
ingredients from the conventional ones, as well as their features of being
more adaptive, robust, safe, efficient and economical. Indeed, ITS aims
to improve safety, efficiency, economy and environment compatibility,
through the application and integration of vehicle control/navigation
technology, sensor technology and communication technology. Figure 17.5
depicts an artist’s impression of a future city deployed with ITS.

To address these aspects, different ITS programs around the world
(ITS America, ERTICO of Europe, VERTIS of Japan, ITS Canada, ITS
Australia, and etc.) have established their fields of development (HIDO
1998; ITS-AUS, 1998; PATH, 1997). Generally, they may be categorized
into five major areas:

♦ Traffic/transport management;
Figure 17.5 Future ITS City

- Traveler information;
- Vehicle control and safety;
- Public transportation; and
- Commercial vehicle operations

The sub-areas covered by each major area are given in Table 17.1 (Lai, 1999):

Of all these areas of development, safety, efficiency, economy and environment compatibility are paramount objectives to be met. Methods or technology developed often have impact on one or more of the four objectives, and are applicable to more than one area. For instance, navigation systems for optimal distance or time travel are applicable for most vehicles on the road, may it be commercial, public or private. They also maximize the traveling efficiency as well as being economical because of the saving in fuel. Table 17.2 depicts some of these methods and technologies developed to meet these objectives.

In terms of research and development activities, there are quite a few areas still undergoing intensive investigations. Details of some of these areas are discussed below:
Table 17.1  Major and Sub-Areas in ITS Development

<table>
<thead>
<tr>
<th>Major Areas</th>
<th>Sub-Areas</th>
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<tbody>
<tr>
<td>Traffic/transport management</td>
<td>♦ Travel &amp; traffic management</td>
</tr>
<tr>
<td></td>
<td>♦ Electronic payment and toll collection</td>
</tr>
<tr>
<td></td>
<td>♦ Emergency management</td>
</tr>
<tr>
<td></td>
<td>♦ Travel information</td>
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<tr>
<td></td>
<td>♦ Urban and Inter-urban traffic management</td>
</tr>
<tr>
<td></td>
<td>♦ Optimization</td>
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<tr>
<td></td>
<td>♦ Management efficiency</td>
</tr>
<tr>
<td>Traveler information</td>
<td>♦ Travel demand management</td>
</tr>
<tr>
<td></td>
<td>♦ Navigation systems</td>
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<tr>
<td></td>
<td>♦ Traveler information system</td>
</tr>
<tr>
<td>Vehicle control and safety</td>
<td>♦ Driver assistance</td>
</tr>
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<td></td>
<td>♦ Cooperative driving</td>
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<tr>
<td></td>
<td>♦ Assistance for safe driving</td>
</tr>
<tr>
<td></td>
<td>♦ Advanced vehicle control</td>
</tr>
<tr>
<td>Public transportation</td>
<td>♦ Public transportation operation</td>
</tr>
<tr>
<td></td>
<td>♦ Public transportation management</td>
</tr>
<tr>
<td></td>
<td>♦ Support for public transport</td>
</tr>
<tr>
<td></td>
<td>♦ Support for pedestrian</td>
</tr>
<tr>
<td>Commercial vehicle operations</td>
<td>♦ Freight and fleet management</td>
</tr>
<tr>
<td></td>
<td>♦ Efficiency improvement</td>
</tr>
</tbody>
</table>

♦ Automated visual surveillance (AVS)  Video or image provides an important information source to many practical real-time traffic management systems and information services. In particular, automated visual surveillance is highly desirable as the number of surveillance cameras is increasing rapidly, in almost every international city. From the videos/images, traffic parameters such as average vehicle speed, volume, flow rate, may be estimated. However, there are fundamental problems needed to be resolved. For instance, the effect of shadow, occlusion, camera modeling, rain, fog, snow and their elimination from the image sequence required much study. Vehicle occlusion and queuing are classical problems without a clear-cut solution yet. On the other hand, the accuracy of the parameter estimation and its response to sudden changes in the scene due to pan-tilt-zoom actions, and the effect of mobile camera also need further research effort.
<table>
<thead>
<tr>
<th>Objectives</th>
<th>Methods or Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>Airbags: for driver/passengers and for pedestrian protection&lt;br&gt;ABS: safe braking under adverse conditions&lt;br&gt;Sensors: sensor information may be used for engine management, parking, comfort setting, maintaining safe distance, providing more information regarding the road and vehicle&lt;br&gt;Advanced speed and steering control: principally as safe driving assistance through appropriate and smooth speed and steering control via sensor information in front, behind and nearby&lt;br&gt;Night driving aids: IR cameras and special headlight configurations have been developed for better vision at night&lt;br&gt;Obstacle avoidance: methods have been developed for either warning the driver of obstacles, or taking avoidance actions&lt;br&gt;Automated surveillance: CCTV/surveillance cameras have been widely employed as early warning system for bad weather conditions, traffic accidents and other possible abnormally&lt;br&gt;Automated vehicle location: for tracking and monitoring of vehicles</td>
</tr>
<tr>
<td>Efficiency</td>
<td>Navigation: optimum path planning and route selection&lt;br&gt;Scheduling: for demand responsive fleet operations or non-demand responsive public bus operations&lt;br&gt;Real-time traffic information: for traffic management and dissemination of information to road users&lt;br&gt;Variable electronic message signs: Better utilization of the road&lt;br&gt;Automated highway systems: for efficient vehicle operations using platoon formation&lt;br&gt;Commercial vehicle assistance: establish communication between vehicles, carriers and information center&lt;br&gt;ETC/ERP: reduce congestion</td>
</tr>
<tr>
<td>Economy</td>
<td>Navigation: shortest distance or shortest time path planning reduces fuel consumption&lt;br&gt;Optimum scheduling: helps reduce redundant routes and maximize operational profit&lt;br&gt;Real-time traffic information &amp; VEMS: helps reduce congestion that saves fuel by at least 10%&lt;br&gt;Vehicle platooning: lower air resistance, saves fuel&lt;br&gt;Electric vehicles: cheaper to run in the long run&lt;br&gt;Carpooling: sharing of private vehicles by subscribers is economical&lt;br&gt;LED traffic light: save energy compared with light bulbs</td>
</tr>
</tbody>
</table>
Vehicle classification  So far, much effort has been devoted to recognize vehicle types rather than actual vehicles. This is not entirely surprising as vehicle types are a lot easier to classify and such information suffices in some applications. However, in other applications that involve detailed tracking or law enforcement, vehicle classification is necessary, thus requiring further investigation.

Obstacle avoidance  One of the on-going development effort in ITS is Automated Highway Systems (AHS). In AHS, some of the driving could be done automatically, i.e., an on-board computer determines the trajectory and speed of the vehicle from either the communication between nearby vehicles/beacons, or from sensors measuring distances and lane markings. In automated driving mode, obstacle avoidance ability must be integrated to the system for special manœuvring such as overtaking. This is more so in town driving when obstacles could be human beings crossing the road. So far, obstacle avoidance research shows that unknown static environments can be tackled without any problems. The issue here is moving obstacles. Reinforcement learning, fuzzy inference methods, artificial neural networks and supervised learning are being considered as possible candidates to solve this problem.

Intelligent traffic light control  Recent research studies indicate that appropriate control of the traffic light duration at junctions will increase the flow rate and therefore, will reduce congestion. Similar study may be extended to coordinating the traffic lights of neighboring junctions, and eventually extended to finding an optimum solution for a wide area of road networks.

Electric/Intelligent vehicles  Research in electric vehicles (EV) has had a long history, and its environmental compatibility is reasonably understood. However, its wider adoption in today’s surface transportation is still hindered by the battery technology and all the associated problems. Much research effort has been devoted to eliminate this barrier. Although we may still be some way away from large-scale deployment of EV technology, various pure and hybrid EV prototypes have ready been well tested. Currently, there is a thrust towards the so-called “Intelligent Vehicle”, mainly driven by some automobile manufacturers. Such vehicle is supposed to be equipped with integrated information
services, entertainment as well as advanced control and safety features. Although the concept works well with petrol vehicles as well as EV, it is apparent that it presents a natural integration with the existing EV philosophy. Much research effort is being invested in this direction currently.

- **Optimal scheduling** Scheduling is frequently employed for demand responsive transportation systems, employed in most commercial vehicle operations, such as freight, delivery and maintenance operations. In some cases, even public transportation systems may benefit from this by switching between non-demand responsive and demand responsive modes. As scheduling is a NP-hard problem, much research is being conducted in studying heuristics and genetic algorithms that may give a near-optimal solution.

- **Path planning and route selection** One of the basic requirements in navigation is path planning and route selection. Many existing navigators do support path planning in a rather rudimentary form. In the future, it is anticipated that path planners or route selectors would have at least three major features. First, it should be able to provide a large selection of paths, where each path is optimized to a particular criterion. Some of these criteria may be shortest distance, shortest time, most economical or most pleasant. Second, it should be able to learn the particular driver’s selection and therefore can automatically adapt a path from his/her previous selection. Much research work is focused on this area, particularly in the learning aspect where neuro-fuzzy approaches are being studied. Third, it should be Internet-enabled. Traffic or service information, as well as personalized information (work schedule, address book) should be accessible via the Internet. Again, much effort is being committed in this area.

