



Railway Stations – Design and Operation

By

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Introduction

Airport, harbours and stations form interfaces within modes and between multiple modes, providing both intermodal and intramodal connectivity. However, a more in depth analysis reveals that such facilities have functions that go beyond their role of links in a transport chain. The authors discuss some of the issues that arise from the need to satisfy a multitude of requirements, focusing on passenger transport. This paper was developed on the basis of a presentation made to the delegates attending the Intelligent City Forum held in Birmingham on 26 May 2011, sponsored by Rail Champions.

A Beacon for the Area

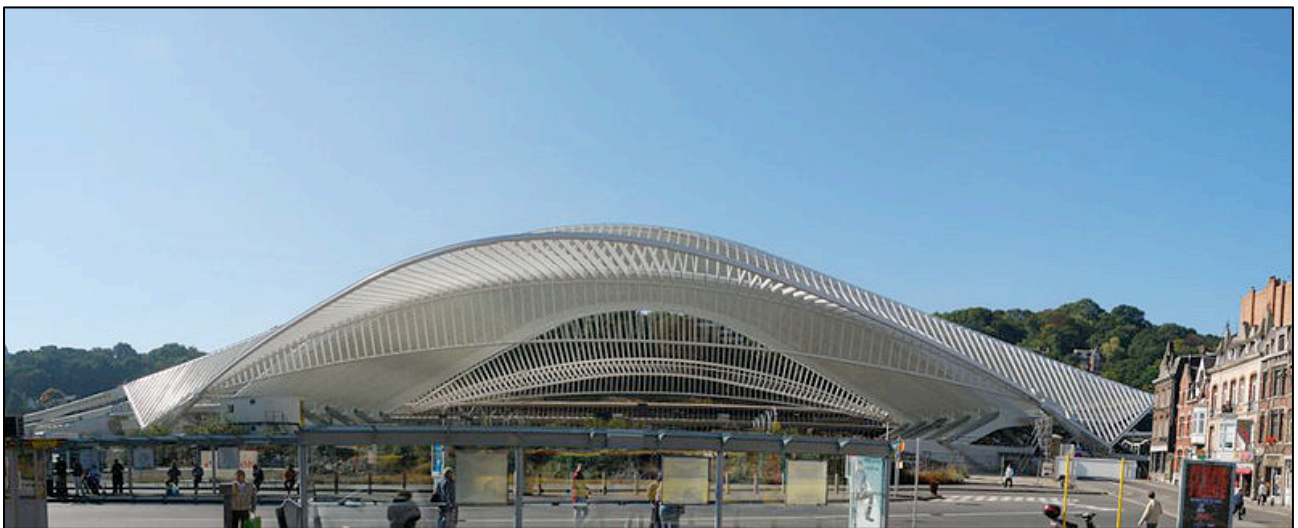


Figure 1: Rebuilt station at Liège -Guillemins, Belgium, designed by the Spanish architect Santiago Calatrava in 2008 and demonstrating the beacon effect. Photo by Le Cointois.

Stations in city environments, with other major structures in close proximity and often surrounded by large, visually and commercially attractive corporate buildings, have to stand out as beacons for the community and the city. They must be eye-catching, built to high standards and they must attract passengers to the railway. Good examples are Berlin Hauptbahnhof in Germany, Lille Europe in France, Liège-Guillemins in Belgium (Figure 1), Beijing South Station in China and the future Canary Wharf station of Crossrail and the renovated St. Pancras in London. However, while a station might have an

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important function as a beacon, it must still be designed to meet the needs of the railway, of the people using it and of the staff running it.

A station is a transport hub, by definition. Even the most humble stop in a tramway network allows interchange between movement on foot and travel by tram. Railway stations thus represent focal points for journey mode changes, places that travellers require for business, commuting and leisure travel. They arrive on foot, by bicycle, car, taxi, bus, coach, tram and metro, and they carry luggage ranging from a small computer bag to a pair of cases each the size of steamer trunks, so they must be able to find the station easily and they must have good access to the facilities and the trains. The station must be designed to allow easy modal changes and to provide a simple approach from within the cityscape.

