Breakthrough in Japanese Railways 5

Japan's Rail Stations

Keiichiro Ando

Introduction

Construction of new railway lines in Japan progressed rapidly from the late 1800s due to competition between the government and private railways, but most private lines were nationalized by 1908 to become part of the government network. Some 40 years later in 1949, the government railways were again restructured into the public corporation called Japanese National Railways (JNR). Almost 40 years later again, the 1987 JNR privatization and division split the business into six private regional passenger operators (the JRs) and one freight operator.

Today, passenger railways in Japan consist of 20,000 km of tracks belonging to the six JRs and 3250 km belonging to 22 non-JR private railways; some 550 km belong to public railways.

Modernization of Japan

Japan's first major contact with the west was the introduction of firearms in 1540 by shipwrecked Portuguese sailors not long after Europe entered the Age of Exploration. Firearms changed conventional battles using archery and swords between the regional warlords who were fighting for hegemony in Japan. Christianity introduced at the same time did not fit Japan's feudal politics and was outlawed in 1612 by Ieyasu Tokugawa (1542–1616). Japanese were prohibited from overseas travel in 1635 and the only contact with the Western world was limited trade with the Netherlands at the Dejima settlement in Nagasaki.

This isolation ended in 1854 with the arrival of American Commodore Perry in the Black Ships, but the West's advance into Asia would have a profound impact on Japan. The political regime changed in 1868 from the military Tokugawa Shogunate to the Meiji government with the Meiji Emperor as head of state, which focused on rapid modernization to catch up with the West.

Stations of Early Railways

The new government aimed to secure a footing as a modern nation using a policy of increasing wealth and military power by industrial modernization. Construction of railways forming a key transport infrastructure for industry was an urgent issue.

Japan's first railway (28.9 km) was opened in 1872, 47 years after the first steam railways in Great Britain. It was built by British engineers and ran between Shimbashi and Yokohama with a journey time of 53 minutes stopping at six stations. To Japan at the time, building a nation that could stand on an equal footing with the rest of the world meant westernizing, and architectural styles were ostensibly Western.

The terminal stations at Shimbashi and Yokohama were designed by Bridgens, an American architect. Although they were different in scale, both exteriors resembled the Gare de l'Est in Paris. Each had ticket windows, waiting rooms, left

Shimbashi Station (1872) (The Photographic History of 100 Years of Japanese National Railways, the Railway Associations)

Paris Gare de l'Est (opened 1851) (Author)

luggage offices, and toilets–they were the first chance for ordinary people to experience Western culture freely.

Japanese railways were built by the government and private entrepreneurs competing for routes mainly in and around Tokyo and Osaka. At the turn of 1900, private railways had nearly twice the track length of the government railways. However, the outbreak of the Russo-Japanese War (1904–05) resulted in nationalization of most key private lines for military reasons, instantly reversing the position to some 7200 km of government lines and 700 km of private lines.

A key feature of early Japanese railways was that they were constructed mainly to carry passengers, so many early stations were simple single-storey wooden structures because transport volumes were inconsistent. In 1898, the Railway Bureau presented standard design drawings dividing stations into five classes. Many stations were probably built based on these drawings.

Design of New Stations

Construction of elevated and electrified urban railways started in the 1900s. The industrialization at that time created significant increases in numbers of urban rail commuters, requiring stations compatible with the new railway facilities. Yurakucho Station opened in 1910 was Japan's first under-the-elevated tracks station.

Tokyo Station was completed in 1914 as the central station for Japan. It was designed by Kingo Tatsuno (1854–1919) but the floor plan layout is said to have been proposed by Franz Balzer (1857–1927). It had an entrance on the south side and an exit on the north side, as well as a gate for the Imperial household at the centre. Trains running towards this station were (and still are) described as going 'up' and those running away were going 'down.'