In terms of deployment, other than the government agencies responsible for ITS in each country, there are many companies worldwide participating in the ITS market, producing products that are tailor-made for specific applications. For instance, Fujitsu offers a *Fire Fighting Equipment Dispatch Systems* that records the calls, automatically selects the vehicles and dispatches firefighters to the fire location. Toshiba offers a *Car & Parking System* that provides parking guidance and information services with a parking facility. Nissan developed a navigation system called *Birdview*, which displays a pseudo 3D view of the digital map and
some landmarks around the vehicle. Hyundai offers an advanced vehicle information and communication system that uses mobile network to provide real-time traffic and traveler information, Internet facility and map base, which are all controlled via a voice module.

In Europe, Spain offers GSM-SMS for information dissemination through Teletext, videotext, audiotext, and Internet supported by the Spanish telephone companies. Daimler-Benz has launched DynAPS, an auto-pilot system that takes into account of real-time accidents, road works and road blocking when performing path planning and selection. Citylog of France offers an automatic accident detection system using camera inputs.

Similar activities are also reported in the U.S., Canada, Australia and many Asian countries, with participants including GM, Delphi Automotive, Intel, Clarion, Toyota, Honda, Samsung, etc.

**CURRENT ITS ACTIVITIES IN HONG KONG**

Current ITS activities in Hong Kong may be roughly classified into three categories: R&D, technologies deployed, and technologies under investigation. In the following discussion, the focus will be on some representative examples of these categories.

**Research and Development**

Major ITS R&D activities conducted in local universities in Hong Kong are depicted in Table 17.3.

As can be seen from Table 17.3, the R&D activities may be further divided into a number of sub-areas covering the traditional transport engineering research (transport planning, traffic/signal control), and the novel approaches (Internet, surveillance, law enforcement). A selected number of examples are given below:

**Bus Operation Simulation**

Simulation in ITS is an important aspect as physical experimentation or field trials are costly and time-consuming. In this case, the simulation of public bus operations enables us to study the effects of changing parameters such as bus fares, schedules, and so on, on the quality of service and the profit of the operation. Figures 17.6a, 17.6b and 17.6c depict the GUI of the simulator (Lau, 1999).
### Table 17.3  List of R&D Projects Carried out in Local Universities

<table>
<thead>
<tr>
<th>Area</th>
<th>Project Title</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulation</td>
<td>Bus operation simulation</td>
<td>HKU</td>
</tr>
<tr>
<td></td>
<td>Auto-toll simulation and reliability</td>
<td>PolyU</td>
</tr>
<tr>
<td>Internet</td>
<td>Internet car park booking</td>
<td>HKU</td>
</tr>
<tr>
<td></td>
<td>Dynamic traffic GIS</td>
<td>HKU</td>
</tr>
<tr>
<td></td>
<td>Internet-enabled navigation</td>
<td>HKU</td>
</tr>
<tr>
<td></td>
<td>Internet live traffic video</td>
<td>HKU</td>
</tr>
<tr>
<td>Law Enforcement</td>
<td>Red light video</td>
<td>HKU</td>
</tr>
<tr>
<td></td>
<td>VRP/VRM recognition</td>
<td>HKU</td>
</tr>
<tr>
<td></td>
<td>Vehicle license number recognition</td>
<td>PolyU</td>
</tr>
<tr>
<td>Surveillance</td>
<td>Automated visual surveillance</td>
<td>HKU</td>
</tr>
<tr>
<td></td>
<td>Traffic parameter estimation</td>
<td>HKU</td>
</tr>
<tr>
<td></td>
<td>Incident detection</td>
<td>HKU</td>
</tr>
<tr>
<td></td>
<td>Junction monitoring</td>
<td>HKU</td>
</tr>
<tr>
<td>Transport Planning</td>
<td>Strategic transport planning</td>
<td>HKU</td>
</tr>
<tr>
<td></td>
<td>Strategic planning and transport modeling</td>
<td>PolyU</td>
</tr>
<tr>
<td></td>
<td>Dynamic traffic assignment</td>
<td>HKUST</td>
</tr>
<tr>
<td></td>
<td>Transit assignment</td>
<td>HKUST</td>
</tr>
<tr>
<td></td>
<td>Transport pricing models</td>
<td>HKUST</td>
</tr>
<tr>
<td>Traffic/Signal Control</td>
<td>Optimal traffic control</td>
<td>HKUST</td>
</tr>
<tr>
<td></td>
<td>Intelligent traffic light control – DISCO</td>
<td>HKUST</td>
</tr>
<tr>
<td>Others</td>
<td>Path planning and route selection</td>
<td>HKU</td>
</tr>
<tr>
<td></td>
<td>Automated vehicle location</td>
<td>HKU</td>
</tr>
<tr>
<td></td>
<td>Digital map base and tools</td>
<td>HKU</td>
</tr>
<tr>
<td></td>
<td>Public transit information and services</td>
<td>HKU</td>
</tr>
<tr>
<td></td>
<td>Pavement management</td>
<td>PolyU</td>
</tr>
<tr>
<td></td>
<td>Fuel consumption and exhaust emission study</td>
<td>PolyU</td>
</tr>
</tbody>
</table>

**Keys:**
- **HKU**  The University of Hong Kong
- **PolyU** The Hong Kong Polytechnic University
- **HKUST** The Hong Kong University of Science and Technology
Figure 17.6a  Bus Routes Displayed on Digital Map

(Details of bus routes supplied by New World First Bus Services Limited; digital map supplied by the Lands Department, HKSAR Government)

Figure 17.6b  Bus Route Displayed on Schematic Map

Figure 17.6c  Bus Arrival Information
Automated Visual Surveillance

Traffic control and management based on surveillance cameras is common nowadays. However, as the number of surveillance cameras increases, there is an obvious need for performing this task automatically. Figure 17.7 depicts the research results of tracking the trajectories (speed and steering angle) of multiple vehicles on multiple lanes using a deformable model-based tracking method (Lai, 1999).

![Vehicle Tracking and Trajectory Estimation](image)

Figure 17.7 Vehicle Tracking and Trajectory Estimation

Internet Live Traffic Video

With the advent of Internet technology, it becomes possible to have live traffic video being accessible over the Internet, and the efficiency of which is mainly determined by the coding/decoding methods used. The introduction of the MPEG4 standard, as well as new coding/decoding algorithms, such as wavelets, offer new opportunities. Figure 17.8 depicts an H.263 based parallel video codec system that at present transmits live traffic video from the Transport Department to the University of Hong Kong (Leung & Yung, 1999). An Internet version will soon be made available.

VRP/VRM Recognition

Current law-enforcement systems on the road, such as red light cameras, speed radar, rely heavily on human recognition of the vehicle registration plate (VRP) and mark (VRM) on a photograph. In the indoor or more controlled cases (tollgates), most VRP/VRM approaches are able to produce acceptable results. However, in a wide-angled, non-restrictive case as depicted in Figure 17.9a, new techniques that are reliable and fast are needed to tackle the hostile outdoor environment where vehicles are not constrained. Figure 17.9b depicts the result of a VRP/VRM recognition system that is able to do just that (Yung, Au & Lai, 1999).
Figure 17.8  H.263 Codec over Fixed Telephone Line
(Video supplied by the Area Traffic Control Division, Transport Department, HKSAR Government)

Figure 17.9a  Input Image

Recognized as: H Y 6 8 2 9
P: 99 100 100 98 99 99

Figure 17.9b  VRP/VRM Recognition Result
Technologies Deployed

The Hong Kong Government has been actively involved in deploying ITS technology over the years. Some notable achievements are:

(a) Installation of ETC at eight major tunnels;
(b) Traffic control and surveillance system (TCSS) on major roads;
(c) SCATS (Sydney Coordinated Adaptive Traffic System);
(d) Red light cameras;
(e) Speed controlled cameras;
(f) Speed radar and laser gun for speed enforcement;
(g) Internet traffic information dissemination; and
(h) Smart card technology applications, such as Octopus and EasyPark.

Figure 17.10 depicts the ETC at Tate’s Cairn Tunnel and the TCSS for tunnels, and Figure 17.11 depicts the Internet traffic images.

Figure 17.10  ETC and TCSS in Hong Kong

Apart from the government involvement, there are a number of private/commercial companies promoting and/or deploying ITS technologies. For instance, a number of public bus operators are currently testing GPS-based position fixing systems for locating their buses, from which real-time traffic information may be estimated and operation schedules may be improved.
Figure 17.11 Internet Traffic Information

Technologies Under Investigation

Two government-driven ITS initiatives are being considered at the moment: Electronic Road Pricing (ERP) and Transport Information System (TIS). The ERP Study has completed the demonstration/field evaluation phase while the feasibility study for TIS has just begun.

