Urban railway development by the advent of a new high speed rail.

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Colofon

Master Thesis Going High Speed

Dual Graduation studio
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Alex Neves, 2012
LISBON
GOING HIGH SPEED
Alex Neves

Urban railway development by the advent of a new high speed rail
At the beginning of my graduation I received an email from the coordinator of the Hybrid buildings graduation lab. This email showed several projects from which the students could choose for their graduation. The project with the most votes would be the graduation project. One of the labs from which we could choose was high speed train and transformations of European stations. This sounded very fascinating and at that moment I did not have an idea yet for my graduation project. What I liked the last couple of years is the fact that every project was different. Making a design for a high speed train station is again something very new for me.

When I saw the choice of Lisbon as location I got enthusiastic, because I have certain affection for Lisbon. My parents are from Cape Verde, which used to be a colony of Portugal. Furthermore I have family in Lisbon and I have been there on holiday for several times. I can also reasonably read Portuguese, which could be very handy.

Because of all this it felt like the project for me. I was happy to hear that more people choose this lab which would result in receiving information of the site and context of Lisbon.

It was not until the graduation year started that I knew that the project was actually not for the dual graduates. Nevertheless I still wanted to do the project and therefor had to define my own project, because the assignment for the lab of Hybrid buildings was fixed and mostly focused on architecture.

This report is the final Thesis as a part of the graduation project Urbanism. In here you can find the process and planning of my graduation project at the faculty of Architecture of the Technical University of Delft.

Because I am a Dual Master student of both architecture and urbanism, I took the opportunity to mention the process and planning of the architecture part as well.

Alex Neves
April 2012, Delft
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Welcome to Lisbon, Portugal

Bird’s eye view
Introduction
Lisbon, Portugal
1.1 Lisbon, Portugal

The development of the railway area in Lisbon by the advent of a new High Speed Rail (HSR), with the station building as the architectural design, is my graduation project.

Lisbon, the capital of Portugal, is by far the country’s biggest city, with the seat of the government, many cultural institutions and a wide range of international companies. It is internationally orientated, but it has its own strong traditions and its own distinct history. The city of Lisbon consists of several centralities. The most important areas are Baixa, the Expo ’98, Belem and Entrecampos business district.

Castelo de São Jorge occupies a commanding position overlooking the city of Lisbon and the broad Tagus River beyond. The strongly fortified citadel

**LISBON’S METROPOLITAN AREA**

- > 2,682,687 inhabitants
  - 1/4 Portuguese population
- > 3,209 km² 23.3% mainland Portuguese area
- > 84 km² City of Lisbon total area
- > 1.3 million people active population at Lisbon’s Metropolitan Area
- > 30% companies headquarters
- > 32.7% national employment
- > 46% GNP

Source: AML 2003 Atlas and www.aml.pt

**Resident Population**

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<thead>
<tr>
<th>Year</th>
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<tr>
<td>1991</td>
<td>663,394</td>
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**Employment (1)**

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<td>1991</td>
<td>1,009,980</td>
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<td>2001</td>
<td>845,900</td>
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**Population Density by km²**

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<th>Year</th>
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<tr>
<td>1991</td>
<td>9,396</td>
</tr>
<tr>
<td>2001</td>
<td>7,998</td>
</tr>
</tbody>
</table>

(1) Population living in Lisbon or Lisbon Metropolitan Area and studying or working in Lisbon

Source: Lisboa – o desafio da mobilidade, July 2005

View from the hills over the historic center
dates from medieval times. After the great 1755 Lisbon earthquake, the Praça do Comércio square near the Tagus river was completely remodelled as part of the rebuilding of the Baixa Pombaline ordered by the Marquis of Pombal. Tourists that are visiting the city can use the antique style trams which run circuits around the city and make it easy on the legs by trekking the hills. Rossio Station, former central station, is a monumental train station looking more like a palace with horseshoe arched doorways. It is located in the Rossio square, a main square in the historic center.