The third floor was destroyed in an air raid during WWII, and the station has been used with a two-storey 'temporary' restoration for 65 years until recently. Construction to restore the station to its original three-storey form with cupolas at the north and south ends is ongoing, with completion scheduled for spring 2011 (see pp. 6 to 13 in this *JRTR* issue).

With steady exports during WWI (1914–18), many second-generation and later stations were beautiful blends of Japanese wooden and Western architecture. Unfortunately, most were lost to later station upgrades and only a few survive today. The major facilities at those times were ticket windows, waiting rooms, and left luggage offices for long-distance travellers. The average life-span of those stations was thought to be about 50 years.

Virtualization of restored Tokyo Station (opened 1914) (1700 Profiles, JR East Design Corporation)

Old Sapporo Station (Third generation, opened 1908) (JR TOWER PHOTO BOOK, Hokkaido Railway Company)

Current Mojiko Station (Second generation, opened 1914) (Railway Architecture News, Association of Railway Architects)

An architectural section was first created in 1920 in the Ministry of Railways Construction Department. It dealt primarily with building design and management. The first design standards for stations were established, along with sizes for waiting rooms and passageways.

The 1923 Great Kanto Earthquake caused tremendous damage across the Kanto region. As a result, stations were changed from wood or stone and brick structures to reinforced concrete and steel with aseismic designs.

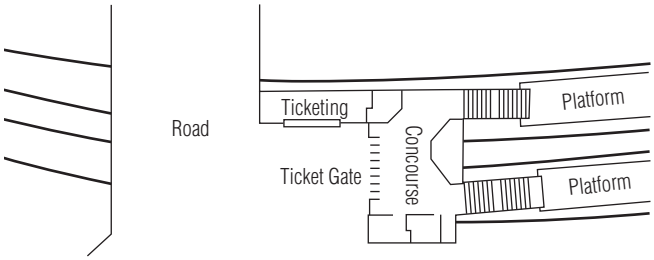
Ochanomizu Station was rebuilt to a new design after the earthquake. It was completely different from previous station structures because it was only for commuters. Flows with passengers moving without stopping by exiting directly to the street formed the design foundation for later urban commuter stations.

Development of urban railways increased from the 1920s. Elevated stations with concourses where people pass freely under the tracks were built to separate road traffic from railways. Kobe, San'nomiya, and Hyogo stations in the Kansai region (around Osaka, Kyoto, and Kobe) had the main part of the station outside the elevated track. However, wide outer concourses (outside the ticket gates) were created under the elevation, and passengers passed through the ticket gate to reach the platform. The broad outer concourses had free passages to come and go under the elevated track. Such a design allowed free access and was easy to understand, so it was often seen in Japanese under-the-tracks stations. Nagoya Station built in 1937 is a typical example.

Birth of Station Building

Station buildings intended to increase passenger convenience with restaurants and shops while increasing railway operator income started appearing at the same time. The first station building in Japan was a five-storey building with 11,000 m^2 of floor area built in 1920 at Umeda Station in the Kansai region by the private Hankyu Railway. The ground floor was let to a department store; there were restaurants on the first floor, and higher floors were used for offices. This was followed in 1925 by the Tenjinbashi Station Building added by the private Shinkeihan Railway to an elevated station; it featured restaurants and shops. In the Kanto region, Tobu Railway's station building in Asakusa in 1931 was the largest of its day with a department store as the tenant. It had eight floors (one underground) with an area of 35,000 m^2. Trains arrived at the second-floor platform, which was connected to the ground floor by an escalator.

Figure 1 Ochanomizu Station (Second generation, 1937)



Tobu Asakusa Station Building (opened 1913) (The 100-year History of the Tobu Railways, Tobu Railway Co., Ltd.)

