Intermodal Concept in Railway Station Design

S. Kandee

ABSTRACT

This article presents perspectives in transport facilities and the design of railway stations influenced by the intermodal concept. The intermodal concept supports the integration of related transportation modes. This concept has been around for some time and has gradually been applied to existing transportation terminals. It is a movement to effectively connect railways with other transportation modes as an interchange. The tendency has recently become evident in several railway stations, affecting their architecture and interior design. Accordingly, the new forms of railway stations were designed to change the conventional image of the stations.

The architecture of the stations has gone beyond the design of main functions, which include core, transition, peripheral, and administrative. Depending on the needs of the station, the design of these spaces has to also include supplementary functions; for instance, integration of light and structure, access for disabled people, and commercial development. It is possible to also see them as an expression of modern technology reflected in their daring structure and use of new materials.

The role of stations and communities is another issue discussed in this paper. Its development gives a significant guideline for the design of intermodal stations. Noticeably, good relationships between stations and their communities encourage commercial approaches and economic growth. These will bring together transportation facilities, commercial development, and local activities that allow the congregation of all classes of people.

INTRODUCTION

The intermodal concept defines the transportation facilities of the 21st century. The idea is described in several ways. It could refer to the interaction between people, services, and different modes of transportation. It is also clearly described by Muller (1999) as "the concept of transporting passengers and freight on two or more different modes in such a way that all parts of transportation process, including the exchange of information, are efficiently connected and coordinated." The mix of transportation facilities will meet the diverse needs of the population. As a consequence, they will form an integral part of the urban setting.

The need for intermodal transportation centers has grown over the years, and the concept is now considered essential to providing convenience for passengers. Hopkinson and Parkinson (1995) defined the intermodal transportation center as a structure combining various technologies of transportation such as regional trains, light rails, bus lines with centers accessible to airports. Moreover many transit planners believe that such centers serve more than just transportation. They include well-designed buildings providing various kinds of integrated services, such as restaurants, newsstands, small shops, and travel information systems. In parallel, the development of the intermodal concept typically pays much attention to utilizing existing infrastructures, for instance, old railway stations or bus terminals which are normally located in central cities. Thus the use of a centrally located station or terminal supports the view that an intermodal transportation center not only forms an integral part of the urban scene, but has the potential for also becoming a tourist center. This trend has already begun in several cities in both Europe and North America where existing railway stations have been converted to intermodal transportation centers. In Asian Countris, like Thailand, this concept has also been applied to the odl railway structure and the new underground system. The linkage of the systems and the integration of station areas at the Central Station or Hua Lum Phong and at Bangsue Junction serve as two such examples.

As pointed out by Floyd (1993) and Tolliver (1995), an intermodal transportation center can be a new form of structure, a distinctive building, or a group of buildings at a single location which are intended to introduce new methods and patterns in handling a large number of people. Efficiency requires that the center is designed and constructed to incorporate the latest technologies and innovations. Many centers built in the late 20th century, for example, have very strong characteristics for combining technology in building structures and systems with architectural and interior design shapes and forms.

THE INTERMODAL CONCEPT AND THE RAILWAY STATION

Dating back to the 1630s, railways were developed in Britain (Vecchio, 1998, p.12). Soon after, they became a major mode of public transportation in many places across the world and served communities with a strong sense of technological accomplishment (Kandee, 2001). Passenger

stations became a new building type and gateways to rail lines connecting cities where technology was expressed through daring structure of the stations. In their early age, large-span train sheds, grand head houses for entrance halls and huge interior concourses were recognized as challenging design solutions of the stations where architecture and engineering perfectly met. Play of materials, texture, light, and space were also another architectural expression that gave the buildings modern presence.

The great age of railway station design was initiated in late 19th and early 20th centuries. Significant influences appeared in the Beaux-Art style, which originated in France. Examples include Grand Central Terminal in New York City, Main Street Station in Richmond, Virginia, and Union Station in Washington, D.C. After World War II, the continuous development of railways slowed noticeably. Since rail passenger service in many places started to decline due to the use of automobiles, the growth of bus transport, and the convenience of air travel--railways were not competitive and many grand stations deteriorated and even closed (Kandee, 2001).

Figure 1. Main Street Station, Richmond, Virginia One of Beaux-Art style stations built in early 20th century.

