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## International Transit Studies Program

### Report on the Spring 2001 Mission

## Design-Build Transit Infrastructure Projects in Asia and Australia

*This TCRP digest summarizes the mission performed June 15–30, 2001, under TCRP Project J-3, "International Transit Studies Program." The report includes transportation information on the cities and facilities visited, lessons learned, and discussions of policies and practices that could be applied in the United States. This digest was prepared by Kathryn Harrington-Hughes of the Eno Transportation Foundation and is based on reports filed by the mission participants.*

### INTERNATIONAL TRANSIT STUDIES PROGRAM

#### About the Program

The International Transit Studies Program (ITSP) is part of the Transit Cooperative Research Program (TCRP). ITSP is managed by the Eno Transportation Foundation under contract to the National Academies. TCRP was authorized by the Intermodal Surface Transportation Efficiency Act of 1991 and reauthorized in 1998 by the Transportation Equity Act for the 21st Century. It is governed by a memorandum of agreement signed by the National Academies, acting through its Transportation Research Board (TRB); by the Transit Development Corporation, which is the education and research arm of the American Public Transportation Association (APTA); and by the Federal Transit Administration (FTA). TCRP is managed by TRB and funded annually by a grant from FTA.

ISTP is designed to assist in the professional development of transit managers, public officials, planners, and others charged with public transportation responsibilities in the United States. The program accomplishes this objective by providing opportunities for participants to learn from foreign experience while expanding their network of domestic and international contacts for addressing public transport problems and issues.

The program arranges for teams of public transportation professionals to visit exemplary transit operations in other countries. Each study mission focuses on a theme that encompasses issues of concern in public transportation. Cities and transit systems to be visited are selected on the basis of their ability to demonstrate new ideas or unique approaches to handling public transportation challenges reflected in the study mission's theme. Each study team begins with a briefing before departing on an intensive, professionally stimulating 2-week mission, after which they return home with ideas for possible application in their own communities. Team members are encouraged to share their international experience and findings with peers in the public transportation community throughout the United States. Study mission experience also helps to better evaluate current and proposed transit improvements and can serve to identify potential public transportation research topics.

Study missions normally are conducted in the spring and fall of each year. Study teams consist of up to 15 individuals, including a senior manager designated as the group's spokesperson. Transit properties are contacted directly and requested to nominate candidates for participation. Nominees are screened by a committee of transit managers, and the TCRP Project J-3 Oversight Panel endorses the selection.

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Study mission participants are transit management personnel with substantial knowledge and experience in transit activities. Participants must demonstrate potential for advancement to higher levels of public transportation responsibilities. Other selection criteria include current responsibilities, career objectives, and the probable professional development value of the mission for the participant and sponsoring employer. Travel expenses for participants are paid through TCRP Project J-3 funding.

For further information about the study missions, contact Gwen Chisholm-Smith at TCRP (202-334-3246; gsmith@nas.edu) or Kathryn Harrington-Hughes at the Eno Transportation Foundation (202-879-4718; khh@enotrans.com).

### About this Digest

The following digest is an overview of the mission on design-build transit infrastructure projects in Asia and Australia. It is based on individual reports provided by the team members (for a listing of team members, see Appendix A), and it reflects the views of the team members, who are responsible for the facts and accuracy of the data presented. The digest does not necessarily reflect the views of TCRP, TRB, the National Academies, APTA, FTA, or the Eno Transportation Foundation.

## DESIGN-BUILD TRANSIT INFRASTRUCTURE PROJECTS IN ASIA: MISSION 14, JUNE 15–30, 2001

The theme of this study mission was "Design-Build Transit Infrastructure Projects in Asia and Australia." Transit projects in the United States have traditionally been constructed using the design-bid-build (DBB) system, in which the transit agency hires an engineering firm to design a project and then puts the design specifications out for construction bids. U.S. transit agencies and owners are, however, increasingly turning to the design-build (DB) project delivery system as a means of cutting costs and accelerating project delivery.

DB contracting has been extensively used in Asia and Australia in all manner of construction. To discuss experiences with this innovative project delivery method, the study team members met with public agency and private company staff in Hong Kong, China; Bangkok, Thailand; and Sydney, Australia.

The mission began with a briefing in San Francisco, conducted by Jan Van Epps, executive manager for West Bay extensions of the San Francisco Bay Area Rapid Transit (BART) district, and others involved in BART's Millbrae extension, which is a DB project. Midway through the mission, the team members participated in an FTA-sponsored workshop on DB in Bangkok.

## THE DESIGN-BUILD PROJECT DELIVERY SYSTEM IN THE UNITED STATES

### What Is Meant by Design-Build?

In a DB project, the transit agency awards a single contract for both design and construction—that is, one firm (usually representing a team of subcontractors) assumes responsibility for both design and construction. The transit agency does some preliminary design work (the amount depends on the project); puts out a request for qualifications, which allows the agency to prequalify DB teams; and then invites DB proposals from the prequalified teams. The request for proposals states the project in terms of the outcome or product desired (i.e., the performance criteria), within the constraints of the project and site, allowing the competing firms to develop proposals that make the best use of their teams' talents. The agency then awards the DB contract on the basis of the best proposal received (from a design and price standpoint).

A variation on this method of project delivery includes the tasks of operating and maintaining the system—what is known as design-build-operate-maintain, or DBOM—for a period of years.

### Why Choose Design-Build?

The DB project delivery system offers several important advantages, including

- An expedited procurement process;
- Less potential for conflict between the engineer and contractor, as they are both working on a single team and under a single contract;
- Shorter construction times, as the design and construction phases can overlap;
- Fewer cost overruns, because the DB contract is typically based on a fixed price;
- Fewer change orders as a result of better design and estimating techniques, greater attention to risk management, and improved methods for scheduling project construction; and
- Streamlined oversight procedures, because there's a smaller number of contracts to manage.

One concern with the DB method of project delivery is that DB may adversely affect small- and medium-sized firms, which must now ally themselves with a consortium of firms. To address this possibility, agencies are using incentive clauses in their solicitations, encouraging participation from small- and medium-sized firms, including disadvantaged business enterprise (DBE) firms, and requiring firms to identify small and minority-owned businesses in their proposals during the prequalification stage. Still, for these and other reasons, some states bar the use of DB contracts on public works projects.

DB contracting usually drives up the cost of preparing proposals, as the proposer incurs a significant amount of design costs. In some cases, agencies and owners pay proposers a stipend to allay some of these costs, but the design then becomes the property of the transit agency, regardless of whether the proposer is awarded the contract.

Agency staff must be trained in this project delivery and contracting method, as the method requires new approaches to procurement, marketing, oversight, quality assurance, and risk management.

### How Does "Turnkey Construction" Differ from Design-Build?

In FTA's parlance, "turnkey contracting" is the same as "design-build contracting." In both cases, a transit agency contracts with a single firm for the design, construction, and delivery of a complete and operational project. After the project is complete, the developer "turns the keys" over to the agency staff, indicating that the project is ready for immediate use. In some instances, the firm is also required to operate and maintain the system for a defined period of time.

The term "super turnkey" refers to when an agency acquires a transit system through the design-finance-build-operate-transfer (DFBOT) process. For example, a firm or consortium would design the project, secure and provide all financing for the project (such as a light rail line), build the project, operate it for a predetermined period of time, and then transfer it to the transit agency. The firm would be repaid its investment through farebox receipts and other means provided by the agency. Super turnkey projects have been routinely contracted in Asia and Australia, but rarely in the United States, with two exceptions being the Tren Urbano project in Puerto Rico and the Hudson/Bergen project in New Jersey.

### FTA's Turnkey Demonstration Program

Section 3019 of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) mandated that FTA conduct a turnkey demonstration program; this program was later modified by Section 3023(a) of the Transportation Equity Act for the 21st Century (TEA-21). The goal was to explore project delivery methods that foster advanced technologies and decrease the time and cost of implementing new transit systems.

TEA-21 defined a turnkey system as "a project under which a recipient enters into a contract with a seller, firm, or consortium of firms to design and build a mass transportation system or an operable segment thereof that meets specific performance criteria. Such projects may also include an option to finance, or operate for a period of time, the system or segment, or any combination of designing, building, operating, or maintaining such system or segment."

Five projects, out of 17 submittals, were selected for FTA's initial turnkey demonstration program:

- Baltimore Central Light Rail Extension;
- San Juan, Puerto Rico, Tren Urbano;
- Los Angeles Union Station Gateway;
- BART San Francisco International Airport Extension; and
- New Jersey Hudson-Bergen Light Rail Transit Extension (this project became the first major DBOM transit project in the United States).

Today, the program is usually referred to as FTA's DB program, in keeping with the construction industry's use of the term.

FTA has identified three "readiness factors" for a DB project:

- Right-of-way acquisition,
- Record of decision (National Environmental Policy Act), and
- Completion of preliminary engineering.

FTA has developed an interim guidance document for transit agencies to use in DB contracts.

### How Is Design-Build Being Used in Asia?

While the United States turned to DB contracting primarily for cost and time savings, Asia turned to DB primarily for financial reasons (privatization)—that is, as a means of financing needed, but otherwise unaffordable, public transportation systems. For example, a firm will be contracted to design, build, operate, and maintain a system for a predetermined period of time; the firm puts up the money to build the project and is repaid, with interest, through revenues collected from passengers and the owner or agency. At the agreed-upon point, operation and maintenance of the system is transferred to the owner or agency.

In the United States, in contrast, there is little incentive for privatization using DB contracting. Transit development is largely the responsibility of government, and money for such development is raised through bonds, taxes, and other means.

## OVERVIEW OF TRANSIT SYSTEMS VISITED

### Hong Kong, China

The Environment, Transport, and Works Bureau of the Hong Kong Government Secretariat is responsible for overall transportation policy formulation and direction and coordination of land transport and ferry services. The bureau is assisted by the Transport Advisory Committee, which advises the Hong Kong chief executive on major transport policies and issues. The commit-

tee has 15 appointed members, including the chair and three government officials.

The Environment, Transport, and Works Bureau is also responsible for the procurement of major road tunnel projects; these projects have been accomplished using the design-build-operate-maintain-transfer (DBOMT) method of contracting. The Cross-Harbor Tunnel, Eastern Harbor Crossing, Tate's Cairn Tunnel, Western Harbor Crossing, and Tai Lam Tunnel were built by the private sector under DBOMT franchises.

The Hong Kong Transport Department, which is part of the Transport Bureau and under the direction of the commissioner for transport, is responsible for managing road traffic, regulating the provision of public transport services, licensing drivers and vehicles, making long-term plans to meet future growth and demand, and licensing and inspecting vehicles.

About 90% of the people in Hong Kong depend on public transportation. More than 10 million passenger journeys are made each day on Hong Kong's public transport system, which includes two high-capacity railways, trams, buses, minibuses, taxis, and ferries.

Electric trams have been running in Hong Kong since 1904. Hong Kong Tramways, Ltd., operates eight routes along the north shore of Hong Kong Island on a 16-km route, carrying some 279,000 passengers daily. The company operates the only all-double-decker tram fleet in the world. However, the wooden trams, nicknamed "ding-ding" for their clanging bells, are being taken out of service to make way for a new generation of streamlined aluminum models, which company representatives say will be safer, faster, and more comfortable.

The Kowloon-Canton Railway Corporation (KCRC) is a public corporation charged with operating and developing domestic, cross-border, and intercity railway services in a "prudent commercial manner." Its 34-km East Line connects Lo Wu, situated at the border with Mainland China, with Hung Hom in Kowloon. The East Line now carries an average of 716,000 passengers per day. Electric multiple units (EMUs), operating in 12-car configurations, provide service to 16 stations and to several established and emerging towns in the North West New Territories.

Since 1986, KCRC has provided feeder bus services to stations along the East Line. Since 1988, KCRC has operated a light rail system to meet the internal transport needs of the fast-developing North West New Territories. The light rail system will soon be expanded to serve also as a feeder service to the new West Rail line, which is now under construction.

KCRC carries more than 1 million people each day. In 2001, its return on average net fixed assets was 7%. KCRC receives no government subsidies, is entirely self-financed, and has been profitable since 1985 (in 1998, it generated an operating profit of 1.76 HKD [$227 million]). In addition to passenger rail service, the corporation operates freight service, mainly to and from the interior of the mainland, and develops property projects with joint-venture partners along its railway networks.

During the visit by the ITSP study team, KCRC representatives stated that substantial new demands have been placed on their system since the reunification of Hong Kong and the People's Republic of China in 1997. Cross-border trips now make up a substantial portion of KCRC's business, and five pairs of through-trains are now operated to and from Beijing and Shanghai on alternate days. On peak festival weekends, cross-border trips often exceed 250,000 persons per day. Freight traffic is also operated along KCRC's lines connecting Mainland China industries with the port of Hong Kong.

The 30.5-km Phase I of West Rail, scheduled to open in December 2003, will provide a much-needed link between growing communities in the North West New Territories and urban Kowloon. West Rail is expected to initially carry 340,000 passengers per day, with demand growing to 500,000 passengers per day by 2011. West Rail will link to the three existing railway systems (KCRC East Rail, KCRC Light Rail, and the Mass Transit Railway) to form a more integrated mass transit network. Only 8% of the project will be at grade: 48% will be underground, and 44% will be elevated.

The government-owned Mass Transit Railway (MTR, or Metro) began operations in 1979 with one line and at the time of the study mission had four lines (the Kwun Tong, Tsuen Wan, Island, and Tung Chung) running through 43 stations along 82 km of track. MTR carries more than 2.2 million people every weekday, making its system one of the most heavily used mass transit systems in the world. MTR also operates an express link to the new Chek Lap Kok International Airport.

Since 1898, double-decker ferries have been carrying passengers back and forth between Kowloon and Hong Kong Island. Today, 13 major licensed ferry companies operate 32 passenger lines on that route.