Belém is famous as the place from which many of the great Portuguese explorers set off on their voyages of discovery. Now it is filled with monumental features and palaces.
Expo '98 (in full, 1998 Lisbon World Exposition) was an official specialised World’s Fair held in 1998. The theme of the fair was “The Oceans, a Heritage for the Future,” chosen in part to commemorate 500 years of Portuguese discoveries. The site reopened on February 1999, as “Parque das Nações” (Park of the Nations), keeping the gardens, Oceanarium (Europe’s then largest aquarium), and observation tower. The area today is thriving, modern, stylish, and safe, attracting 18 million tourists a year to its gardens, museums, commercial areas and modern buildings. It has also become permanent residency for up to 25,000 people and one of Lisbon’s premier business centers, with many multinational corporations basing their headquarters in its main avenue.
Entrecampos means “between the fields” in Portuguese. Entrecampos is located between Campo Grande (large field) and Campo Pequeno (small field). Praça de Entrecampos is a plaza, a large roundabout in Lisbon. At the center is Lisbon’s Monument for the Heroes of the Peninsular War. The plaza is the starting point of three major avenues: ‘Avenida da República’ to the South, ‘Avenida dos Estados Unidos da América’ to the East and ‘Avenida das Forças Armadas’ to the West. Near this plaza there is the railway station: a viaduct building. The central business district (CBD) is located around Entrecampos with Luxurious hotels, the College campus and several other hotspots. On the other hand there are also several fallow lands and the railway cutting threw the city.
Historic development

Lisbon emerged as a nation state in the early 12th century, and ranks as one of the world’s longest founded cities. The earthquake of 1755 destroyed nearly the entire city. The city was rebuilt by the Marquês de Pombal, who thus created the Baixa Pombalina, a commercial area that still attains attraction. In the 19th and 20th centuries, the city has spread progressively to the North and areas such as the Avenidas Novas (New Avenues) were added.

The city is described as prime romantic designed in a utopian manner. The main axis of Lisbon (between Rossio and Marques do Pombal) was introduced not primarily as a means of urban expansion but due to material persistence of strategic connection between the city and its productive suburbs.

The government found that Lisbon needed a parisian boulevard in order to make way for the bourgeoisie, which implied an contemporary idea of progress. The city went through a reorganisation of the old urban tissue, modernising the city not by expansion but by reorganising the historic spaces. But when making way for the city axis (avenida da liberdade), there was also more space available next to it. These spaces were filled as tabula rasa in a parisian manner.

The introduction of another structural axis happened when the government wanted to connect Campo Grande with Marques do Pombal in a similar parisian manner.

The fundamental articulation of the city was attained by this monumental axes which kept expanding towards the north in order to reach Campo Grande. This northern expansion symbolised a certain progress from the past as the city kept going away from the old city center. Even though well connected, this axis represents the development from past to future, from traditional routes to open spaces.

The historic time line shows that there were two important periods for the railway: The period of the construction and the modernization. The city of Lisbon expanded along the river and the main roads. The first railway line was the one along the river with a terminus at the historical center. The city center has three termini’s with a waist line outside the historic city center. The latest line is the connection with the south side of the river.
1.2 Research Going high speed

History railway stations and HSR

When revealing the literature on railway stations, the focus is much on the role of the railway station in itself than the spatial layout of the urban fabric in their vicinity. Railway stations are points of transport interchange. In the main their purpose is to let people leave a place or to arrive at this place. Different kinds of people face each other and interfere with one another in buildings of this sort. Here, the drama of departure and arrival takes place. In essence, the station is a space between a particular place and the trains. Today, however, the station is no longer dedicated to travel alone. During the two last decades, several other and especially commercial functions have established themselves inside stations (Edwards, 1997) as well as in the station’s vicinity.

In the golden age of railway building, engineers had to deal with 3 major problems. Firstly, they had to build practical and solid stations. Secondly, the problem of perceptual continuity had to be solved. The building had to fit into the prevailing visual environment. Thirdly, the engineers had to create new constructions for new functions (Betjeman, 1972). The most characteristic contribution that railway architecture has made to the civic appearance of our built environment is the hall of concourse. The architects of that period were responsible for the building’s proportions, while the engineers were accountable for utility (Meeks, 1957). In this way the railway station became a reflection of the impact of technology on the mobility of the masses.

The railway station is a good example for a primary element in the sense of Rossi’s theory of the architecture of the city. It is an artefact in Rossi’s sense for it conditions the further development of many towns and cities (Rossi, 1984). Many authors will say that the great passenger stations were one of the engineering miracles of that age and a highlight in urban design (Edwards, 1997). It became as important as the piazza and the marketplace in many cities. Betjeman expresses this as follows: “Railway terminals in the last century are the cathedrals of the railways” (Betjeman, 1972).

After half a century of a globally high emphasis on road construction and an equally widespread neglect of railway infrastructures, the last two decades were marked by a renaissance of the railway. Due to increased pollution, congestion of private cars in the streets, ecological movements and an increased public interest in sustainable development, public transport by rail has regained attention. The railway system can be regarded as a solution for the transport problem of the cities. The ecological benefit of travelling by train, combined with technical breakthroughs concerning new types of trains, as high speed trains running at 250 km/h, new types of suburban light rail systems, and new combined types of metro systems – all this has led to increased rail investment. Likewise, new high-speed rail links have been built between cities such that a throughout modernization of the old railway stations or the construction of new ones became inevitable. One was thus heading for a functionally smooth transport system. Basically, it seems that modern railway stations mostly have the same spatial structure as old ones. The textures of the material, however, are slightly different (Edwards 1997).