The ERP evaluation is carried out by two international consortia: a Japanese consortium consisting of Mitsubishi Corp, Toyota, NTT, DENSO and Mitsubishi Heavy Industries; and another consortium led by GEC Marconi. The technologies considered were dedicated short-range communication (DSRC) and GPS-based location system.

The DSRC system was mounted on overhead gantries at the old Kai Tak Airport and at four on-street sites in the Wanchai area. They have demonstrated that through the combination of smart card and an in-vehicle unit, via a 5.8GHz communication band, charging can be performed satisfactorily. In this case, enforcement is dealt with by automatic vehicle registration number recognition.
The GPS-based system used differential GPS with an additional digital compass because of the hostile "modern canyon" effect. At the same sites as mentioned above, they also demonstrated the viability of using GPS to locate the position of vehicles and charge them according to this information. Although its viability is positive, there are major stumbling blocks before any practical deployment. The classical multi-path problem at areas with dense population and high-rise buildings remains unsolved, even with differential GPS.

In the case of TIS, the feasibility study aims to determine answers to how Hong Kong may support an information infrastructure and service for acquiring and disseminating traffic and transport related information. Key areas to be studied include data acquisition strategies and mechanism, data analysis algorithms, data warehousing techniques, data mining methods, English and Chinese Geographic Information Systems (GIS) based visualization tools, and information dissemination approaches. Based on today's information and communication technologies, information may be disseminated to the general public via numerous channels such as Internet, radio, TV, pagers, mobile phones, and storage media (CDROM). On the other hand, traffic management professionals are expected to be able to access the information through more dedicated channels for management and control purposes. A schematic view of what the TIS may include is depicted in Figure 17.12.

![Figure 17.12 A Conceptual Diagram of the Future TIS](image-url)
WHERE DO WE GO FROM HERE?

From the discussions in the preceding section, it is apparent that almost all ITS activities in Hong Kong have been performed in the government or the universities. The government has been focused on deploying off-the-shelf technologies, whereas the universities have been focused on finding solutions to research problems. Frequently, their goals are not necessarily common. Although there has been collaboration between academia and government departments at an informal or personal level, such collaboration is usually not funded. This reduces the commitment from both parties and the motivation to succeed. On the other hand, funding through the Research Grant Council is heavily biased towards research and publications, and the funding from ISF/SSF/ITF requires industrial support, which demands a more mature ITS industry.

At present, industrial activities in the ITS area are not of the same intensity. There are companies engaged in ITS development, and there has been some collaboration between universities and the industry, but the scale is small due to the limited number and size of ITS or ITS-related companies in the business locally. Government-industry collaboration is of a similar scale. Because of this limitation, local ITS needs often are fulfilled by imported solutions. The issues associated with this scenario are that first, technical know-how does not come with the imported solution. This prevents us from acquiring the particular expertise for our future development. Second, imported solutions need localization, which may not be successful all the time. Indeed, there have been cases where the imported solution does not work in the local environment, or we suffer a long teething period. Third, imported solutions are costly in both the initial outlay and the subsequent maintenance. Once such cost is committed, it becomes difficult to consider other options or alternatives even if the solution is inadequate.

It is obvious that the matters of congestion and pollution will only become worse over time. This presents an urgent need for improving our transportation systems, hopefully in the not too distant future. Given the flourishing communication and information technology development in Hong Kong, the R&D capabilities demonstrated by the local universities and the desire of the government to seek viable solutions to our existing transport problems, it becomes obvious that local solutions would be forthcoming, if the environment is right.

Therefore, it appears plausible that establishing a formal collaboration framework between all parties concerned may bring about an improved
environment, and perhaps ignite the growth of a new ITS industry that could make Hong Kong even more competitive in the future. The question is thus, how do we bring this into reality?

From our point of view, the answer to the question consists of five parts. The first and foremost is that the government should take the lead in determining long-term vision and the corresponding strategic goals for ITS. The importance of this must never be understated. It is only when the vision is shared and the goals are made known, then sizeable momentum can be built up. To enable this to occur, a strategic planning body would be needed for sharing the vision, developing the goals, and formulating programs to meet the challenge.

Second, an administrative body would probably be needed for program development and management. This is essentially the executive arm of the planning body in the whole matter.

Third, funding should be made available for strategic applied research, development and deployment in a methodical manner. This funding should be targeted by the administrative body to specific programs or projects, and should be driven top-down, meaning that project objectives should be specified first, and research and development proposals should be invited specifically to meet those objectives. We believe this is beneficial to both the funding body and the participants.

Fourth, a collaboration model should be established for government departments (deployment), commercial companies (development) and academic institutions (research) to work on specific projects/programs from inception to product delivery. We believe this would increase the interests and commitment from all parties involved, and would improve the chance of bringing ideas into real and useful products.

Fifth, an incentive scheme should be introduced to encourage the growth of the ITS and ITS-related industries. Although Hong Kong does not currently have an ITS industry as such, we do have strong related industries such as mobile communications, information services, and potential industries such as mobile computing and autoPC, that can be further developed.

CONCLUSIONS

The field of ITS is indeed an exciting one. It is full of opportunities and challenges. Many countries have positioned themselves to meet the challenges and take the opportunities. Their plans extend right into the
21st Century, and involve billions of dollars. Hong Kong so far has
developed some ITS capabilities. However, we are far from being
competitive in this area yet. If our vision is to build an IT based, high
value-added economy in the future, perhaps, this is the right time for us to
seriously formulate strategies, objectives, plans and actions. Hopefully,
these would enable us to move forwards, to build a safer, more efficient,
more economical and more environment compatible transportation
environment.

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THE NEW AIRPORT

Since its opening on 6 July 1998, the Hong Kong International Airport at Chek Lap Kok has won several awards of excellence from world renowned organizations and is now operating as a world class airport.

The airport is constructed on reclaimed land and has an area of 1,248 hectares (Figure 18.1). It has two runways which are 3,800 metres long and 60 metres wide, capable of supporting ultra long haul flights. The south runway has been in operation since the opening day and the airport commenced full dual runways operation since 31 August 1999. The south runway is equipped with Category II Instrument Landing System (ILS) on both ends and the north runway is equipped with Category IIIA ILS for approach from the northeast and Category II from the southwest.

Figure 18.1  The Hong Kong International Airport at Chek Lap Kok
AIR TRAFFIC CONTROL EQUIPMENT

In order to support the operation of the new airport, some 20 items of air traffic control equipment have been purchased and installed (Figure 18.2). These include new navigation beacons installed in the vicinity of the airport (at Lung Kwu Chau and Siu Mo To) to support instrument flight procedures; new radars installed at Sha Chau and Tai Mo Shan to improve the coverage at the new airport and in the Pearl River Delta; ground surveillance radar at the airport to detect aircraft and vehicles on the airfield; and new communications equipment to enable two-way voice communication with aircraft.

Figure 18.2 Radars, Navaids and Comms Facilities for the Hong Kong International Airport

In the Air Traffic Control Complex and Control Tower at the middle of the airfield, computerized Radar Data Processing and Display System (RDPDS), Flight Data Processing System (FDPS), Aeronautical Information Data Base (AIDB) and Automatic Message Switching System (AMSS) are installed to provide air traffic control service to aircraft operating within Hong Kong airspace and communication services to airlines operators, overseas airports and neighbouring air traffic control centres (Figure 18.3). The new RDPDS is also equipped with some of the new Air Traffic Management (ATM) functions such as conflict alert and minimum safe altitude warning (MSAW). With these new features, flight safety is greatly enhanced.
TRANSITION TO SATELLITE-BASED SYSTEMS

The existing ATC systems rely mainly on ground-based radar, navigation aids and communications equipment which have a number of limitations, for example, limited coverage (mainly due to line-of-sight coverage of VHF, UHF, etc), their susceptibility to the effects of adverse weather, the lack of digital data transfer capability between aircraft in the air and air traffic control units on the ground.

In the early 1980s, it became evident to International Civil Aviation Organization (ICAO) that the present ground-based ATC system would not be adequate to meet the demand and operation in the 21st Century. As a consequence, a Special Committee on Future Air Navigation Systems (FANS) was established in 1983 to study, identify and assess new technologies as well as to make recommendations for the future development of air navigation systems for civil aviation.

The systems developed by the FANS Committee are known as the satellite-based Communications, Navigation and Surveillance/Air Traffic Management (CNS/ATM) systems. The functions of the various systems are described below.

Communications

This initiative mainly involves the introduction of data relay and voice communications using satellite platforms. Currently, these forms of communications are readily available in the commercial sector. In some
newer type of aircraft, Satellite Communication (SATCOM) is already available to the passengers and Aircraft Communication Addressing and Reporting System (ACARS) available to the flight crew.

The regular use of data communications, as opposed to voice communications under the existing system, will offer new opportunities for improving the speed and accuracy in the dissemination and receipt of aeronautical information amongst different aeronautical authorities, aircraft in flight and airline operation centres, thus enhancing efficiency. The major components include Satellite Voice Network, Controller-Pilot Data Link Communication (CPDLC), High Frequency (HF) or Very High Frequency (VHF) Data Links, Aeronautical Telecommunication Network (ATN) and Air Traffic Services Inter-facility Data Communication (AIDC). The specific functions of these systems are shown in Table 18.1.