Taxis are a very popular way of travel in Hong Kong. For environmental reasons, taxi owners are being encouraged to switch from diesel to liquefied petroleum gas (LPG) before the end of 2005.

Bus services are provided by franchised operators, selected through a competitive bidding process. Some of the larger operators are Kowloon Motor Bus (Hong Kong's largest public transport operator), Citybus (the first franchised operator to have a fully air-conditioned fleet), and New World First Bus (the newest franchised bus company).

The Peak Tramway, which began passenger service in 1888, is a double-reversible funicular railway (cable car). The tramway is operated by a private company, and the infrastructure was completely modernized in 1989. See Figure 1.

The major transit operators participate in a smartcard ticketing system, known as the Octopus card.

**Bangkok, Thailand**

The Mass Rapid Transit Authority (MRTA) of Thailand is a state enterprise within the Office of the Prime Minister.

*Figure 1. For more than 100 years, the Peak Tramway has been providing passenger service in Hong Kong.*

Established in 1992, MRTA is charged with finding ways of improving transportation in Bangkok. At present, MRTA is responsible for the construction of four projects that will form an 80-km heavy rail mass rapid transit system:

- MRTA Chaloem Ratchamongkhon Line (Blue Line Initial System) (20 km),
- Blue Line Hua Lamphong-Bang Khae Project (13.8 km),
- Blue Line Bang Su-Phra Nang Klao Bridge Project (11.6 km), and
- Orange Line Bang Kapi-Rat Burana Project (34.6 km).

In late 1992, MRTA engaged a consultant to prepare preliminary design and tender documents for the first phase of the elevated Blue Line based on public investment policy. The project was subsequently cancelled because of government and policy changes. In 1993, MRTA called for the private sector to invest in the Blue Line and selected B-Land Group as a concessionaire. The selection likewise was canceled, this time because the government decided that half of the project should be underground, rather than elevated, and could not afford the additional construction cost. Two years later, the government decided to make the entire 20-km Blue Line Initial System project an underground metro system. In August 2000, MRTA awarded a 25-year concession contract for the initial phase of the project to Bangkok Metro Company, Ltd. (BMCL). MRTA is funding about 80% of the project (civil engineering and construction), and the concessionaire will finance the trains and equipment and operate the system. The first section is scheduled to open in August 2003.

The elevated rail line—known as Skytrain—running through the business district is operated by Bangkok Transit System Corporation (BTSC). The system was designed, built, and financed by a consortium headed by Siemens/Italian-Thai Development (ITD). The line began operations in 1999, and BTSC is operating the system under a 30-year design-build-own-operate-transfer (DBOOT) concession. The system infrastructure was turned over to the city council in 1999; the electrical and mechanical equipment will be transferred to the city when the concession expires. The system has two lines: Sukhumwit (17 stations) and Silom (7 stations). Several other lines are planned. Although ridership has been slowly increasing, it is nowhere near projected. See Figure 2.

Plans for the Bangkok Elevated Road and Train System (BERTS, also called the Hopewell System) have been dramatically scaled back. BERTS was originally designed to be an elevated highway, rail, and light rail system, but construction was stopped in August 1997, 2 years before the scheduled completion date and with less than 15% of the project built. The latest plans are for a rail-only system, with some sections at grade and some sections elevated. At the

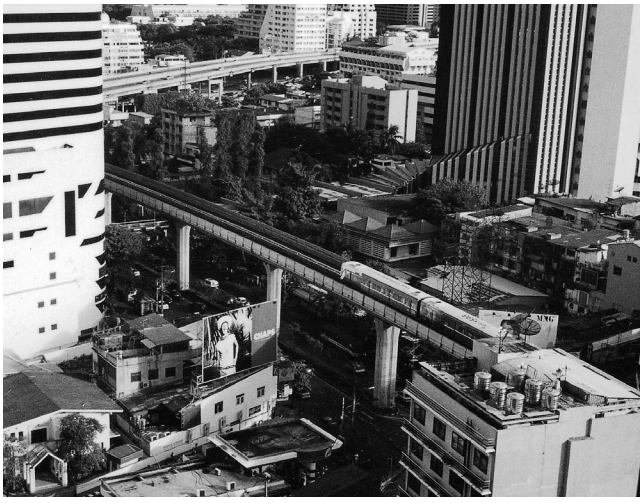

*Figure 2. Skytrain, the elevated transit system that runs through densely populated Bangkok, is operated under a 30-year DBOOT contract.*

time of the study mission, the only signs of the project were the unfinished columns lining the road to the airport.

The Bangkok Mass Transit Authority (BMTA) is a state-owned agency that operates city bus services in the greater Bangkok area. Bangkok classifies its bus services into three categories: non-air-conditioned buses, air-conditioned buses, and microbuses, which are geared for commuters and offer on-board fax and telephone service, newspapers, and a guaranteed seat.

A large taxi fleet, which includes three-wheeled "tuk-tuks" and motorcycles, augments the bus services.

**Sydney, Australia**

The Department of Transport is responsible for formulating and implementing transport policy and developing transport plans for the state of New South Wales. The department also accredits and regulates transport providers and provides funding for transport services and infrastructure.

The New South Wales government has implemented a plan aimed at developing a truly integrated transport system for Sydney. The plan, outlined in its *Action for Transport 2010,* calls for the biggest transport improvement program since Sydney's underground rail line was built in the 1920s. The New South Wales railway was the first government-owned railway in the British Empire. Opened as a 22-km line in 1855, it is now one of the world's most complex systems, carrying nearly 1 million passengers daily on an 8,000-km rail network that includes 306 stations. State Rail operates passenger rail services and feeder coaches throughout the Sydney metropolitan and outer-urban areas, as well as the regional centers of New South Wales. The services are provided by State Rail's two business groups: CityRail and Countrylink.

CityRail carries 278 million passengers per year over a 2,060-km network extending north, west, and south from the city. Services begin about 4 a.m. and run until midnight, when Nightride bus services operate in the Sydney suburban area. In 1998, a 6-km extension to Homebush Bay opened, providing participants and spectators easy access to the Olympic games. The Olympics were also the impetus for a heavy rail DBOM expansion to the airport.

The extensive CityRail network is now becoming increasingly congested along several of its main lines (see Figure 3). The Parramatta Rail Link (PRL) is a circumferential extension of the CityRail network. The 27-km line will link Parramatta (west of the city) to Chatswood, and 70% of the line will be underground. PRL is intended to ease congestion on the busy Main Northern and Main Western lines, allowing up to 18,000 additional people per day to travel

*Figure 3. Sydney's popular CityRail system carries about 278 million passengers each year.*

into the central business district during the morning peak and reducing travel time.

The shareholders for PRL are the director general of Transport New South Wales, the State Rail Authority, and the Rail Infrastructure Corporation (which owns and maintains the New South Wales rail network). Once the line is completed, it will be owned and operated by the State Rail Authority and the Rail Infrastructure Corporation. PRL's cost is estimated at 2.6 billion AUD ($1.4 billion).

Countrylink operates long-distance rail and feeder coach services throughout New South Wales and across state borders to Canberra, Melbourne, and Brisbane. Countrylink carries more than 2.5 million people per year.

A light rail system—Metro Light Rail—began operations in 1997. Trams run 24 hours a day, 7 days a week, to key destinations throughout Sydney. The Metro Monorail provides service in the shopping area in the central business district. Both Metro Monorail and Metro Light Rail are operated by Connex.

The State Transit Authority provides bus and ferry services. The Sydney bus system serves a population of 1.7 million and covers an area of 645 sq km. The ferries carry commuters between residential suburbs and the major bus/rail interchange at Circular Quay, as well as provide extensive cruise services. More than 13 million ferry passengers are carried each year.

Sydney has one of the largest public transport systems. But rapid urban development and increasing usage of private cars are straining the transportation network. This strain has prompted the New South Wales government to try to reduce the rate of growth in car usage, especially for journeys to work. To attract more people to public transportation, the government has plans to develop an integrated system of bus and train services throughout the growing suburbs.

The planned network includes bus rapid transit (BRT), which will provide a fast, safe, and reliable alternative to the car. By 2003, Sydney's first BRT will be completed, providing service every 5 minutes at peak times and every 10 minutes at off-peak times. The 94-km BRT system, to be built on the west side of the island, is intended to be a DBOOT project.

## DETERMINING THE OPTIMUM PROJECT DELIVERY SYSTEM

The DB project delivery system (or one of its variants) has been used extensively on transportation projects in Asia and Australia. The primary impetus for the use of DB contracting for transit infrastructure projects is potential cost and time savings.

### Decision Factors

The issue of how a proposed infrastructure project will be financed is fundamental to determining which contracting method should be used. Nongovernmental financing, either by private sources or by a development bank, largely dictates that the agency perform only enough engineering to define the project in tender documents and that the procurement be performed using DB contracting. The funding partners, particularly in developing nations, want the successful construction consortium to have the ability to design and construct simultaneously so as to speed project delivery, control changes, and ensure on-time project completion. For such projects, then, the decision to use DB is typically an easy one.

In the context of a contracting method decision, environmental conditions are defined as the *total* environment, including ground conditions, development density, political issues, community relations, and other factors. Projects in areas of unknown or difficult ground conditions may prove to be very expensive to construct using DB because the amount of risk will have to be factored into the contractor's bid. Conversely, projects in well-known conditions—where the construction risk is low and where the agency could benefit from innovations in design, means, and methods—lend themselves quite well to DB contracts.

Development density can affect the decision because construction of facilities near or under occupied buildings may require greater control over the contractor's means and methods, particularly if construction will create excessive noise or cause surface settlement.

The political environment is important because in some jurisdictions it may be advantageous to let a single contract in order to avoid a lengthy, bureaucratic approval process for multiple contracts. In addition, if political issues are likely to lead to substantial changes during the project, the relative flexibility of DBB might be more advantageous.

The percentage of design already completed by an agency can be a deciding factor in determining which contracting method to use. If an agency needs to specify the appearance of stations or structures because of community or politically driven concern or requirements, the consequent high degree of design performed by the agency may lend itself to the use of DBB. Interestingly, however, a high percentage of design by the owner may also point to DB as the method of choice, particularly if the design is incomplete. If a project that was to be DBB is delayed or suspended before designs are finalized, the competitive pressure to use as much of the incomplete design as possible by bidders on a DB contract will ensure maximum use of the design documents supplied by the agency. Thus, the restart of a delayed DBB project may strongly lend itself to switching to a DB procurement.

In a major construction program, the ratio of nonconstruction, or "soft," costs to total project costs can be used as one measure of efficiency. DB projects can reduce the "soft" costs of contract administration, project management (particularly the complex interfaces between contracts and contractors), and engineering.

The size of an agency's project management staff can be an important issue when choosing project contracting methods. DB allows projects to be delivered with a much smaller

agency staff. The Hong Kong Transport Department says this flexibility is a key reason for choosing DB—the agency wants to keep the size of its civil service staff to a minimum. If an agency has, however, a long-term construction program and a stable, professional workforce, it may choose to use DB infrequently and only in cases where designs are relatively simple and innovation is desired. In the case of a smaller agency with less experienced staff, DB contracts help control costs by avoiding the duplication of skills among staff and consultants.

Project cost and schedule are key factors in any project decision, but in Asia and Australia these factors can take on even more importance, as a shorter schedule and a guaranteed price may be necessary in order to attract sufficient capital to fund a project. Faster project delivery schedules and higher contingencies in the award value can ease concerns of financial institutions, which typically do not want to be approached for additional funds after financial closing.

Another element of project delivery that applies generally, but not solely, in Asia and Australia is that of risk. For example, in Thailand the agency goal is to place all risk with the contractor to avoid having to request additional funds from the funding sources (whether private or government). Once the decision is made to allocate risk in this manner, regardless of which party is least able to manage the risk or its cost, DB is chosen. In DBB, in contrast, it is almost impossible for the agency to avoid all risk because the agency "owns" the design and will be responsible for any extra work or corrections necessary to complete the project.

## Hong Kong

### *Mass Transit Railway*

**Contracting Methods and Criteria.** MTR is a large, stable operator and constructor. The agency's rail project staff numbers approximately 1,000, down from 1,300 at the peak of the line expansion projects. As a profit-making company, MTR places a great deal of emphasis on the construction and startup of additional lines.

MTR uses consultants only for design, not for track work or rail vehicle design, which are done in-house. Construction management is also done in-house, as MTR managers believe that MTR provides better communication and reduces the time to react to field changes by eliminating the "go-between." MTR construction management personnel are given 5 million HKD ($641,000) in signature authority to keep changes from affecting budgets and schedules. Embracing the idea that the party most able to deal with specific risks should assume those risks, MTR uses DB for its tunnels and bridges because tunnels and bridges present the least amount of unknown conditions in the Hong Kong construction environment. The amount of tunneling already completed in Hong Kong for both railways and highways, the depth of the tunnels underground, and the relative lack of structures above have made DB the contracting method of choice for such project components. Nonetheless, MTR still retains the risk of unforeseen ground conditions, thus precluding the inclusion of large risk dollars in the contractor's bids.

Project components that are complex and have large numbers of interfaces with other components or contracts are delivered using DBB. MTR's management of these interfaces gives the agency higher confidence in project success than if these responsibilities were left to a single contractor or contractors.

**Experience.** MTR's five most recent line extensions were completed on time and under budget using the project management structure largely put in place in 1975. Working with consultants and contractors is an important key to success, say MTR staff members, who now have a reputation in the contracting community as being "tough, but fair." The initial system was constructed using DB, but as the agency grew and its employees became more experienced, MTR moved away from DB; today, MTR mostly uses DBB. The choice of process—DB or DBB—is determined by risk management considerations and the desire for alternative designs.