Railway stations entered a new age again in the late 20th century after the introduction of high-speed trains (Binney, 1995; Powell, 1994). As evident mostly in Europe, many new stations were built, and the old ones were renovated to efficiently serve the system. The revival of the stations was intended to create a continued language in station architecture. Borrowing from the 19th century architecture, the daring construction of very large spanned train sheds and the use of new materials, such as lightweight steel and glass, become a distinctive feature of 20th century railway architecture. Nicholas Grimshaw's Waterloo International Terminal in London is one of the great new stations, which represents this new beginning. With a 1,300 foot-long and a 53 foot-wide shed supported by bowstring-shaped steel trusses, it clearly expresses the challenging work of bringing architecture and engineering together (Parissien, 1997).

Figure 2. Waterloo International Terminal, London
The exterior view of the train shed.
Source: **The Best in Leisure and Public Architecture**, (p.150), 1993.

Figure 3. The interior view showing bowstring-shaped steel trusses of Waterloo International Terminal.
Source: **The Modern Station: New Approaches to railway architecture**, 1997.

Once different transportation modes were unconnected, but today the trend is towards an integrated system. Many railway stations form an interchange between modes of transportation that may include buses, air services, metros, taxi, private cars, and so forth. The intermodal concept is, therefore, being applied to railway stations to reflect a new form of service. In addition to serving intercity rail lines, the concept emphasizes linkages to other transportation systems, the expansion of service across borders, and rail networks linking cities and their suburbs. As a consequence, new forms of station type are required. International, airport, and metro or light rail stations represent different types emerging as distinctive building patterns for railway stations impacted by the intermodal concept (Kandee, 2001; Edwards, 1997).

INTERNATIONAL STATIONS

This station type emerged in the past two decades after the introduction of high-speed trains connecting countries in Western Europe (Binney, 1995). The services of rail lines crossing countries' borders demanded particular facilities that differ from those of other stations. Many facilities have been borrowed from airports and adaptively applied to existing rail services. They include passport control, security checkpoints, and the different levels of departure and arrival pattern.

The Waterloo International Terminal in London is an excellent example of this type of station. It utilizes many of the characteristics and functions of airports and provides different levels for departing and arriving passengers. The extraordinary structure of a 1,300 foot-long shed added to the old structure and supported by steel trusses also strongly expresses the language of airport architecture. Train tracks are on the third level. The floors below the train shed are designed to handle 15 million passengers annually with terminal services providing easy access to and from the concourse located on the ground level (Binney, 1995).

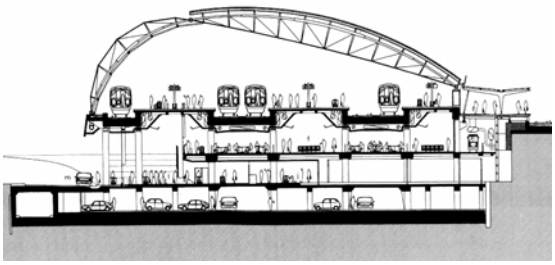

Figure 4. Waterloo International Terminal, London Cross section showing different levels of departure and arrival.
Source: **Railway Stations: Planning, design and managemen**t, (p.252), 2000.

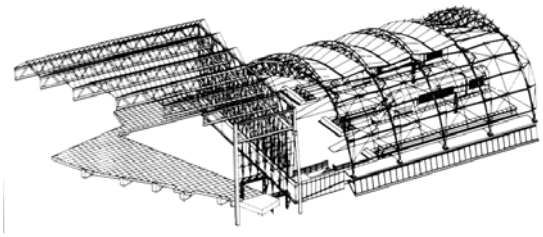

Figure 5. Waterloo International Terminal, London Dissected Perspective showing platform level on the third floor and its roof.
Source: **Railway Stations: Planning, design and management**, (p.254), 2000.

AIRPORT STATIONS

Linking airports to inner cities via rail lines is one convenient way for passengers to access airports. This connection requires that railway facilities are located at the airport. Therefore, such railway stations are constructed as additional parts of airport buildings and some facilities with selected design elements adapted from the airport terminals to these stations. Obviously, the space provided must be sufficient to meet the needs of air-travel passengers who need extra facilities for baggage and group tours. Signs in a variety of languages are also provided when international travelers use the trains to airport connections.

Copenhagen Airport Station located in Kastrup, Denmark is a good example of this station type. The triangular structure of Terminal 3 is added to the airport's main terminal, and the station is placed at the point of the triangle to serve around 15% of passengers using the airport (Living Architecture 17, 2000).

Figure 6. The exterior view of the terminal 3 and the train station, Copenhagen Airport, Denmark.
Source: **Living Architecture 17**, (2000), 156.