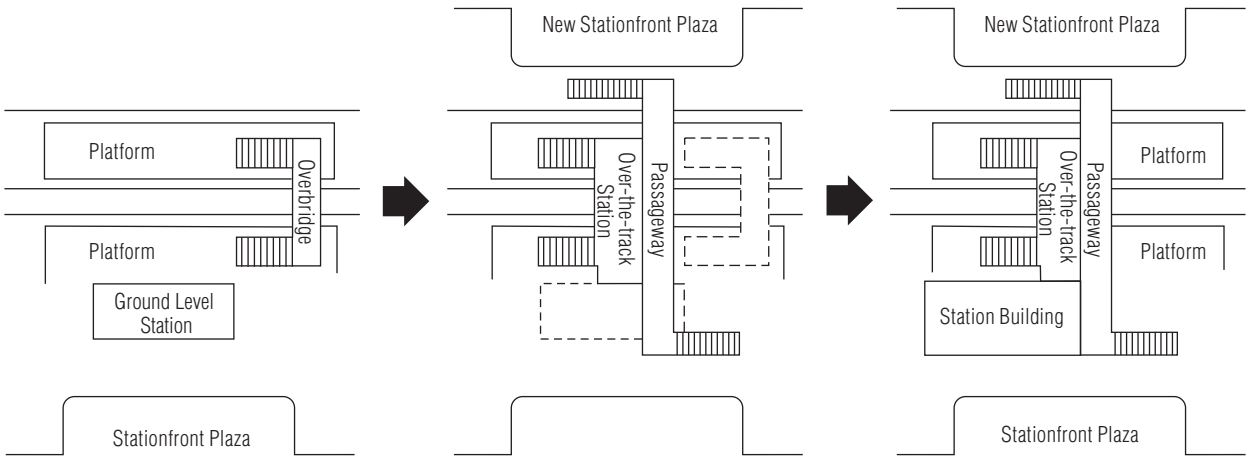
Diversification of Station Upgrade Methods

Japan's WWII defeat in 1945 marked the start of reconstruction of bombed and worn-out facilities. The government railways were reorganized as JNR with the sole purpose of running railways. Restoration of key facilities, such as tracks, took priority and there was little budget for station restoration.

The pace of urban reconstruction was astounding, and demand from communities for station renovation was strong because stations formed the town 'face.' In these tight circumstances, private capital was used to fund station reconstruction. Specific methods were local government taking over JNR debt, constructing station buildings using private capital ('general public' stations), and petitioning for station construction using 100% private capital.

Petitioned stations were those where the community requested that JNR construct new stations. The community provided all funding, but completed facilities became JNR property. In many instances, stations were built at the expense of the developer, especially where there was trackside community development.

Figure 2 Over-The-Track Station Evolution and Free Passageway



'General Public' Stations

So-called 'General Public' stations were constructed mainly by using private capital where commercial facilities and the station merged into a station building and construction costs were recovered by income-earning facilities. Expenses for facilities intrinsic to stations, such as ticket offices, were covered by JNR, while costs for waiting rooms, concourses and toilets were split between JNR and the private developer; costs for restaurants and shops were covered by the private developer who retained the station facility management rights. Toyohashi Station in central Japan opened in 1949 as the first general public station with the ground and underground floors housing station facilities as JNR assets and the first and higher floors as private assets where fees for property use were paid to JNR.

Many stations nationwide underwent renovation using this general public station method. They are similar to the station buildings built independently by JNR. JNR's previously government-regulated business scope was relaxed in 1971 as debts worsened to allow JNR to construct its own profitable station buildings. By the 1987 privatization and division, JNR had converted about 50 stations into station buildings. Naturally, private railways also actively developed station buildings with commercial facilities.

Over-the-tracks Stations

Japanese stations tend to be on one side of the tracks and passengers pass through the ticket gate to access the platform. As a result, station users from the opposite side of the tracks must cross to get to the station. A method to solve this inconvenience and to renovate stations was building stations over the tracks and creating a free passage between the station sides.

JNR's first over-the-tracks station was built in 1954. Many stations thereafter were built in three concurrent parts: over-the-track construction, passage construction, and station building construction.