### *Kowloon-Canton Railway Corporation (KCRC)*

**Contracting Methods and Criteria.** The Kowloon-Canton railway has grown to be a heavily used suburban railway with several lines and high ridership. Like MTR, KCRC has a program of line extensions, which has enabled KCRC to develop a stable project management staff, including construction managers. KCRC uses DB for straightforward civil works where conditions are known, as well as for complex systems projects where requirements are known but innovation is encouraged. The only current civil contracts using DB are the two West Rail tunnels, where underground conditions are predictable. More complex civil works such as stations, which include very specific foundation designs due to unpredictable soil conditions and which must accommodate the addition of high-rise structures above in the future, are consistent with the risk assessment method of choosing the contracting approach. The tunnel contracts are awarded on the basis of qualifications and price. Prequalified bidders are required to include a technical presentation of the approach to the work. If an approach is deemed deficient, KCRC may reject the bid. The construction management function on DB contracts is handled by KCRC staff to reduce the potential for corruption and to ensure high quality.

DBB contracts are awarded on a low-bid basis, with construction management performed by a consultant hired by the final design consultant.

**Experience.** KCRC project experience with the DB tunnel contracts has been good. The successful bidders modified the alignments to reduce cost, and the contracts include close to a 1% cost growth, which is exceptional for tunneling work. The company has not, however, been able to quantify

a relative decrease in total cost by using DB contracting, and it thus intends to continue the use of both contracting methods, with choice to be dictated by risk and complexity.

*Hong Kong Transport Department*

**Contracting Methods and Criteria.** The Hong Kong Transport Project uses the DBOMT method of project delivery for its highway tunnel projects for two main reasons: the tunnels are heavily used, and the revenue collected at the toll booths is sufficient to pay operating and amortization costs of the project. Each tunnel requires separate legislation and includes a 30-year franchise agreement, which starts at the beginning of construction. At the end of the franchise period, the facilities are transferred to the Transport Department.

The use of DBOMT for these facilities is driven by the project's ability to yield a profit to the franchises. This ability attracts private capital to the project (saving government resources for other projects), reduces risk to the government (risk is assumed by the franchisee), and avoids large increases in the civil service ranks. Because these tunnels are under water, there is little disruption and inconvenience to the public during construction.

The elements of the project agreement that govern until transfer include the construction duration, contract terms and responsibilities, expected return on investment, toll levels, and compliance with applicable regulation.

**Experience.** The Central Harbor Tunnel was transferred to the government after a 30-year franchise period ended in 1999. Issues surrounding the transfer were the negotiation of a maintenance-only contract, which was necessary to provide for continued employment for existing franchisee employees; audit and inspection procedures that needed to be executed; and a toll increase that had to be politically justified on the aging facility. (The government had wanted to raise the toll during the franchise period as a means of diverting traffic to other tunnels or modes, but could not because the toll increase would have enriched the franchisee unduly.) This toll inflexibility is one of the few drawbacks of the DBOMT scheme as executed by the Transport Department.

An example of a cooperative venture by the Transport Department and MTR is the Eastern Harbor Crossing. Built by the New Hong Kong Tunnel Company, the Eastern Harbor Crossing incorporates heavy rail tracks in the tunnel, and its platforms and entrances are located under an existing elevated MTR station. MTR will pay a total of 2.6 billion HKD ($334 million) semiannually over 18.5 years for the use of the railway portion of this project.

**Bangkok**

*Mass Rapid Transit Authority*

**Contracting Methods and Criteria.** MRTA engaged a consultant to assist in the execution of the tender documents and to augment staff during construction and startup. The DB method is being used because of the need to accelerate the approval process through the Thai Cabinet and because the Thai government is borrowing the money for construction from the Japan Bank for International Cooperation. Funding sources, such as the Japan Bank for International Cooperation, usually prefer DB because it affords them confidence in the project delivery system as a "package," speeds design and construction, and helps ensure timely project completion.

The project is divided into five civil contracts let by MRTA:

- Contract 1—Underground Structure South,
- Contract 2—Underground Structure North,
- Contract 3—Maintenance Depot,
- Contract 4—Track Work, and
- Contract 5—Elevators and Escalators.

The system contracts are let by the operation and maintenance concessionaire and include vehicles, signaling and communications, traction power, automatic fare collection, and maintenance depot equipment. MRTA has hired a construction management consultant (to monitor civil construction) and a systems supervision consultant, in addition to the program management consultant.

**Experience.** MRTA has experienced delays in the contract award process as a result of the lengthy government approval cycle time. Nonetheless, work was 57.49% complete in January 2001, almost right on schedule (the schedule was for 59.62% completion at that date). The DB process has led to some innovations, such as schedule savings made possible by designing the station trackway wide enough to allow the tunneling machine to pass through a concreted station; this innovation allows the tunnels and stations to be constructed concurrently.

*Bangkok Transit System Corporation (BTSC)*

**Contracting Methods and Criteria.** Skytrain, BTSC's elevated project, was entirely privately financed and thus required a DB contract. The project's funding partners needed the confidence that DB instills regarding project speed and control. The concessionaire was given a contract with a guaranteed maximum price and a guaranteed completion date, along with the requirement for a comprehensive warranty.

From the owner's perspective, the contract (in which the contractor assumed most risks, including unmapped utilities) reduced agency risk, provided the contractor with cost and schedule control, shortened delivery time overall, and allowed for quicker responses to changes. However, these benefits did come at an increased cost.

The construction was completed in a 39-month period. Although ridership continues to increase, as of June 2001 it was only one-third as high as projected. It is unknown whether the level of ridership will support the expenses of

the concessionaire or whether the government will have to intervene and provide some sort of subsidy to ensure the continued operation of Bangkok's first heavy rail system.

## Sydney

### *Parramatta Rail Link (PRL)*

**Contracting Methods and Criteria.** After consulting the management of rail projects in other countries, PRL staff identified the primary project goals as the need for fast startup of construction, the need to control the appearance of the stations, the desire to place the tunneling risk on the contractor, and the need for operation and maintenance to be performed by CityRail.

The civil construction was placed in one DB contract, with approximately 10% of the engineering performed by PRL (consisting of the alignment and basic requirements). All systems work was placed in another DB contract, again with approximately 10% of the design supplied by PRL.

The stations will be contracted for individually using "document-construct," where PRL supplies 60–75% of the design and the contractor completes design to final and documents the as-built condition. This approach maintains some advantages of DB, but allows PRL to define the stations' appearance.

**Experience.** The entire PRL cannot be built with the funding available at this time (only 1.6 billion AUD [$8.9 million] has been budgeted). The line will thus be built in stages—to Chatswood by 2006 and to Parramatta by 2009.

PRL will solicit registrations of interest and qualifications. PRL envisions three to four line section (mainly tunnel) contracts and will attempt to divide them to include consistent ground conditions in each contract. PRL would also like to limit contract size to approximately 300 million AUD ($166 million)

Architects are now working on the station designs. Once the designs are 60–75% complete, they will be sent out for bids. Contracts are expected to be awarded on the basis of price and other factors.

### *AustralAsia Railway Project*

The AustralAsia Railway is an ambitious project extending the standard gauge railroad that currently ends at Alice Springs in central Australia to the northern port of Darwin, the closet port to southeast Asia. The goal is to reduce the cost and schedule time of freight traffic between Australia and Asia.

The project is 1,410 km long and estimated to cost 1.2 billion AUD ($661 million). The Australia Trade Practices Act will guarantee access to this railway by more than one freight operator. After it became apparent that the private sector could not or would not fund the railway alone, the federal government allocated 470 million AUD ($259 million) to make the project viable. This project is one of the few rail infrastructure projects with federal government participation.

**Contracting Methods and Criteria.** The Trade Practices Act prohibits the government from awarding facilities contracts that may result in a monopoly. Since this railway will be the only one in the area, it was necessary to create an "access regime" that defines the access of shippers to the railway and the method to be used in setting competitive rates among them. This access regime, which will be in place for 30 years, was then approved by the National Competition Council. The regime provided a measure of financial predictability to the proposer. The regime specifies how shipping rates will be calculated and attempts to balance the need for competition with a reasonable return for the proposers.

**Experience.** The tender documents included only technical requirements, performance specifications, and cost requirements. The 40-page technical section basically described only the alignment. This limited scope led to high amounts of contingency dollars in the bids, which the government is now attempting to negotiate down.

The agreement has been signed, and the consortium is continuing detailed design. The right-of-way is not totally secured at this time and requires the acquisition of Aboriginal land, which will take time to resolve. There will be little government oversight during the project, and the consortium carries all risks.

### *New South Wales Highway Projects*

Two highway projects were studied as part of the mission: the New South Wales M4 Western Motorway and the Eastern Distributor. Both projects were undertaken to increase highway capacity with nongovernmental capital. These motorways were also undertaken with little government participation in the project's management other than being the franchising agency and providing performance criteria.

The M4 motorway project consisted of the upgrade of a four-lane, 11-km road to six lanes and provisions for an additional 10 km of six-lane roadway. The M4 was opened in 1992 at a cost of 245 million AUD ($140 million). All right-of-way was provided by the government.

**Contracting Methods and Criteria.** The desire for private capital and the ability of these tollways to generate revenue led to the DBOOT method of contracting. Interestingly, in the case of M4 motorway, the consortium did not include a contractor; the actual construction was contracted using DBB, with the consortium acting as the owner and providing quality assurance of design and construction.

**Experience.** The tollways have been successful in construction and operation. The Australian public has been willing to pay the tolls in exchange for less congestion, making the

projects viable long term. The experience here is very similar to that of the Transport Department's tunnel projects in Hong Kong.

## PROJECT DELIVERY PLANNING

### Internal Engineering and Management Capabilities

The capabilities of the owner's team for each project varied considerably, especially from country to country. In Hong Kong, where the rail transit owners have had considerable success over a long period of time, strong internal engineering and management capabilities have developed. In Bangkok, by contrast, where rail transit is a new phenomenon and there is little technical expertise on the owner's staff, virtually all engineering and management is contracted out. Although Sydney has an established rail transit system, the owner prefers a lean in-house staff. Of the three locations, the Sydney model most closely resembles the new DB model used in the United States, while the Hong Kong model more closely resembles the traditional DBB model used in the United States.

*Hong Kong*

The Hong Kong government issues concessions for all Hong Kong rail transit projects to one of the two railway companies in the country (KCRC or MTR), which then obtains private financing. Thus, from the government's point of view, all rail transit projects are DB and are similar to a build-own-operate-transfer (BOOT) project. The government places all engineering and management responsibility with the rail corporations and maintains minimal internal staff to administer these projects.

Within the transit companies, engineering and management administration of construction projects is done almost entirely in-house. The companies hire final design consultants, but provide them with extensive standard design guidance and requirements and have considerable oversight staff. The companies do not use construction management consultants or inspection staff, preferring to perform this work in-house.

*Bangkok*

The government has little engineering and construction expertise in rail transit and, thus, relies on contractors or consultants for nearly everything. In the case of the Skytrain DBOOT project, the concessionaire assumed full responsibility for the design, construction, and maintenance of the project and for training government staff in its operation. With nearly all risk placed on the concessionaire, it was logical to have the concessionaire also provide engineering, construction, and construction management. The concessionaire itself consisted of a large systems-oriented firm (Siemens) paired with a local construction company (Italian-Thai) and was thus able to provide nearly all professional services itself, without needing further contracting. Both the government and the concessionaire retained an independent checking consultant to oversee the quality control/quality assurance (QC/QA) aspects of design and construction. For convenience, the concessionaire chose to use the same firm as the government, thus requiring only one independent design review check and avoiding conflicts between separate reviewers.

In the case of the subway (MRTA Blue Line), which is mostly government financed and will be government owned and operated, the government has hired consultants to perform practically all oversight functions. A project management consultant firm provides all professional services, including design and construction oversight. The consultant hires subcontractors to perform tasks for individual contracts within the project. The government also has retained an independent certification engineer, separate from the project management consultant firm, to provide an additional QC/QA check on the project, especially the systems portion that is being provided by a concessionaire. See Figure 4.

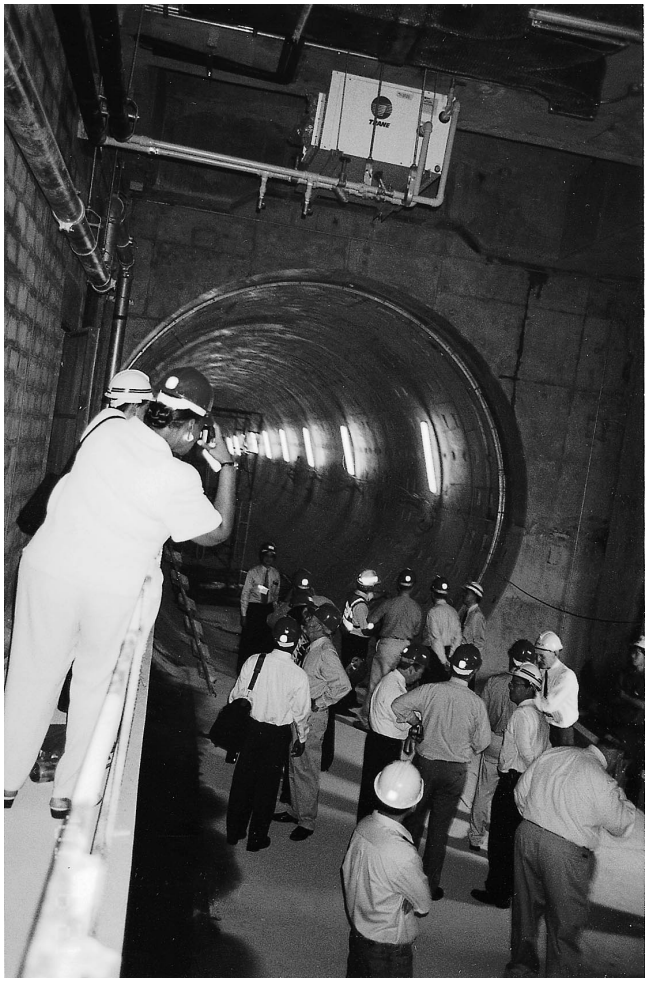

*Figure 4. An 80-km heavy rail underground system is currently under construction in Bangkok.*

*Sydney*

For government-financed rail transit projects, the government routinely uses DB contracts. In-house staff is generally lean for both DB and traditional DBB contracts; for example, for the PRL, the staff will peak at about 50 people. The government usually relies on consultants to perform preliminary engineering and document preparation, as well as to perform general construction management functions.