METRO OR LIGHT RAIL STATIONS

Generally, light rail refers to a transit system, which combines the vehicle technology of trams and buses with the characteristics of steel rail engineering. It is well adapted to cities and suburban needs, and also has the advantages of flexibility and less expensive installation and maintenance than a regional rail system (Edwards, 1997, p.52). A good example is the Bangkok Mass Transit System (BTS). It is a street-based high-level light rail system that places most stations on a double cantilever supported by a line of single columns.

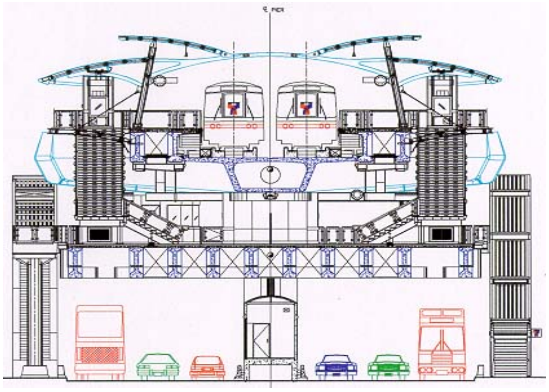

Figure 7. Cross section of a BTS station.

These attributes also make such stations very suitable for linking rail services to airport. Often, a metro station and an airport station may serve simultaneously as the starting and destination points for the same rail service. This necessitates the sharing of certain facilities. For example, baggage check-in and security may be provided at the metro station rather than at the airport station. The Chek Lap Kok Terminal, Hong Kong is a station that provides those facilities supporting air travel. It gives direct access to the airport terminal building for passengers arriving at or departing the airport by rail.

ASPECTS OF STATION DESIGN

The design of today's stations tends to be different in expression from their early age. Presently, they are often designed in such a manner as to take advantage of existing structures that affect the spatial planning. Attention is greatly paid to problem-solving of their interior spaces. There are four main functional areas typically housed in most stations; core, transition, peripheral, and administrative areas (Kandee, 2001, p 14).

Core areas focus on processing passengers. Conceptually, they can be considered as a circle surrounded by closely related areas that includes ticketing, information, baggage handling, reclaiming, and waiting.

Transit areas connect transit facilities in the core areas to the transportation modes. They usually include secondary, but often-essential facilities such as, restrooms, telephones, and commercial spaces.

Peripheral areas support circulation outside the main buildings. They often include platforms, tracks, and vehicle service spaces.

Administrative area control both traffic and station management. Found only in some station types that provide complex arrangements for handling a large number of passengers. These areas can be isolated from other facilities or inserted among them.

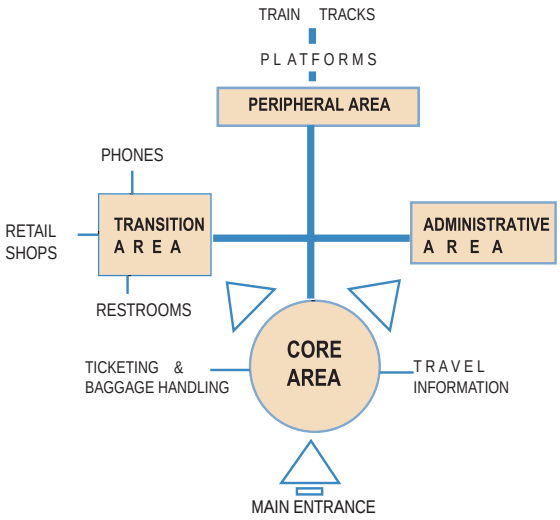

Figure 8. Flow diagram of functional elements within railway stations.

Table 1 Functional Standards of Four Main Areas in Railway Stations

	Activities	Area requirements	Users	Comments
Core Area	**Departing** - Checking train schedule. - Ticketing. - Baggage handling - Fare collection. - Gate check-in. - Waiting. **Arriving** - Meeting & greeting. - Reclaiming baggage	**Main Hall** - Information. - Ticket office. - Ticket machine. - Ticket counters with baggage check -in. **Departure hall** - Automated fare collectors or staff. - Seating **Arriving Hall** - Meeting point or seating. - Baggage reclaim.	- Passengers & guests. - Staff. - Passengers - Greeters. - Staff.	- ticket sales in several forms depending on type and size of stations. - All functions may take place in one open space, i.e., main lobby, ticket hall, etc. or separate areas, but connecting. - An arrival hall is normally the same area as a departure hall.
Transition Area	**Departing, Arriving, Working & Visiting** - Using public facilities. - Walking to vehiclees or waiting around before boarding - Shopping or eating.	**Connecting Area or Main Circulation** - Public service facilities, i.e., restroom, public & lockers. - Amenities, i.e., shops, restaurants and snack bars.	- All users: passengers and their guest, staff, and visitors.	- Public facilities are necessary for any type of station. - The variety of amenities depends on the type, size, and concept of stations.
Peripheral Area	**Departing, Arriving, Working** - Boarding. - Loading and unloading. - Maintenance.	- Platforms. - Tracks. - Workshops or vehicle service areas. - Traffic signal.	- Passengers. - Staff.	- Numbers of platforms and train tracks derive from numbers of passengers a terminal can handle. - Maintenance services are provided only at large terminals.
Administrative Area	**Working & controlling Traffic System** - Working. - Controlling traffic systems and functions in the stations.	- Management office. - Traffic controlling office.	- Staff. - Visitors.	- Locations of administrative office may be isolated from others or inserted among facilities in every area, but they have to be able to control all systems.