The High Speed train is one of the most important technological breakthroughs in transports. The high speed train is not only faster but also offers much higher quality on the railways and is part of the concept of social mobility, slashing journey times. The world currently has about 5,000 km of high-speed network, 3,000 of which is in Europe. The first line was built in Japan in 1958 and opened in 1964. Japan has been at the cutting edge of high-speed technology ever since. France pioneered high speed in Europe with the opening of the line between Paris and Lyon in 1981. It was an instant success. The TGV competed successfully with domestic air transportation. It was on this line that the world record was set with a speed of 513 km/h. This record was only broken in 2003 when China tested a Maglev High Speed train that touched 581 km/h. (Trip, 2007)

During the 1980s and 1990s the French network was expanded steadily. The most profitable connections had been constructed first (Sénat, 1998; Powell-Ladret, 1999:40). In the meantime, other European countries had begun to develop their own high-speed systems, most notably the German Inter City Express or ICE, the AVE (Alta Velocidad Española) in Spain and the Pendolino tilting train in Italy. Several European systems are based on the TGV. One such system is the Thalys, a TGV-type PBKA train connecting the Benelux to Paris and Cologne; another, the Eurostar between London, Paris and Brussels. With the expansion of the network in France, Germany and other countries, a European network has gradually come into existence, which is strongly favored by the European Union’s Trans-European Network policy. (Trip, 2007)
Modern railway stations appear to be lighter, safer, and more commercial than older ones. The airport station is a new type of railway station, developed during the last two decades. Presumably, stations of this sort are more effective in use. Here people can easily find their way from the trains to the departure hall. On the other hand, railway stations in a city centre are slowly turning into something between a railway station and a shopping centre. A railway station is open for everyone. It is a public place with a public facade to the city. It has a scale of human movement and a complexity of function inside the building. However, how it is connected to the local street net is often forgotten in most research projects. (van Nes and Stolk, 2010)

Idea and expected outcome of HSR

The size of the consequences for a city depends on a number of things. Although there is no proof that infrastructure leads to economic growth, it can be stated that sufficient infrastructure is essential for economic development (Zonneveld and Trip, 2003). The impact of the high-speed train goes well beyond its mere transport technical aspects. Like the railway itself before, the European high-speed network considerably accelerates the process of time-space compression in Europe. The significant reduction in travel times between cities and regions over recent decades has been interpreted most expressively in the map of „shrinking Europe“ by Spiekermann and Wegener. The map shows how distances are deformed in relation to travel time between regions by high-speed train [not including, therefore, the effects of increasing air transport]. Planned improvements will, for a constant timescale, effectively bring regions closer together. In 1991, shrinkage is mainly limited to France, which at that time had by far the most extensive high-speed network. By 2010, the European network will have been expanded and other countries will be affected too, notably Spain, Italy and Germany. (Trip, 2007)

The time-space convergence leads to a greater reach of a city. This has overlap of the influence zones or relevant regions as a result. In order to compensate this and minimize the backwash-effect, where companies and inhabitants move to places with better access to the European market/network, companies will have to become more competitive. It can be expected that they will focus on those areas where they have a comparative advantage. This specialization between cities can lead to a growing cooperation and to a strengthening of the network of cities (Pol, 2002, van den Berg and Pol, 1998).

The implementation of the HST leads to urban and, supposedly, economic development around the stations it calls at, and most notably to the redevelopment of station areas in many cities. However, the effects that cause HST stations to become architectural showpieces also raise expectations with regard to the economic effects of the HST. This is based on the accessibility effect of the HST, as well as on the abovementioned image. As one station planner stated, the list of cities that are relevant in Europe nowadays equals the list of cities included in the HST network; this may not be entirely true in fact, but it is increasingly the way things are perceived, which makes it a reality in effect. Thus, the HST fuels the ambition of European cities increasingly involved in a mutual, international competition for economic growth and prestige. The question of the extent to which these ambitions are justified in the sense that the arrival of the HST may indeed be reasonably expected to generate such large economic growth is the subject of a wide and diverse field of research on infrastructure development and urban and economic development. The main question here, however, is how this large-scale redevelopment of station areas is taking place, and to what extent it contributes to vibrant, lively urban areas.