**Site Development**

In general, the degree of site development performed by the owner (government) was the same in the three countries: the government is responsible for land acquisition, but responsibility for utility relocation and underground site conditions is placed on the contractor. The Bangkok government provided no information to its Skytrain concessionaire on existing utilities or site conditions, while in most other cases existing condition maps and preliminary soil investigations were provided. Despite providing this information, however, none of the owners would consider taking responsibility for a utility not shown in the existing condition maps, or for a utility in a different location than shown in the existing condition maps. In Hong Kong and Sydney, the government also performed required environmental reviews and provided environmental requirements to the contractor (similar to U.S. practice, except that U.S. owners often assume some degree of responsibility for the accuracy of existing condition maps provided to the contractor).

*Hong Kong*

At the project level, the Hong Kong government treats its rail projects in a manner similar to a DBOOT. The principal responsibility of the government in these projects is to obtain real property and then turn the real estate over to the rail transit company for construction. Typically, the government will obtain rights to a "corridor" that is larger than the actual rail line needs, allowing the rail companies some flexibility in choosing their alignments. The government also procures additional property at station sites to allow for joint development as part of the project and conducts environmental clearance activities.

Other site preparation responsibilities (utility relocation, access, etc.) are left to the rail companies, which generally pass these risks to the contractor. The contractor assumes the risk for the accuracy and completeness of existing condition maps and for geotechnical conditions. Geotechnical risk is not considered large in Hong Kong, because conditions there are generally well known.

*Bangkok*

Site development issues in Bangkok are handled in a similar fashion to Hong Kong—that is, the government is responsible mainly for land acquisition, with the contractor liable for other aspects. The contractor encounters particular risk for utilities (because existing condition information is scarce and unreliable) and for local impacts to traffic and business in the dense urban core where rail construction is taking place. Subsurface conditions, while generally homogeneous, are difficult for the contractor (the entire area is low-lying, with a high water table, and is prone to settlement).

Unlike Hong Kong and Sydney, Bangkok does not have a well-defined environmental clearance procedure. For the Skytrain project, for example, public input occurred during the concessionaire's design phase, necessitating major changes (such as the relocation of the yards and shops). Most of this risk ended up being borne by the concessionaire.

*Sydney*

Sydney also performs all real estate acquisition, but tries to relocate major utilities. Sydney uses various levels of design preparation, and thus the level of utility relocation and site preparation correspondingly vary. The Sydney government conducts an environmental clearance process similar to that used in the United States.

**Construction Contracting Arrangement**

The types of contracting arrangements encountered during the study tour generally have parallels within the United States; however, the "mix" of the contracts can be quite different. Delivery of an entire project (say, an entirely new rail line or extension) was done either by private financing (common in Bangkok and Hong Kong), by government financing (the usual method in Sydney), or by a combination of the two (notably the Bangkok subway project). Within projects, individual contracts are generally smaller than in U.S. DB projects (i.e., there is less contract consolidation), creating more interface responsibility for the owner. Owners are much more likely to mix DB contracts with traditional ones in a single project, in contrast to the United States, where a project is either DB or DBB.

*Hong Kong*

Because of its practice of issuing concessions to the railway companies, the Hong Kong government essentially practices total consolidation of contract functions. There is only a single prime contractor, responsible not only for construction, but also for design and maintenance.

Within the rail corporations, however, the picture is quite different. These companies use DB for only a very few contracts (usually tunnels that have few interface requirements with other contracts or with existing facilities). The project is divided into numerous small contract packages, with civil contracts following geographic lines and systems contracts

divided by discipline. Design for the traditional contracts is taken to a very high level (essentially 100% as it is understood in the United States), and, for DB contracts, extensive guidance is provided from the owner. The companies cite a number of reasons for this methodology. First, the local contracting community is not well suited to very large integrated contracts. Second, the companies themselves have extensive in-house management capabilities, as well as a very strong idea of what they want. Third, company managers believe that the companies can successfully handle the interfaces between contracts and are better suited to deal with government and public input on the design of stations and other public facilities.

*Bangkok*

The government in Bangkok uses DBOOT contracting for many of its rail projects. These projects necessarily have a single prime contractor, or concessionaire. The concessionaire typically either constructs the project itself (for example, the Skytrain project) or hires a single contractor. Thus, the degree of contract consolidation is very high. Because of its limited experience with rail transit and limited funds, the government has chosen to limit its involvement in the technical aspects of the rail projects. Similarly, many of the concessionaires are financial investors with little construction expertise, and so they want to turn over all construction aspects of the project to a single, highly experienced contractor.

For the government-owned subway project, there has been a partial consolidation of contracts. The government awarded a total of six major contracts, one of which was a concession for systems design and installation and maintenance. This partial consolidation was similar in scope to what was done for the BART airport extension project in the United States, except that there was no "integrated" civil/systems contract. The government kept the civil and systems constructions contractually separate and managed the interface itself. This approach created a classic interface problem when the systems concession was late being awarded, delaying the civil contractors and forcing the government to make "educated guesses" about systems requirements.

*Sydney*

Sydney's experience with DBOOT projects is more limited than that of Hong Kong and Bangkok; however, like Hong Kong and Bangkok, Sydney awards a DBOOT project to a single prime contractor. Current government policy is that no government financial assistance will be provided to a DBOOT concessionaire (the project financing must be totally private). Because rail transit lines generally do not make a profit in Sydney, the reliance on a single prime contractor has made DBOOT projects somewhat problematic.

For individual contracts within a project, Sydney routinely uses DB and, in fact, has defined several levels of DB. The DB (or, as it is known in Sydney, design-construct) contract involves very minimal owner design (generally only specifications and design criteria and perhaps a few drawings) and is generally used for line sections or tunnels where there is little interface and little public interest or input. For the document-construct contract, the owner provides design to the 50–60% level; this type of contract will be used for stations or other areas where extensive public input is anticipated. Where there is an interface with the existing rail lines (for example, at a tie-in point), the government generally provides a 100% design and may even do the construction itself. As can be seen from these examples, the choice of which type of contract to use is based on several considerations: desire for innovation; desire for control over the design (especially where outside parties have an interest); and number of interfaces involved. Although the government could legally issue a single integrated contract, it generally has not done so for many of the same reasons discussed in the Hong Kong example above.

A good example of the city's very flexible decision making regarding the types of contracts to use may be found in the PRL project. After a rigorous definition of objectives and assessment of requirements, the government chose a combination of DB, document-construct, and in-house construction to complete the project.

**Flexibility Is Key**

Meeting with agencies and contractors in Asia and Australia made clear that few "new" techniques are being tried there, at least in regard to project delivery planning. Flexibility is a key part of the equation—owners must be prepared to use whatever methods are most appropriate for the project at hand.

In the realm of contract consolidation, Asian owners clearly are more comfortable with the DBOOT model of turning over total responsibility to a single contractor, but are less inclined to consolidate contracts when paying for the work themselves. In none of the cities visited did the study team find an "integrated contract"; as a result of the lack of integrated contracts, Asian owners assume a relatively large degree of responsibility for coordination and interface between contractors.

The owner organizations in the three cities differed mainly in the degree of in-house effort versus private management being used. Notable in all cases was the use of an independent checking or certification engineer, separate from either the owner's or the contractor's design firm, to provide a "third eye" overseeing the contractor's design activities. Such a scheme provides a valuable quality check as long as the independent firm is thoroughly familiar with the contract provisions and aligns its comments and oversight to the contract at all times.

## ENGINEERING DESIGN APPROACHES

### Hong Kong Transport Bureau

The Hong Kong Transport Bureau conducts feasibility studies prior to initiating a project. The government specifies the terms, allowing the two railway corporations to bid on a level playing field. In reviewing the proposals, the government considers all relevant factors, including technical and financial factors. This process is designed to enhance the cost-effectiveness of the project.

Major construction projects such as tunnels, which follow a different process, require that the franchisee adhere to the maintenance and standard specifications for DBOOT projects that are provided by the Transport Bureau. However, the franchisee does the full design, which the government reviews and approves.

The franchisee must include in its design proposal measured benefits to the community and cost for new railway extensions. The selected railway corporation is responsible for completing the feasibility study.

The government hires a consultant to oversee the DBOOT projects; this oversight includes the inspection of the franchisee designs and project certification after construction. The certification process also involves several government agencies, such as the highway, fire, and police departments.

The government hires an independent consultant to facilitate difficult negotiations of the project terms and responsibilities. Transport Bureau staff stated that the government is reluctant to provide funds if there are any environmental impacts requiring design changes or mitigation.

### Mass Transit Railway (MTR)

By enforcing strict cost controls, MTR has achieved a high level of operational efficiency and standards. This management model has afforded MTR on-time completion of railway projects while staying within budget.

MTR considers its projects to be design-build-operate (DBO), in which MTR controls the construction costs and the schedules of concessionaires. MTR absorbs the costs with respect to feasibility studies on proposed railway-related construction projects. Once the government approves the project, all of the construction costs incurred are financed until project completion. At that point, all relevant construction costs are transferred to fixed assets, such as shopping centers and apartment complexes that are leased by the developer. Over the years, MTR has created a successful and unique business model, deriving significant benefits from integrating railway business with the development of substantial properties in conjunction with stations and depots.

MTR has an in-house project design capacity for special areas such as signals, communications, and stations. In each area, MTR assigns chiefs who are responsible for setting design standards and conducting technical audits. MTR's management believes that no consultant can provide the same level of design expertise as the in-house design team. MTR established a clear definition of the corporation's design standards. The project managers adhere to three phases for design implementation: preliminary, scheme, and detailed. This approach has created a project management team that has not changed significantly since 1979.

Consultants and contractors are selected to ensure the right mix of expertise to detail the preliminary engineering designs. Also, the MTR management staff prequalifies their consultants on a project-by-project basis and conducts performance appraisals on all consultants.

The civil and signal designs are well advanced (to approximately 95% level). These designs are done in-house to minimize the number of system interface problems and to ensure quality control. A separate project manager is responsible for the signal system design. The in-house designers are not allowed to participate on the project teams other than to resolve a design issue.

The consultants are tasked to finish detailing the designs to 100% level or scheme design before advertising the project. MTR allows its design consultants to submit design changes if the changes are cost-effective solutions or innovative ideas for expediting the construction schedule. Contractors can also submit designs when applicable.

MTR's project management staff employs design management objectives to facilitate coordination with the contractors. Some of the key factors that are established before the commencement of the project is mutual respect and trust for both project teams. MTR's managers have strong management skills, which are developed by changing the managers' responsibilities on various projects. These skills have afforded the corporation the depth of a multiskilled staff.

MTR's new management structure, introduced in 1999, is based on solid line reporting rather than on a matrix. This structure reduced the time for authorization and approval of tender documents.

In its 26-year history, MTR has never had to litigate or go before an arbitrator to resolve design disputes. MTR's management resolves any claims or disputes with a contractor prior to the project commencement. MTR's management model emphasized interactive sharing, teamwork, listening, and cooperation, which help the project teams stay focused and be more proactive. Typically, 15 contracts that require coordination are associated with the project.

MTR staff stated that the resident engineer resolves all contractual disputes within 2-day or 2-week time frames with stringent change control procedures. If disputes were not resolved within the specified time frame, the next level of supervision intervenes to assist in resolving the dispute.

MTR also hires an independent engineer consultant to be a facilitator for resolving design disputes. However, if the concessionaire or contractor is unsatisfied with the design dispute resolution, the concessionaire or contractor can submit a claim at the end of the project. This approach of partnering and guaranteeing incentives for on-time comple-

tion of the project gives the corporation more leverage in resolving design disputes and claims by the concessionaire or contractor.

MTR has installed systems that are far more advanced than most railways in Hong Kong. The number of patrons who ride the system during peak hours necessitates 2-minute headways. In 1999, MTR started operating from a state-of-the-art operations control center (OCC) that controls and monitors train movements through the system. The OCC also controls the temperature on trains, as well as in stations. All MTR stations will soon be outfitted with passenger screen doors; these doors are intended to help ensure passenger safety and to increase the efficiency of the air-conditioner in the trains and stations.

**Kowloon-Canton Railway Corporation (KCRC)**

KCRC considers its tunnel projects to be DBOOT, in which KCRC controls construction costs and schedules of the concessionaires. The KCRC concessionaires must adhere to the design criteria and construction standards set by the Transport Bureau.

Consultants and contractors are selected on the basis of their alternate bid designs. The electrical and mechanical systems are designed in-house to approximately the 33% level. The civil designs are more advanced to ensure that the project is community friendly during the design and construction phase.

KCRC staff oversees the consultant during the design and construction phase, which includes value-engineering reviews to ensure cost-effective solutions.

The KCRC major project coordination hurdles are addressed during the design and construction phases due to the disruption of the road users and light rail operations. KCRC's managers and consultants employ prudent construction planning techniques to minimize delays in busy urban areas. KCRC also recently adopted a proactive approach to addressing public concerns during the design phase. This approach will continue during the construction phase. The project's 20 individual contracts for the design and testing of the systems are another key factor in ensuring quality control.

**Bangkok Transit System Corporation (BTSC)**

The BTSC consultant established preliminary design criteria based on an electric railway that would be constructed to international standards. The BTSC transit system is an updated version of proven transit system technology, which is currently in service in the cities of Hong Kong and Singapore.

*Design Responsibilities*

BTSC hired an independent engineer to check all of the concessionaire's designs for compliance. Although the concessionaire had 90% of the system designed, a redesign was needed because of alignment changes and the requirement of the BTSC consultant for proven systems with a service life of at least 5–10 years.

