3. THEORETICAL INVESTIGATION

The influence of railway stations and their design

3.1 Abstract

The purpose of this investigation is to determine the influence which stations and their related railway infrastructure had on the cityscape, architecture, the urban fabric, development and planning of the city and its society.

To provide a fuller understanding as to why stations developed in the way they did, and why they looked as they did and to a large extent still do, the development of railways and the functioning of stations is investigated. Station design being an offspring of industrial architecture, the historical development of the latter is then outlined. The progress in and results of the developments in station architecture, required to cope with ever increasing size demands so as to enable the handling of ever-increasing passenger volumes, are then reviewed. The achieved results are compared to those of large structures built before railway station construction commenced. In conclusion, the effect that the stations, their structures, and related railway infrastructure had on architecture, the cityscape and urban development are assessed, the latter also in the light of the reduction or demise of rail services currently being experienced throughout the world. The influence of the impact in these three areas on society is then reviewed, before concluding.

This section is structured as follows:

Introduction
The growth of railways
Station operation and functioning
Further factors influencing station design
Architectural concretization of station functions: ‘cathedrals of industry’
Influence of stations on architecture
Influence of stations on the cityscape
Ecclesiastic cathedrals vs. secular ‘cathedrals’: the influence on society
Influence of stations on urban planning

Fig. 3.1 Travel risks before the coming of the railways

Fig. 3.2 South Africa's rail network

Conclusion

3.2 Introduction

The development of railways has had a major influence on the economy and society of the world. Railways improved communications and speeded the world up, doing largely away with slow and often dangerous road- or canal born transport. The impact of this influence is much more evident in Europe, due to railways originating and being constructed there to a much greater extent than anywhere else in the world (with the possible exception of the north-western United States of America ('USA')). Their development, flowing from the Industrial Revolution which occurred in the late eighteenth and early nineteenth centuries, facilitated the commercial, economic and subsequent political rise of Europe, and specifically of the United Kingdom, to the predominance it played in world politics up to the First and even Second World Wars. Through this predominance European powers were able to conquer the major part of the world, creating their colonial empires, which, in turn, led to the development of railways therein, opening them and their produce up for integration in the international economy of the times. South Africa, too, owes the construction of its major railway trunk lines from the coastal ports to the interior to this desire for economic integration: after the first lines were built to satisfy local (Cape Town and Durban) transport requirements and with the hinterland having little to commend its integration into the coast-centred economy, only the discovery of the hinterland's diamond and mineral wealth spurred its connection with the coast.

The extent of the influence of the development of railways has, however, stretched much further than this. The sheer size of the facilities required, leading to construction of stations of ever increasing size and their occupation of extensive areas by their infrastructure requirements (tracks, marshalling yards, sidings and workshops), changed the development of architecture, the appearance, conception and perception of the cityscape, the structure of urban layout and future development, and the reaction of society to large buildings. Railways and their structures had this profound influence, arising at first from the confrontation with the railways' expanding demands, and then with the empty spaces left behind by their currently experienced shrinkage or even demise.

Investigating and understanding the influence of railways on architecture and cityscape, and how it all came about, and the implications on urban design requires looking at the origin and history of stations and their architecture, their components and their operation.

It should be noted, due to the fact that modern railways originated in the United Kingdom ('UK'), that this will be the area focussed upon in the following. Developments in continental Europe (including the Netherlands, which had a large influence on South Africa) and the USA were similar although somewhat later, initially using British equipment and methods of operation: only with time were operations adapted to local

conditions and preferences. But, in essence, a station anywhere in the world fulfils the same functions, applies the same principles of layout, is generally built from the same choice of materials and techniques, and ultimately derives from the first British precedents. With South Africa's railway history having been influenced by both British and Dutch (initially British-influenced) precedent, I consider the focus on the developments in the United Kingdom to be sufficient to illustrate the issues being investigated.

3.3 The growth of railways

Fig. 3.3 Preston Station, England

Fig. 3.4 T he locomotive: a steam engine on wheels. Women's Memorial precinct, Bloemfontein

A railway is generally operated to transport, against remuneration, passengers and freight (exceptions are military and plantation railways). A railway station represents, simply stated, a place where trains stop to allow passengers to board or to alight, and freight to be loaded or unloaded. The execution of these functions requires a support structure, which is to be found in or near the station, and is discussed further on.

However, the number and appearance of railway stations, as we know them, derive from two results of the Industrial Revolution: the unprecedented need, availability and feasibility of large-scale rail transport, and its concomitant expansion of railway lines, and the progress made in the engineer's and architect's ability to construct the large structures required for them. The prior represents the reason for the proliferation of stations and yards with their resulting occupation of large areas in the urban fabric, the latter the reason for their impact on architecture and cityscape.

In turn, large-scale rail transport and the accompanying large structures were made possible by, on the one hand, the progress made in the use and application of improved materials (cast iron, wrought iron and steel, and the ubiquitous corrugated wrought iron sheeting as a lightweight roofing material), and, on the other hand, by the harnessing of steam for the powering of machines of various kinds by means other than water power. Placing the steam engine (also constructed of the improved materials) onto wheels, and linking the steam engine's piston to these, resulted in the engine moving along. This moving engine or 'locomotive' was placed on rails to guide it, and the modern railway was born. ('Rail-ways' existed beforehand, used to carry iron ore and coal from the mines to the closest canal or coast for further transportation by water, but their propulsion was by means of gravity, horses or mules. Distances that could be covered with these means were very limited, and passengers were very rarely transported. It was the mobile steam engine which made railways a generally viable option to move freight and later on passengers.)

The mentioned Industrial Revolution developments do not imply that factories and warehouses did not already exist then. They did, but on a much smaller scale, as machines were normally powered by water

power. Even foundries used water power to operate the bellows needed to generate the required furnace heat. Most factories were accordingly located by fast-running streams with enough power to drive the machinery involved, and were often tucked away in remote valleys. The new availability of steam-powered machines enabled entrepreneurs to operate more machines at the same time, which in turn required larger premises to house these. This need for larger factories led to the development of 'industrial architecture', the principles of which were initially applied to station design. – Furthermore, factories could now be located by any water, still or fast-running, as long as it was sufficient to feed the steam boilers; alternatively, the water could be led there. Accordingly, to facilitate access to their markets, factories could and were now often placed in towns and cities. However, this greater freedom of choice regarding location removed them from the proximity of rivers or canals previously required to transport their raw materials to them and their finished products from to the markets. But this did not remain a problem for long: the growing availability of railways negated the problem, and, in turn, the increased demand for freight transport contributed further to the expansion of the railway network and the traffic carried by it.

Fig. 3.5 No. 3 Mill (1826, by Robert Owen), New Lanark, Scotland

After some initial resistance, often by vested interests, against this 'fiendish' invention, bad for health and sanity of both passengers transported and people and animals passed (Ellis, 1954:34), railways quickly proliferated to provide the services required for the accelerated transportation of ever growing volumes of people and merchandise. These expanding railways needed stations where the required services could be provided and which, due to the ever increasing volume of passengers and freight transported (before the advent of motor and air transport), grew bigger and bigger.

To understand the growth of stations, with the resulting impact on architecture, cityscape, and urban planning, it is also necessary to understand the components making up a station, determined by the operational and support functions required to handle the rail-transported passengers and freight.

Fig. 3.6 Old time station scene: Cuneo's "*London & Birmingham Railway*"

3.4 Station operation and functioning

As stated above, railways require stations for the purpose of embarking and disembarking passengers, selling tickets to them, and allowing them to wait for the departure of their trains. Furthermore, passenger luggage has to be stored, and mail has to be handled (though less so in current times, mail now being transported by motor and air transport). Freight, too, has to be warehoused, loaded and off-loaded. Locomotives, passenger carriages and goods wagons have to be maintained and serviced in workshops, and have to be stored on sidings, in round-houses and in yards when not in use. It was discovered with time that these activities are better accommodated in enclosed structures or at least under shelter, for a variety of reasons, *i.a.* weather protection, safety and access-control, the exception being the storage of

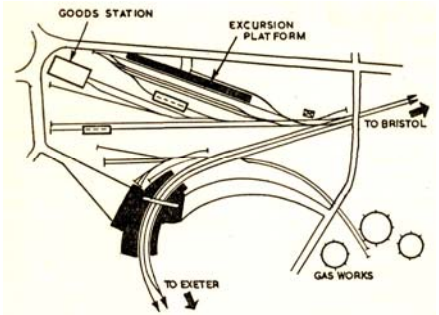

Fig. 3.7 Goods station separated from passenger Station (at bottom). Weston-super-Mare station, UK

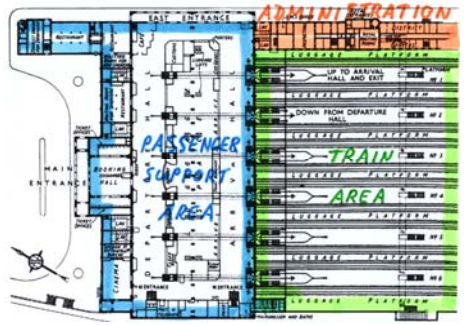

Fig. 3.8 Area functions of stations: Copenhagen

Fig. 3.9: Area of passenger/train interaction, Gare de Lyon (1897-1900), Paris

carriages and wagons.