The process started with a plan to construct a free passage above the tracks to rejoin the community split by the station. Since the existing station interferes with construction of the free passage, the over-the-track station was constructed at the same time. Then the space freed up by relocating the ground-level station was used to construct the station building. The community bore most of the cost for the free passage and over-the-track station construction.

Under-the-tracks Stations

From one viewpoint, urban railways are an inconvenience because the tracks divide the city. Track elevation at road crossings is often required to make cross-track road transport more efficient in densely populated urban areas. However, track elevation is very expensive and JNR asked the Ministry of Transport responsible for roads to bear some costs.

In the 1940s, JNR and the Ministry bore the costs equally but JNR's burden was cut to 33% in 1956 and again to 10% in 1969, while the share borne by private operators was 7%. Projects were implemented as part of urban planning, and even today, elevation is used to create many new under-the-tracks stations.

Station Revitalization

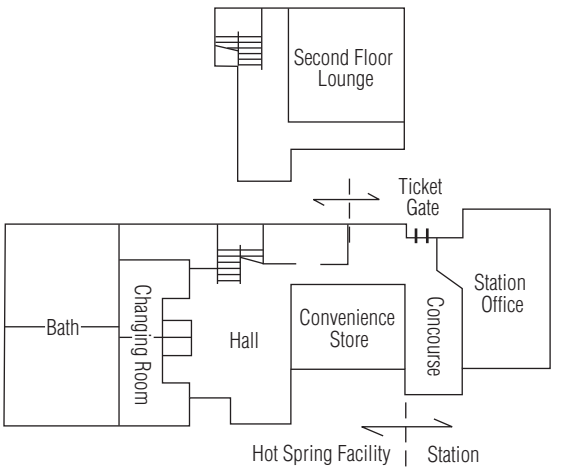
The 1964 start of the Tokaido Shinkansen and subsequent spread of the shinkansen high-speed rail network gave the impression of well-managed railways but JNR was still sustaining continued heavy losses year after year from 1964 as passenger numbers continued dropping. Out of JNR's 22,000 km of track, 40% were rural lines with small populations; the rapid spread of private car ownership in the 1970s and decreases in railway passengers left income from the fare box unable to meet the costs of renovating stations, especially in rural areas. A countermeasure was needed.

Some stations playing a central role in the community but that could never be commercially viable were downsized. In these cases, the local government built a small complex of other public facilities at the station, securing a presence for the station.

The first JNR station to be reconstructed on this basis was Uzen-Mukaimachi Station (now Mogami Station) on the East Rikuu Line. It was rebuilt in 1983 in combination with a public hall. Many similar measures were used to develop stations with less than 5000 passengers a day and to revitalize towns. A variety of stations have emerged with tourist information offices, shops selling local products, event facilities such as public halls and meeting places, citizens' services such as libraries and galleries, hot-spring baths, agricultural cooperatives, and food and gift shops. Those used on a daily basis by local residents still remain vital and viable.

Hotto-Yuda Station on the Kitakami Line with hot-spring baths serves just under 200 passengers a day, but the hot spring had 500,000 customers in 4 years! The village library with park-and-ride functions at Etchu-Funahashi Station on the Toyama Chiho Railway Line loans the most books per citizen of any library in Japan.

Figure 3 Hotto-Yuda Station Floor Plan at Opening



(Railway Architecture News, Association of Railway Architects)

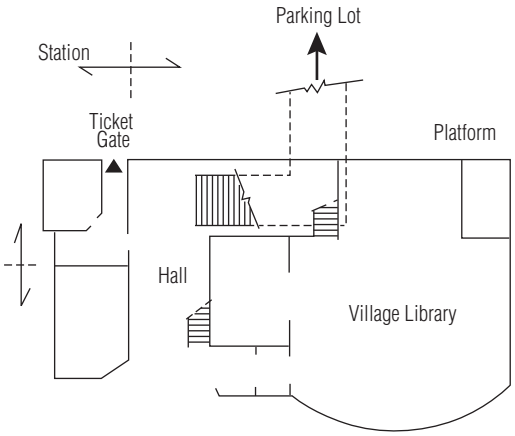
Factors behind Station Changes

Early railway stations were for long-distance passengers, so the main facilities were waiting rooms and left luggage offices. However, the increase in commuters using passes changed the station floor plan from a waiting style to a more fluid form. Station functions and features also evolved according to customer character, railway company policy, equipment advances, and social demands.