Table 18.1 Communications Equipment

<table>
<thead>
<tr>
<th>Major Components</th>
<th>Specific Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satellite Voice</td>
<td>♦ Replace noisy High Frequency (HF) communications</td>
</tr>
<tr>
<td>Controller-Pilot Data Link (CPDLC)</td>
<td>♦ Make use of uplink/downlink of satellite data for exchange of ATC instructions and pilot-controller communications</td>
</tr>
<tr>
<td>HF/VHF Data Link</td>
<td>♦ Exchange ATC data between pilots and controllers – replace voice communication</td>
</tr>
<tr>
<td>Aeronautical Telecommunication Network (ATN)</td>
<td>♦ Cover inter-networking infrastructure for global aviation telecom network</td>
</tr>
<tr>
<td></td>
<td>♦ Allow datacom service for different user groups</td>
</tr>
<tr>
<td></td>
<td>♦ Global aeronautical datacom service in aviation environment</td>
</tr>
<tr>
<td>Air Traffic Services (ATS) Interfacility Data</td>
<td>♦ Exchange ATC information between two ATC units (flight notification, coordination and transfer of control)</td>
</tr>
<tr>
<td>Communications (AIDC)</td>
<td></td>
</tr>
</tbody>
</table>

Navigation

This initiative involves the use of signals from a set of satellites as opposed to ground-based beacons and navigation aids under the existing system for navigation as well as making approaches and landing. Global
Positioning System (GPS) which is widely used for position fixing is a good example. New systems being developed are the Global Navigation Satellite System (GNSS), Wide Area Augmentation System (WAAS) and Local Area Augmentation System (LAAS) (Table 18.2). The new systems will provide a high-integrity, high-accuracy and all-weather navigation services. With suitable upgrade, they would be able to support precision landing by aircraft (Figures 18.4a and 18.4b).

<table>
<thead>
<tr>
<th>New Systems</th>
<th>Key Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Navigation Satellite System (GNSS)</td>
<td>◆ Replace long range ground-based navigational aids</td>
</tr>
<tr>
<td></td>
<td>◆ More accurate enroute and terminal navigation</td>
</tr>
<tr>
<td>Wide Area Augmentation System (WAAS)</td>
<td>◆ Broadcast signals for aircraft to correct &quot;erroneous&quot; GNSS satellite data to define its accurate position</td>
</tr>
<tr>
<td></td>
<td>◆ Can be upgraded to provide precision landing – replace ILS</td>
</tr>
<tr>
<td>Local Area Augmentation System (LAAS)</td>
<td>◆ Short range navigation and precision landing aid similar to WAAS</td>
</tr>
<tr>
<td></td>
<td>◆ Provide even more accurate data</td>
</tr>
</tbody>
</table>

**Surveillance**

This initiative involves multiple efforts to improve the surveillance of aircraft. The existing radar systems have a range limitation (furthest coverage about 264 nautical miles). The Automatic Dependent Surveillance (ADS) can be employed to automatically and continuously track the aircraft’s position, heading and speed outside radar range and display the information to the controller via satellite or VHF/HF links (Table 18.3). The real time information received will permit the controller to exercise positive control of air traffic, particularly in areas outside radar coverage. Within the busy airspace in the vicinity of the airport, Mode S radar (which provides the capability of individual addressing, thereby facilitating aircraft identification) will be introduced to supplement the traditional Secondary Surveillance Radar (SSR). Furthermore, Enhanced Ground Movement Control System (EGMCS) will be provided to allow more positive and accurate surveillance of moving targets such as aircraft, vehicles on the airfield.
Figure 18.4a  CNS/ATM Systems for En-route Operation

Figure 18.4b  CNS/ATM Systems for Approach/Landing Operation
Table 18.3  Surveillance Systems

<table>
<thead>
<tr>
<th>New Systems</th>
<th>Key Features</th>
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<tbody>
<tr>
<td>Automatic Dependant Surveillance (ADS)</td>
<td>♦ Provide aircraft position outside radar coverage</td>
</tr>
<tr>
<td>Mode “S” Secondary Surveillance Radar (SSR)</td>
<td>♦ Individual aircraft addressing</td>
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<td></td>
<td>♦ Transmission and reception of digital data between aircraft and ground stations</td>
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<tr>
<td>Enhanced Ground Movement Control System (EGMCS)</td>
<td>♦ Accurate surveillance of aircraft and vehicles on airfield</td>
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<td></td>
<td>♦ Provide runway intrusion alert</td>
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Air Traffic Management (ATM)

This new initiative consists of new methods of air traffic services provision, the use of air traffic flow management to regulate traffic flow and the provision of safety related features such as conflict prediction and alert, minimum safe altitude warning (MSAW), arrival metering, sequencing and spacing, and trajectory conformance monitoring, etc. The aim is to provide an integrated ATM system in a regional or global context which would permit aircraft operators to conduct flights in accordance with their preferred route, dynamic adjustment of flight profile in accordance with weather conditions encountered en route, thus permitting operation in the most optimum and cost-efficient manner. This is known as “free flight”.

BENEFITS OF THE CNS/ATM SYSTEMS

The CNS/ATM systems will tremendously improve the handling and transfer of updated information such as weather, aeronautical information, status of aircraft and ATC messages between aircraft and the ATC centres. They will also extend surveillance coverage beyond the normal limit and improve navigational accuracy. As a result of the new initiatives, reduction of separation between aircraft and increased capacity will be achieved. The advanced ATC Automation System will exchange data directly with aircraft through data link. This will enable improved conflict detection through intelligent processing, provision for the automatic generation and transmission of ATC clearances for conflict resolution as well as offering a new environment for operation of “free flights”.

In summary, the direct and indirect benefits of the CNS/ATM systems include enhancement of flight safety, increase in airspace capacity, savings
in flight time and fuel, as well as reduction in disruption to air services arising from adverse weather.

IMPLEMENTATION OF CNS/ATM SYSTEMS

On the international front, the first Global Implementation Plan for the satellite-based CNS/ATM systems was developed by ICAO in 1993 and subsequently updated (Figure 18.5). All Contracting States, including China, are required to comply with the Plan. At the same time, the Asia Pacific Economic Co-operation (APEC) has also established a Satellite Navigation and Communication (SN&C) Systems Advisory Committee to monitor and co-ordinate, in conjunction with the ICAO Regional Office and various APEC Economies, the implementation of such systems within the APEC region.

Many countries have commenced study, operational trial and evaluation of the CNS/ATM elements with a view to complying with the Global Implementation Plan and launching services of the new CNS/ATM systems for use by airlines at an early date. In this regard, the United States, Japan, Singapore and the Mainland have started the design and trial of at least five elements of the CNS/ATM systems.

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<th>Global Communications System Implementation</th>
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<td>AMSS</td>
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<td>HF Data</td>
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<td>VHF Data</td>
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<tr>
<td>SSR Mode S</td>
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<td>ATN</td>
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<td>AIDC</td>
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<tr>
<th>Global Navigation System Implementation</th>
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<tr>
<td>Enroute(GNSS)</td>
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<tr>
<td>Terminal/</td>
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<tr>
<td>Non Precision Approach (WAAS)</td>
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<td>Precision Approach (LAAS)</td>
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<th>Global Surveillance System Implementation</th>
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<tr>
<td>ADS</td>
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<tr>
<td>ADS-B</td>
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<tr>
<td>SSR (Mode S)</td>
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</table>

Figure 18.5 ICAO Global Implementation Plan for CNS/ATM Systems

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Many of the newer generation of aircraft are now FANS equipped. The exploration of new FANS routes to North America to shorten the flying time has also been one of the major development in the Asia Pacific region. Over the years, the North Pacific Flexi Routes have been heavily utilized. However, with the opening of the Russian Far East airspace, more new routes are now available. Examples are the FANS route to Chicago and the Polar route to New York (Figure 18.6).

![Air Routes Between Hong Kong and North America](image)

**Figure 18.6** Air Routes Between Hong Kong and North America

CAD commenced preliminary planning and investigation on some of the CNS/ATM systems since 1992. Initial trial on two elements of the systems, i.e. ADS and CPDLC, has started in June 1994. The results have been satisfactory (Figure 18.7). To maintain the competitive edge of Hong Kong in the civil aviation field, CAD has worked out a 3-phase CNS/ATM Implementation Plan (Figure 18.8).

![Automatic Dependent Surveillance (ADS) Display](image)

**Figure 18.7** Automatic Dependent Surveillance (ADS) Display
### Figure 18.8  Overall CNS/ATM Systems Implementation Programme for Hong Kong

**CONCLUSION**

Hong Kong's New Airport has excellent facilities and plenty of potential for development, and highly capable of supporting traffic growth well into the 21st Century. In addition, we are also committed to implementing the CNS/ATM systems in order to provide a safer and more efficient air traffic control system to cope with the future demand. With the new facilities available, we are confident that we shall be able to maintain Hong Kong as a centre of regional and international civil aviation.
INTRODUCTION

Modern cars and the other vehicles and associated infrastructure that provide transportation/mobility represent technological triumphs – and will be steadily improving with new technology. However, problems such as traffic, parking availability, and long and tedious commutes increase with population and affluence. There are various regulatory tax and incentive strategies for alleviating these problems. The challenge for Hong Kong has been to combine available technology (not just cars) with policy into a mobility system satisfactory for both the individual and the community. There is no perfect solution, but Hong Kong has done an exemplary job so far, and can be expected to continue to adapt as new pressures become evident.