Goods stations, round-houses and workshops were initially placed within the same area as, or in very close proximity to the passenger handling facilities. In later years they were often removed to other premises, as the land occupied by them was required to accommodate the expanding passenger facilities. This occurred in Pretoria, where, at the beginning of the twentieth century, the freight station was still part of the main passenger station, was then removed to a spur to the west, still adjacent to the present station, before finally ending up in distant premises, such as *i.a.* Hercules yard. Similarly, the Pretoria workshops were initially located to the south and south-west of the station, before being removed to Capital Park and Koedoespoort in the 1950s and 1960s. Here, however, it was the expanding workshop demands which led to their relocation; the land so vacated was left an empty swathe in the urban fabric (and is the site chosen for the proposed railway museum). – Although the goods handling and workshop facilities were subsequently removed from the passenger handling facilities, their initial incorporation in the station complex increased the size of the area and structures required by the railways, which in turn impacted on station architecture and cityscape. The removal of these functions to separate premises had further major impacts on urban planning, as they, too, generally occupied larger areas than the passenger stations themselves. It is however the accommodation of the growing passenger volume that resulted in a major impact on architecture and cityscape, and thus the passenger station will initially be focussed on, whereas the impact on urban design is common to passenger and freight stations and workshops, and will be assessed later.

A passenger station usually accommodates three, and sometimes four functions, each contained in a separate area, but linked to the others: the ‘train area’, the passenger support area and the railway’s administration or office area. Hotels are the fourth function sometimes added to the station complex. The first or ‘train area’ is concerned with the handling and control of the arriving, waiting and departing trains and of the boarding or alighting passengers, using platforms adjacent to the train tracks (area of passenger/train interaction), the second area, also called the ‘concourse’, with providing the necessary support functions for the passengers and their contact with the railway administration by way of e.g. ticket buying and information gathering (area of passenger support), and the third and forth areas are reserved for the railway administration’s functions and guest accommodation respectively, where these are included in the same complex.

The area of passenger/train interaction occupies the largest amount of area, due to the length of trains. Increasing volumes of passenger and originally of freight traffic led to more and longer trains, necessitating the expansion of this area. This was first satisfied by freeing space through the afore-mentioned removal of the freight handling facilities to other locations. Accommodating the functions of the train area on more than

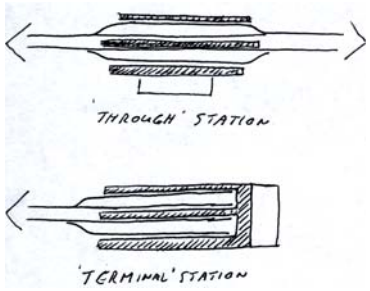

Fig. 3.10 'Through' and 'terminal' station

Fig. 3.11 Passenger support functions placed on foot-bridge itself. Hamburg *Hauptbahnhof*, Germany

Fig. 3.12 Foot-bridge, Leeu-Gamka station

one level is wellnigh impossible, due to the sheer difficulty of providing lengthy access ramps for a train to make the necessary change in level: South African Railways/Transnet considers a gradient of 1:66 as the steepest main-line gradient viable, avoiding slowing trains down too severely. Allowing for a change in level of say 8 m for an upper storey would require a costly ramp of over half kilometre length. (Exceptions do occur, for example at New York's Central Station.) Any expansion of this area is thus generally in a horizontal direction. – The station's train control function itself, historically placed within or adjacent to the track area, can be placed these days within or without it, as electronic control has obviated the need for visual contact between the controller and the trains. It is therefore not treated as a separate function or area.

The 'passenger support area' or 'concourse' should have its functions easily accessible to passengers. This requires that booking offices, ticket selling booths, information counters and toilets should be based adjacent to or in close proximity to the passengers' main route of movement, which is from the station's roadside entrance to the platforms, and *vice versa*. This arrangement allows for the streamlining and non-interruption of the main passenger flow: long deviations from this route are minimized, and disruptive cross-flows to the main direction of flow are reduced, thereby also improving the orientation of the masses moving through this area. Less important passenger support facilities, such as waiting rooms, restaurants, shops and baggage storage or collection areas can be placed further away, though they should still be within easy reach. By being located slightly further away, 'superfluous' passengers are 'removed' from the main circulation routes, instead of standing around and thereby obstructing the main routes of flow while waiting e.g. for their train to depart. – Two approaches exist for the placing of the concourse with regard to the train area: it can be on the same level as the train area's tracks and platforms, or on a different level. 'Terminal' stations usually apply the same-level approach, as, with trains entering from and leaving in the same direction, the crossing of passengers and trains can be avoided. This approach is furthermore found in small stations, a foot-bridge generally providing for the safe crossing of trains and passengers. However, space constraints or a desire to incisively split these two areas of separate functions have often forced the split-level approach, often found in large 'through' stations (stations where trains arrive and pass through, *i.e.* do not leave in the same direction as they came from). Here passenger and train traffic are required to cross each other, and safety considerations demand the provision of foot-bridges or underpasses for their separation. Placing the supportive functions on a level different to the tracks' location satisfies the safety considerations, with passengers ascending or descending to the platforms: the functions are effectively placed on a large foot-bridge or in a large underpass. Ramps, stairs, lifts and/or escalators are provided, requiring additional space and adding to the cost of construction. Combinations of same- and split-levels are also possible, but are scarce. Examples of same-level stations in South Africa are Cape Town and Pretoria (Central) stations, of split-level Johannesburg and Bel Ombre (Pretoria). – As the concourse area requires aforementioned proximity to the main flow of passengers, an increase in the concourse's

Fig. 3.13 Offices above Broad Street station (1892-93), Philadelphia

Fig. 3.14 Great Western Hotel, Paddington Station, London

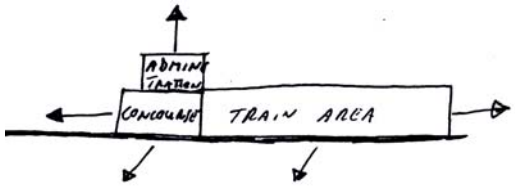

Fig. 3.15 Usual directions of expansion for different areas of station

passenger volume-related area requirements would preferably be satisfied in a horizontal direction, following the route of the street entrance-platform/train track axis: splitting it over more than two levels would result in complex and complicated movement patterns.

The railway's administration or office area's functions, where required on the premises, are not directly concerned with handling of and interaction with passengers, and thus do not require being easily accessible to them. It is thus of less importance that they be located close by and on the same level as the passenger flow routes, and they are often placed in a more remote area or on a different level, this reducing the total ground area required for the station complex. The administration part can be of any height and number of storeys. Expansion would generally be in a vertical direction due to potential ground area and resulting cost savings: horizontal expansion would only occur where vertical expansion costs would exceed those of horizontal expansion, e.g. if for some reason cheap land were still available.

In addition, many railway companies provided hotel accommodation in the large cities as part of the service to their passengers. These were usually upmarket establishments and formed either part of the station complex or were situated in very close proximity. The best-known example is the Grand Midland Hotel (1865-71, by Sir Gilbert Scott), forming part of the Midland Railway's St. Pancras station. Providing functions different to those found in the general concourse area, they were architecturally treated as a separate entity, an approach similar to that employed in accommodating the railway administration offices. As with the latter, they would also rather expand vertically than horizontally, enhancing their prestige. For purposes of this investigation, they will be seen as part of the office area.

The three areas thus have their own, different expansion possibilities, although practicality dictates that passenger/train interaction and passenger support should be on the same level, or at most only one floor apart, with sufficient routes of access between them to avoid bottle-necks. It is, however, their directions of growth which is so important in assessing the influence they had on cityscape and architecture. The vertical expansion of the administrative function had little influence of its own: this was already occurring in factories, as will be seen later. (Refer to 'Development of Industrial Architecture', Appendix 1.) It is the accommodation of the growing passenger-related activities of railways which had a major impact: the horizontal expansion requirements of the train and concourse areas dictated wider and higher spans to create the required volumetric enclosure.

South African passenger station design had to face an idiosyncrasy imposed upon it when the apartheid-policy of racial segregation was developed to its full extent as government doctrine: all station facilities had to be duplicated, for 'white' and 'non-white' passengers, to use the then current terminology. Old stations had to be adapted to meet the segregation requirements, whereas the new ones built in Johannesburg,

Cape Town and Durban had this duplication incorporated in their design. The entrance for 'whites' was normally at the front, whereas the facilities for 'non-whites' – though in many places forming the greater part of commuters – were tucked away around the corner. With the demise of the apartheid policy the segregation has fallen away, though the architectural evidence is still there. – The effect of this political aberration falls outside the ambit of this dissertation and will not be investigated in greater depth

However, the design of passenger stations is not limited to the accommodation of the mentioned three or four primary functions relating to passenger transport and train operation. There are more factors at play.