The biggest change involves the ticket gate. Seat reservation systems started appearing with the spread of computers in 1964. Ticketing facilities underwent a change with concurrent advances in automatic ticket vending machines and automatic ticket gates. Recent changes from cardboard tickets to pre-paid IC cards have made route changes and transfers easier. However, although mobile phones and the Internet allow reservations to be made easily outside the station, there is still some demand for conventional cardboard tickets, hindering major changes in station layouts.

Left luggage handling has also undergone a major change. Railways no longer handle luggage transport; in

Figure 4 Etchu-Funahashi Station Floor Plan



Japan at least, private delivery companies have taken on that role. Temporary luggage storage has also shifted to coin lockers.

The greatest factor that has changed stations in recent years is the legal requirement to become barrier free. In 2009, approx. 23% of Japan's population was age 65 years or older, a figure unmatched elsewhere in the world. Installation of elevators and escalators in stations handling 5000 or more passengers a day became mandatory with a completion target of 2010. Now, there is a demand to install elevators in stations with less than 5000 passengers. For this reason, installation of people movers by modifying the concourse in a way that does not interfere with passenger flow is underway. Many major station renovations have been made in conjunction with such construction work.

Another issue that has plagued railways for a long time is providing passenger information. Methods including monitors displaying information about train delays have been tried. Today, the Internet is a convenient source of the shortest routes and quickest transfers, but effective in-station methods have yet to be achieved. The information has proved particularly difficult for users to understand in stations with commercial facilities due to crowding, displays mixed with commercial advertisements, and high noise levels.

Recent Stations

As Japan faces a greying society, economic growth is also stagnant. Primary industries in particular are declining due to a lack of successors, and population continues to concentrate in urban areas, causing rural depopulation. Regional urban areas are also seeing a hollowing out of the city centre with the development of large-scale suburban commercial facilities. This has resulted in a remarkable decline in the number of station users and poor business conditions for station buildings. There have been various efforts to rejuvenate the community using station renovation.

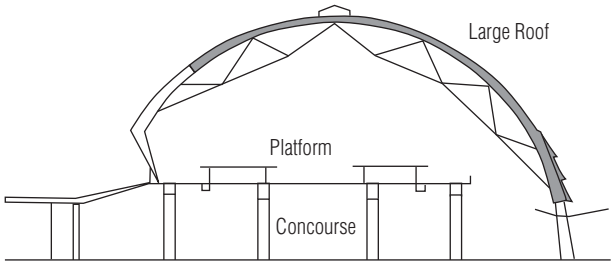
Stations can be classified mainly as: metropolitan stations where commercial facilities are viable; hollowed-out major urban area stations; regional city stations in the process of deterioration; commuter stations in residential areas; and mostly unmanned stations. For hollowed-out major urban area stations, it is important to first stimulate the community. Existing city areas are important assets, and there is a movement to make use of that existing infrastructure and change it into an urban structure meeting the needs of the aging population. This has already been started in Toyama and Aomori cities by forming a compact city concentrating urban functions within walking distance of stations and transport hubs.

For regional city stations in the process of deterioration, the station itself is often made into a local tourist destination in addition to the aforementioned revitalization. Fortunately, some railways have a firm railfan base, and stations in small to mid-size cities have been made into distinctive scenery using local subject matter and images as measures going beyond revitalization. Recent typical examples are Kochi Station on the Dosan Line covered with a large wooden shed in 2008, Ryuo Station on the Chuo main line in a motif of local crystal, and Iwamizawa Station constructed with used rails in 2009.