This paper provides an overview of the dominant challenges and strategies, and then discusses four areas that may deserve higher priority in any plan for the future than they have been receiving. These are 1) rapidly develop telecommuting that coaxes individuals to travel on the “electromagnetic highway” instead of adding to road traffic; 2) put human power at higher priority, with facilities/infrastructure that makes walking and biking more attractive; 3) “look up”, away from the congested surface, to technologies that provide above-ground mobility for people and goods: aerial structures, or local low-level flight; and 4) alter the K-12 education system to emphasize creativity, and thinking skills in general, so that youngsters become more interested in transportation challenges and strategies and have the chance to contribute ingenious ideas. These youngsters soon will be adults creating and supporting solutions for mobility in our future world.

Looking at the future, quick adoption of creative strategies, some more revolutionary then evolutionary, may be justified.
BACKGROUND

This paper provides an overview of mobility in general, with an emphasis on cars and on Hong Kong's specific circumstances. It draws on a background that includes "impractical" pioneering vehicles that must rely on the tiny power from human muscles, photovoltaic cells, and/or small batteries, but also includes joint operation with giant automotive corporations.

Figure 19.1 From Gossamer Condor to GM Impact Car at AeroVironment, Inc.

Figure 19.1 helps describe connections at AeroVironment Inc. between the human-powered Gossamer Condor in 1977 and the battery-powered GM Impact in 1990. The Gossamer Condor's only "practicality" was winning aviation's then-largest cash award, the Kremer Prize, for achieving sustained/controlled human-powered flight. However, as a catalyst it initiated the journey that in 1990 resulted in the GM Impact car. This vehicle revitalized the battery-powered car field, and had a role in the creation of California's Zero Emission Vehicle mandate that induced all car manufacturers globally to push efficiency and alternatively-powered vehicles. The Impact subsequently was tailored by GM into the production of EV-1, a large and dramatic commitment. Figure 19.2 shows the fragile 32 kilogram Gossamer Condor being pedaled around the Kremer course by Bryan Allen. Figure 19.3 shows the GM Impact car, that demonstrated snappy performance (0-60 miles per hour in 8 seconds), and showed that
low aerodynamic drag (drag coefficient of 0.19) is compatible with good looks.

Vehicle technologies are well covered in many books, journal articles, and the popular media. This paper does not try to duplicate or add to the large existing coverage of vehicles, but rather looks at systems application and policy aspects.

Figure 19.2  The Gossamer Condor

Figure 19.3  The GM Impact Car

SETTING THE STAGE

Few people realize just how fast the world is changing. No reasonable forecast can be made for technologies or activities a whole century from now. If we consider population growing at 1% per year (much lower than the actual present rate), our 6 billion global population will be around 16 billion by the end of the 21st Century. More striking is contemplating the
growth of information technology. Assume that it continues growing at the rate of Moore’s Law (more correctly called Moore’s and Robert’s Law) that found empirically a doubling of capability every one and a half years. The capability increase over the next century would be more than $10^{10}$ (100 billion billion). The per capita information technology capability will increase by about 7 billion. Some realities, such as fundamental physical properties, and the lack of resources on a non-expanding earth, will provide limits so these huge numbers will not be achieved, but the numbers illustrate the point that there has never been a period of such change in the history of civilization, and forecasting beyond a decade or two will have little validity. Quite aside from these fantastic growth rates, there will certainly be new unpredictable breakthroughs and pressures that cause comparably large effects.

Another sobering perspective on growth and change is shown in Figure 19.4. The total weight mass of vertebrates on land and in the air is presented. It divides into two parts: the human-related portion (humans plus their livestock and pets) is now 98%; the rest, all wild nature, is only 2%. Ten thousand years ago that 98% was less than 0.1%. We humans have in effect out-competed nature almost completely. We are in full charge of the future of vertebrate life on earth outside the oceans, and we are well on our way to depleting ocean life dramatically.

All of the above suggest contemplating the next several decades, not the whole next century. Corporate decisions generally fit a short term framework, say 1 to 5 years, although overall strategy may utilize longer perspectives. Government, representing the whole of society rather than a single business, can justify a longer horizon. It can pay more attention to basic research and long term policies, and so a 3- to 20-year time framework is more suitable. This presentation looks at the 3- to 20-year picture, of significance both to industry and government.

It is worth remembering that each person is both an individual purchaser/consumer and also a voter and member of society. As the former he or she buys what is most suitable for the individual; as the latter he or she may vote for actions that promote more societal goals. These two aspects of a person are very often incompatible. In the United States people wish everyone else would drive efficient, small, non-polluting cars, but at the car dealer end up with a giant sport utility vehicle, perhaps even one for every member of the family. This is just one example that policy and desires of people can be much more important than technology. Customers are the designers of cars in the United States, more so than are engineers.
CARS AND MOBILITY SYSTEMS

In the United States mobility is assumed to be cars. If a problem with cars arises, such as the consumption of fossil fuel hurting our balance of payments and also making us vulnerable to the volatile politics of some oil-producing countries, or if the vehicles produce local, regional, or global pollutants, the strategy that immediately arises is to make the cars better for fuel efficiency and decreased pollutant emissions. These solutions will not help problems of traffic, parking, and time wasted commuting and, in fact, cars that cost less to operate will exacerbate the problems by coaxing people to put more cars on the road. As the problems of overcrowding arise, technology is invoked to build more parking places, pave more roads, and, with information technology, permit more vehicles to be handled per hour per lane. All such "cures" are limited, and they deal with symptoms rather than root causes. The systems engineer who observes the problems finds it necessary to consider total mobility systems, intermodal transport – everything from walking to mass transit and personal cars, etc., and even including elevators and escalators in high buildings and moving walkways in airports. As these systems get explored it becomes obvious that policy becomes very important, as do people's habits and expectations and resources. In fact policies and strategies are more critical now than the technology of vehicles. The vehicle technologies are
receiving a great deal of attention around the world, especially since the 1990 California mandate on Zero Emission Vehicles was initiated to serve as a catalyst for battery-powered and hybrid cars that put strong emphasis on low emissions.

For a quick review of mobility we can start with walking and proceed through bicycles, electrically-assisted bicycles, motor scooters and motorcycles with 2-cycle gasoline engines, larger 3- and 4-wheel vehicles with a large percentage of 4-cycle gasoline engines, buses and trucks (primarily with diesel engines but some using gasoline), and trolleys -- some trolleys and buses drawing electricity from overhead lines or rails -- and trains using similar power sources or steam or diesel. For a complete picture, large ships and airliners need to be considered -- both rely mostly on liquid fuels.

In the car realm there are many variations to consider for providing power. Gasoline is the most common, diesel is widespread, and there is more attention now to alternatives such as liquified natural gas, compressed natural gas, ethanol, and methanol. Batteries are used, rechargeable ones, finding their best application in niches where total energy requirement is not large, meaning primarily small and local vehicles. Inexpensive lead acid batteries are getting better and better all the time, and new battery types with better cycle life and energy storage capacity are emerging. Even the best are no match for the energy per kilogram derivable from burning fuels. Flywheels and turbines and supercapacitors are being investigated. Fuel cells are getting a great deal of attention while specialties such as Stirling cycle engines and thermo-photovoltaic systems and many other specialty techniques are being looked at.

There is a great deal of publicity about every alternative power system for vehicles. It is hard to decide which techniques are going to be the winning ones. It is glad resources have been found to work on so many. It does seem as though something involving electricity with energy storage on board that permits regenerative braking will be a part of our long-term future so that instead of heating brake linings we recover the energy of deceleration. Hybrids are complex but will steadily get simpler and cheaper and may be the ultimate winner. It is worth noting that humans are hybrids; we use one kind of energy source for anaerobic high power, and another kind of energy source for aerobic continuous lower power, as do most animals. Nature may be a good guide in this subject.

Gasoline and diesel power systems are well developed, relatively inexpensive, and steadily improving in efficiency and pollution control.
They provide tough economic competition for any new technology that offers advantages in pollution emissions (including the global climate changing CO₂). Batteries provide clean power but limited range. For small areas, such as Hong Kong or Hawaii, the range limitation becomes less of a problem, especially as the development and distribution of fast charge devices continues and grows. Battery-powered buses are increasing in popularity, especially because their acquisition is often by government-related institutions that have societal perspectives.

There is much literature about transportation vehicles and a good bit emerging about total systems. Some suggested documents listed below give a bit of attention to vehicles themselves, but much more attention to the more important systems aspects:

1) *New Mobility White Paper on Using Technology and Partnerships to Create More Sustainable Transportation*, UCD-ITS-RR-99-1, March 1999, by SALON, SPERLING, SHAHEEN and STURGES, Institute of Transportation Studies, University of California, Davis; 530-752-4909, e-mail: itspublications@ucdavis.edu.