Many HST station areas take the form of what we may term „international business centers“: locations that aim to attract the offices (head offices in more ambitious areas) of, in particular, internationally oriented producer services, without actually disregarding the main offices of international manufacturing or energy firms. The HST may facilitate the development of an international business center for two main reasons. First, it provides additional transport facilities, which are especially important given that knowledge-intensive business still very much depends on face-to-face contact. This implies that proximity is very important, and clusters of related companies and individuals will form. Second, but by no means less importantly, the HST station provides an image that suits international business. It provides an elegant way of travelling. This image is reflected in the new stations that are being built in many cities. Of particular note is the striking architecture of many high-speed train stations, which calls to mind the glorious railway cathedrals of the nineteenth century. Furthermore, many of the existing stations where the HST will call are being renovated and enlarged. (Trip, 2007) This image is very important for a city, as this enlarges the opportunities to attract...
and retain business and people. The reason for this is that this perception of status is a leading motive for both business and residents to locate near a high-speed train (HST) station (Pol, 2002).

High-speed rail connections and image are particularly valuable assets, and the HST is considered a must-have by local politicians (Trip, 2007). So it is important for a city to provide an attractive climate for businesses to settle there, but there also is another line of reasoning that is important in this case. Highly educated workers have high job mobility and thus will base their decision on where to live more on the attractive living conditions than on a specific firm. Providing these conditions as a city can attract or retain these workers and as they are very important to businesses these will follow. The high-speed rail characteristics: the enlarged accessibility and the image can help in achieving these qualities (Pol, 2002).

**Realitycheck**

As these effects of the HST are the largest in the primary development zone, the area within ten minutes walking distance of the station, both people and businesses will want to locate there. But this is not as straightforward as it looks because a high quality living environment and infrastructure are not easily compatible. Combining them brings great financial costs, which can only be recovered by high rent levels and the highest can be achieved with office buildings (Bertolini, 1996). A high density of offices will negatively influence the sustainability of the urban development when they are not balanced by other functions. According to Pol (2002) the dimensions of sustainable urban development are: 1 diversified economy, 2 diversified districts, 3 multi-modality, 4 minimising nuisance of transport, 5 attractive public spaces and buildings in harmony with the city size and nature. These dimensions are very much compatible with the key elements of quality of space defined by Trip (2007): diversity, integration and quality of public space.

At present, railway stations perform a variety of functions. They are not just giving access to trains. First of all, they are places where people change from trains to the pavement, to subways, buses or cars, to a bicycle, a taxi, the light rail, to other trains, or to airplanes. Otherwise they simply arrive at their final destination, which is in the immediate vicinity of the railway station. Furthermore, train stations are also shopping malls, meeting places and urban landmarks. They are distinctive and complex places. They serve us in our social, cultural and functional interactions. (van Nes and Stolk, 2010) The passenger’s station is the architectural manifestation of the railway system and its connection with the urban fabric. It is both a gateway to a rail network and it is a threshold for passengers entering a city.

“What gives the railway station particular significance as architecture and essential elements in the life and cultures of cities is precisely this interface between these two worlds - the railway system and the urban back cloth” (Edwards 1997, p. xi).

Transport is no longer the luxury it was during the last century. However, it is an essential component of the modern ages. Train lines connect urban centres to other urban centres, and stations are places where people travel through. Interestingly enough, stations have become important economic catalysts for urban development. Their improvement has led to massive urban development around several station areas.

More recently, railway stations have changed their functions. Th eroles of waiting rooms are disappearing, and people go shopping or eating before they enter the trains. Railway stations begin to acquire the character of a covered market, where not only railway companies are selling a variety of services, but where retailers and restaurants are competing for the passengers’ “attention” (Edwards 1997, p. 7). Companies and shops establish themselves along the ways where people are moving. Seemingly, the increased popularity and effectiveness of train travel and the role of the station as a point of transport interchange have turned the railway station into a kind of leisure world. The drama of urban life can be witnessed to be in full flow. People can watch each other, and it is a resort for all kinds of people: the urban tourist, the shopper, the unemployed, the homeless, businessmen, salesmen, retailers, train spotters, commuters and train personnel. It is open for everyone, not only for travellers (Edwards 1997, p. 173).