The stations had to be built on 9-m-wide columns placed in the central median and 12 m above the roadways to minimize any disruption of existing utilities during construction. Some of the station designs are unique because of their location and because they had to be nonharmful to the environment.

The concessionaire mentioned that the system integration was a challenge because of the specified type of equipment. Another major hurdle was traffic management during construction, which initiated some of the innovative construction techniques used for the stations.

The concessionaire had several major design disputes to resolve, which the BTSC's independent engineer helped facilitate. The longest-running dispute (2.5 years) dealt with radio frequencies. Another lengthy dispute (1.5 years) involved the location of the train depot.

**Mass Rapid Transit Authority (MRTA)**

MRTA's consultant establishes the design criteria and standards, as well as the procedures and process for ensuring quality control. The selected consultants developed high-level performance specifications and preliminary designs to approximately a 10–15% level, but the architectural designs are advanced before the project is bid. The government hired an independent engineer to assist the design consultant with the review of the concessionaire's detailed designs and construction. The design and construction contractors take full responsibility for ensuring that design and construction complies with the specifications and standards and provides the required life-cycle.

The design consultant and construction contractor are responsible for project coordination, including coordination with government agencies.

The biggest challenge that MRTA's consultant has been tasked with is managing six different contracts. The six contracts were not bid at the same time, causing delays with interfacing the contracts and with construction and affecting the delivery schedule of various components.

Another potential problem is traffic management during the construction phases. Each construction site is managed in subsets corresponding to the concessionaire's construction plan of the stations.

The consultant facilitates the resolution of design disputes and conflicts between the owner and contractors. The major design dispute with one of the contractors thus far has been water leaking into the tunnel. This dispute went before an arbitrator, and the contractor lost. MRTA managers can immediately stop payment or request a redesign if the contractor does not comply with the design standards. Also, liquidated damages are enforced if key dates are not met.

Although there has been a significant number of change

orders during this first phase of the project, MTA staff stated that all of the disputes to date have been resolved.

### Sydney's Integrated Transportation Action Plan

The Sydney government hires a consultant to provide a performance-based specification for the Sydney government's tunnel DBOOT projects. The government provides no design criteria or standards for these types of projects, but the contractor must adhere to 151 terms of condition. The government handles rail and bus DBOOT projects differently. Several consultants assist with the in-house designs before bid. Contractors are selected for their innovative ideas and experience and for adherence to strict cash flows, which is part of the contract requirements.

Depending on the type of project—DB or traditional DBB—the consultant might design anywhere from 10% to 60% for civil construction documents. The consultants support the in-house work of station designs, which are typically designed to the 75% level (systems are usually designed to the 30% level). The selected consortium then has full responsibility for completing the design and construction of the project. In the DBOOT project, the government specifies the standards and provides high-level performance specifications; the selected consortium then becomes fully responsible for completing the design and construction.

The government relies on consultants for project oversight during the construction phase.

The government's consultant develops mechanisms to handle contractual disputes. Typically, an independent engineer is hired to assist in checking the design and dispute resolutions. The government allows contractors to subcontract signal or interface installations back to the government to avoid design disputes that may increase the project cost.

## FINANCING DB PROJECTS

Private-sector financing of public transit infrastructure projects is a popular concept that has emerged in recent years. In a DB project, a public sponsor responsible for a transit system combines the design, construction, and, in some cases, financing and operation of a transit project into one or several contracts so as to more effectively manage risk.

Throughout the United States and around the world, there is a major effort to more effectively allocate the risk of infrastructure projects between the sponsoring public agencies and private contractors that design and construct these projects. The theory behind the DB approach is that risk should be allocated to the party more able to manage that risk.

The parties involved in financing a DB project may include the sponsoring public agencies, an equipment manufacturer, licensed architect and engineering firms, a general contractor, and associated specialty firms, depending on the nature of the project. Some DB projects are also associated with real estate development or other activities linked to the transit project that can generate a revenue stream to assist in the project financing. These associated activities require professionals such as real estate developers, appraisers, real estate market analysts, urban planning and design specialists, financing and legal professionals, and environmental specialists.

The sponsoring agencies vary depending on the type of project being considered. In the case of high-speed rail projects, the public entity has most often been a special agency created by the state legislature to oversee the project. This agency, in turn, may rely on the state government to provide assistance in reviewing project design, reviewing environmental impact statements, obtaining all necessary permits, monitoring construction, and providing general support from other agencies on an as-needed basis. The sponsoring agency also may contract out these assignments to the private sector.

Sponsoring agencies in intercity projects may include transit agencies, commissions, regional governments, and/or state, federal, county, or city governments. Sponsoring agencies would use their own staff or contract out to the private sector responsibility for the oversight functions required in a DB project.

The composition of the private partner and its legal structure also varies. It may consist of a new company created for the project, a prime contractor or joint venture of existing companies, partnerships combining the real estate development and the rail project, or a combination of these approaches. In most cases, an equipment manufacturer, usually the vehicle provider, plays a primary role, along with the general contractor.

The legal structure of the private partner is important because the government sponsoring agency relies on the private partner for any guarantees regarding completion of the project and revenue operations. The government sponsoring agency must be satisfied that the entity has sufficient working capital to prevent delays, has a good track record in the industry for completing similar projects on time and within budget, and has a reputation for settling contract disputes and change orders in a fair and efficient manner.

The sponsoring government agency is accountable to the elected officials that established the public policies allowing the project to proceed. The sponsoring government agency ensures that the project complies with the legislation and other legal conditions that authorize the government agency to sign a DB agreement. The authorizing legislation will provide guidance on the structure of the agreement.

The primary roles of the sponsoring agency are to select the private partner, negotiate a DB agreement, and monitor the progress of the project.

Project financing ultimately depends on the revenue base, which supports the financing package. In cases where user fees are part of the revenue base, the elasticity of the fee structure on revenue capacity is an issue. For transit, the

issue of elasticity extends to nonoperating revenue sources, such as dedicated local option taxes, which directly affect the capacity to support project financing.

Financing a DB project with contractor participation brings the financial capability of the private contractor into the process, creating a set of issues that, if approached correctly, may assist in bringing a financial package to the market and, in turn, achieve market acceptance.

The private contractor's financial capacity and project performance are factors that rating agencies have considered in evaluating securities to finance transportation infrastructure projects. Of primary importance is the condition of the private contractor's balance sheet and recent income statements. These documents are regarded in the context of having the financial capacity to maintain an aggressive construction schedule toward successful project completion. The issue is one of maintenance of an adequate cash-flow position while awaiting progress payments. The contractor's financial capacity is also at issue in cases where the contractor has an equity interest in the project, which may be in the form of a note receivable. This type of vendor financing represents delayed profit taking, which has a measurable effect on the income and working capital of the contractor.

One of the greatest benefits of DB projects is the opportunities they afford for private-sector financial participation. These opportunities may include supplier financing of construction or equipment, either directly or through supplier-arranged loans or equipment lease/buyback arrangements. Additional funding support may be tied to related land development, where transit infrastructure projects create opportunities for real estate development around the station locations (i.e., transit-oriented development).

The fundamental effect DB has on financing is in terms of the impact on cash flow. By creating an optimum construction schedule, DB creates demands on cash flow to meet the drawdown requirements of a fast-track construction schedule. This effect has implications for the types of financing mechanisms that are used to gain access to capital markets.

## Financing Issues

A discussion of project financing may be divided between construction financing and permanent financing. Construction financing is short term in duration and carries an interest rate premium reflecting the lack of collateral offered by the project. Permanent financing is arranged at project completion.

The upside risk in transit operations is increased ridership. Pricing, which is not intended to cover costs, and increased ridership concentrated in peak periods (rather than off-peak periods) frequently require increased service levels. Increased service levels lead to widening operating losses. Attracting permanent private financing, as part of a transit DB method, requires some incentive related to operations. This incentive could take the form of bonus payments for increases above a target level of ridership that included achievement of a specified operating ratio. However, while some formula related to service could be developed to create upside risk, it would ultimately add to the subsidy requirements for transit service. (This addition would exacerbate the primary problem currently confronting the U.S. transit industry—namely, funding for operations and maintenance.)

## Hong Kong Eastern Harbor Crossing Project

The Hong Kong government has formulated and implemented a territorywide plan designed to reduce congestion and provide efficient transport links to all parts of the territory. The construction of the Eastern Harbor Crossing was an essential part of that plan. See Figure 5.

The crossing, which cost Hong Kong about 3.4 billion HKD ($435 million) is the largest single transportation project undertaken by the private sector in Hong Kong. It is a complex tunneling project comprising 8.6 km of roads and a 5-km extension to the mass transit railway. The new tunnel has significantly eased cross-harbor road and rail congestion.

The 2,300-m project provides a road and rail crossing of Victoria Harbor between Quarry Bay on Hong Kong Island and Cha Kwo Ling on Kowloon Peninsula. The crossing was achieved by means of an 1,860-m immersed tube placed across the harbor, with cut-and-cover tunnels forming the approaches for the road and rail tunnels on the Kowloon side and bored tunnels on Hong Kong Island.

The immersed tube consists of 15 units, each constructed of reinforced concrete and having a deadweight varying between 44,000 tons and 46,000 tons. The units house five separate conduits, of which two accommodate the railway, two accommodate the road, and one forms a service and ventilation duct. Ventilation buildings situated at each end of the immersed tube not only provide a separate ventilation system for the road and rail tunnels, but also house the auxiliary electrical and mechanical service equipment.

From the late 1970s to the early 1980s, the Hong Kong government had been actively considering a second road crossing of Victoria Harbor to overcome ever-increasing traffic congestion. However, the government had yet to crystallize its thoughts on this matter when, in June 1984, it received a proposal from Kumagai Gumi, Marubeni Corporation, and MTR for a combined road and rail crossing. After discussion, the government called for open tenders in October 1984, and on April 1, 1985, the government received nine international bids. In June 1985, three bids were placed on a shortlist. Kumagai Gumi expanded its consortium to include the China International Trust and Investment Corporation of the People's Republic of China; Paul Y Construction Company, Ltd., of Hong Kong; and Liley Construction, Ltd., of Britain. Together, the companies formed the New Hong Kong Tunnel Consortium.

After extensive negotiations, the government announced in December 1985 that the consortium led by Kumagai Gumi

*Figure 5. The Eastern Harbor Crossing includes a 5-km extension to the mass transit railway, helping to ease congestion between the Hong Kong Island and the Kowloon Peninsula.*

was the successful bidder. The Eastern Harbor Crossing Ordinance, providing the legislation granting the franchise, was passed, and construction started on the project in August 1986. Construction was completed in September 1989, 4 months ahead of schedule.

The organization of the project includes separate road and rail companies and franchises. The New Hong Kong Tunnel Company, Ltd. (NHKTC), the road tunnel company, is owned by the government of Hong Kong; China International Trust and Investment Corporation of the People's Republic of China; Kumagai Gumi Company, Ltd.; Marubeni Corporation; Liley Construction Company, Ltd., of the United Kingdom; and Paul Y Construction Company of Hong Kong.

The Eastern Harbor Crossing Company, Ltd. (EHCC), the rail finance company, is owned by Kumagai Gumi and China International Trust and Investment Corporation. The main contractor is Kumagai Gumi, which has entered into a fixed-price, lump-sum DB contract with NHKTC, which has contracted with EHCC for design, construction, and management.

A 4.4-billion-HKD ($565-million) multisource debt and equity-financing package was arranged for the Eastern Harbor Crossing Project. The package consists of a 3.3-billion-HKD ($429-million) debt-financing package and 1.1 billion HKD ($135 million) in equity. The owner of the road tunnel (NHKTC) was to receive 2.8 billion HKD ($359 million); 1.6 billion HKD ($205 million) was for the owner of the rail tunnel (EHCC).

The financing structure was designed to accommodate the objectives and constraints of the project sponsors and future shareholders, financial institutions, and the Hong Kong government. The financing structure effectively integrates bank credit facilities, provided by a syndicate of local and international banks, and installment sales credit facilities, provided by Japanese and Chinese leasing companies, with a common security package.

Terms for the project debt financing include repayment provisions extending to the year 2007 with no financial guarantees, "soft loans," or special aid from any government. The debt will be repaid solely from road tolls and rail operating payments to be made by MTR.

Security for the debt and equity financing rests largely on the 30-year road and 22-year rail franchises granted in August 1986 to NHKTC.

Separate and independent debt and equity financing for the road and rail tunnels were structured to satisfy the government's detailed requirements as set forth during the franchise competition, while at the same time creating a sound basis for both creditors and investors to put their

money at risk. This separation enables NHKTC to issue equity capital in the Hong Kong market at an appropriate time and permits the general public to share in the anticipated financial success of the project in years to come. The terms and conditions of the debt financing permitted the shareholders to receive dividend payments subject to the satisfaction of certain financial tests.

The financing package also allows the two-project companies access to the most cost-effective finance sources available, including fixed- and floating-rate bank loans and negotiable instruments, tax-based leases, and export credit.

The financial risk of the project was managed through the following:

- Only limited and nonrecourse credit was used.
- Debt financing was entirely in local currency.
- Equity financing was in currencies considered relatively strong.
- There were major innovations in the project financing structures and in the financing vehicles and terms that were carefully tailored to the particular project.
- The environment provided project creditors with confidence regarding the commercial and political risks for unusually long periods.
- Governments accepted some project risks and have provided limited resources.

### Financing Observations

In the United States, the majority of transit DB projects have been funded through federal grants. The DB project delivery system has not been used widely because of the limitations on federal funding programs for private projects and the less expensive financing offered by tax-exempt bonds, which encourages the public sector to maintain reliance on conventional procurement processes. Although many of these limitations are being relaxed, lenders are still unsure about the opportunities and risks posed by private infrastructure investment. However, with the recent toll road experiences, lending institutions can become more accustomed to assessing the risk associated with transportation projects.