Ryuo Station (1700 Profiles, JR East Design Corporation)

Figure 5 Kochi Station and Cross Section

(Railway Architecture News, Association of Railway Architects)



Above-station Development

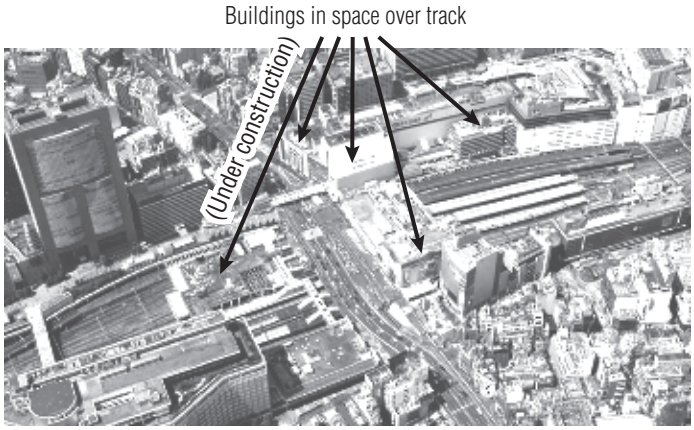
Excluding freight, Japanese railways are structured so that everything from infrastructure maintenance to train operation is managed by the same company. The business mainstays are commuters using passes in urban areas and inter-city high-speed shinkansen. These profitable sectors support regional transport.

As Japanese society becomes more aged, commuter transport is expected to decline, and there is no telling what will happen to railway operations. After the JNR privatization, the JRs tried their hand at non-railway related real estate development. It proved difficult to make profits due to lack of know-how in that industry so now the JRs are using railway assets connected directly to stations to secure non-railway income. A notable example is the intensive use of the space above stations.

As mentioned above, private railways pioneered station buildings, and JNR followed with general public stations. JNR initially carried out intensive use of ground-level stations, but expanded to the space above tracks in 1962 with Tennoji Station. Development is also needed for existing built-up areas in cities, and stations became multi-purpose in the 1980s with urban development projects by the national government.

Shin-Yokohama Station building opened in 2008 is a recent example of reconstruction of station plazas along with intensive use of the railway-owned part of those plazas not previously zoned for use.