**TELECOMMUTING**

The prior discussion about Moore’s and Robert’s Law provides the background that assures teleconferencing and telecommuting will sometime be huge. The growth has been slower than forecasters expected during the last decade, but big changes will be part of the near future as high definition video becomes widespread, and various human interfaces and robotic technologies advance. Wide bandwidth transmission is proliferating. The “last mile” is traversed by twisted conductors, cable,
fiber optics, or by wireless technologies from local towers, aircraft, or satellites. Video conferencing technology will be moving ahead to where virtual presence can scarcely be distinguished from actual presence (and even physical handshakes can be conducted in spite of 10,000 km separations). Many jobs can be done at home – in fact an increasing percentage of jobs – but many cannot and so commuting, and traffic jams, will still be prevalent. The telecommuter can also tele-travel to recreation spots, but tele-vacations do not seem attractive to everybody. Nevertheless, telecommuting will have a major impact as a substitute for mobility. A desirable substitute.

DO NOT FORGET HUMAN POWER

Human’s initial mobility was manifested as walking. Walking is rather effective for what was and still is a primary form of transportation, namely low speed without a large load. Human leg muscles are not so good when carrying a heavy load and/or going fast (jogging, running) because those evolutionary pressures that led to modern humans, while providing us with great versatility in our movements, only produced good efficiency for the most common mode, walking. On a hard, flat surface, carrying a heavy load, does not in itself consume power. The average kinetic plus potential energy of the load stays constant, but the human gets tired. On a bicycle at high speed the main power consumption comes from overcoming air drag. Running at half the bicycle’s speed is just as hard for the human that needs cope with only one eighth the system power, meaning the power to cope with the air drag (at one half the speed the drag is one quarter and the power, drag times speed, is one eighth). The bike with low rolling resistance can also carry a heavy load with but little extra power.

Obviously a bike can be a big help in local mobility but it has some cost, does not protect you from the elements, is usually awkward for carrying large loads, and is inconvenient for storing or being secure from theft or vandalism. Also, in some cultures, it is equated with low social status; in some others, its use does not label you “poor” but instead identifies you as someone interested in exercise and good health, having “green” attitudes, and being intelligent and economically well-to-do. In the Netherlands (conveniently flat) the bike is widely used.

In 1975 the International Human Powered Vehicle Association (IHPVA) was launched and established competitions to stimulate inventors and cyclists to “go as fast as you can, without the inhibiting effects of rules or customs” (P.O. Box 1307, San Luis Obispo, CA 93406). The
short distance speed record is now about 110km/hr, established on a bike with elegant streamlining to cut aerodynamic drag. IHPVA also unleashed design creativity for more practical vehicles for commuting and recreation: tricycles; long or short wheelbase recumbents; and some semi-recumbent versions. The recumbents, with comfortable wide seats, have recently become rather popular because an article was published in a major bicycling magazine connecting male impotence to the rigors of riding on a narrow bicycle seat.

Electric assist for bikes comes in many forms. Common batteries may not provide much power or energy per kilogram, but when little power or energy is required (as when supplementing primary human power) they make a lot of sense. Electric assist is popular in Japan, and getting more widely used in Europe. It has only a small number of users in the United States where the basic problem is that a bike fits only uncomfortably into a transportation system dominated by cars.

Bicycles or tricycles, with and without electric assist, will become more popular when special streets or lanes are provided so they do not have to compete with large, fast, cars. The economy of bicycles, and health benefits, are significant. A total mobility system that benefits citizens as much as possible will put priority on paths for walking and bike riding. The electric assist levels hills and copes with head winds.

LOOKING UP
Creatures that fly are more complex, and require more sophisticated structure and energy systems than do their non-flying relatives. Birds and bats are evolutionary success stories, as are flying insects (most insects fly at some stage in their lives). The benefits of flight, foraging over long distances, while escaping from the ground surface that inhibits movement and is fraught with danger from predators, obviously are greater than the penalties for being complex creatures. Humans are ground dwellers and mostly 2-dimension thinkers. As we find danger and inconvenience on the ground, we keep trying to make incremental improvement in systems to do the ground job better. We may benefit by raising our sights upward.

Goods can be transported by large or small GPS-equipped autonomous vehicles that are simpler than helicopters but can hover. They can also be transported in a city along cables strung between buildings. Elevated walkways already exist so people can move from building to building high above the ground. There are many plans for Personal Rapid Transit vehicles as well as monorails that move on elevated tracks. These
all represent methods of moving things laterally over jammed cities. Cities with tall buildings and associated elevator systems have introduced us to "up". With creative research we may be able to provide mobility up there.

THE EDUCATION/CREATIVITY ROAD

It may seem inappropriate to bring the topic of education of youngsters into a discussion about urban mobility. However, all the earlier discussion here built a case that any effective future mobility system will be complex, continually changing, and never as successful as everyone would wish. The students of today will be users of the mobility system of tomorrow. Also, they will have much responsibility for solving the challenge of improving the system to fit increased societal demands and to utilize new technologies and systems.

The needed broad thinking skills, including creativity, are not well treated in typical schooling. People are inherently creative, just as they have inherent capability for effortlessly picking up language that surrounds them in their early years. In school, language use grows and language skills increase, but creativity can atrophy in an atmosphere where your grade, your incentive, is to find one correct answer, never take risks or make mistakes, and work by yourself. This is presumed to prepare you for the real world that rewards you (in effect gives you marks) for accomplishing things, getting the job done, usually working in teams, seeing several sides to issues, and being willing to explore alternatives instead of assuming only one possible answer.

Schools that give you some necessary skills in reading, writing, and arithmetic usually also give you negative reinforcement of your wonderful inherent capability for curiosity, delight, creativity, and accomplishing things on your own and with friends. Singapore has clearly recognized this challenge, and while heading every global list of academic excellence, has decided that it must do equally well in thinking skills. These include creativity, problem solving, and critical thinking, but also feature seeing the big picture, the essence of subjects, dealing with consequences, and understanding how your (and everyone’s) mind works as a self-organizing system, and that an inherent feature we all share is mental blinders — the worst mental blinder being that we think we do not have mental blinders.

It is incredible to me that typical schools throughout the globe omit discussion of how your mind works although the nurturing of this mind is presumed to be the aim of schooling. This is like trying to teach geology without mentioning plate tectonics, or biology without mentioning DNA.
or evolution. There are various good courses for thinking and creativity. I am a supporter of Edward de Bono’s techniques for unleashing thinking skills because the methods are so simple, easy to apply, and need no memorization. His numerous publications are available through any bookstore. I am also an enthusiast for the IMMEX problem solving program of Dr. Ron Stevens. (Department of Microbiology & Immunology, 43-319 CHS, UCLA School of Medicine, Los Angeles, CA 90024; 310-825-3456.) He incorporates a computer that, while facilitating your search for solutions to a real world type problem, monitors your decision process and recognizes its pattern – an analysis then to be used for discussion between you and a teacher.

The emphasis here on thinking skills is because the youths now in school will have to cope with, and improve, a complex changing world. Mobility is an aspect of this world. It takes thinking skills to deal realistically and creatively with limits, with deciding on goals now that we humans can do almost anything we want, with being embroiled in the competitions between human minds and computers and robots, and with deciding whether to move back toward our biological roots that included the muscle-powered mobility of walking, or venture completely into a non-natural virtual world, or seek a compromise between these two extremes.

**FINAL COMMENTS**

In exploring options for future transportation/mobility systems it has been necessary to discuss tough challenges and some shortcomings of present and proposed systems. This should not give a negative cast to the situation. Personal mobility is a wonderful aspect of modern civilization. We cherish it. We accept (while wanting to minimize) traffic jams, parking problems, and the danger of accidents because the benefits of mobility are so large. Most people around the globe will find their mobility improving over the next several decades, but the problems of mobility in larger and larger cities will continue to be with us. We need to attack the problems by all means possible. I am partial to “leap” solutions rather than slow incremental growth. It is fun to be involved in “leaps” because they can have great overall societal value and also offer business opportunities.

Leaps, or revolutionary solutions, are usually of high risk but high value. How to introduce them into well-established infrastructure is a different problem. The best technique is to try small pilot projects that will illuminate key factors but not waste money.

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Hong Kong, a miraculous success story in many ways, has treated mobility effectively, and this monograph is evidence of serious intent to make the future even better.
INTRODUCTION

Many transportation applications can be supported by centralized location and navigation systems, which utilize communications networks, host facilities, and other infrastructures together with the on board vehicle equipment to locate and navigate (Zhao, 1997a). These applications include automotive telematics and modern public transit systems. An automotive telematics system typically communicates over a telecommunications network while a modern public transit system is an application of the automatic vehicle location (AVL) system.