Toll roads provide more examples for DB financing because they generate a steady stream of revenues from user fees. Transit projects can capture revenues from real estate development in and around transit stations. These opportunities are, however, more speculative and depend on the strength of the local economy. Real estate development revenues may not provide adequate security for debt financing and may need to be combined with other revenue sources. Other potential revenue sources include operating agreements, dedicated local tax revenues, lease payments, and fare revenues.

DB projects (or a variation) in the United States tend to be projects that cannot be built under conventional methods, mainly because of limited public resources or time constraints. They are initially proposed and supported by public agencies, which then seek private involvement. However, in Hong Kong, Bangkok, and Sydney, private consortia or development banks often identify project opportunities and propose them to the host governments, contingent upon private funding sources from the various international financial lending institutions. In several international cases, such as the Sydney Harbor Tunnel project, the government made existing facilities available to the project company so that tolls could be used to help finance the project.

The stability of economic and political elements in the project location are important to the success of a DB project. This stability is particularly significant in assessing the risk associated with a project and allocating the risk accordingly.

Including a government agency as an equity partner in a DB project is not unusual. This strategy can provide substantial operating support, credit, or equity, in addition to political support and legitimacy.

## TEAMING AND PARTNERING ISSUES

### Teaming

There is usually a single project manager for a DB project; he or she oversees the entire project and acts as the final point of authority for the planning, design, and construction phases. The project manager operates through a number of consultants, who may be in charge of various aspects of the project. Government-appointed monitors are chosen to supervise and approve the project during the various stages of design, construction, operation, and transfer.

In the case of DBOOT projects, teaming sometimes involves operation and enforcement rights, in which the operator is given rights to charge fees, issue tickets, or collect tolls. The operator may work with the police to enforce these rights, including the right to prosecute citizens. Sometimes a liaison is established to mediate between the operator and the government enforcement entity, such as the police, on issues like violence, road rage, air quality conformity, and environmental concerns.

In general, teaming arrangements have

- Allowed the governments in Hong Kong, Bangkok, and Sydney to undertake more projects without incurring additional national debt;
- Allowed a modest amount of risk to be transferred to the contractor and provided a measure of cost certainty for a number of projects;
- Enabled projects to be put on fast-track schedules, with the result that projects have been completed sooner than they would have been under the traditional DBB approach;
- Enabled the delivery of high-quality standards;
- Helped advance the “user pay” principle as a means of

achieving balance between needs and how to pay for them; and
- Resulted in strategic partnerships, with the net effect of an ongoing long-term technology transfer process.

**Partnering**

Project partnering is a means of dispute prevention and resolution in the construction industry that relies on facilitating communications between the parties to identify and solve problems before they become claims or lawsuits. It is often used in DB projects where a higher degree of communication and collaboration is important to the success of the project. Partnering does not change the contractual relationship between the parties, nor does it change the commercial reality of the business relationship between the parties. As a result, partnering often breaks down when money becomes an issue.

Many of the partnering programs on U.S. transit projects focus on the business culture—namely, communications, trust, and common goals. Sometimes this focus is enough; other times, it is not, and the discontent leads to claims and lawsuits. In most cases, the discontent arises because partnering, in its traditional sense, fails to address commercial reality. That is, the parties to the contract have no means of changing the contract to address commercial reality—the government has no money and, thus, cannot effectively engage in problem solving, even when the problems are caused by the government's own failure to fulfill its obligations. The difference between success and failure often hinges on how well each project team has been able to manage its commercial reality.

Partnering works in Hong Kong because provisions for commercial reality are built into contracts. The KCRC contracts are very specific about lump-sum pricing, but include provisions for additional sums and day work for added flexibility. The contracts have very specific processes for changes, but when administering these processes, the agency is not blind to a contractor's commercial reality. As one KCRC staff member said, "We don't play hardball with the contractors because we don't believe it is good strategy."

KCRC has a dispute escalation mechanism that moves the problems forward. According to the staff member mentioned in the previous paragraph, KCRC is "totally transparent in discussing problems." KCRC has quarterly meetings with the senior managers for the parties to discuss the project's problems and to develop solutions. The senior managers tend to look at problems as business issues and try to solve them in the context of commercial reality. KCRC staff believe that KCRC is particularly effective at addressing problems because, as an indirect arm of the Hong Kong government, KCRC has fewer regulations than typical government agencies have.

MTR also seems to recognize and take a pragmatic approach to commercial reality. According to one MTR staff member, the company "deals with problems on a commercial basis, not just on a contractual basis." The company assumes responsibility for managing the interfaces between contractors. According to the MTR staff member, this responsibility is one reason why MTR needs to take a practical approach when addressing contractual disputes. MTR believes that this style is beneficial because "it is very important to the contractors that the client be predictable." MTR is proud of its "tough but fair" reputation. MTR started using project partnering in a structured format in 1999 and believes that this practice has driven down costs. MTR's goal is to "drive up the contractor's margins by decreasing costs, rather than making claims," thereby demonstrating the extent to which MTR appreciates the importance of commercial reality. This goal even extends to administrative processes: MTR includes its contract administration and legal resources as part of the project teams. The goal also extends to procurement strategies. According to MTR's head of procurement/contracts, MTR staff members are researching the use of target cost contract approaches and are beginning to move toward cost reimbursable pricing methods.

*Bangkok*

In Bangkok, the approach to commercial reality is much different. One agency, MRTA, is using fixed-price, lump-sum contracts for its new light rail subway system. MRTA does not include any kind of performance bonus scheme in the contracts. Furthermore, while MRTA managers say that they "try to avoid disputes," it is unclear what strategy MRTA uses to do this or whether the strategy is successful. Likewise, the Skytrain contract, in which the risk of unknown conditions was shifted almost entirely to the contractor, was considered a success by the contractor because enough contingency was built into the price to cover any unexpected risks. It was unclear how much of a premium BTSC, the owner, paid for this transfer of risk.

In Australia, transit agencies have moved further toward a balanced view of commercial reality, through their use of alliances, which take partnering a step beyond traditional DB contracts by actually changing the contractual relationship between the parties. The parties become "partners" in the real sense of the word, financially and contractually tied to each other's successes and failures, not just "partners" in the figurative sense, as in traditional contracts where project partnering is used.

The alliance method, originally developed in the oil industry, has been used in Australia on private-sector projects since about 1994. Alliance agreements vary from project to project, but they share the following characteristics:

- The alliance agreement contains a clear definition of commercial reality, which typically specifies that direct costs are guaranteed to be covered, but payment of margins, overhead costs, and profit are subject to an equitable system of reward and penalty for exceptional and poor performance.

- The agreement equitably allocates risk between the parties and provides for projectwide risk management, usually through projectwide insurance.
- The agreement specifies a clear decision-making process that is grounded on what is best for the project.

The alliance agreement identifies various performance objectives relating to cost, time, environment, community relations, and safety. These objectives are very similar to the goals and objectives that are developed for a typical partnered project. What makes an alliance different is that, in an alliance, achievement of these objectives results in tangible, financial rewards; failure to achieve the objectives results in tangible, financial penalties. Specifically, the savings that are achieved at the end of the project are available for distribution to all alliance participants, depending on how well the participants achieved the alliance objectives.

A key issue that has emerged since the implementation of alliances in Australia has been that of public accountability—specifically, how does a government agency ensure that public accountability is satisfied when traditional competitive bid processes are set aside? The Australian National Audit Office (ANAO) asked this question in the context of ANAO's audit of a major alliance project, the National Museum of Australia. After an extensive audit of the project, ANAO reached the following conclusions:

- The procurement processes substantially complied with Australia's public procurement requirements.
- Successful project alliances depend on skillful management of the particular risks involved. The financial incentives that were in place were appropriate to encourage "best for project" behavior.
- Project alliances offer potential benefits over the traditional construction contracting methodology, but they raise new and different risks that have to be managed—in particular, determining the appropriate balance between protecting the partners' financial interests and protecting the commonwealth's financial interests.
- The alliance partners had sound processes and procedures in place to appropriately monitor the progress of construction and manage the cost, time, quality requirements, and other project risks in a timely manner.

## PROJECT OVERSIGHT

Owner oversight was performed on all projects encountered on the study mission, regardless of the project type. The level of oversight, however, varied from project to project. In most cases, the owner oversight included reviewing design and auditing quality assurance during construction.

In Hong Kong, the private financing required in the DBOOT projects requires additional oversight. An independent checking engineer is employed to provide oversight during the design and construction. The duties of the checking engineer are to ensure compliance with the design criteria and requirements of the DB contract. These services also were used for quality assurance audits during construction of the project. A committee consisting of representatives from the financier, owner, concessionaire and the DB contractor handled dispute resolutions on these projects. With DBOOT projects, owner oversight continues through the operating period to ensure that proper maintenance efforts are being provided by the operator. At a specified time prior to transfer of the facility, an inspection for heavy maintenance or systems upgrade is held. If the owner determines that these items are needed after this inspection, the operator will implement them. The operating terms typically provide for these efforts and include a mechanism to reimburse the operator. The mechanism includes an accelerated depreciation schedule for the operator and a commitment of the owner to assume any outstanding debt from this owner-requested maintenance or systems upgrade.

The projects in Bangkok generally followed the format described for Hong Kong. For Skytrain, another DBOOT project, the concessionaire employed an independent checking engineer to provide oversight during design and construction. The concessionaire also employed a consultant engineer in an advisory capacity because the concessionaire had very little transit experience and needed advice in developing the DB tender package. The Skytrain project had an oversight committee that included the financier for resolving disputes.

The Bangkok subway project is a combination of the DBB delivery method and the DB method. Government staff or their consultants are designing the civil work for the project. The systems elements, power provisions, and rolling stock are being developed through the DB project delivery method. Scheduling delays in procuring and approval of the DB contract affected the civil work efforts. To keep the civil work on schedule, the owner hired a consultant to develop front-end engineering design support. These front-end efforts developed a conservative template for the rolling stock to finalize the tunnel and station dimensions. Ultimately, the selected rolling stock was smaller than assumed, leaving an oversized tunnel. Even though this conservative approach led to an additional cost for the owner, the approach cost less than if additional tunnel excavation were needed.

The Sydney projects (extension of service to the Olympic Park, the Airport Link, the PRL, and the extension between Alice Springs and Darwin) were a mixture of DB and DBB delivery methods.

## PROCUREMENT METHODOLOGY

The majority of transit infrastructure and facilities projects in Hong Kong, Bangkok, and Sydney are contracted out by the government through an open tendering (i.e., con-

tracting) process, in which the private sector is invited to submit proposals on designing, building, operating, and maintaining the project for a franchise period of 25–50 years. At the conclusion of the franchise period, the system is transferred to the government. The merits of these types of contracts include the ability to tap the experience and capital funding of the private sector, thereby reducing the government's financial risk, and the ability to reduce the size of the civil service staff. The government's role is to define the alignment of the project, conduct feasibility studies, and invite the private sector to provide a proposal through a tendering process.

Hong Kong, Bangkok, and Sydney have approached DB projects in a way similar to the way the United States approaches transit operating contracts or franchises. When proposals are evaluated, the contractor's approach to the project, past performance on similar projects, financial capability, and technical expertise are considered.

The procurement methodology used by government organizations, as well as some private corporations, is in accordance with their participation as procurement entities in the Agreement on Government Procurement (GPA) of the World Trade Organization (WTO). The objective of the GPA is to provide for open and fair competition among domestic and foreign suppliers of goods, construction, and services in tendering contracts when the contract value reaches a certain threshold. (The United States is also a participating party in the GPA and shares this common objective.)

The tender, the response to the tender, and the resulting contractual agreement will define the rights and responsibilities of the government and of the private contractor; include plans to build, operate, and maintain the transit line; include projections of ridership levels and revenue; and have a clause by which the government has the right to take over the contract if the private operator fails. The private operator must take responsibility for compliance with regulations and ordinances. At the end of the franchise period, the project transfers back to the government.

The government agencies, and to some extent the private corporations, choose DB as a project delivery system when there will probably be changes in government or regulatory policy during the period preceding tendering or construction. Choosing DB is one way to avoid going through repeated approval processes at government levels due to changes of politicians and/or staff. The changes that may occur include modifications of the building codes, of permitting requirements, and of contract approval requirements. The procurement process may be condensed by up to 2 years by the reduction in the number of contracts the government must let.

Government departments employ consultants when the necessary staff required to undertake the work is not available in the civil service and the nature and duration of the assignment does not justify the government recruiting or training staff specifically for the project. The consulting services engaged may be in areas such as management, engineering, and architectural support for construction projects. The government's procurement principles of value for money, open and fair competition, and accountability apply to the procurement of consulting services.

### Consultant Selection Procedures

Any consulting service procured depends on the experience, capability, expertise, and method of approach of the selected consulting firm. A specialized set of consultant selection procedures has been established.

Procuring departments typically compile a shortlist of consultants based on their relevant experience in the field and invite them to submit an expression of interest. Consultants who have expressed interest and who have been shortlisted will then be invited to submit technical proposals on the basis of a consulting brief. A consulting brief normally covers the objective and scope of the services, duties and duration of the services, information required from consultants' proposals, deliverables expected where applicable, method of assessing the proposals, and any special features or terms and conditions of the consulting agreement.

To reflect the importance attached to quality and to allow an unbiased assessment of the qualitative aspects of the proposals, the evaluation of consultants' submissions will involve two steps: the technical assessment and then the fee evaluation. Consultants are required to submit technical proposals and fee proposals separately.

The assessment team will evaluate the consultants' technical proposals according to the predetermined selection criteria and then will open and evaluate the fee proposals. At this point, the consultant who has achieved the highest combined technical/fee score is recommended for appointment.

### Dispute Resolution

The design consultant manages disputes and has the authority to instruct the contractor to perform the work, even in a dispute. The contractor, who must make any changes that the design consultant directs, may file claims for additional costs incurred as a result of those changes. An agreement is then made between the design consultant and the contractor to determine the value of the dispute and the resulting change. Dispute resolutions are generally handled with meetings and agreements between the contractor and designers. An unresolved dispute typically goes before an arbitration board.