Figure 6 Development of Over-the-Tracks Space at Shinjuku Station

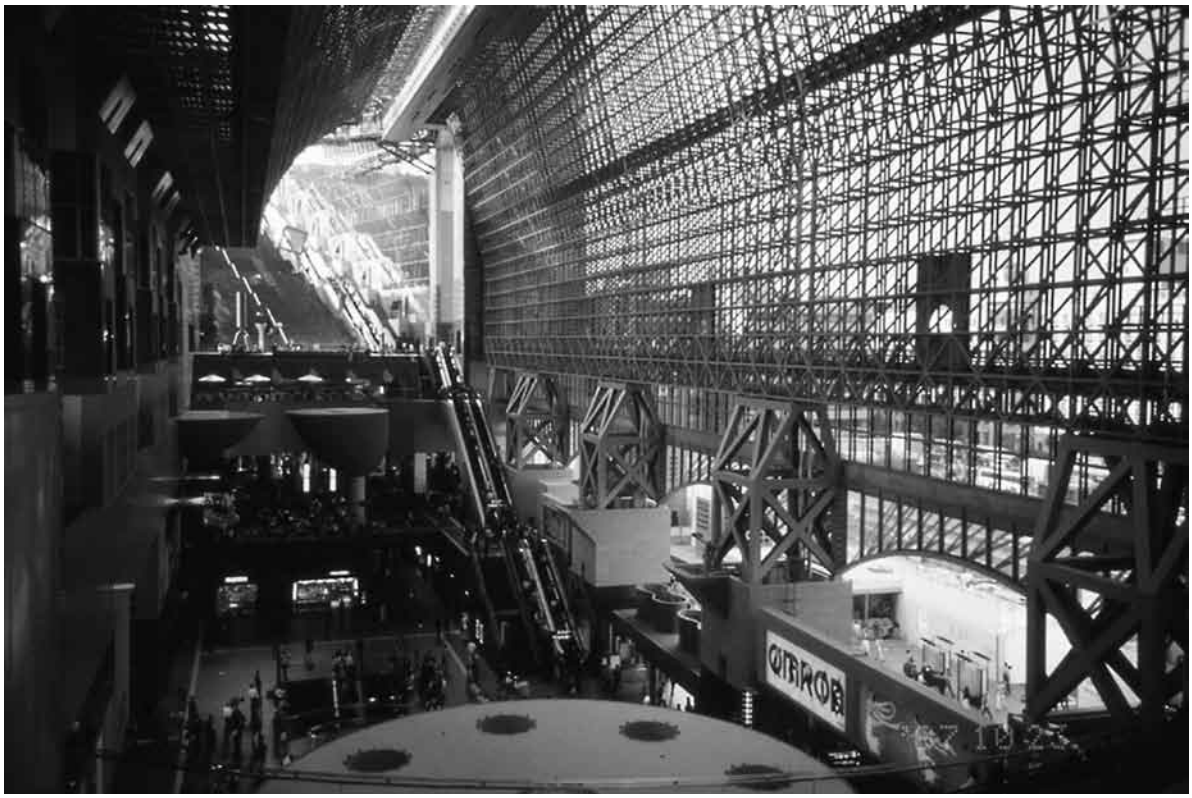


(1700 Profiles, JR East Design Corporation)

Multi-purpose Stations

Intensive land use and conversion to multi-purpose use with multi-functional facilities at major stations in metropolitan areas are being conducted actively by both private railways and the JRs to the extent that they are forming towns within towns. Underground space is being used too. An example of a large commercial space on two underground levels under elevated tracks is Hankyu Railway's Umeda Station completed in 1969.

Kyoto Station (Author)



Kyoto Station concourse (Author)

JR West's 238,000-m^2 Kyoto Station building completed in 1997 is a typical multi-purpose station, featuring a department store, hotel, restaurants, theatre, museum, and government facilities. It sports a grand open ceiling space in the centre, a station concourse with an aerial hallway, and various commercial facilities that share a large open space. JR Hokkaido's 274,000-m^2 Sapporo Station building also houses a department store, hotel, offices, cinema, and more. It changed the face of the commercial district in Sapporo, a city with a population of 1.89 million.

There are many other large multi-purpose terminal stations owned by both the JRs and private railways in cities with populations exceeding 1.5 million, such as Tokyo, Nagoya, Osaka, and Fukuoka.

Shops in inner concourse (ekinaka) of Tokyo Station (Author)

Ekinaka

Japanese stations are commonly separated into an outer concourse that anyone can pass through, and an inner concourse where only passengers with tickets can enter. The border is the ticket gate. Traditionally, the inner concourse has cafes along with small kiosk shops selling things passengers use on trains, such as magazines, snacks, drinks, and sundries.

Recently, there has been an increase in stations featuring large shops, restaurants, and commercial areas selling things such as authentic sweets and prepared foods in the inner concourse. Such areas are called *ekinaka* (literally 'in the station'). *Ekinaka* have been developed especially in stations with multiple lines where many passengers transfer. They cannot fit into the conventional concourse, so they have been built in conjunction with station barrier-free renovations, etc. However, the *ekinaka* concept has been criticized by some local shopkeepers because the railway operator retains shoppers who would otherwise use shops around the station.

Shinkansen Stations

Japan's shinkansen network is based on elevated tracks with no level crossings, so most stations are under-the-tracks. Shinkansen are constructed with public funds, so only the minimum land needed for railway operation is bought and the boundary of the stations must be within the viaduct walls. As a result, it is difficult to design shinkansen stations with individuality.