“In the new urbanity of the post industrial age, the station with its open democratic structure, its public spaces inside and out, and its corridor of movement etched upon the face of the city, represents an important civilizing element” (Edwards 1997, p. 181). The combination of sustainable development and environmental considerations with social and cultural functions makes railway stations interesting kind of highly complex buildings and their
relationship to the local place. Due to noise and security mostly airports are placed outside city centres. Like airport stations, intermodal hub stations located in industrial areas are not connected to the local place where it is located. Larger railway stations are placed within or close to a city centre. They are localized in its dense network of central facilities. It is even more a part of city life, with a smooth transition from the city street to a seat on the train (Edwards 1997, p. 26). In smaller towns or villages, the railway station tend to be one building located along the tracks. Often the architecture of the building mirrors the local building style at the place. The smallest type of railways station consists of a track located along the rails with one shelter for the rain and a ticket machine. These stations tend to be located in the countryside or in post-war sub-urban areas. The impact of a station will be the largest around junction stations as they have the biggest option value. The wider choice and greater flexibility is appreciated even if it is not used (Pol, 2002).

**Causes of unsuccessful railway areas**

Mobility on rails is acknowledged to be one of the most sustainable means of transportation between cities and towns. Therefore, a railway station’s location in a built environment and its degree of accessibility is essential to reach as many travellers as possible. As stated before, it is believed that a railway station attracts economic activities such as shops, retail and offices. However, the spatial configuration of the local street and road net in a railway station’s vicinity is seldom taken into consideration. (van Nes and Stolk, 2010) A local area’s degree of vitality has to be spatially supported by a local well-connected and integrated street and road network (Kusumo, 2005).

The railway station area as a new central place in the city and has similar necessity as a centre in the city. Paksucharem (2003) argued that the key to the successful creation of an urban place out of a transport node is the same as that which prevails in general, namely that spatial configuration is critical. Bill Hillier and his colleagues at the Space Syntax laboratory propose that the live centrality is related to its spatial context; thus an urban centre is never stable, but consists in a process. He also argues that while we may find movement and attractors (land-uses which benefit greatly from generating movement, such as retail shops) highly related to each other, we cannot assume that movement can be explained by attractors until we are sure that the configurational properties of the grid have not influenced both the presence of movement and the presence of attractors (Hillier, 1984).

Based on Space Syntax theory, Read studied the centrality issues on Dutch cities. He argued that configurationally, cities consist of different scales of movement. These scales are layered, distinguished by the scales of mobility, and are designed to convey different scales of movement. The hierarchy or functional layering built into the shape of the urban grid of Dutch cities involves firstly the regional movement network which conveys movement at a scale which cities as points or destinations within it. Secondly, it involves the city-scale movement network, a set of spaces in the grid, which are suited by their geometry for carrying traffic over the medium and longer distance. And thirdly, it involves the grid at the neighbourhood or local scale. The regional scales appear locally most often in a nodal node - e.g. stations, metro stops or parking garages. (Read, 1996)

The city scale is mostly linear and continuous, and is differentiated and ‘formed’ by its level of integration into the local scale. It is suggested that in order to produce that sort of real urban centrality, we need to integrate locations into the urban system at a variety of scale levels. The centrality is a product of layering of scales. This means that real urban centrality depends not only on the contribution of a regional context, but also on a context at a ‘city’ scale as well as at a local scale. In other words, the location needs to be systematically connected to the more traditional urban scales as well as to the new ones (Read, 2000).

At the local scale, Jacobs has suggested the importance of small-blocks in generating diversity in the city (Jacobs, 1992). This idea has been further elaborated by Siksa (1997). He found that some block forms and sizes were better than others in making city centre layout more amenable to adoption, or more robust in meeting varied development needs over time. Small square blocks, 50-60 meters, perform better than larger blocks because they produce finer-mesh circulation patterns, more potential frontages, more coherent block fabrics and finer-grained, continuous urban fabrics and both low and high-rise buildings. Thus, he argued further, if certain block forms have worked well, or have produced particular effects in the past, there is a reasonable expectation that they will perform similarly in other cases in the future.
Next steps
Whether sustainable urban development or the quality of space is achievable is very much dependent on the local context or in other words the path dependency of a location. Path dependency can be described as a chain of successive events; these events have shaped the current situation and will influence the future. There are many kinds of path dependency but in this case the technical, geographical and the institutional are the relevant ones (Trip, 2007). They influence the possibilities and aims related to the effects of in this case the high-speed train connection of the city. The availability of space and of (public) funding, the local infrastructure (public and private feeders) and the local actors all affect the choice of for instance the station location (van den Berg and Pol, 1998-2) and the characteristics of the station area that need to/will be invested in (The node, the place, the spatial quality or the image (Trip, 2007)). The choices made can have a big impact on the city, not only on the functioning of the station itself but also on city as a whole.