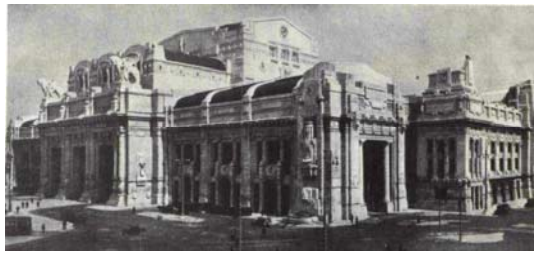

Fig. 3.16 The 'prestige' factor: Milan Central Station (1906-31, by Ulisse Stacchini), Italy

Fig. 3.17 'Waiting room': Pennsylvania Station (1906-1910, by McKim, Meade and White), New York

3.5 Further factors influencing station design

By being the point of departure or destination for the majority of all train travellers, and due to the sheer size of the resulting volume of passengers and related train movements handled, city passenger stations are more important than town or village stations. The large volume handled inherently dictates that such stations have to be large: it does not only influence the size of the train handling area, where passengers embark and disembark, but also determines the size of area required for the handling of these passengers, and the functions and services that go therewith. This total size is, as such, the concretization of the functional aspect of moving people and operating trains, and the design of a station is essentially and primarily function-driven.

However, stations, and especially large city stations, however, have to additionally give the prospective traveller a feeling of assurance in the safety of the conveyance he is about to board, and to enhance the image of integrity and solidity of the entity owning the railway (even more so when the head offices of the railways were accommodated on the same premises). In contrast to the transient train, the company or government owned railway station is the permanent, always visible representative of its owner. Furthermore, during the last quarter of the nineteenth and first fourteen years of the twentieth centuries, and mainly centred on continental Europe, growing issues of national prestige were thought to demand buildings worthy of representing the nation as a whole. The brief for the new Leipzig, Germany station (completed 1906) contained a clause stipulating that the building 'should, as an imposing architectural monument to Leipzig's commercial status, bear witness to Germany's economic expansion' (quoted in Binney & Hamm, 1984:137). Similarly, the Milan Central Station (1906-31, by Ulisse Stacchini) was deemed necessary to show off Italy's standing to the world. This philosophy of 'prestige' or power architecture is still evident in many structures of today. Aesthetic considerations can therefore not be neglected in favour of pure functional station design: Stations have the added 'necessity' of prestige, mainly concretized in the concourses building, which are built to impress the viewer, who may not necessarily be a user of it. This

Fig.3.18 Cape Government Railways Station, Cape Town (postcard)

Fig. 3.19 NZASM Station, Pretoria (postcard)

Fig. 3.20 Sannaspos Station, Free State

makes the structures even larger: aisles, staircases, waiting rooms and restaurants of great size, splendour, opulence and monumentality are often included within gigantic and towering façades. The functional design, though of primary importance, is thus enriched (or corrupted) with aesthetic and symbolic enhancements in various forms and enunciations. Architectural historian Edgar Jones summarizes that 'The value of a building as a source of status and a means of advertising became increasingly apparent… Thus the shape of industrial [and railway] architecture in Britain was determined by aesthetic considerations and, at root, the evolving needs of manufacturing [and transportation] enterprise.' (Jones, 1985:13). – South African examples of stations of large size and grandeur are the historic and/or new stations of Cape Town, Johannesburg, Pretoria, Durban, Pietermaritzburg, Port Elizabeth and Bloemfontein, albeit that their designs may not all inspire admiration. An odd exception to the splendour of the main stations of important cities is the rather inconsequent pre-1910 Pretoria railway station: the NZASM considered Johannesburg to be their more important station (based on passenger and freight volume handled), and put more effort in its representative effort where its business was concentrated.

The dominance of city stations nonetheless does not negate the importance of the lesser station: railway traffic is not only limited to non-stop express trains between major cities. The towns and villages served by the railways all have their stations, albeit of lesser splendour than those of the city, and sized to match the requirements of the traffic handled in these places. However, the same characteristics apply to these as to those in the cities: they were, when built, still large structures relative to those of their surroundings, and of a design to reflect the supposed solidity of the entity behind the train. – South Africa contains many such examples of smaller, yet elegantly styled and, for their urban environments, substantial station buildings: Middelburg (Transvaal), Kroonstad, Cradock, Worcester, Leeu-Gamka and Matjiesfontein. – Such smaller stations must not be confused with 'halts', where trains stop to allow on-coming trains to pass, and generally passengers do not board or alight. These halts offer little more than a name board and the railway staff's offices and accommodation.

It may be noted that the provision of a platform of the same height as the passenger carriage, facilitating easy boarding of the train, is actually a luxury not found in many stations. (British and South African stations of all sizes were generally provided with them, albeit occasionally shorter than the calling train.) South African exceptions do occur: the platform at Gouda station (Western Cape) and Sannaspos (Free State) are no higher than about 150 mm above ground level. The lack of carriage-height platforms is not only a general characteristic of the rural stations in poorer countries, such as India (based on own sighting), but also of the majority of the stations in the USA.

City passenger stations thus, throughout their history, have had to combine the large and ever expanding expanse of area required to handle the passenger/train interaction and passenger support with the need of

Fig. 3.21 Low platforms at Santa Fe Station, Denton, Texas, USA

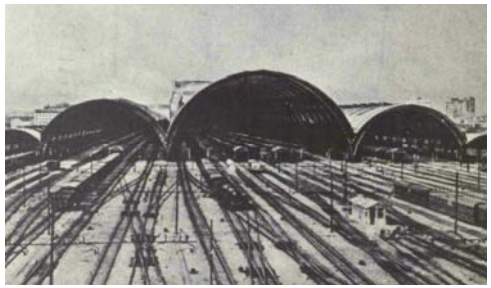
Fig. 3.22 Train area: Approach to Milan Central Station (1906-31, by Ulisse Stacchini), Italy


Fig. 3.23 Concourse, Manchester Victoria Station (1909, by William Dawes)

prestige, symbolizing the safety of transport and the solidity of the organisation behind the railway. They were therefore, generally, after the initial 'experimental' phase of early station construction, built for both functional and prestige purposes, which had to be satisfied by larger and grander station designs. However, in the architectural design the incorporation of the prestige factor was subordinate to the imperative of accommodating the identified primary functions of a station, having the respective areas and their connection operate efficiently and smoothly.

3.6 Architectural concretization of station functions: 'cathedrals of industry'

As stated, the area of a station can effectively be sub-divided into three areas, each with its own functions: the largest area of passenger/train interaction ('train area'), the smaller area of passenger support (concourse, for passenger/railway administration interaction), and the optional railway administration area. I highlighted that the prior two would generally only expand horizontally, and that the latter had a choice of doing so vertically or horizontally, albeit, in the main, vertically.

A station is thus, in fact, an integrated complex of three functions, each with its own functional, and thus architectural requirements. The prior two are usually adjacent to each other, and may be combined, but the layout of the train area will dominate, due the physical and space-intensive constraints of train operation. It also demands an area of equal level (to prevent trains or carriages from running away, should their brakes fail), sufficient length (to accommodate the longest train), and sufficient width (to accommodate both the number of trains in the station at any one point in time, as well as enough and sufficiently wide platforms for the volume of passengers boarding or leaving the trains). The greatest number of trains in a city station generally coincides with the peak of passenger volume experienced during business rush hour, with employees entering the city for their place of employment, or heading for home in the suburbs.

The concourse demands an area of sufficient size for the accommodation of functions such as ticket selling, making of reservations, providing of information, handling of baggage, catering for passengers and holding of waiting passengers, all of which should not obstruct the simultaneous space demands of the main flow of passengers between the station entrance and the trains. The supporting functions are thus generally placed adjacent to the route of main passenger flow, but sometimes within it, in the form of islands, which should not impede passenger flow. The maximum passenger volume passing through at any one time must thus be anticipated and planned for, and will peak during rush hour, as explained above.

The railway's administrative offices generally occupy a separate area, usually with their own entrances, placed either adjacent to or outside the concourse, so as to not impede the flow of passengers. This area

Fig. 3.24 The 'supershed': First Grand Central Station (1869-71), New York

Fig. 3.25 Train-sheds of King's Cross Station (1850-52), London

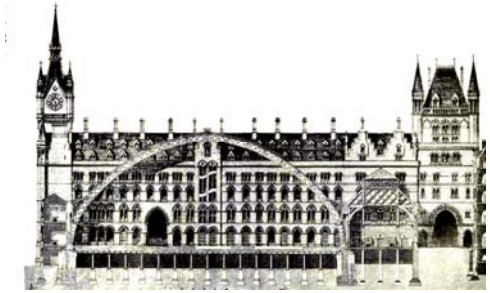

Fig. 3.26 Section of St Pancras Station (1866-68), London, with hotel behind

may thus be treated totally separately, being, in effect, a normal office structure. – A hotel is occasionally added for the convenience of passengers.

An analysis of the layout of a large station will reveal that often the three components are located in three different structures (four, if a hotel is included). These structures may be of totally independent of each other structurally, and of different styles, reflecting the difficulty of matching the engineer-orientated design of the train area to the others.