### Procurement Methods of Private Corporations

Private corporations use the following methods of tendering:

- Open tendering—Tender invitations are published in various publications where appropriate. All interested parties are free to submit tenders.

- Prequalified tendering—Applications for prequalification are invited from all interested parties. Applicants are prequalified and short-listed according to the financial and technical capabilities required in a particular contract. The invitation procedures follow the open tendering procedures.
- Single tendering—A tender invitation is sent to only one supplier. This procedure is used only when circumstances do not permit open tendering, such as extreme urgency or security, proprietary products, or reasons of compatibility.

**Prequalification and Tender Assessment**

Prequalification documents and tenders are evaluated in accordance with preapproved evaluation plans. These evaluation plans contain objective criteria to determine whether the relevant prequalification documents and tenders comply with the requirements of the private corporation.

In general, the following evaluation criteria are used for the prequalification response and the tendering response:

- Technical expertise of the supplier;
- Financial strength of the supplier;
- Relevant experience of the supplier; and
- Supplier's approach toward the design, production, or construction of a related project.

**Hong Kong**

In Hong Kong, the treasury secretary has the overall responsibility for ensuring that all government procurement activities are conducted in accordance with the regulations and tendering procedures. For large contracts, departments must seek acceptance from the treasury secretary before entering into a contract with a successful tenderer. This requirement reinforces the need for expedited processing of contracts and for the DBOOT method of project delivery to alleviate any problems that may be caused by changes in government. The Architectural Consultants Selection Board and the Engineering and Associated Consultants Selection Board must approve the award of architectural and engineering consulting agreements. There is no restriction on the qualification or eligibility of bidders wishing to tender for goods and services invited by way of open tendering, except that overseas companies that tender for works contracts must set up a registered office in Hong Kong or appoint a local agent of good standing.

Contractors may direct complaints about the process or result of a tender directly to the procuring agency, to the relevant tender board, or to various commissions against corruption. The reasons why a tender was unsuccessful are disclosed to the unsuccessful tenderer. Commissions are empowered to investigate a complaint against public tender.

In addition, pursuant to its obligations under WTO GPA, the Hong Kong government set up a review body in December 1998 to deal with alleged breaches of the WTO agreement. Any challenge should be made to the review body within 10 working days after a contractor learns or reasonably should have learned the basis of the challenge. The review body may receive and consider a late challenge, but a challenge shall not be considered if it is filed later than 30 days after the basis of the challenge is known or reasonably should have been known.

**Thailand**

Thailand's procurement system is highly decentralized. Each of Thailand's 200 government agencies can procure the goods, services, and works it needs itself. The prime minister's office, by cabinet approval, has authority to issue and update regulations that stipulate procurement procedures and standardized contracts. All government agencies in central administration and provincial administration must comply with these regulations. Local administration and state enterprises, though not under direct control of the central government, have to uphold key cabinet procurement policies, such as the preference for Thai products. The Bureau of the Budget plays a role in overseeing government procurement by stipulating standards for some commonly used items (for others, the procuring agency can set its own specifications). The auditor general has oversight power over government procurement by auditing and evaluating procurement activities of any agency. The prosecutor general plays a role in reviewing any bidding document and contract that does not follow standardized forms.

Procurement regulations aim to spend public funds economically and efficiently, give fair and equal opportunity to anyone to supply goods and services required, prevent corruption, and respond to the government's social and economic policies. Competitive bidding (i.e., open tendering) is the best method of achieving these objectives and must be employed for higher value contracts.

Procurement of goods and services, excluding consulting and engineering services, is handled according to one of the following five procedures:

- The "price agreeing" (i.e., negotiating) procedure applies to contracts of not more than 100,000 baht ($4,000).
- The "price inquiry" (i.e., selective tendering) method applies to contracts of 100,000 baht to 2 million baht ($4,000–$80,000).
- Competitive bidding (i.e., open tendering) applies to contracts of over 2 million baht ($80,000); under the international competitive bidding variant, invitations to tender are prepared in English, and foreign firms may bid. The price inquiry method is simpler than competitive bidding in that it imposes less stringent requirements for publicizing tender notices. Under competitive bidding, bids are evaluated first against the technical criteria stipulated by the procuring agency; the lowest-

price bid is then selected from among the bids that meet the criteria.
- The "special" (i.e., limited tendering) procedure applies to certain conditions similar to those stipulated in Article XV of the GPA.
- The "special case" method applies in the case of direct contract to authorized government agencies or state enterprises.

For consulting and engineering services, a Thai consultant must be engaged as the leading firm. Consulting and engineering services may be engaged either by direct negotiation with a particular consultant or by screening qualified consultants, inviting proposals, and then negotiating price with the consultant with the best technical proposal. Generally, a project's requirements will indicate qualifications of potential suppliers or contractors. Prequalification may be made for each project by establishing lists of qualified bidders at the procuring agencies.

Under competitive bidding, invitations to tender are advertised at the procuring agency and on the radio or in a newspaper, generally in the Thai language. Full information required by prospective bidders is provided in tender notices. Bidders are then given at least 20 days to prepare and submit tenders for competitive bidding (45 days for international competitive bidding). Some procuring agencies may publish details of contracts awarded on a voluntary basis.

Contractors may lodge complaints directly with the procuring agency, the prime minister's Committee in Charge of Procurement, or the Petition Council. In the case of the Petition Council, the petitioner must lodge the complaint within 90 days of when he or she knew the cause leading to the petition. The council will consider the petition without delay. After the council has reached a decision, any remedial measures will be recommended to the prime minister within 7 days. The remedial measures might include revoking an act inconsistent with the law or without justifiable reason. An interim remedy may be issued by the council itself, when appropriate.

### Australia

In addition to the national or commonwealth government, Australia has six state governments and two commonwealth territory governments. The state and territory governments and the commonwealth government are each responsible for their own procurement within a central framework of procurement policy, principles, and government requirements. The principal objectives of government procurement are open competition, value for money, ethics, and accountability. Depending on the commonwealth or state, there are some preferences for local services. Advertising of bidding opportunities is not required if there is a limited list of approved providers. There is also no requirement to publicly disclose bid/proposal results or contents of proposals.

Unsuccessful bidders may complain to their commonwealth's ombudsman that the procurement process was not fair; they are entitled to a hearing, but the procuring agency is not compelled to accept the decision.

There is no public disclosure regulation in Australia, and all bids can be kept confidential. This means there are no bid protests.

## QUALITY ASSURANCE

All the agencies interviewed believed that they had achieved or were achieving a high level of quality in their projects. Quality was recognized as a necessary requirement in all projects and was an aspect that could not be compromised. Quality can be achieved in all types of delivery methods, but may require different approaches.

There are two main approaches to ensuring a quality project:

- Ensure that the organization and structure of a project achieve quality goals and
- Take specific, detailed actions to ensure quality throughout the project.

Organizational and structural approaches include the method of project delivery (including decisions regarding DB, DBOOT, etc.) and contractor selection and contractual responsibilities.

Specific, detailed actions relate to the process and steps defined by the owner to provide for quality assurance, including quality planning, QC/QA, specific contractual requirements related to QC/QA, and the owner's quality oversight staffing and organization.

The DB project managers in Hong Kong, Bangkok, and Sydney define their role primarily as one of oversight. All recognize that the DB contractor has primary responsibility for QC/QA. Each of the DB projects used a quality audit system to perform this oversight role. An audit process recognizes that not every detail can be checked and inspected. Therefore, the owner selects or audits certain specific requirements to ensure that they meet contract requirements.

An audit process enables the owner to ensure that project requirements are being achieved without being directly involved in the inspection process and duplicating the contractor's QC/QA efforts. As stated by the managers for the PRL in Sydney, "Our oversight will focus on ensuring that the contractor's QA program is working." Similar philosophies were heard in Bangkok and Hong Kong.

Differences were observed for the level of staffing applied to quality oversight. Hong Kong maintained a larger staff because of the limited application of DB and the complex, large-scale projects and interfaces to be managed. Project staffing was adjusted downward in the oversight of the DB tunneling contracts to reflect the assignment of greater responsibilities to the contractors.

Bangkok maintained relatively large staffs to oversee the

quality of its DB or DBOOT projects. MRTA's oversight of its projects includes a front-end design consultant, two civil construction oversight consultants, and a mechanical/electrical systems oversight consultant, along with the program management consultant. BTSC had an owner's staff of over 200 at the height of construction.

Sydney, however, will have a staff of only 30 professionals to oversee the $1.4 billion, 27-km PRL. The oversight function will focus on ensuring that the contractor is properly performing its quality program.

Managers at all three cities believe that they have the proper staffing levels to perform their quality oversight responsibilities. Quality oversight staff varies by agency and project. Personnel for the lead contractor for the Skytrain in Bangkok stated that the overall relationship between contractor and owner was very good and was not hindered by the owner's quality oversight staffing levels.

An approach to ensuring quality in both Hong Kong and Bangkok was the application of an "independent checking engineer." This engineer is a consultant reporting to the owner who provides independent checks to ensure that the design and construction have been performed to meet contract requirements.

On the Skytrain project, the independent checking engineer could review any design and send it back, if necessary. He or she could approve all designs and tests, witness any manufacturing tests, and inspect any construction. Both the owner and the contractor stated that the experience with the independent checking engineer was positive. The owner believed that the use of such an engineer was critical, because Skytrain was the first rail transit system in Thailand and concerns over safety and quality were paramount.

Selecting the contractor is key to ensuring a quality project. Thus, the owners did not use price as the only criterion for contractor selection. Generally, all three cities require the prime contractors to be ISO 9000 certified (ISO 9000 is an international standard for quality systems). Such certification accords confidence that the contractor has an approved quality program and has made the effort to become certified.

Many of the provisions of ISO 9000 do not directly apply to major public construction projects. The International Organization for Standardization (ISO) has been addressing these concerns and is developing revised standards to incorporate these provisions.

Each project and city applied unique processes to ensure quality. Although there were distinct variations, a number of conclusions and recommendations can be made.

Managers on each project believed that their project had achieved an acceptable level of quality.

Each project considered quality as a given in the project results. Quality is not sacrificed in DB projects.

Projects involving new rail systems were likely to use DB or DBOOT as a means for maximizing quality in project delivery. The new organizations did not yet have the technical or managerial expertise to manage complex, new rail projects. They use the experience of a large contractor to deliver a quality product. Larger, more experienced and mature organizations such as MTR and KCRC in Hong Kong are capable of managing the interfaces and overseeing quality and use DB only in specialized applications, such as tunnels.

Selecting a highly experienced DB contractor is essential in ensuring project quality. Contractor selection criteria always included factors other than cost. The ability to assess a contractor's capability during the selection process is essential in ensuring project quality and should be part of any DB selection process.

Most projects required their contractors be ISO 9000 certified.

Although DBOOT project delivery systems are primarily used for financial purposes, they have an important bearing on project quality. A contractor that is required to maintain a facility for 25–30 years has a vested interest in producing a quality product. Poor quality would result in higher operating costs, with a damaging impact on the bottom line.

Project alliances represent a new frontier of project delivery systems. Alliances incorporate a merging of project goals and organizations by the owner and contractor to achieve a common purpose, including quality projects.

All DB projects reviewed used some form of quality auditing, which emphasized oversight of the contractor's quality program.

Owner's organizations to oversee project quality in DB projects varied significantly. The size of owner's organizations ranged from 30 people to more than 200 people. Each project must organize the oversight function according to the unique characteristics of that project.

## OPERATIONS AND MAINTENANCE

An operations and maintenance questionnaire was sent to the agencies and corporations visited on the tour; responses are summarized here.

### MTR Operations Department

MTR operates 923 rail cars over a 82.2-km route. The system is in service 19 hours per day.

Although many of the rail stations had retail outlets and small vendor stores in the station, the mezzanines were free of debris and graffiti. The station floors were polished, shining, and well lit. The interiors of the trains were extremely clean. Fare collection machines were visible, accessible, easy to operate, functional, and appeared to be well maintained.

DB contracting was used by the Operations Department for the train modernization project in 1999–2001 and on new station management systems in 2001–2002. The rail system was completed in 1977, and the takeover period varied from 1 day to 12 months, depending on the defect liabil-

ity from the last delivered train or station. The owner has primary responsibility for operations, and a segment of the maintenance is contracted out. The contractor provides training for the employees, which includes the operations and maintenance (O&M) manuals, familiarization training, and detailed software training (offered in several stages over a 6-month period). The O&M personnel are unionized, and MTR has 1- to 5-year operations support contracts and a maintenance contract that ranges from 2 years to 7 years.

Formal partnering was used in later contracts. As defined by MTR, partnering is a modern strategic business management approach. Formal partnering relationships were developed between MTR and the contractor and include the following: mutual objectives, an agreed-upon method of problem solving, continuous measurable improvement, and the best use of resources. This formula contributes to the successful on-time performance and reliability of the rail system.

The rail system operates at a profit, and MTR uses several O&M approaches to contribute to the system's success. These approaches include clear, succinct customer requirements; close attention to customer requirements; good system integration documentation; eternal vigilance; attention to detail; and experienced personnel. MTR's project management approach is proactive and hands on, and its O&M staff worked with the engineering department to establish user needs at the start of the detailed design phase of the project.

### Bangkok BTSC

The Skytrain system in Bangkok is very reliable and operates on time. The stations are extremely clean, as are the interiors of the railcars. Platform signage and graphics are very visible and legible. Station and security personnel in the stations are extremely courteous and professional. In addition, station interiors are well lit at all times, and station exteriors are well lit at night. Station attendants sell fare cards, provide directions, and distribute maps and entertainment brochures to passengers.