Integration of the station in different ways into the city is essential if the whole metropolitan area is to profit. As for the spatial integration, people need to get to the station and from the station to the whole metropolitan area. This in not only essential for the functioning of the station itself but also for the cohesion of the city to prevent polarization, where the success of the station area drains other areas. This polarization is fed also by the phenomenon of the primary development zone. The zone within 5 minutes walking distance of the station is the area in which the development of the station has direct effects and thus will profit the most. Functional integration (exchange of users with other areas) and mental integration (mental map, visual links and legibility of the spaces) (Trip, 2007) also play a huge role though mostly on a smaller scale.

Analyses methods for a successful railway station area
Two methods have been used in order to reveal the correlation between streets net’s degree of spatial integration and the value of a railway station, the space syntax method and the Node Place value model.
The Node Place value model, developed by Bertolini, aims at correlating the degree of functionality and degree of local place qualities for nodes (Bertolini 1999). According to this model, a station functions well when the node value and the place value correspond. The parameters for deciding the node value are the variation in the mobility types, the frequency of the public transport system of a hub, the accessibility of the network connected to the node, and the mobility means that can reach the hub. The parameters for the place value are dependent on the number of functions accessible in the vicinity of the node, such as dwellings, offices, public buildings, leisure activities and shops and the way these functions are connected to each other.

A mono-functional node with for example only offices has a low degree of place value than a node with dwellings and offices. The Node Place value model illustrates therefore the optimal correlation between place value and node value. If there is a balance between these correlations, it is defined to be a successful node and place. Often railway stations located in these kinds of places tend to be successful. As soon as either the place value or the node value is dominating, these places are defined not to be successful for nodes.

The aim with using the space syntax method is to get insights on how the spatial structure of the street and road net affect human activities in built environments. The space syntax method, developed by Hillier and his colleagues at the University College London, is able to calculate how a street relates to all others in a town or city. The recent versions of the Depthmap software are able to calculate topological distance (how...
integrated a street is in relationship to all others in terms of the number of direction change), geometrical distance (how integrated a street is in relationship to all others in terms of the angular relationship between them), and metrical distance. Moreover, the software is able to both describe and visualize a built environment’s spatial inequalities, and to simulate and trace movement routes of computer-generated agents. The way these agents move is based on research in a present urban context (Turner 2004).

Since the space syntax method analyses pure spatial relationships quantitatively, the results can be correlated with numerical statistical data such as pedestrian flow rates, crime dispersal, land use values, etc. A study of Kusumo (2005), for example, investigates spatial integration of railway stations in the existing urban fabric and analyses the influence of the railway station’s location on the distribution pattern of retail and service firms. Station areas of two cities in the Netherlands were analyzed by the grid configuration analysis using Space Syntax techniques to uncover space-structural detail within urban fabric as a field of movement and activity. The software uses colour codes for the various integration values. In this way, one can see in one glance the spatial structure of settlements. As research has shown, there are correlations between a built environment’s spatial layout of its street and road net and the location of economic activities, crime dispersal, land use along streets, and property values (Hillier et al 1998). Therefore the degree of spatial integration affects mobility flow rates.

Moreover, it also affects the location of various economic activities such as firms and shops (Hillier et al 1993, 1998). If the structure of the street and road net changes, the mobility flow and the location pattern of economic activities are affected (van Nes 2002). In this respect, a station or a node’s place value can be quantitative measured on the various degrees of spatial integration of the street and road net. The spatial parameters can be correlated with the social and technical parameters indicated in the Node Place value model.

**Requirements international business location**

International business requires large amounts of modern, efficient office space, which can no longer be accommodated in inner cities and, instead, often results in large-scale, monotonous and rather schematic areas. Many cities are placed in the dilemma of how to meet the requirements of international business without being left with a local version of Brussels’ Quartier Nord. Neglecting the demands of business is not an option, as any large city needs this kind of activity in order to prosper economically, and competing cities are eager for any opportunity to fill the gap. Even cities such as Paris and London cannot neglect the requirements of international business. This partly explains the existence of locations such as Canary Wharf and La Défense. The latter was developed in order to protect inner-city Paris from modern office development and to accommodate, at the same time, the demands of international business (Hall, 1999:109; Rykwert, 2000:222 ff.). Indeed, many of these areas fail to provide the quality and metropolitan atmosphere required for high-end locations, being monotonous and dull rather than lively and vibrant. The types of firms that locate to these areas tend to be quite sensitive to the quality and status of their offices, however. Quality of the urban environment, for instance the quality of architecture and urban design and the attractiveness of public spaces, may actually prove profitable in terms of increased real estate revenues; despite the additional investments it requires (Rowley, 1998; UCL, 2001; Sparks, in: Bell, 2005:101).