One important application that can be supported by centralized systems is a wireless enhanced 911 (E911) system. The 911 telephone number is used in the United States to provide emergency assistance for the caller, initially for the line-based (wireline) telephone system only. Other countries have similar systems, but may use different numbers such as 110 for China and 999 for Hong Kong. The key advantage of an enhanced 911 over the basic 911 is that the public safety officer knows the caller’s location and phone number. "Wireless E911" is a system evolved from the original wireline-based system to the wireless system. Ideally, it would provide the same functionality as the wireline-based implementation.

The U.S. Federal Communications Commission (FCC) has recently made E911 a mandatory requirement for wireless communications services such as cellular telephone, wideband (broadband) personal communications services (PCS), and geographic area specialized mobile radio (SMR). This ruling and upcoming service is called wireless E911. The FCC requires that by 1 October 2001, public safety answering point (PSAP) attendants of wireless communications networks must be able to know a 911 caller’s phone number for return calls and the location of the
caller, so that calls can be routed to an appropriate PSAP and related emergency assistance attendants (FCC, 1996). The system and attendants must be able to locate the caller within a radius of 125 meters in 67% of all cases (Phase II) or within 125 meters RMS (root mean square). This rule could facilitate the development of many vehicle location and navigation applications that use communications infrastructures similar to those used for wireless E911. Besides emergency assistance, it will certainly trigger many location-based services with the mobile phone or wireless network. Therefore, it is not difficult to understand why telecommunications manufacturers and operators have been actively pursuing the technologies to locate the mobile phone.

**LOCATION TECHNOLOGIES**

There are three most commonly used location technologies: stand-alone, satellite-based, and terrestrial radio-based (Zhao, 1999). As examples, a typical stand-alone technology is dead reckoning. A typical satellite-based technology is global positioning system (GPS). A typical terrestrial radio-based technology is the “C” configuration of the Long Range Navigation (LORAN-C) system. For wireless E911, the radio-based (satellite and terrestrial) technologies are the most popular ones. In this paper, we will address these technologies only. The principles behind them are discussed below.

Radio-based technology typically uses base stations, satellites or devices emitting radio signals to the mobile receiver to determine the position of its user. Signals can also be emitted from the mobile device to the base. Commonly studied techniques are angle of arrival (AOA) positioning, time of arrival (TOA) positioning, and time difference of arrival (TDOA) positioning. All these methods require radio transmitters, receivers, or transceivers. In other words, they depend on emitting and receiving radio signals to determine the location of an object on which a radio receiver, or a transceiver is attached. To make the position determination, these methods generally have the assumption that one end of the positioning system is fixed and the other end is moveable such as a mobile phone. However, the location determination capability can be either at the fixed end or at the mobile end. Generally, it is up to the system designer to decide where the final location determination capability should reside. For performance improvement, hybrid methods (various combinations of the techniques discussed or with additional techniques) are possible.
The angle of arrival (AOA) system determines the mobile phone position based on triangulation (Figure 20.1). It is also called direction of arrival in some literature. The intersection of two directional lines of bearing defines a unique position, each formed by a radial from a base station to the mobile phone in a two-dimensional space. This technique requires a minimum of two stations (or one pair) to determine a position. If available, more than one pair can be used in practice. Because directional antennas or antenna arrays are required, it is difficult to realize AOA at the mobile phone.

![Figure 20.1 Location Determination by Angle of Arrival (AOA)](image)

The time of arrival (TOA) system determines the mobile phone position based on the intersection of the distance (or range) circles (Figure 20.2). Since the propagation time of the radio wave is directly proportional to its traversed range, multiplying the speed of light to the time obtains the range from the mobile phone to the communicating base station. Two range measurements provide an ambiguous fix and three measurements determine a unique position. The same principle is used by GPS, where the circle becomes the sphere in space and the fourth measurement is required to solve the receiver-clock bias for a three-dimensional solution. The bias is caused by the unsynchronized clocks between the receiver and the satellite. Similarly, for terrestrial-based systems, it also requires precisely synchronized clocks for all transmitters and receivers. Otherwise, a one microsecond timing error could lead to a 300-meter position error.

The time difference of arrival (TDOA) system determines the mobile phone position based on trilateration (Figure 20.3). This system uses time difference measurements rather than absolute time measurements as TOA does. It is often referred to as the hyperbolic system because the time difference is converted to a constant distance difference to two base stations (as foci) to define a hyperbolic curve. The intersection of two hyperbolas
determines the position. Therefore, it utilizes two pairs of base stations (at least three for the 2-dimensional case as shown in Figure 20.3) for positioning. The accuracy of the system is a function of the relative base station geometric locations. Furthermore, all the radio-based technologies discussed can be affected by interference, blockage, and multipath. It is a great challenge to solve these adverse effects caused by the environment we live in.

Figure 20.2 Location Determination by Time of Arrival (TOA)

Figure 20.3 Location Determination by Time Difference of Arrival (TDOA)
Mobile Phone Location Determination

As mentioned above, both satellite-based and terrestrial-based radio technologies can be used for location determination. Cellular networks are terrestrial-based communications systems. It is natural to utilize the signals of the network to determine the mobile phone location. Research in this area has been very active recently as evidenced by the new round of the papers published (Caffery and Stuber, 1998; Klukas, Lachapelle, and Fattouche, 1998; Rappaport, Reed, and Woerner, 1996; Stilp, 1995). One simple method for mobile phone location is to use the cell area (or cell ID) of the caller as the approximate location of the mobile phone. This results in the position error as large as the cell area. For instance, a pico-cell could be 150 meters in radius while a large cell could be more than 30,000 meters in radius. Therefore, this method has not demonstrated that it can achieve 125 meters RMS reliably even under the best of conditions.

Because AOA requires the installation of directional antennas or antenna arrays, many companies have chosen either TOA or TDOA as their implementation choices. Both TOA and TDOA are time-based measurement technologies. They can be implemented either based on the forward (down) link signal or reserved (up) link signal. In addition, the location determination capability can reside either at the network side or at the mobile phone. In order to locate several base stations or cell sites, the sensitivity of the mobile phone may need to be increased. For better location accuracy, certain phones may require higher chip or bit resolution such as 1/8 or 1/16. These methods also require software modification on the mobile phone and additional location determination units and related software in the network. As discussed above, the mobile phone needs to listen to the signals of at least three base stations or cell sites. The visibility and geographical locations of these base stations will affect the availability and the accuracy of the location determination.

Since the performance of the satellite-based GPS receiver is getting better and better while the receiver size and price keep going down, many companies have engaged in developing an assisted GPS solution for the mobile phone, which requires mobile phone hardware modification. GPS provides an affordable means to determine position, velocity, and time around the globe. It is developed and maintained by the U.S. Department of Defense. Civilian access is guaranteed through an agreement with the Department of Transportation. The position determination principle of the system is based on TOA.

In addition to the task of shrinking the GPS antenna to fit with a
typical mobile phone, an ordinary standalone GPS receiver chip set is difficult to embed in the mobile phone for three main reasons. First, its start-up time (from turning on to the initial position fix) is relatively long due to its long acquisition time of the navigation message modulated on the satellite signals. Second, its processing ability for the weak and multiple reflected satellite signals, especially indoors, is poor due to its expectation of line-of-sight signal reception. Third, its power consumption is relatively high for the mobile phone due to its continuous position fix operations. To deal with these problems, a network assisted GPS solution is proposed. The basic idea is to establish a GPS reference network whose receivers have clear views of the sky and can operate continuously. Once the mobile phone is turned on, the assisted data derived from the GPS reference network are transmitted to the mobile phone GPS sensor right away to aid the fast start-up and to increase the sensor sensitivity. While the embedded sensor only takes a snap shot of the available satellite signals to make sure it synchronizes with the assisted data, the position fix elements derived from the mobile phone sensor are then returned to the network for final calculation to save the mobile phone power and CPU cycles. An alternative is to do the final calculation at the mobile phone. Additional assisted data, such as differential GPS corrections and others, can be transmitted to improve the location accuracy and long-term acquisition. Other satellite systems can also been used, such as Russian GLONASS. Besides adding a GPS reference network and additional location determination units in the network, the mobile phone must embed a GPS sensor and its antenna. Recent field trials of the assisted GPS system have shown the feasibility of this technology. However, the current implementation has not demonstrated that it can cover every location where voice communication is available. In addition, this solution will not work for legacy phones.

LOCATION-BASED SERVICES

It is well believed that location-capable cellular phone and network will be available by 1 October 2001. Although U.S. FCC's original intention was to fulfill the role of the mobile phone as a part of the emergency call and assistance system, its ruling will clearly have positive impacts on many existing services and will certainly generate more new services which were not available to the general public before.

One market study report has categorized the mobile location services into safety, information, tracking, remote, and billing services, respectively (Blonz and McCarthy, 1998). Safety services, especially personal security, are very critical to many countries as evidenced by the US-led mandatory
wireless E911 ruling. Similar services will also be available to the other counties early in the next century. Information services include weather, traffic, navigation, and directory assistance. They can dramatically improve the quality of peoples' lives. Tracking services can monitor continuously the location of the vehicle, asset, and people. Through these services, companies could increase their productivity while minimizing the cost for tracking down their goods and properties. People would have less concern over whereabouts of their loved ones. Remote services can provide further convenience as unlocking the car, monitoring the engine, collecting tolls, and guiding precision surveying and farming equipment, etc. Finally, billing services will be able to differentiate a variety of customer services. For instance, home-zone billing could encourage low-mobility subscribers to migrate traffic from conventional wireline-based networks to wireless networks. All these services will generate revenues for many old and new businesses. By the year 2005, as estimated by Ovum, there will be a $20 billion market for network-based location services and a $2.5 billion market for vehicle-based location services worldwide. Similar forecasts have been available from other companies for the worldwide or individual regions, and specific segments of the market.