Circulation

One of the most important requirements of any station is that of accommodating circulation. This relates to movements of trains as well as those of passengers with their luggage and other people such as 'weepers and greeters'. The station also must create a safe interface between the two types of traffic. It is essential that the people movement flows in a station are designed carefully, both during normal operation and during emergencies like security alerts and evacuation. Signage and sightlines form an important part of maintaining efficient flows for passengers, while effective railway control allows trains to arrive in and depart from stations with minimum delay (Figure 2).

Intermodal changes also need careful evaluation, so that passengers arriving by road can access the station facilities easily and without obstructing waiting areas, or exits. Equally, ticket offices and machines need to be positioned and provided in sufficient numbers so that users can queue and access the facility without obstruction and without resulting in shuffling lines of stressed travellers blocking the station's pedestrian and vehicle routes.

Mixing types of passengers can cause congestion and frustration. At St Pancras International station in London, arriving international train passengers merge into the local commuter crowds flowing towards the Underground station interchange. At peak times, this creates a mix of slow and fast moving pedestrians in a narrow space obstructed with pillars, lifts and greeters.

Private car access is often an issue at stations. Drivers meeting trains can cause congestion if a suitable short term parking area is not provided. People do not want to pay exorbitant parking charges just to meet relatives and friends who have chosen to come by train. Such charges can discourage train travel.

Interchange Role

Passengers arrive and leave by train but almost universally, they change their mode of transportation at the station³. It may be from train to train, or from train to any other movement mode, from foot to bus, taxi, car, bicycle or metro. The Kings Cross and St Pancras stations complex gives a good example of the variety of modal changes possible and the good and bad features of all of them.

First, we should realise that the area covered by the combination of the stations of St. Pancras and Kings Cross is vast. It takes ten minutes to walk directly from one side to the other. Clearly thought out routes are essential for arriving and departing passengers. Secondly, the whole complex has been rebuilt and updated, as far as is possible within the considerable restrictions imposed by English Heritage, a body that has been described as a willful inhibitor of the modernisation of Britain's



Figure 2: Passenger circulating area at Liverpool Street station, London with train service destination display. Retail units are provided at both ground floor and first floor levels. Photo: Author's collection.

³ Saglians in the Grisons area of Switzerland is a rare example of a station where only intramodal connectivity is provided since there is no road access.

infrastructure. The rebuilding is complete yet the Kings Cross side of the project suffers from poor interchange facilities because passengers gravitate towards the completed and improved St Pancras International station. So, what is wrong with the facilities provided?

Looking at facilities for cyclists first, these are provided but they are a long way from the station, sharing space with a car park north of the St Pancras station complex. The premises are secure but a casual user would be pushed to find the cycle storage area unless they had done their research first. Other countries do it better (Figure 3.)

Car and taxi pick up and drop off points are provided, of course, but it is not always clear where taxis are supposed to stop and there are different locations around the complex. There's nowhere for cars to wait to ease picking up duties. Confusingly, the Network Rail description of the available facilities does not align with what is on the ground.

Buses have a total of nine different locations for access around King's Cross and St. Pancras, scattered across the roads around the complex, some of which are best accessed by using the subways intended for users of the Underground station. The access route for the Underground is split, with two connections from the St Pancras side and one from Kings Cross.

Cost of Time

Passengers value time and the time they spend on different parts of a journey can be aggregated by calculating the 'generalised cost' of the journey, usually not in money terms but in total minutes – a reflection of the fact that people's wallets may be unlimited but not their lifespans. Different parts of the journey are weighted according to how they are perceived by the passenger so that, for example, time spent on the train is weighted at one, while time spent waiting for a train is multiplied by a factor of two. In a station, the activity of changing between trains can have a generalised cost of up to 30 minutes, e.g., when people are forced to climb stairs. In reality, the time taken may be much shorter. It just depends on how efficient and convenient it is and how the situation is perceived by passengers.