The identified need to accommodate the maximum train and passenger volumes and their respective operating and support facilities resulted in the large structures we know, and which provided the challenge to station architects and engineers. The realisation of these structures was only possible through the advances made in materials and technology, as applied in and expressed by industrial architecture. – Station architecture can be seen as a newer and specialized sub-field of industrial architecture, in that factories, being existent before the Industrial Revolution, are the older type of structure and had already anticipated structures to house more than one function, *i.e.* the manufacturing process (and the often concomitant warehousing) and the administrative functions. Station architecture differs in that it has to provide, in addition, for large, varying and transient volumes of trains and people, and the related support functions to process these volumes smoothly. Both factories and stations had to provide large structures to accommodate their respective functions. Innovative solutions were required to accommodate the expanding requirements of space to be enclosed, and, with regard to stations specifically, in the main of the station's train area: the key element to the design problem was to create an as large as possible, covered but column-free area, as columns would impede the layout of tracks and train movement, and the flow of passengers to and from them. In addition and if possible, the height of this sheltering structure had to be sufficient to allow for the engine's smoke to draw upwards and to escape through openings in the roof. The new materials available (cast iron, wrought iron and much later steel), combined with increased knowledge of their strengths, enabled the finding of the solution: the supershed. The supershed is defined by architectural historian Chris Wilkinson as 'buildings enclosing a large single volume of space with relatively long spans and without major subdivision.' (Wilkinson, 1991:vii) and is characterized by 'modular construction, standardization, mass production, prefabrication, mechanization, lightweight construction, systems integration, rapid site assembly and demountability' (*ibid*:4).

Station supersheds may either contain the areas of both passenger/train and passenger/railway interaction/passenger support within it, or be reserved for the handling of the passenger/train interaction only, with the concourse functions housed in a near-separate, different kind of structure. It is the supershed which had such a pronounced influence on architecture, the cityscape, urban development and, through these, on society.

Fig. 3.27 St. Pancras Hotel (1865-71), London

Fig. 3.28 Model of International Rail Terminal (1988), Waterloo Station, London

Fig. 3.29 The ubiquitous tower: Dearborn Station (1883-85, by Eidlitz), Chicago

Before analysing the impact of the supershed, it is of interest to obtain a background of the progress made in industrial architecture, which, through the availability of improved materials and technology made the construction of the supershed possible, the historical development of railway stations and the achievements made, reaching their zenith in the vast dimensions of the supershed, and the involvement of the architect and engineer in it, and the difficulty the profession of architecture had in accepting the new materials and methods of construction. Furthermore, the interior dimensions of the supersheds dwarfed those of the until then unchallenged large cathedrals. This background is however not essential to assessing the impact of the supershed as such, and is thus included in appendix 1.

It suffices to summarize that stations grew phenomenally: the first main line station serving London, the London and Birmingham Railway's Euston station (1836-37, by Robert Stephenson), at first covered by a column-supported 13 m span of 61 m length, has expanded through the years to now cover an area of 74,925 m² (including the non-covered track area). Station architecture culminated in Britain with William Barlow erecting the then world's largest single arched structure, London's St. Pancras station (1863-67), its wrought-iron span being 73 m wide, 209 m long, and 30 m to the point of arch. The clock tower is 68 m high. The adjoining Midland Grand ('St. Pancras') Hotel (1865-1871, by Sir Gilbert Scott) is the biggest neo-Gothic secular building in the United Kingdom (Binney & Hamm, 1984:136). – This station also illustrates the initial quandary faced by station architects: whereas the enclosure of the track area is best addressed by a purely functional design, the desire for 'prestige architecture' in and around the other areas does not lend itself easily thereto, resulting in a clash in the style of execution, united only by the continuous flow of passenger movement through both. At St. Pancras station an architect-designed, ornate, impressive, Neo-Gothic masonry-finished hotel façade in 'front' hides the engineer-designed, utilitarian, functional, iron-and-glass train-shed behind it.

Developments in the USA culminated with the construction of the world's largest single-span train-shed at Philadelphia's Broad Street station (1981-93, by Wilson and Truscott, additions by Furness and Evans), with three-pinned trussed arches spanning 91 m, with a height of 33 m and a length of 181 m. (Wilkinson, 1991:10 and Meeks, 1978:89 and 103) – However, supersheds were costly and had other drawbacks (set out in the appendix), and were at first replaced by so-called Bush sheds and then butterfly sheds. Station design itself also moved on with the times, reflecting both the Art Deco and Modernist styles, with extensive use of the new medium of reinforced concrete. However, with the loss of the supershed element from the designs, the passenger support area superseded the track area as the architecturally more dominant one, gaining large and high concourses, whereas the track area was protected only by the aforementioned low butterfly sheds. Current station designs in Europe, mainly, but not limited to suburban routes, follow the latest style trends, showing a mix of concrete, steel, glass and masonry work. The occasional station

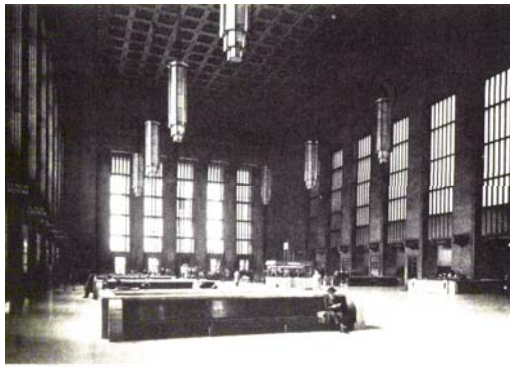

Fig. 3.30 The superlative concourse: Thirtieth Street Station (1927-34, by Graham, Anderson, Probst and White), Philadelphia

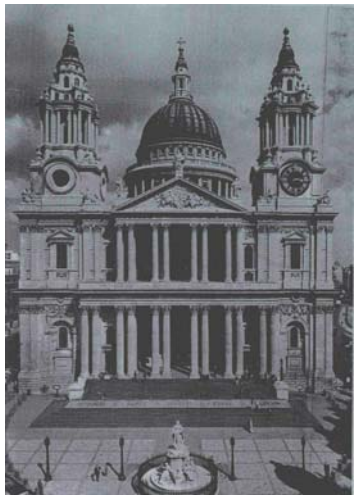

Fig. 3.31 St. Paul's (1675-1710), London

supershed is still built: a recent example is that covering the extension of London's Waterloo Station's International Rail Terminal (1988, by Nicholas Grimshaw and Associates). The latest shed being built is the new Berlin *Hauptbahnhof*, still in process of completion. Its four tracks are spanned by a shed, its appearance reflecting back on the classic train-shed of iron and glass.

Ironically, while the supershed was replaced in newer designs by the rather insignificant butterfly sheds over the platforms, it was being incorporated in the design of the concourse area. Being of vast sizes, both so as to more easily handle the volume of passengers, and for purposes of prestige, they were covered with massive spans of either cast-iron or concrete to allow for uninterrupted space. New York's Pennsylvania and Grand Central stations are good examples of this, while in South Africa this trend is evidenced in the new Johannesburg and Cape Town station concourses.

In the station complex, the supershed was generally distinct from, but linked to the also expanding horizontal passenger support area, and often, too, to the vertically expanding administration and hotel structures. The combined structure, expanding both horizontally and vertically and often with a clock tower incorporated in the design, was of a structural size not encountered before the Industrial Revolution. It is not for nothing that these station complexes, and especially the supersheds, due to their area, size and enclosed volume and silhouette, were occasionally referred to as the 'cathedrals of industry'.

The justification of this soubriquet is understood when the dimensions of ecclesiastical cathedrals are compared to those of the secular cathedrals. St. Peter's, Rome (1506-1626, by Bramante, Sangallo, Giocondo, Raphael, Peruzzi, Michelangelo, della Porta, Fontana, Vignola and Maderna) has an external length of 213 m, internal length of 183 m, internal width of 137 m, nave width of 26 m, vault height of 46 m, and internal height of cupola 102 m with internal diameter 42 m. St. Paul's, London (1675-1710, by Sir C. Wren) has an internal length of 141 m, internal width of 31 m, internal height of domes surmounting naves of 28 m, internal height of large dome 65 m with internal diameter 34 m, and an area about 6,000 m² (extracted from Fletcher, 1975).

Cathedrals were thus both shorter and narrower than the new train-supersheds. Though both nave and towers still exceeded the latter in height, drawing the eye upwards, they were not able to impart the same feeling of space to the perceiver as the stations were able to do: the experience of large space in cathedrals was curtailed by the narrowness of the nave. Having the greater tower height did not affect the experiencing of space, as they are not visible from the interior. The cathedral tower's crowning height on the city silhouette, when compared to a station, was now intimidated by the latter's greater length and bulk. However, with ever higher buildings surrounding both, both have lost on their impact.