**IMPACT ON TELEMATICS AND PUBLIC TRANSIT SYSTEMS**

Location-capable phones and networks will have significant impact on intelligent transportation systems (ITS). In this section, we discuss two specific applications of ITS: automotive telematics and modern public transit systems.

A typical example of an automotive telematics system is the mayday system (Zhao, 1997a). It provides vehicle occupants instant connection with a service center for emergency assistance or roadside services while automatically reporting the vehicle position. Many people in the United States view this system as their top priority when adding new equipment to their vehicles. It can be expanded to include many other services such as remote door unlocking, remote engine diagnosis, theft detection, notification and stolen-vehicle tracking, airbag deployment notification, automatic route guidance, travel information, and hands-free and voice-activated mobile phone or pager. Because of its popularity, many automobile manufacturers have been and are bundling it as an OEM unit for new model cars.

A mayday system uses a cellular phone for voice and data
communications and a global positioning system (GPS) receiver for positioning (Zhao, 1997b). The key features of the mayday system are its human-centered design with a cost-effective location capability and its on-demand wireless communications. With a human-centered design, the system can be activated either by the user with a pushing button or by an emergency event detected by one of the vehicular safety sensors. After the communications channel is established, the user can keep in voice contact with a human operator at the service center. With on-demand communications, the system does not need to communicate with the remote host on a regular basis as most automatic vehicle location (AVL) systems do, so there is a drastic reduction in silence air-time and its associated expenses.

With the current mayday system, the location device and communication device are separate items integrated into one system. Generally, the cellular phone and its transceiver are attached to the vehicle as non-removable devices. So is the location device. Once the location-capable cellular phone is available, there may be no need for the fixed location and communication devices in the car. All we need could be a portable phone which integrates location and communication functions into one device. This will keep the same telematics functionality while reducing the number of phones for many users and could leave room for other in-vehicle devices.

A typical modern public transit system has the automatic vehicle location (AVL) capability (Zhao, 1997a). An AVL system tracks the locations of a fleet of vehicles in a particular area and reports the information to a centralized server via a communications network (Zhao, 1994). This server can take different forms, such as a dispatch center, a traffic information center, or a transportation management center. For such a system, the location sensors keep updating the dispatch center on the route the vehicle is traversing. The communications network for information transmission can be dedicated radios, satellites channels, or short-range beacons installed along the road. Additional functions could be added such as route-by-route transit schedule, en-route information (on-board and at the bus station), transfer management, fare collection registration, passenger counting, vehicle diagnosis, emergency alert, paratransit management, and on-board video surveillance (Nowland-Margolis and Hiller, 1998; Pantall, Steward, Tsakiri, and Walker, 1999). Due to the availability of centralized communications and its management center, a commonly used location technology is differential GPS (DGPS). Some public transit systems are further assisted by dead-reckoning sensors.
to complement GPS weakness often encountered in urban canyon, where tall buildings and other human-made landmarks cause satellite signal blockage and reflection.

With the advent of the location-capable phone, the complexity of the on-board equipment for the modern public transit system will be further reduced. If the cellular phone location determination could be as accurate as fifteen meters or less, there would be no need for any on-board dead-reckoning sensors. If the cellular service could be less costly, there would be no need for any specialized communications network. Furthermore, we could imagine how such a phone could assist the passenger. For instance, before even reaching the bus stop, the phone would be able to display when the next bus would be available based on the approximate time of arrival or distance to the bus stop. If the passenger wishes, it could also remind them individually when a pre-determined destination has arrived or inform them of attractions and services along the bus route. Many more possibilities exist to serve the passenger better than before.

CONCLUSIONS

Mobile phone location determination activities have been intensified recently due to the 1 October 2001 deadline. Telecommunications standard organizations are busy incorporating the new location technologies into their standards, whether it is GSM, UMTS, CDMA, CDMA2000, or TDMA. Three main standard organizations involved are European Telecommunications Standards Institute (ETSI), Telecommunications Industry Association (TIA), and T1 Committee. T1 is sponsored by Alliance for Telecommunications Industry Solutions (ATIS), which is accredited by American National Standards Institute (ANSI). Among the technologies discussed above, TOA, TDOA, and assisted-GPS solutions are the leading contenders. Once these technologies are standardized, the location-capable phone will hit the market soon. The location-based services will certainly follow. Besides wireless E911, these services may include location-sensitive billing, location tracking, location-based advertisement, and information services such as navigation, weather, and points of interest. Similarly, automotive telematics and public transit systems will benefit. As we learned, these systems will be less and less complex while providing more convenient and attractive services. We certainly hope that this will in turn make our transportation systems operate more safely and efficiently, with less congestion, pollution and environmental impact.
REFERENCES


Postscript

It is the intention of this book to cover as much ground as possible in the field of transport, particularly those issues that we consider crucial to the development of an efficient and sustainable transport system in Hong Kong in the 21st Century. However, as the contents of this volume indicate, it is simply impossible to include every aspect of such a diversified discipline as transport, not to mention the whole range of modes on offer in Hong Kong and the variety of transport issues that are uncovered in this vibrant metropolitan city. As a result, we have to be selective, but the topics that are not covered in this monograph such as freight transport, the paratransit modes, and the tunnels, for instance, all play an indispensable role in the well-being of our transport system, and all warrant further studies on their own.

During the preparation of this monograph, a number of events have taken place that have implications for Hong Kong’s future transport system. The government announced the decision to build a Disney theme park and resort at Penny’s Bay on Lantau Island. The park will open in 2005. Hong Kong Disneyland is expected to attract over 5 million visitors in its first year of operation, rising to 10 million in about 15 years’ time. New roads will be built to connect North Lantau and Penny’s Bay, and there will also be a rail extension to serve the theme park. A lot more traffic will be generated between Lantau and the urban centre, and the way the government assigns traffic between road and rail will serve as a testimony to its credibility in upholding our sustainable transport goals.

China’s imminent accession to World Trade Organization (WTO) is another factor in mind. As an international gateway to China, and a middleman between China and the rest of the world, Hong Kong has played a unique role in the past serving the mainland. It is generally acknowledged that WTO accession will lead to enormous growth in international trade and investment in China. The development of direct trade connections between China and other WTO members may be considered as a disbenefit to Hong Kong’s service industry, but the overall expansion of trade should provide Hong Kong with many business
opportunities. The demand for port and ancillary services in Hong Kong is likely to grow.

There are three other encouraging developments in transport that merit attention.

Recently, the government has expressed a commitment to promote pedestrianization in Hong Kong. So far, Russell Street in Causeway Bay has become the first full-time pedestrianization scheme in Hong Kong. Other heavily trafficked areas in Causeway Bay are also pedestrianized on a part-time basis. Similar schemes have been implemented in Mongkok and Tsim Sha Tsui, and it is promised there will be more to come. The most encouraging sign so far is that other than the pedestrians, the retailers in the pedestrianized areas also support the schemes.

The Transport Department has set up a Local Advisory Panel in September 2000 to conduct an Intelligent Transport Systems (ITS) Strategy Review. The Panel is consisted of local experts and academics in ITS. The objective is to assess how ITS can fit into Hong Kong’s transport strategy and the priorities of ITS applications in sustaining and further strengthening Hong Kong’s position as a world-class city. This is an important step forward in making Hong Kong's transport system to be safer, more efficient, comfortable, and user-friendly through the use of ITS.

Within a month, the Director of Environmental Protection decided against two Environmental Impact Assessment (EIA) reports for two different transport projects – one being the Lok Ma Chau Spur Line that cuts through Long Valley, and the other being the Lantau North-South Road Link between Tai Ho Wan and Mui Wo – on the ground that construction is likely to cause adverse environmental impacts on areas that are of high ecological value. The Environmental Protection Department has made it clear that they have no objection to projects that improve transport connections, but clearly they believe there are better alternatives. The rulings provoked strong protests from some stakeholders. For the environmentalists, this is a first victory. For transport planners and policy makers, there are some important lessons here.

The development of a truly sustainable transport system in Hong Kong is still some way off. To achieve such an objective requires some fundamental changes in transport priorities and in the way that policy making in Hong Kong is conducted. Despite greater emphasis on rail system development and the provision of improved facilities for pedestrians, Hong Kong still has to address the seemingly inevitable
increase in road traffic. As the recently completed CTS-3 has shown, catering to the transport needs of Hong Kong will pose some daunting challenges in the years ahead. If we are to move to a more sustainable development path, then we will eventually have to come to terms with the need to contain the growth in vehicle numbers as well as the use of road vehicles.

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