Facilities at Stations

Passenger and other users' facilities must be an integral part of station design, aligned with the size and importance of the hub as a whole. Apart from pedestrian routes designed to separate incoming and outgoing flows and areas for general circulation and waiting, there must be a structured approach to establishing the correct location of station facilities and the routes leading to these.. Aside from the ticketing facilities mentioned above, there is normally a need for information enquiry points, toilets and waiting rooms – or at least decently sheltered open areas – for departing passengers awaiting trains. Nowadays, in the UK, the tendency is to limit well provided waiting lounges to premium passengers paying first class



Figure 3: Dutch station cycle point with secure, automated, smart card storage, CCTV and a cycle shop. The system is provided at over 40 stations in the Netherlands. Photo F Schmid.



Figure 4: Bank of five escalators at Canary Wharf Underground station in London. Photo Author's collection.

fares, while other passengers are expected to remain in the general circulating areas or to use the coffee shops scattered around larger stations.

Retail Outlets

Station owners and architects are always looking for ways to develop the commercial possibilities of the station and its environs. Good retail outlets of the right type can add a useful source of income for the station owners or operators and they help to provide a sense of community and interest within the station and its surroundings. They also provide an extra presence within the station that reduces the opportunities for crime and vandalism and instills in passengers a better sense of security.

Care must be taken to choose the right kinds of shops and to ensure that the sales and services are appropriate for the station context. Thus, on a railway that suffers from alcohol related excesses, it may not be sensible to allow alcohol to be sold and it might be unwise, from a security standpoint, to accept a lease offer from a retailer selling military memorabilia in a gift shop. Fast food shops may also not be desirable because they create the potential for vast quantities of litter.

The usual outlets seen on stations are cafes, sandwich shops, newspaper stalls, bookshops, florists and gift shops. Dry cleaners and shoe repairers are also popular. Larger stations often have room for fashion outlets. In almost all cases, it is important that the shop fronts are obvious to customers but, at the same time, they must not restrict walkways through the station or obstruct exits, escalators and lifts. Leases must also include a requirement for retailers to meet the railway's fire and safety protection requirements and that staff are properly trained for alarms, evacuation and emergencies. It is essential that station managers regularly inspect retail premises to ensure that they comply with their lease obligations.

The location of retail premises and their proportion in relation to the station size and shape must be designed in at the very earliest stages of the station planning process. They must not be allowed to fill space that is needed for passenger movement or waiting. Until very recently, Waterloo Station in London had some large retail units spread along the main concourse area. These provided a very good utility for the shoppers but they prevented passengers from moving around freely, obstructed the view of the large train describer systems and caused serious overcrowding problems whenever services were disrupted. As a consequence of ever increasing passenger numbers, the retail units had to be removed to recreate the necessary circulating space. Happily, the visual impact and station sightlines of the whole concourse area have been hugely improved as a result.

Lifts and Escalators

Escalators (Figure 4) are essential in areas of stations where large volumes of passengers need to change levels and their location and orientation must be carefully thought through. Sufficient space must be allowed at the entry point to allow a queue to form for people waiting to use the escalator and more space is needed at the exit point to make allowance for those who insist on standing still as soon as they get off. Information signs and customer facilities must not be positioned directly at the escalator exit so that passengers are not tempted to crowd the area. A new or rebuilt station will usually provide lifts for disabled passengers but the most common use of these expensive features is by passengers encumbered with luggage who do not want to use stairs or escalators.

Communications

We must not forget that a large station involves a wide and complex communications network, including telephone, radio, CCTV, public address, train arrival and departure displays, news media, WiFi and both fixed and variable direction signs. In performance terms, reliable communications are an essential feature of a station, under both normal and emergency conditions (Figure 5). Large steel structures, such as station roofs can form a considerable obstruction to a communications network if the propagation of electromagnetic waves has not been allowed for in the design. The use of specialist communications systems by emergency services must also be addressed in the design of the facilities. Power supplies for all these systems must be secure and reliable.