Source: **Prototype Intermodal Transportation Center**, (p.15), 2001.

The four areas described above represent the major physical and functional elements considered necessary in establishing an intermodal station and, consequently, must be included in its design. The interrelationships between the four functional areas collectively constitute an intermodal station.

To achieve good functional flows among the four areas, and smooth connections in and out of the stations, their physical relationship needs to be linked together. Additionally, the space capacity must efficiently handle the increasing number of passengers. Clear routes to other transport modes and to pedestrian ways should be well designed and safe to use. The width of routes should reflect the functions within the building and the scale of movement. Other significant features inside the station building need also to reflect functional hierarchies. Passengers should be able to find their way from entrance to ticket hall, to platform, and to train without obstruction. As a result, the main circulation space often has to be expanded physically. In many cases, the different roles of the expanded circulation area are usually defined in terms such as connected concourse, main concourse, main hall and entrance hall.

As Edwards (1997) points out, "the single transportation function of the traditional station has given way to multi-functionalism, which in turn has led to complex and diverse station forms". The voluminous concourse space occurs to serve those complex activities. Space inside may be disorienting. The clutter of shops, stalls, information displays, ticket booths, and so forth, could increase confusion. Thus, the internal circulation reinforcing the functionnal priorities needs to be used in conjunction with narrower routes to help distinguish major and minor spaces.

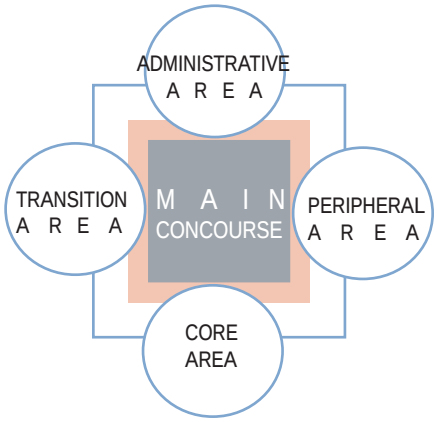

Figure 9. The interrelationships between the four functional areas constituting an intermodal station.

As stated earlier, the complexity of functions results in the consumption of spaces and the organization of activities. The center will not serve a useful purpose if the design accommodates only existing elements without taking into account what is new. The design aspect has to serve more than main functions of traditional stations which provide only normal sequences--ticket halls, waiting areas, platforms, and trains. Many supported functions, therefore, have been combined with the basic ones in order to adequately meet the diverse needs of the public while in transit. These give supplementary aspects discussed as follows:

INTEGRATION OF LIGHT AND STRUCTURE

The structural expression of the station helps achieve the internal circulation by allowing more natural light through the building to aid navigation. Obviously, many modern stations have similar features—framing, columns and trusses. This has meaning in architecture not only for aesthetic, but for practical reasons as well. The manipulation of natural light through transparent roofs and walls, blending with artificial light, could provide passengers the clarity of orientation in the building more effectively than internal signs only. The lines of columns are also important to guide the passengers to their preferred routes. These might be noticeably seen in complex stations containing commercial areas whereas light and structure are used to guide patrons from public to private interests; for example ticket hall to shops or cafes.

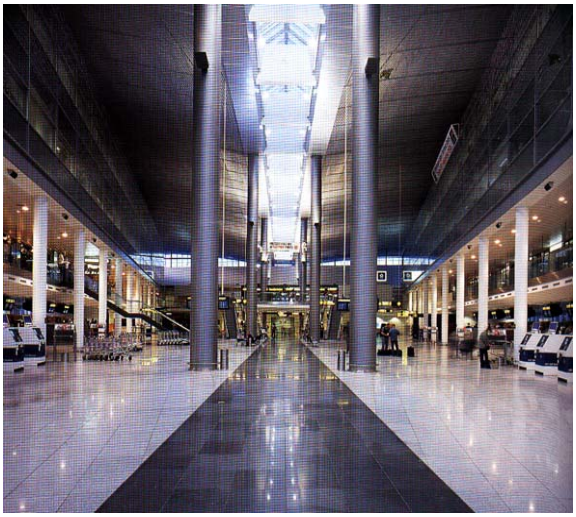

Figure 10. Skylight and lines of columns at Terminal 3, Copenhagen Airport Station, Denmark, help orient passengers to the railway station.
Source: **Living Architecture 17**, (2000), 146.