Fig. 3.32 The old: St Martin, Landshut (1392-1432), Germany

Fig. 3.33 The new competition: Grand Central Station (1888-90, by S. Berman), Chicago

The comparison of stations and their supersheds to cathedrals is not as incongruous as it may initially seem. Before the advent of the prior the general population could only experience the awe-inspiring volume of vast enclosed space in the cathedrals of the big cities. Palaces and town halls, also being structures which contained large enclosed spaces, were not easily accessible to the everyday man, except in a serving capacity. Station architecture changed all this fundamentally.

Having traced the development of railway stations, their function, architecture and the achievements made therein, and having compared it to other larger structures preceding the introduction of stations, it is now possible to assess the effect that they, and in the main the supershed associated with them, had on architecture, cityscape, urban development and society. The impact of architecture and cityscape on society is discussed immediately after their respective assessments, whereas, with the railway infra-structure's impact on urban development and, in turn, its very tangible impact on city society, these are interlinked in one discussion.

3.7 Influence of stations on architecture

The influence of the large cities' railway stations on architecture was twofold: on the one hand, satisfying the needs of a large station led to great strides being made in the application of the new materials available and the architect's and engineer's knowledge of how to use them improved, and, on the hand, it influenced how and by whom the sensation and the sense of space and building volume were experienced.

Technological advance arose from 'inventing' the type of structure required for large stations, culminating in the flourishing of the supershed. The supershed's characteristics of 'modular construction, standardization, mass production, prefabrication, mechanization, lightweight construction, systems integration, rapid site assembly and demountability' (Wilkinson, 1991:4) were all new concepts to the then designers, and their application led to a revolution in design. Large spans could be bridged and large spaces enclosed. As designs were 'liberated' by the new and economically available materials, such as larger sheets of plate glass and corrugated iron, and stronger materials such as cast-iron, they were at the same time constrained by the uncertainty involved in using them in constructions, as no detailed information on their characteristics, such as strength and bearing capacity, was available. This handicap was only overcome as the necessary knowledge, such as the design of cast-iron trusses, became available, often only discovered empirically. Cases of supershed collapse occurred occasionally; however, the gain in knowledge led to developments still seen and felt today, as it is being readily applied to factories, hangars, warehouses and shops: for example, the large wholesaler or supermarket is presently more often than not housed in a supershed.

Fig. 3.34 St. Peter's (1248-1880), Cologne

Fig. 3.35 Leipzig *Hauptbahnhof* (1906-15, by Lossow and Kühne), Germany

Interestingly enough, the increasing application of the new materials was matched by huge debates in architectural theoreticians' circles as whether their use was ethically justifiable. The theoreticians were out of their depth, as their much hallowed principles of aesthetics were suddenly being compromised by engineer-designed structures of purely functional nature: art was deemed as having been sacrificed on the altar of functionality… Augustus Pugin (1812-52), as an example, abhorred the new materials. John Ruskin (1819-1900), of *The Stones of Venice*-fame, was embarrassed by the use of iron, only conceding that new rules had to be evolved for its use. Others expressed mixed feelings: architect George Edmund Street (1824-81) 'admired metal in pure engineering, but loathed the commingling of architecture and engineering in façades which seemed to be supported by sheets of glass. He felt that as construction in iron became more scientific, it became artistically more unsatisfactory. The naked use of iron had enjoyed a short, premature reign during the 1850s, but by the 1870s a strong reaction had set in and iron was, if possible, concealed from view.' (Meeks, 1978:91) The man in the street wanted picturesque and palatial stations, and the obliging and sensitive architect gladly provided him with it, regardless of the theoreticians' qualms. This disguise was effected with the application of the Revivalist styles, narrated under the discussion of industrial architecture (refer Appendix 1), and labelled by architectural historian Meeks as the style of 'Picturesque Eclecticism'.

The debate was further fuelled by the new approach to station architecture, with the engineer being intimately involved with the structural (and often aesthetic) aspects of the design. In the early beginnings of station design the architect was not even consulted, the design usually being entrusted to the engineer. It was only when the prestige factor in the appearance of the passenger support area became important that the architect became more involved. However, as the integration of the growing concourse with the also growing train area became more and more difficult, the respective design responsibilities were often cleanly divided between the architect and the engineer. Some architects saw the task of unifying the two structures as virtually impossible, with only some attempt at contiguity being considered possible, and the co-existence of engineer and architect was accordingly not always harmonious. (A cynic could comment that only the architect's loathing of the engineer's involvement led to the prior's debate over the acceptability and use of the new materials by architects, as otherwise, all of a sudden, the glory of a large commission – and the professional fee – had to be shared or could even be lost…)

Regarding the creation and realization of huge enclosed spaces by architects, the supershed's impact was profound: its development by, and application in railway architecture had an effect on the perception, understanding and experience of space by society at large. In the past, such experience was limited to the space contained in churches, the only large structures accessible to the man in the street. The size and height of these, generally larger and taller than any other structure in the city, had thereby historically

Fig.3.36 The clash between the architect and the engineer: the Neo-Gothic St. Pancras Hotel and concourse hiding the functional train-shed behind it

Fig. 3.37 St Peter's, Cologne (1248-1880)

proclaimed their hierarchy, their dominance in and over society. The supershed's impact here was due to the competing size of its bulk and of its enclosed space and resulting large volume contained within. The average man in the street was now able, in his pursuit of everyday activities, to experience a new sensation: the sense of vast, but structurally enclosed space, raw, unmitigated, with minimal superficial application of ornament, impressing through its incredible and uninterrupted dimensions. Previously unimaginable large (and now secular) spaces and volumes became accepted as normal, after the initial amazement yielded in the population: their users became used to non-institutional large structures and their everyday use of them, and were no longer intimidated thereby. This influenced the field of their application for the architect: he could now, with comfort and confidence, design such large structures, knowing that their users were not likely to object to them. This acceptance also explains in part the ability to later use the supershed as a station concourse for prestige purposes, as, whilst proclaiming hierarchy, both inside and outside, it impressed but no longer intimidated unnecessarily (which might have prevented its uninhibited usage by the passenger).

Furthermore, the clarity of structure and the straight-forward, undisguised use of the new materials led to the acceptance by the public of functionalism, albeit slowly and with periods of retrogression, during which the station's concourse buildings, offices and hotels were styled in various Revivalist styles such as Italianate or Neo-Gothic. The acceptance of functionalism by the population was possibly aided by its being used to the visibility of Gothic churches' structure, and now seeing this principle repeated in the train-shed, although it did take some time to make this mind-shift to the similar underlying principle, although they differed in appearance. 'The spatial quality and structural clarity of the Gothic cathedrals are in many ways comparable to that of the Victorian train-sheds. The latter, in addition, were economical, functional, simple of form and economic to build.' (Wilkinson, 1991:vii). Norberg-Schulz (1974:169) further ascertains that Baroque principles also followed a concept of open and dynamic space. The utilitarian structures of iron and glass as applied in stations echoed both these characteristics. However, in this process glass, which had replaced masonry in walls and ceilings, and shifted from being associated with a mainly religious connotation (when used in large areas): it was now as easily associated with commercial and other secular structures and activities. Concurrent with this development was the aspect of the so much larger volumes now being enclosed by secular and not only institutional structures. The perceived historic hierarchy of certain structures and the institutions represented by them was changing…

3.8 Influence of stations on the cityscape

The effect of the city station's supershed on the cityscape resulted from the visual impact it made on the city's silhouette. Historically, cathedral spires and town hall towers generally were the largest and tallest

structures in the cityscape, rising high above the huddled silhouette of the city. They were imbued with a commanding hierarchy due to their exceptional size, unique shape and strategic location, often placed in the centre or on the highest point of the city, increasing the perception of dominance over its surroundings. They formed points of focus around which one could imagine the city to revolve, and points of orientation in the city fabric. This perception of superiority was now being opened to competition from stations, and in the main from the supershed: The need for covering the large horizontal expansion of the train area led, as stated before, to ever more commanding vertical heights being necessitated by the structural considerations underlying the spanning the area to be enclosed.

Fig.3.38 Churches as the historic focal points: Rostock, Germany, in 1943

Architectural theoretician Ching states that 'the principle of hierarchy implies that in most if not all architectural compositions, real differences exist among their forms and spaces. These differences reflect the degree of importance of these forms and spaces, as well as the functional, formal and symbolic roles they play in the organization [the city and its society]… The manner in which the functional or symbolic differences are revealed is critical to the establishment of a visible, hierarchical order. The form or space to be seen as important or significant must be made uniquely visible. The hierarchically important form or space is given meaning and significance by being an exception to the norm, an anomaly within an otherwise regular pattern.' (Ching, 1996:338) By being different to the surrounding structures the cathedrals had achieved a position of hierarchy. – By association, through this dominance of the skyline, the physically perceived hierarchy of these structures imbued the institutions they represented with a similar position of dominance in society and culture, which was generally not challenged. A form of power architecture is thus embedded in cathedrals, too.

Fig. 3.39 Stations as the new focal points: St Pancras, London

This is where the effect of station architecture on the cityscape was most influential. It has to do with the exterior shape and form of stations: the appearance on the city silhouette of the stations' then enormous supersheds, generally linked to a majestic office or hotel building and crowned by an even taller clock tower, suddenly placed new and different focal points on it. The city showed an increase not only in the number of vertical elements, but also of bulky horizontal volumes rising above the surrounding buildings. The physical hierarchy of the previously dominating institutional structures was suddenly challenged, a competing hierarchy undermining the existing.