Another line of thought relates a more diverse set of urban quality or quality of life issues to the competitiveness of cities in the long term (Kresl, 1995; Segedy, 1997; Rogerson, 1999; Gospodini, 2002; 2006). In recent years, Richard Florida has been the most notable advocate of this idea. Building on the work of Marshall (1920), Schumpeter (1939), Reich (1991) and in particular Jane Jacobs (1961; 1969), Florida stated in The Rise of the Creative Class (2002a) that advanced service economies are driven by a specific creative class. This, in turn, should be attracted and retained by certain characteristics of the day-to-day urban environment, which Florida defines as ‘quality of place’. In short, in order to be attractive top-end business locations, these areas must provide some of those urban qualities they seem to be incompatible with. Still, relatively little is known about how this takes shape in actual redevelopment projects (Spaans, 2004:341).

Thus, the quality of the HST station area is in one way or another relevant to its potential as a high-end business centre. Moreover, unlike
La Défense or Canary Wharf, HST stations are often located in city centres. They are important as public spaces, which makes it even more important that they are high quality urban areas, rather than simply business locations. And many such projects are currently being initiated and planned for.

1.3 Summary & Conclusion
This report is aimed at studying which, how and why certain spatial transformations occurred after in particular having a High Speed Train connection. It deals with literature about railway stations and the HSR to form a basis for my graduation project.

It is clear that the connection to the HST network requires a big (financial) investment, but the impact of the HST can be big as well. Integration in the network of European cities is a necessity to remain a player in the international (economic) field. The hierarchal position that the HST gives a city is an essential element of the competitive position of a city, but it has to be accompanied by a sufficiently high quality of living conditions and an economy that can handle the competition of other cities as their relevant regions can overlap due to the new proximity in time.

It can be concluded that the advantages of the advent of the high speed train are mainly indirect. As stated previously infrastructure does not lead to (economic) growth, but sufficient accessibility is a necessity [Zonneveld and Trip, 2003]. The gains can be divided in into two main parts: The gain for the city as a whole, the improved accessibility and therefore the image and competitiveness. And on the other hand the momentum it gives for the redevelopment of the station area and to a lesser degree to the city. The size of the impact both positive and negative is very much defined by the path dependency of the city itself, the current position in the networks, the spatial possibilities in the city, the available funds and the local actors.

The results from van Nes and Stolk´s inquiry show that various types of station areas and dwelling areas require different strategies for generating sustainable means of mobility in the planning and urban design practice. From a sustainability perspective, the methods applied in this inquiry contribute to make a priority list of urban tasks in the future plans. Such basic qualities do not depend on the number of shops, tracks, railway companies, the density of the built mass, or on the size of the piece of architecture in which they figure. It is the spatial structure of the street and road net on various scale levels in the vicinity that generates the degree of sustainable means of mobility. It can be measured in terms of inter-accessibility, interconnectivity and the density of the street and road net in the stations´ direct vicinity.

Kusumo investigated to what extend railway stations attract investments and vital shopping areas in their vicinity. She analyzed the local street pattern and correlated the degree of spatial integration with the location pattern of shops. Her case study shows that stations are not enough to attract shops and investment in the vicinity. A local area’s degree of vitality has to be spatially supported by a local well-connected and integrated street and road network (Kusumo, 2005). She applied the traditional space syntax method, where only the number of direction changes from each street to all others is taken into account. Railway stations seem to be a direct product of the transportation modes of the society. New technology relating to new kinds of trains or to public transportation in general might come about in due course. Developments of this sort will probably set new claims on railway stations. But until now, a sustainable well-functioning station generating sustainable means of mobility depends on having a good connection to the local street net in its direct vicinity. (van Nes and Stolk, 2010) According to Kusumo (2007), designing a central location of economically dense and supportive environments around the railway station must be done with the knowledge that the main determining factor is not the station’s regional accessibility, but its integration with the local urban structure.

From this thesis I gained knowledge of methods and tools required to recognize and perform necessary spatial transformations that should be done to develop a successful railway station area. My graduation project is the development of the railway area in Lisbon by the advent of a high speed train line, with the station design as the architectural project. This thesis is a theoretical framework for my graduation project, which shows previous scientific investigations on the lack and need of attention on the vicinity of railway stations for urban development instead of just the railway station.
2.0 Problem Definition
Context Lisbon
2.1 Setting the scene

With the expanding High Speed Train network in Europe, more and more cities are cueing up to get connected to it. Every city has (or will have) the dilemma of deciding which is the best route of the HSR and the location for a High Speed Train station.