Figure 11. Mix of natural and artificial light at platform level of Copenhagen Airport Station, Denmark.
Source; **Living Architecture 17**, (2000), 168.

ACCESS FOR DISABLED PEOPLE

The design of the station ought to meet barrier-free requirements throughout the facilities. Accessibility is an issue that concerns everyone. Ross (2000) envisions that disabled people using railway stations are not only people in wheelchairs, but they include blind and partially sighted people, deaf people and those with poor hearing, people with learning disabilities, people with heavy luggage, people with young children, and elderly people. Impediments to access should not be considered only physically, but also psychologically. In addition to solving the problems of steps, curbs, stairs, long walkway, steep ramps, and narrow doorways, some psychological impediments needs to be identified and relieved at the design stage. Examples include fear of crowded conditions, perceived unhelpfulness of staff, unreliable provision of toilets, etc. Those demand attention from both railway operators and designers.

ADVERTISING AND PUBLIC ARTS

Advertising and public arts can be used to brighten up the stations. Besides the architecture of the stations that gives exterior appearances and acts as local landmarks, artwork and graphic design inside could help identify the stations and give them images. They may serve the interiors as either backgrounds or focal points. An outstanding sculpture or painting at the booking hall or the station concourse may act as a good meeting point. The repetition of advertising posters along a distant walkway may entertain the passengers while walking to their trains.

Figure 12. Sculpture of women by Hanne Varming at Terminal 3, Copenhagen Airport Station, Denmark.
Source: **Living Architecture 17**, (2000), 140.

TRAVLE INFORMATION

Travel information systems are essential for any station. Up to date and accurate information is always required. It could be displayed in various forms, for example posters, fixed signage, TV monitors, dot matrix, and LCD. The use of them, however, needs appropriate balance that depends on types and numbers of passengers at each station (Ross, 2000). In station complexes, information should be provided in appropriate forms, and it needs to give decision points which allow efficient space for passengers to find their ways around the building. Certainly, the displays must be visible in all conditions.

COMMERCIAL DEVELOPMENTS

Adopting the intermodal concept makes the station more complex. More functions are integrated, and numbers of passengers are increased. The stations appear to be more than people-processors, but can expedite people's lifestyles. Similar to the design of airport terminals, the trend of the station design is to take full advantage of the time passengers wait around by providing facilities and entertainment. It is evident that many grand stations in the United States, Great Britain, and Japan begin to look like shopping districts that become tourist attractions. Many urban functions are brought inside the stations. It gives the opportunity to bring together restaurants, retail outlets, cafes, offices, currency exchanges, banks, post offices, car rental companies, movie theaters, and so on. The historic Union Station in Washington, D.C. is a good example of this concept. The 600,000 square foot space has been adaptively redesigned and renovated to become a major retail, entertainment, and transportation center (Kandee, 2001).

Figure 13. Union Station, Washington, D.C.
The interior view of the main hall that is redesigned to become a shopping center.
Source: **The Modern Station: New Approach to rail way architecture**, (p.6), 1997.

Developing countries like Thailand are also following this trend. The new subway system giving linkage with the main rail lines will develop the central station, Hua Lamphong Station, as the main business area for commercial purposes. This area will also become a transportation center and an interchange for those who live inside and outside the city center.

CONCLUSION

Applying the intermodal concept in rail services heralds a number of developments**,** one of which is the role of railway stations. The increasing numbers of passengers has resulted in the need for modern and rational designs of stations. The functions of station design are broadened. The form of the building becomes more complex. As a result, conventional stations are gradually replaced by station complexes, which do not serve travel alone. They are not just places where trains stop to collect and deposit passengers, but they become a gateway to and from communities.

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Somruedee Kandee received her M.F.A. (Interior Environments) from Virginia Commonwealth University, USA and B.Arch. (Interior Architecture, Honors) from King Mongkut's Institute of Technology, Ladkrabang. She is currently an instructor in the Department of Interior Design, School of Fine and Applied Arts, Bangkok University.