Since the JNR privatization, shinkansen infrastructure other than rolling stock is financed from the public purse and then leased to the railway operator. As a result, the station construction and environmental improvement, including the station plaza, is up to the local government. New shinkansen stations often have memorable entrances, facilities to promote local tourism, and public facilities attached to the station when the local government sets up the station plaza. This demonstrates how the community has strong expectations that the shinkansen station will help stimulate the region.

Future of Railways and Stations

Railways remain in tough competition with other transport modes and railway operators are working to improve their corporate image and the image of the lines by deploying PR strategies to develop trackside tourism with the goal of increasing passenger numbers and income. This is a unified image strategy encompassing diverse items ranging from crew uniforms and carriage design to design of stations, shops, and guidance.

Japan's greying pensioners are also avid railway travellers who can be targeted by railway operators offering travel packages that satisfy their curiosity. As a result, there are various planned travel products and railway membership programmes with premiums, such as discount tickets.

Station planning is changing alongside changes in travel structure and social awareness. Women often select facilities based on the availability of clean toilets. Thus toilets in city-centre stations have been greatly improved and it is not unusual for them to have powder rooms. While most toilets in Japanese stations are free, they are mostly in the ekinaka inner concourse.

Eliminating level differences between the platform and train is a natural safety measure. Other changes to the

Powder room in ladies' toilet at Ikebukuro Station (Author)

Ninohe Shinkansen Station and city tourism/produce centre and observation deck (Author)

platform include gradual restoration of waiting rooms that were once on the decline and the installation of platform doors on crowded platforms. Greening and use of natural materials is also on the rise with today's increased ecological awareness. Efforts to conserve in-station energy and improve the thermal environment, which were originally left to nature, have started with partial cooling by mist being tried.

Another issue for the future is use of IC chips as tickets. Mobile phones with prepaid IC chips are already available, and the border between travel and consumption is becoming vague as passengers' behaviour changes as features such as curated information, cashless purchase, online reservations, etc., become commonplace. From the railway's viewpoint, it is easier to collect information on customers, and there will probably be advances in customized service provision.

Technical Developments

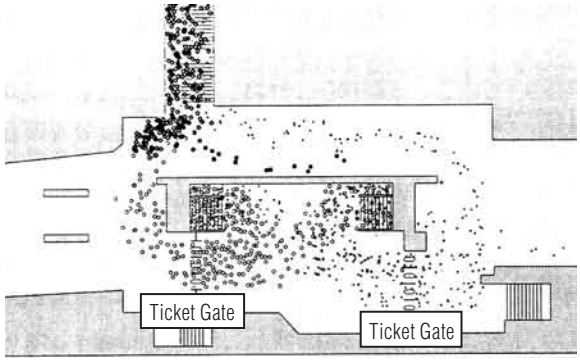
Passenger flow simulation

Stations must assure the safety of passengers so smooth flow is important, especially during rush hours. However, it is difficult to accurately judge the level at a given time in crowded stations with heavy flows.

Research on how to plan Japanese stations, and how to locate facilities appropriately and calculate the scale has been conducted by the Railway Technology Research Institute from the 1930s. Acceptable passenger densities, how to deal with emergencies, and the required strength of station handrails and other facilities are all examples of experience gained from past accidents caused by overcrowding.

Passenger flow simulation using computers was successfully achieved in 1978 to visualize flows second by second, and it is still used today to determine the need for station improvement, especially for crowded rush hour stations with little space.

Figure 7 Passenger Flow Simulation



High-rise Architecture

In 1960, there was a plan to reconstruct Tokyo Station as a high-rise building. JNR conducted research for 3 years on the required aseismic design, because the height of Japanese buildings at that time was still restricted to 31 m. The research focused on switching from rigid structures to flexible structures that absorb seismic energy.

Thankfully, Tokyo Station was not converted to a high-rise structure, but Japan's Building Standards Act was revised in 1964 based on the results of JNR's research. The 31-m height restriction was removed, and Japan's first high-rise building was born as the 147-m Kasumigaseki Building in 1968. ■

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