The effect must have been startling to a citizenry only used to the spires and domes of the mainly religious institutions arising amongst them. It must have been similar to seeing a beached whale. The stations became tourist attractions, drawing vast sight-seeing crowds who came to look at these massive and unprecedented structures. Their dominant position on the skyline challenged that of the old, established institutions. New points of orientation were created, and new associations formed in the mind of the populace: St Pancras was no longer associated with a church, but with a station…

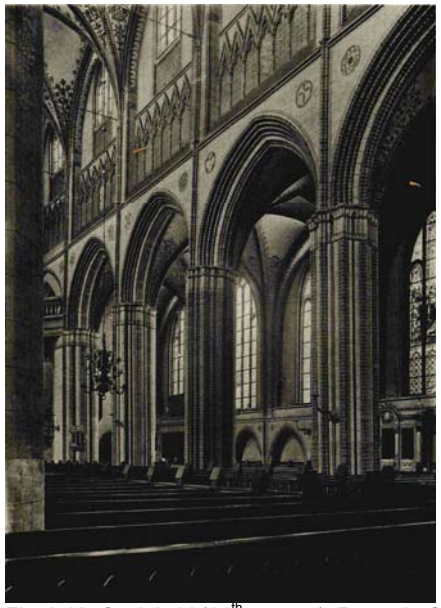

Fig. 3.40 St. Jakobi (14th century), Rostock, Germany

Fig. 3.41 Manchester Central Station (1876-80, by John Fowler)

In this way the population was prepared for the further growth of huge volume structures other than those of religion, royalty or city government, such as larger and larger factories, warehouses and department stores. Large bulk buildings became less intimidating, through their everyday use, and became accepted elements on the city skyline. Similarly, the large areas occupied by these large structures were accepted as normal, opening the way for further large-scale developments in architecture and their acceptance by society.

3.9 Ecclesiastic cathedrals *vs*. secular 'cathedrals': the influence on society

In the past, cathedrals and churches served as both focal points and as points of orientation, and historically had concretized existential meaning, emphasized by their central and dominant location in the city lay-out. Gothic churches' longitudinal plan, verticality, lofty volume and slender spires, and the said central placement in the urban fabric marked their status. (Norberg-Schulz: 92-93) According to architectural historian and theoretician Norberg-Schulz, the church was, during the Gothic period, the central representation of what could be termed a cosmic ordered universe, whereas during the Renaissance it stood for a mathematically and geometrically ordered universe, and in the Baroque as the focus or spatial centre of meaning of the world and its centralized systems. In all periods the cathedral and the church (and thus religion) represented one of the focal points of life, together with royal residences and town administration buildings. These institutions provided the visible focal points of urban life, the conspicuous structures on which the lesser mortals' life focussed and around which their life flooded. These erstwhile only structures of presence had directly or indirectly ruled the life of those looking up to them, and the structures exuded the trappings and symbolism of power. The church, though accessible to the masses, was reserved for the presence of God; the potentially accessible town hall was for those elected or appointed thereto; and the palaces, reserved for the king and nobility, were inaccessible unless one was a servant.

With the supershed 'cathedrals' slowly but surely starting to exceed the size of the afore-mentioned institutional structures (which had historically provided the focal points of society, thereby proclaiming their superiority and psychologically enforcing the institutions' dominance over the man in the street), the latter's visually commanding position was challenged and undermined. This was not in the sense that the population started to doubt such institutions' authority, but the railway stations, those superior, attention-commanding and awe-inspiring structures freely accessible to them at their own discretion and nobody else's, enabled them to experience, for the first time without intimidation, the quality of vast space and volume. This, in my opinion, removed some of the awe in which the other large-sized institutional structures (and institutions) had previously been held, in this sense freeing the ordinary man by making such spaces

Fig. 3.42 Once at the city's edge, the city has jumped across the railway: Braamfontein yards, Johannesburg, with Queen Elizabeth Bridge in the distance

Fig. 3.43 Now a barrier cutting through the city: approaches to Park Station, Johannesburg

and volumes more 'normal' to him. This competition of focal points thus undermined the traditionally important existential meanings, and contributed to the liberation from the constricting institutional systems of the past. This had social and cultural implications: the city-dweller and the visiting rural inhabitant became *blasé* about large volumes… 'The church and palace lost their importance … and during the nineteenth century [the railway station,] the monument, the museum, the dwelling, the theatre, the exhibition hall, the factory and office building took over their role.' (Norberg-Schulz, 1974:173)

3.10 Influence of stations on urban planning

To understand the impact of the large city stations on urban planning we need to, first, look at where the first stations were placed, and the impact this placement and the railway tracks' approaches to them had on the development of the urban fabric of the city, and, secondly, the effect on the urban texture caused by the more recent decline and even demise of railway services.

Initially stations were placed where both the physical constraints imposed by railway approach and station construction (as set out in Appendix 2, 'Design considerations: choice of site') could be satisfied on available and reasonably cheap land, as initial capital was limited. This was usually on the periphery of the city, as a green-field development. If a through station was so placed, the station did not disrupt the existing city fabric, but did hamper further growth in that direction, as it and its connecting railway tracks to both sides formed a substantial barrier to communicating with the 'off', non-city side. Access to it was difficult: few bridges were provided, once again due to expense. Accordingly the land on this 'far' side was less attractive for development, and remained relatively cheap, and was then used for the housing of the poorer classes, who couldn't afford better. This development is reflected in the view of staying on the 'right' or 'wrong' side of the railway line. The situation was often exacerbated by the placing of the carriage sidings and workshops next or close to the station, so that the barrier became even wider. Adding even further to it was the subsequent placing of industrial zones next to certain stretches of the railway, for convenience of freight shipment access. 'The horrors attendant upon the transformation of the countryside into industrial belts, the 'cinder strips', was about to appear.' (Meeks, 1978:57) – Then, in turn, to facilitate convenient access by the workers to public transport or to the industries adjoining the railway lines, their residential areas were stringed along these railway lines or industrial areas (within walking distance, as cars were then far and few between and alternative public transport not always easily available); furthermore so because land was cheaper there (as stated before), making it attractive to speculators and developers. The growth of the suburbs was in fact aided by the availability of railway transport. 'Commuting by railroad was abetting the flight to the suburbs.' (*ibid*:57) This urban flight was however not limited to the poor crowding around the railway-adjoining suburbs for lack of better space. The wealthy also took the opportunity to escape from the

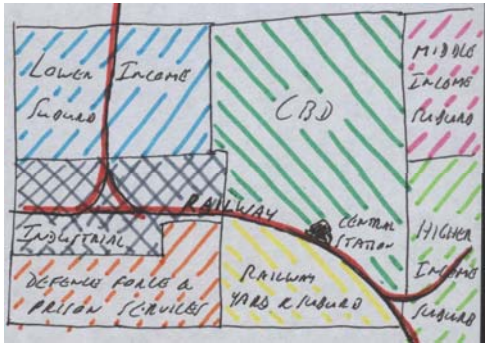

Fig. 3.44 Initial urban development pattern along Pretoria's railway lines

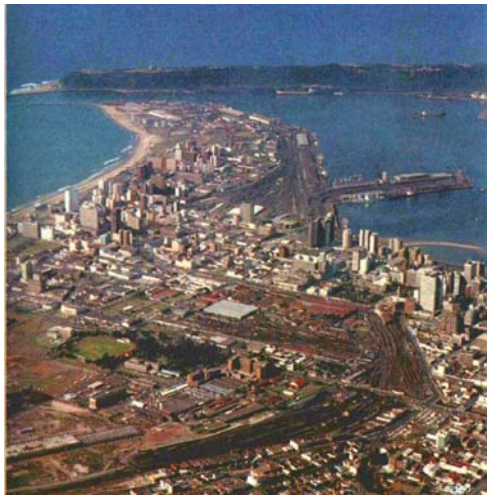

Fig. 3.45 The North Coast line terminating at Durban station (centre right) formed a barrier to the further sea-ward development of the city to its east

crowded and often insalubrious inner city environment (sanitation was not as yet a general feature), and erected or bought country estates, which they could easily reach by coach and horse from the nearest station. A ring of wealth was forming around the squalor of the worker-class suburbs. The railways and associated increased mobility were thus contributors towards urban sprawl.

The areas adjacent to the railway lines were thus seen as 'blue-collar', as they were generally populated by the lower income group. The upper classes could afford transport (horse-drawn carriages or cars) so that they, not being dependent on walking or public transport, could afford to stay in areas further away from the railway. Through this process of causation the differentiation in residential location between the various income groups became strengthened and more stratified: the further from the railway, the richer the population. (In South Africa this process was disrupted by apartheid policies.)