BTSC is responsible for operations; maintenance services are provided by a contractor (Siemens), which also provided as-built drawings and maintenance documentation. The contractor used the train-the-trainer approach, and training started 18 months prior to when the railcars went into service; continuing training is provided as necessary. The O&M personnel at BTSC are not unionized. The operations contract was let for 2 years; the maintenance contract runs for 5 years. There were informal teaming relationships established during the construction process. The contractor used two unique O&M approaches on this project: continual cooperation with the owner to enhance the system and improve ridership and a vested interest in the success of the system after the contract is completed.

The BTSC staff is extremely satisfied with the capabilities and performance of the contractor on this project. The contractor was also involved in planning and building the system.

### Sydney Parramatta Rail Link

Responsibility for operations and maintenance for the PRL, which is now under construction, lies with the owner (State Rail Authority). PRL will provide the owner with as-built documentation and warranties.

### Effects of DB on Operations and Maintenance

DB issues related to O&M were not central items of discussion on this mission and were not addressed in great detail. According to the results of post-mission surveys, however, several O&M issues in Bangkok, Sydney, and Hong Kong railway systems appear similar to the O&M issues in U.S. railway systems. These issues include the time frame for training personnel, the use of train-the-trainer approaches for equipment and systems, receipt and documentation of as-built drawings, transition periods from contractor to owner that ranged from 6 months to 2 years, and a mix of project delivery methods, each determined by the type of project.

There were also significant differences between O&M in the United States and O&M in Asia and Australia, including the following:

- Asian and Australian governments use private companies or concessionaires to operate their rail systems. As a result, the private-sector focus on profit margins seems to influence and encourage collaboration among operations, maintenance, and engineering early in the design stage.
- The Asian and Australian governments rely on O&M contractors for infrastructure projects and rail systems to a greater degree than is typical in the United States.
- Of the three countries visited, Thailand has the only system currently operating with nonunionized personnel, and this situation is not expected to change.
- Formal and informal partnering relationships have been advantageous to the owner and to the contractor.

## JOINT DEVELOPMENT

In Hong Kong, Bangkok, and Sydney, the method of project delivery is, for the most part, incidental to the creation of joint development projects. Joint development is a transit-oriented project built on land owned by a transit operator. Such projects are physically or functionally connected to a public transit facility. Although the primary purpose of the development is to promote transit ridership, a growing goal of joint development projects is to create an income stream for the transit operator, which can then be used to support both operating and capital expenses.

The magnitude and success of joint development programs varied greatly among the three cities visited on this study mission. Hong Kong is recognized as a leader in the use of dense, mixed-use development associated with transit projects. Hong Kong also has one of the world's highest rates of transit ridership, as well as population density. In Hong Kong, the transit operator owns a significant number of the joint development projects.

Bangkok, which also has a high population density, still relies largely on automobiles and buses for mobility. When Skytrain opened in downtown Bangkok in 1999, much of the area near the stations was already developed.

Development at or around transit stations in Sydney is primarily in the hands of private interests.

**Hong Kong**

Joint development is an integral part of DB project delivery for MTR, as MTR plays an important role in establishing new property complexes in Hong Kong to develop new stations. MTR has been involved in the construction of numerous major, mixed-use, high-rise communities centered above and around rail stations, including shopping centers, office buildings, hotels, multifamily residential towers, schools, health care centers, recreational facilities, and open spaces.

MTR has an established track record in planning, designing, and managing railway property developments. MTR must obtain the Hong Kong government's consent to develop properties adjacent to or above selected railway sites and to enter into agreements with property developers to build, at the developers' cost, to MTR's standards. The government controls all vacant land and is thoroughly involved in the planning process. In conjunction with the government, MTR prepares a master layout plan that provides for a suitable mix of residential and commercial development and includes the main infrastructure for the site. In the majority of circumstances, MTR is responsible for carrying out enabling works prior to the commencement of the property development. The scope of these works may include the civil and structural works for the property development podium, which comprises parking decks, public transport interchanges, and railway interface and support works. The costs of any enabling works carried out and paid for by MTR are usually reimbursed by the developer as a mandatory payment.

MTR usually divides a large development site surrounding a rail station into development packages, which are, in most cases, then offered to developers by public tender. In special circumstances where it is considered beneficial to MTR, such as where a proposed development is adjacent to a development already undertaken by a developer and where economies can be realized, MTR may invite only one developer to submit a proposal. Bid packages contain a design scheme prepared by MTR to help developers respond. Typically, there are four broad stages in the development award process:

- The shortlisting stage, based on evaluation of development experience and marketing and management abilities;
- The consultation stage;
- The tender invitation stage, in which selected developers are invited to submit offers; and
- The award stage, beginning when a developer is selected and culminating when the terms and conditions of the development agreement are finalized and a development contract is entered between MTR and the selected developer.

Regarding the sharing of joint development revenues, the property developers' costs include payment of the government land premium, which is based on the market valuation of the site. MTR benefits through (1) the sharing of profits with the developers in agreed-upon proportions of any cash profits from the sale or lease of the properties, (2) the sharing of assets in kind, or (3) up-front payments from developers. In some property developments, MTR is entitled to outright ownership of certain buildings (or a share of certain buildings) upon completion.

To maximize opportunities for postconstruction development of adjacent sites with both revenue and ridership potential, MTR installs the infrastructure components necessary for joint development when the track and stations are being built. Joint development opportunities are a priority for MTR from the inception of the rail planning process.

For station areas on KCRC's West Rail project, which is currently under construction, the Hong Kong Special Administrative Region government will decide how the developable land will be used. Nine locations for potential property development have been identified, but they will be made available only after the West Rail project is completed and running. All sites are now under planning by the government, and no definite plans have been confirmed yet.

In accordance with the project agreement entered into between KCRC and the Hong Kong government for West Rail Phase I, KCRC will act as the government's property development agent for the property development projects. Although KCRC will initiate the projects, the government will become the sole beneficiary from the net proceeds of the property sales.

**Bangkok**

BTSC, the concessionaire for the Skytrain system, has no control over developable real estate near its transit stations. BTSC does not own vacant land adjacent to its stations, nor does it have real estate development authority. The system was thus built without much consideration of nearby development, and the company instead focused its efforts on convincing existing building owners to link their businesses to the Skytrain stations.

BTSC does, however, solicit bids from marketing contractors to handle all commercial areas and advertising in stations

and trains. As BTSC is a private company, the process is simple, much like any other private procurement process.

At one point in the development of the system, the Treasury Department (which owned the land used for the Skytrain depot) initiated a project to build a comprehensive office complex in combination with the depot. The project was to include a shopping arcade and office building. The project's planning was conducted independent of the planning for the rail system; when the economy experienced a downturn, plans for the shopping arcade and office building complex were abandoned.

The MRTA (subway) master plan was approved in conjunction with approval of the rail system. The plan recognized that the development of a mass transit network should be done in concert with the overall development of Bangkok itself. MRTA has not been granted authority to engage in joint development projects. MRTA does, however, develop and rent space in certain stations to retail stores.

### Sydney

Considerable mixed-use development exists around stations throughout the rail system in Sydney. Almost all of this development is privately owned. The government's role in joint development is to create policies that encourage transit-oriented development by the private sector, with the chief benefit to the rail system being primarily increased ridership.

In its l998 report titled *Action for Transport 2010—An Integrated Transport Plan for Sydney*, the government declared that all future urban development in Sydney must be integrated with the expansion of the city's public transportation services and infrastructure. In recent decades, however, Sydney's residential and employment growth has moved beyond the transportation network, making it difficult for many residents to get to and from work without a car. The policy requires that developers do the following:

- Continue to improve the transport network, especially in Western Sydney.
- Focus new development on existing transportation corridors and on major centers.
- Reserve corridors for new transport facilities and guide future urban growth.

The airport line and the light rail to Pyrmont and Ultimo are examples of how major new transportation infrastructure can be integrated with urban development. The airport line opened in 2000, and although the line has yet to generate the level of development and ridership originally projected, new housing and jobs are planned at several stations.

Redevelopment of the harborside suburbs of Pyrmont and Ultimo was planned at the same time as the light rail was being built, so that the light rail could serve the growing population as well as the expanding office, retail, and entertainment venues.

The state government, working with the Parramatta Council, has developed a Regional Environmental Plan for Parramatta Center, which is Sydney's second major activity center and the focus of business, shopping, and entertainment in Western Sydney. This plan combines land use planning, heritage, economic development, and transport initiatives.

The state government is proposing to follow the successful Parramatta example with similar integrated initiatives in Liverpool, Blacktown, Penrith, and the Macquarie/North Ryde area. The government also supports policies to discourage freestanding and isolated retail and entertainment facilities throughout Sydney and is improving its management of employment centers so that the location and design of these centers will ensure easier access for workers, as well as for freight. A new metropolitan parking policy, which severely limits parking in the city, will help manage the use of cars and, thus, improve air quality.

The state government will ensure that new residential developments are built and designed to support public transportation walking and cycling. The following targets have been set for greenfield sites:

- A minimum of 15 dwellings per hectare (6.1 dwellings per acre),
- A maximum of 5 km (3.1 mi) from existing or proposed mass transit (bus or train), and
- Minimum 15-minute frequencies for local public transport during peak periods.

## CONCLUSION

The transportation agencies encountered on the study mission used the DB project delivery method for different reasons. Factors considered in choosing DB included tapping private-sector resources for capital and experience, reducing the risk to government and the burden of infrastructure investment, allowing resources to be directed to other government services, and curtailing the size of the civil service.

Another factor for choosing DB was the political leadership. It is not uncommon for political leaders to want to see infrastructure projects completed during the political leaders' terms in office. Because the DB project delivery method often results in shorter project schedules, it has gained favor with many political leaders.

The revenue service date, which is critical in financing plans for revenue-driven infrastructure projects, is also a key factor in the decision to use DB. Contracts typically do not include incentives for early completion, but contractors know that the earlier the finish, the lower the overall cost and, hence, the greater the profit margin.

## APPENDIX A—STUDY MISSION TEAM MEMBERS

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Richard F. Clarke, Project Director, Regional Transportation District (Denver, Colorado)

Gloria J. Gaines, Assistant General Manager, Metropolitan Atlanta Rapid Transit Authority (Atlanta, Georgia)

Thomas D. Horton, Group Manager, Seismic Retrofit Program, San Francisco Bay Area Rapid Transit District

Janette A. Keiser, Legal Counsel, Sound Transit (Seattle, Washington)

John C. Lewis, Director, Systemwide Maintenance & Improvements, Massachusetts Bay Transportation Authority (Jamaica Plain, Massachusetts)

Dennis Newjahr, Director, Planning & Capital Development, Tri-County Commuter Rail Authority (Pompano Beach, Florida)

Pierre Osei-Owusu, Senior Transit Planner, Durham Area Transit Authority (Durham, North Carolina)

Charles W. Stark, Executive Officer-Construction, Los Angeles County Metro Transportation Authority

Mukhtar A. Thakur, Director, Office of Passenger Rail Transit, Minnesota Department of Transportation

Joel Washington, Transportation Program Manager, Federal Transit Administration

Carol E. Wise, Vice President of Operations, Central Ohio Transit Authority (Columbus, Ohio)

Kathryn Harrington-Hughes, *Mission Coordinator,* Director of Operations, Eno Transportation Foundation (Washington, D.C.)

## APPENDIX B—STUDY MISSION HOST AGENCIES

**San Francisco, California**
San Francisco Bay Area Rapid Transit System

**Hong Kong, China**
Hong Kong Transport Department
Kowloon-Canton Railway Corporation
Mass Transit Railway
Railway Development Office, Hong Kong Special Administrative Region

**Bangkok, Thailand**
Mass Rapid Transit Authority
Bangkok Mass Transit System Public Company, Ltd.
Siemens
DeLeuw Cather (Parsons Transportation Group)

**Sydney, Australia**
Department of Transport
New South Wales Department of Urban Affairs and Planning
State Rail New South Wales
Parramatta/Chatswood Rail Link Group
PPK Environment & Infrastructure Pty., Ltd.
UITP Australia
Booz-Allen & Hamilton
Sinclair, Knight, Mertz

## APPENDIX C—ACRONYMS

| | |
|---|---|
| ANAO | Australian National Audit Office |
| APTA | American Public Transportation Association |
| AUD | Australian dollar |
| BART | Bay Area Rapid Transit (in San Francisco) |
| BERTS | Bangkok Elevated Road and Train System |
| BMCL | Bangkok Metro Company, Ltd. |
| BMTA | Bangkok Mass Transit Authority |
| BOOT | build-own-operate-transfer |
| BRT | bus rapid transit |
| BTSC | Bangkok Transit System Corporation |
| DB | design-build |
| DBB | design-bid-build |
| DBE | disadvantaged business enterprise |
| DBO | design-build-operate |
| DBOM | design-build-operate-maintain |
| DBOMT | design-build-operate-maintain-transfer |
| DBOOT | design-build-own-operate-transfer |
| DFBOT | design-finance-build-operate-transfer |
| EHCC | Eastern Harbor Crossing Company, Ltd. (in Hong Kong) |
| EMU | electric multiple unit |
| FTA | Federal Transit Administration |
| GPA | Agreement on Government Procurement |
| HKD | Hong Kong dollar |
| ISO | International Organization for Standardization |
| ISTEA | Intermodal Surface Transportation Efficiency Act of 1991 |
| ITD | Italian-Thai Development |
| KCRC | Kowloon-Canton Railway Corporation |
| LPG | liquefied petroleum gas |
| MRTA | Mass Rapid Transit Authority (in Thailand) |
| MTR | Mass Transit Railway (in Hong Kong) |
| NHKTC | New Hong Kong Tunnel Company, Ltd. |
| O&M | operations and maintenance |
| OCC | operations control center |
| PRL | Parramatta Rail Link (in Sydney, Australia) |
| QC/QA | quality control/quality assurance |
| TEA-21 | Transportation Equity Act for the 21st Century |
| WTO | World Trade Organization |