Maintenance

Maintenance of both the fabric and equipment of the station must not be neglected at the design stage. Apart from the usual requirements for waste disposal and the provision of robust surfaces that make for easy cleaning, pity such visitors as the window cleaner, who may be required to reach large and very tall structures. Safe access for cleaning and glazing replacement must be built into the design. Remember too, that escalators and lifts may have to be withdrawn from service for maintenance or renewal, so additional facilities must be available under these conditions.

Operations

We should not forget that a station has to have trains in it. Careful planning is essential to get the right layout to accommodate the type and volume of trains expected. With a design life of at least 60 years, the layout must be flexible and must allow for future expansion. The folly of providing only four platforms for the Midland Main Line at St Pancras is already apparent and the restriction on the capacity here will become worse when the line is eventually electrified throughout.

The type of service provided will affect capacity at stations. At a through station with a mix of local and commuter services, combined with long distance trains, the layout of the station needs to combine efficient train movements and the shortest unconstrained passenger flows possible through the facilities and to and from the modal change areas.

At a terminus, turnround time is important. For commuter type trains, it is reasonable to expect a train to be 'turned round' or reversed in 10 minutes but this time will double for a long distance train needing re-supplying with food, drink, water and toiletries. Remember too, the time taken for each train to clear the platform and access route plus the time for the next train to occupy the platform must be allowed for.

Faregates

Many stations now incorporate gated barriers, dividing the station into 'paid' and 'unpaid' areas. The whole question of gates is emotionally charged: passengers who pay their fare regard barriers as an obstruction and an unwritten accusation that they cannot be trusted. Less frequent travellers see them as difficult and many do not understand how to use them. Gate design in general leaves much to be desired, with sluggish operation, unreliable performance, non-universal ticket recognition and too few units to cope with peak hour traffic. Railway operators regard them as hugely beneficial, since it has been shown that, after they have been installed, fraud is reduced and income increased, with additional benefits experienced in terms of station security (Figure 6). More needs to be done to encourage acceptance by users.



Figure 5: Example of poor and confusing signage at station exit. Safe and clear signage is essential for good passenger circulation. Photo: Author's collection.



Figure 6: Example of paddle type faregates at Canary Wharf London Underground. The paddles are at a height to prevent persons jumping over the top. Photo: Author.

Do not forget the staff

A station forming a part of a city hub is a major employer and most major stations are open 24 hours a day. As a rule, each job that must be staffed 24 hours requires the employment of five persons. Some jobs will involve temporary or part time attendance at the station and staff movements and changes will be frequent. There will be permanently employed staff for the station operation and, probably, contract staff for maintenance and cleaning, personnel of the operating companies, retail staff and separate units for policing and security and they all have different needs in terms of the station environment. Emergency services must also be considered when designing access to the site and any special facilities provided for them.

Train crews, for example, will require accommodation at large stations, some being permanently based there but some requiring only facilities for personal needs breaks or as waiting areas. Their facilities should be as close to platforms as possible to remove excessive walking time from their duty periods.

Managing and providing facilities for the large permanent and transient staff population forms an essential part of a station's operation. The station will need full and complete facilities for them, including control rooms, rest areas, offices, bathrooms, storage, training equipment and conference rooms. All these facilities must be designed to be secure and easily inspected, if the station is to work effectively and safely.

A brief summary

For a station to function as part of a significant city hub, good architecture and design are essential but the choice of structure and facilities must be founded on the underlying principles of how passengers, staff and third parties behave. Providing simple free-flowing circulatory areas is a key element in assuring the main function of a station: boarding, alighting and transferring within and between nodes. Today, these basic principles are becoming ever more important as the sheer volume of users is threatening the performance of many British stations.