An example of the railway-induced settlement pattern would be Pretoria, where the NZASM's sidings, round-houses and workshops were placed to the south of the first station, and thus to the south-west of the second station. The railway workers' cottages placed to the south of the workshops have never been fully integrated into the Pretoria city fibre: It forms an isolated and near-forgotten suburb, linked only by a long foot-bridge and a circuitous vehicle access route. The first industrial area of Pretoria was then placed along the rail route to the west, curving around to the north. It is here that we find the oldest industries, bordered to the east by the central business district ('CBD') and to the west by the 'blue-collar' worker's residential area of Pretoria-West. The first upmarket residential area of Pretoria was to the east and south-east of the CBD, removed from the rail lines. The country estate of Sammy Marks, early Transvaal industrialist, was built in the 1890s close by the Pienaars River, a fair distance to the east Pretoria, but was within easy reach of the Delagoa Bay railway line. Similarly, Jan Smuts commuted by public train from his estate at Irene, south of Pretoria. – In certain cases, as during the apartheid policy-driven settlement pattern developments in South Africa, the barrier of a railway line made for a convenient and gladly used separation between the various population groups, due to its impermeability.

However, the 'off' side city and suburban development does not need to remain an area without urban fabric; generally it develops its own urban infrastructure, with its own small commercial core and community support structure, as it is, for example, too inconvenient to take a circuitous route to the 'right' side of the tracks for small purchases or other minor tasks. Thus coherent communities can form here, fairly independent of the other, so-called 'proper' side of the rail lines. Nonetheless these areas are more inward turned than 'non-barriered' communities, and focus their attention and further development into the non-railway direction. As such, the rail-adjacent areas have reacted on the railway 'feature' of the site where they developed, after the creation of this feature. It is a response no different to that of reacting on a physical, geographic feature, such as a river, coast line, lagoon, swamp, mountain or cliff face, albeit less

Fig. 3.46 The wedge-like intrusion formed by the approaches to the terminus: Frankfurt (am Main) Station, Germany

attractive.

Developments in, for example, London, Paris, Frankfurt, Cape Town and Durban were slightly different. Here the railway companies operated from terminal stations, so that the railway approach tracks were from one side of the station only. The railway companies tried to reach as close as possible to the CBD, as a convenience for their passengers and freight shippers. However, limited capital resources initially restricted them to the cheaper outer city or rural land, at some distance from the city. City authorities were also averse initially to the railways' penetrating too far into the city proper. In these cases, the city expanded differently: although the Great Western Railway's London terminus was located at a small village named Paddington, on the Edgware Road, about a mile from London, around the original diminutive station of 1838 soon clustered many buildings; but even as late as 1846, the first Paddington Station had only a prim, unornamented façade, with trees, flocks of sheep, and clumsy road coaches near its doorways. Then London quietly crept up to Paddington and embraced the village. Similarly, on the southern side of the Thames, when the London and Southampton Railway purchased the site of its Waterloo station, there were only several small streets in the vicinity. The terminus itself was built on ground occupied by cow-yards and hay-stacks (Carter, 1958:18) The city thus grew outwards to connect its centre to the station, with often the central business district itself expanding towards the stations due to the desirability for offices to be close to railway connections. The large station structures acted as a draw-card for the area and formed the catalyst for the further development of the area. The suburbs then started to envelope and burgeon between the railway approaches to the cities, resulting in the impression of fingers reaching into the urban fabric towards the city centre, although it actually happened the other way round. Development of industrial and lower income group residential areas along these fingers generally occurred in the same way as described for through stations. However, similarly to the 'off' side of through stations, the segments between the rail lines often developed as fairly cohesive suburbs, the barriers created by the intersecting railways being treated similar to non-bridgeable rivers. The smaller stations along the lines often formed the small catalyst core of such a suburb's commercial activities. – Once again the surrounding areas reacted on the barrier feature of the site where they developed, after the creation of this feature, as if it were no more than a physical, geographic feature, such as a river, swamp or cliff face. – The difference to the impact of terminal stations is that there is not really an 'off' side to these suburbs, as the CBD forms, at least partially, a link between the various suburban segments; however, outwards from the termini the rail lines do form barriers impeding easy communication between the so separated suburbs.

The exception to the discussed initial peripheral location of a station is where a railway is cut through the existing urban fabric towards the city centre, in order to gain a closer, more convenient or new access for its passengers. It is very seldom that the tracks of an originally peripheral station would be extended further into the CBD, largely due to the astronomical cost of such extensions. Exceptions are London's Charing

Fig. 3.47 The approaches to terminus stations segmenting the urban fabric: St Pancras (in centre) and King's Cross Stations (to right), London

Cross Station, extended in 1864 for 4 km from London Bridge Station at a then cost of nearly £ 4,000,000 (Carter, 1958:56), as well as London's Waterloo and Paris's Gare d'Orsay Stations. The Waterloo extension was constructed through a mix of then still rural and peri-urban land, and that of the Gare d'Orsay in a tunnel along the Seine embankment, leading to periodic flooding. The worst destruction of the urban fabric was however wrought by the late construction of the approaches to London's St Pancras (1854) and Marylebone (1899) Stations. The latter two as late-comers to London found it necessary to cut through the suburban sprawl that had developed along other existing lines, as described above. This forced the large-scale removal of the local residents. This way of locating a station, whether of a terminal or though station type, causes serious disruption and destruction of the urban texture: the existing fabric of the community and roads is destroyed by this wedge driven through it, severing social, cultural and commercial links. The pattern of movement and connection within the area is damaged on all levels, with regards to the residents' transport, economic, cultural and social connectivity: a part of the city or suburb is effectively sliced off from the area where it has focussed on for obtaining its support, such as shopping and health care. The few bridges, overcrosses and underpasses provided do only slightly alleviate the havoc caused. – Less disruptive interventions are possible: the approaches to Berlin's new *Hauptbahnhof*, utilizing the existing underground tracks of the *S-Bahn*, limit their damaging impact on the existing urban fabric.

The placement of stations did have an impact on the city's street grid. As they were normally placed where it was most convenient, in a location compatible with both the needs of railway approach construction and the closest, affordable proximity to the city centre, they were often placed in odd positions with regard to the grid, although attempts were made to have them at least face onto a main street. Also, as the locating of the streets had preceded the placement of the stations and thus could not foresee these, there is a lack of squares of ample proportions in front of so many London stations, and direct access from the CBD was sometimes circuitous. Only from the 1880's onwards were new stations planned and incorporated as focal points within the city fabric, mainly in cases where the city grew out towards the station. An example is that of the second Munich *Hauptbahnhof*: a wide boulevard was constructed from the western city gate, the *Karlstor*, to the new station. Baron Haussmann reversed the process: when cutting his boulevards through the already existing slums of Paris, he used stations, such as the Gare de l'Est, as nodes, making them all of a sudden focal points, an honour which they did not have before. In South Africa, the first Pretoria Central station was to the south of Scheiding Street, between Paul Kruger and Bosman Streets (then Market and Koch Streets).This did not provide any focal point. This situation was only amended with the Sir Herbert Baker-designed second station (1910), prominently placed at the upper end of Paul Kruger Street and providing a visual anchor to this street.

It is evident that the placing of stations and the railway alignment had a major influence on the urban texture of a city. However, its indirect contribution to the stratification of income classes into different suburbs, in

contrast to the aforesaid liberating and thus positive effects resulting from the large structure of the station appearing in the cityscape and creating the opportunity for the non-privileged to experience large spaces, should not be laid at its doorstep: this was the result of the ruthless speculation of the land developers exploiting the need of less privileged to be close to the available means of transport or their place of employment.

Fig. 3.48 The end: Manchester Central Station (1876-80, by John Fowler)

The foregoing reviewed the impact of the construction of the stations and their railway approaches during the railways' expansion phase. Since then, the scenario has changed drastically.

Trains at one time carried as 80-90% of all travellers and freight of the world. After exponential growth – which in South Africa took of in the second half of the nineteenth century and peaked around the middle of the twentieth century – railway transportation has entered a period of stagnation and decline. The train's lesser flexibility (compared to that of car and truck), the lower relative speed, and the inability of railway management to improve the services rendered to its customer base have led to this decline. The loss of passengers and freight has been exacerbated by the spatial spread of homes and employment opportunities, made possible by the ever increasing ownership of cars and trucks. Regarding passenger transport, 'in general, the continuous growth of personal wealth is paralleled by an ongoing increase in car ownership ratio, while processes of social differentiation and emancipation bring about more complex mobility patterns, for which public transport is often ill equipped. Trends in the job market also contribute to an increased multidirectional, diffused mobility. Furthermore, the locational preferences of many, if not most firms and households seem to be for low-density, car-orientated, suburban and exurban locations…. In recent decades, population growth and employment growth have been maximal in peripheral, car-orientated locations.' (Bertolini, 1998:25) The latter factor also contributes to the loss of freight traffic, as these dispersed locations are difficult to serve efficiently by rail. Also, 'there is a general trend towards the retreat of the state. As a result, railways are torn between pressures to become profitable, and pressures to contribute to an environmentally and socially sustainable mobility.' (*ibid:*25)

As a result of decreasing volumes and decreasing subsidies, many rail services are no longer viable and are either reduced in quantity or totally stopped. In the latter case, the lines over which they operate are closed down, making the stations redundant, together with the adjacent sites previously holding railway-related activities such as carriage sidings, workshops and shunting yards. These large, open and now vacant areas occupy a potentially favourable position: 'Typically, the stations were erected in the course of the nineteenth century at the limits of the city; today, those sites may be in the midst of revitalizing metropolitan cores [or where attempts are made to revitalize them], or densifying and diversifying peripheries. Often they include large and unfragmented portions of disused or underused land (most notably because of the relocation [or shrinkage] of annexed freight yards).' (Bertolini, 1998:39).

Fig. 3.49 The derelict site of the demolished workshops area, Pretoria-Salvokop

Fig. 3 50 The legacy: abandoned shed, Pretoria-Salvokop

Due to the centrality of such areas, and the large spaces made available by the demise of their original function, they can once again become a magnet for redevelopment, but containing functions other than transport: offices, shops, convention centres, recreational and sports facilities, housing and light industry. However, a crucial issue 'is the typically high development costs and comparatively low revenues, which mean that a financial deficit is structural. … Generally, initial ambitions (such as multifunctionality and open spaces) are not checked against financial-economic feasibility, nor are they translated into hard programme demands/requisites. The inevitable result is downsizing in the course of the process. Partly as a consequence there is a strong orientation towards office development… The list of conditions considered necessary to realize the development potential is long. Most importantly, enough car parking and good accessibility by car are to be guaranteed, while public transport must improve. A broader functional mix is required, including offices, but also shops, public services and housing. This mix must be complimentary rather than concurrent to that of the city centre. … The implementation strategy must entail an answer to the question of how the mix of profitable and non-profitable elements is achieved, and how the latter are financed.' (Bertolini, 1998:41)

To summarize: The impact of the original location of stations and their rail approaches caused a quandary with regard to urban planning: essential as they are for the functioning of local, regional and national transport and mobility, the continuous band of land occupied by the railway, once placed conveniently and non-interrupting at the edge the city, now cuts like a giant swathe through the urban fabric, which has expanded to the extent of enclosing it fully. Through no fault of its own the stations and alignments form a cut, a chasm in the city, disconnecting the areas to its sides. In mitigation it may be said that generally the railway stations and their approach alignments preceded the construction of the suburb, the latter developing around them as if they were a geographical feature, similarly accepting and accommodating the presence of these large structures and large open areas such as carriage sidings in its midst. Damage to the urban fibre was perpetrated by those railway constructions thrust into suburban or urban areas after these had been developed. This, in addition, damaged the existing commercial, social and cultural patterns of movement, forcing wholesale re-orientation by the severed components. It is the bridging of this nonetheless existent gap, which often separates areas of totally different urban characteristics, which provides a major challenge to the architect and the urban planner. And where the railways no longer run, or have vacated the workshop and yard areas, these large tracts of empty land lie as open wounds in the urban fabric, unloved, unused, unproductive, and still separating the adjoining urban areas. It is with their re-incorporation into this fabric that the architect and urban planner are challenged, but their task is often fettered by the various involved parties: developers, railway administration, municipality, residents and other users of the area concerned or its neighbourhood. Each of these parties has a different goal, the compromise solution to which is wellnigh impossible to find.

3.11 Conclusion

The developments of the Industrial Revolution resulted in the unprecedented expansion of industrial production, of which the large-scale growth of a railway network was but one aspect. This growth necessitated the construction of ever larger stations to handle growing volumes of passengers and freight, and the growing number of longer trains transporting them. Freight operations were soon separated out of city stations to make more space available for passenger traffic. A station comprises a collection of components, each with its own function. Passenger stations generally accommodated the functions of the train track area, the passenger handling concourse area, the railway administration offices, and occasionally a hotel in their vast complex, which, in effect, consisted of different and separate, but adjacent structures, linked by the flow of passenger traffic through them.

Industrial architecture, based on the historic development of factory construction, was at first applied to the design of stations, for which no precedent had existed. Soon station design developed separately, needing to specialize so as to find solutions for the demand of increased enclosed space for the track areas, these requiring larger and larger areas having to be spanned without intermediate column support. This led to the introduction of the supershed, the ‘cathedral of industry’. This structure, enveloping vast space and volume, had a significant, direct impact on the cityscape, architecture and urban planning, and a more indirect one on society.

With regards to architecture, the requirements of the stations for passenger and train handling necessitated the development of the supershed, designed at first by engineers only, but then, with the increasing demands of ‘prestige architecture’, in conjunction with architects. These station design-related demands led to advances in the knowledge about the new materials developed during the Industrial Revolution and how to use them, which in turn has enabled the modern architect and engineer to design such structures as large factories, aircraft hangars, warehouses and shops.

The supershed also influenced architecture by changing the perception and experience of space. Large spaces were previously limited to institutional structures such as cathedrals, churches, palaces and town halls, to which general access was limited and which were associated with certain cultural values. Suddenly, by visiting a station whose train-shed’s dimensions were even larger than those of the institutional buildings, everybody, regardless of background, could experience spaces unimaginable before. The use of large structures became an everyday event, no longer exceptional. This changed the field for the architect: he could now, with comfort and confidence, design such large structures for other applications, knowing that their users were unlikely to object to them as being intimidating. Furthermore,

though often interrupted by fall-backs into Revivalist styles for the concourse, office and hotel structures, the use of undisguised materials in a functionalist style in the train-shed paved the way for their usage in modern-day functionalism.

Architecture can furthermore influence people and society by such trappings as are associated with 'power architecture', but this can go even further. It can influence the psychology and culture of a nation by providing competition to established hierarchies, as symbolized by the positioning and size of previously existing structures. This appears to have contributed indirectly to a shift in social and cultural values in the population, undermining the existing hierarchy by questioning it with structures of similar or larger dimensions.

Station architecture's influence on the cityscape was the impact that the station building, in the main the supershed covering the area of passenger/train interaction, had on the city's silhouette. It provided new points of focus and orientation. It challenged the existing hierarchy of structures: suddenly the until-then-dominant structures of church, nobility and town government where not the only points of focus. The supershed opened the way for other large-scale, secular edifices to challenge the institutional ones. The population got used to structures of ever-increasing area and bulk, both in horizontal and vertical dimension, and was less prone to regard institutional edifices with unreserved awe.

With regards to urban fabric and development, it was shown that the city parts surrounding pre-existing railway stations and alignments reacted to these features as they developed, in a response no different to that of a physical, geographic feature such as a river: the urban development jumped the barrier, which did however remained to impede the integrated development of the city. Where the urban fabric pre-existed the intrusion of station and railway line, the damage to the urban, commercial, social and cultural fibre was severe and forced a re-orientation by the severed community. Due to a number of reasons the areas adjacent to railway lines generally developed as industrial and lower income group residential areas.

With the reduction in train services and the resulting closure or shrinkage of the areas required by railway operations, much of this land is becoming available for redevelopment. It represents an infill opportunity on now vacant land. It challenges the architect and the urban planner to use this opportunity to add positive features to it and its vicinity, acting as a catalyst for further development, to uplift the often down-trodden surrounds and to make them more attractive. Such redevelopments can be on large or small scale. Such redevelopments should not be based only on idealistic conceptions of what would be nice to have: they should be approached as multi-functional, but financially viable projects, which will often include office developments as a component.

Where historically the urban area reacted on a pre-existing railway feature, a redevelopment including large-scale structures may not be necessarily out of place, as the surrounding area, when originally developing, had previously actually reacted on its large-scale predecessors. Thus, on the one hand, where large structure-remnants such as train-sheds still exist, although abandoned, they could possibly be put to use for alternative functions and be spared demolishment. On the other hand, where they were demolished, the architect may consider a large-scale replacement structure of similar outline or proportions as not inappropriate, as it would recall historic precedent. In contrast, where the abandoned facilities were a later incision into an existing urban fabric, the opportunity for redevelopment should be used to re-integrate the severed parts, although it should be borne in mind that in the many years of separation the two parts may nonetheless have each gone their way in adapting to it: a forced reintegration may now be as harmful an intervention as the original incision.

The inclusion of large structures in such a redevelopment is, as said, *per* se not unacceptable, seeing that it falls back on the historic precedent of its prior use, and that the original large station structure often acted as a draw-card and development catalyst in the past, for the area surrounding the station. A large, eye-catching structure or group of structures forming part of a redevelopment may once again serve as such a point of focus, in a now otherwise derelict and forgotten urban area, by creating a destination of interest and attraction therein. Turning the area into an acceptable, even desirable location should in turn contribute to its upliftment and urban regeneration.

It can thus be seen that the development of stations, with their supersheds, and the railway-related infrastructure has had a lasting influence on the development and perception of architecture, cityscape and the urban development of cities, with concomitant social and cultural implications. With the reduction in train services currently being experienced, leading to many large and open spaces becoming vacant as the railway stations, facilities and lines are closed or abandoned, the challenge is now to identify future usage for these spaces, which in turn can act as a catalyst of upliftment for the surrounding area. This, in turn, should facilitate city (re-)integration.