Mobility on rails is acknowledged to be one of the most sustainable means of transportation between cities and towns. Therefore, a railway stations location in a built environment and its degree of accessibility is essential to reach as many travellers as possible. However, the spatial configuration of the local street and road net in railway stations vicinity is seldom taken into consideration. (van Nes and Stolk, 2010)

A local area’s degree of vitality has to be spatially supported by a local well-connected and integrated street and road network (Kusumo, 2005). Railway stations in Europe, and especially those related with the High Speed Train, are embracing greater areas than the building itself. Some of these areas are inadequate for mobility, marginal to urban fabric and unattractive, (in-) directly showing social, economic and environmental burdens at several scales. (Introduction Graduation Lab: High Speed Train and transformations of European Stations. Cavallo, 2009)

The development of the railway programme in Portugal includes some high-speed connections linking the main cities inside the country with cities in Spain and central Europe. Oliveira and Abreu (2004) state that many discussions about possible alternatives and political arrangements with Spain concerning the connecting points at the border of both countries took place while studies assessing the feasibility of alternatives were carried out (traffic, economic, technical, environmental, etc). The major issue related to this subject concerns the connection of the two most important Portuguese cities (Lisbon and Porto) to the Spanish high-speed train network, this being the main scope of the feasibility study put for tender by RAVE (the Portuguese railway company responsible for the high-speed train projects).

The Portela Airport in Lisbon is located within the city limits. But the new plans for the new airport have taken the airport out of the city, in order to eliminate the close low planes that fly through the city, disturbing the people and constraining the height of the buildings to a minimum. The implementation of a high-speed rail network in Portugal is a commitment to economic development, social and territorial cohesion and the modernization of the country. Lisbon already had a route planned for the HSR through the city, with a stop at the Gare the Oriente station, designed by Calatrava, in the Expo 98 area. In that plan the new airport was proposed in the north. However, now that the proposed airport is moved to the eastside of the river, new alternatives are being suggested. Furthermore, the HSR was not having a stop at the actual centre of activity in Lisbon, which possibly is a missed opportunity. (Nunes da Silva, 2009)
2.2 Project aim & objectives

Project aim
The aim of the project is to make a strategic plan for a HSR connection around the city of Lisbon, with a sustainable, spatial development of the strategically chosen railway area and station design, which will also benefit the whole city.

Objectives
The objective of the thesis is to identify the general, spatial requirements and tools for the spatial integration of HSR networks in the existing urban fabric.
On the local scale, the objective is to develop design guidelines for a HSR station and its surrounding area, balancing their roles as infrastructural node and place in the city.
Furthermore the objective is to create a worthy HSR station and make an economic center of the railway area, by, among other things, testing the degree of accessibility and spatial configuration of the local street and road net in the stations vicinity. The architectural design should contribute to the urban development.
On the regional scale, the objective is to strategically choose a route for the HSR around the city of Lisbon.

Products graduation project
The project consists of literature study, research and a design as end products. The literature study was aimed at studying which, how and why certain spatial transformations occurred after, in particular, having a High Speed Train connection. The results from the paper were helpful in developing a spatial strategy for my graduation project.
The graphical and written presentation with an overview of means and building strategies to redesign an urban area. Also architectural typologies were analysed from which strategies were derived.
The most important factors for design principles are High speed, railway area, train station, space syntax, accessibility, Infrastructure, Network, Sustainable development, Transformation and Transport node. The sustainable redevelopment of the railway area and the design of a High Speed Train station, discussed in this thesis, are the last part of the three end products.
2.3 Research questions

Main research questions

In what way can Lisbon benefit spatially of being connected to the High Speed Rail?

Sub research questions urban project
- What is a strategic location for a HSR station, which will benefit both the city and the transport node?
- Which route should the HSR take to have an optimal, sustainable effect on the whole city?
- Which potentials of the current railway area can result and be used in the creation of a new and improved economic center?
- Which spatial requirements and tools are necessary for the spatial integration of HSR networks in the urban fabric?
- Which method can be used to reveal, test and design a good spatial configuration of the local street and road net in the stations vicinity?

Sub research questions Architectural design
- How can a High Speed Train station lead to durable urban development around a railway area in Lisbon?
- What are criteria for a successful integrated public space within a hybrid building, like a High Speed Train station?
- Which programs can accommodate the development of a new concept for the High Speed Train station area?
- How can architecture improve the performance of a station area in a different cultural and physical context, like Lisbon?
2.4 Methodology

The research is composed out of different approaches. The research questions form a basis for the graduation project. The following methods were the most used methods to answer the questions and provide input for the design.

At first a study on the collected literature will be done to clarify the knowledge that already exists. The study of the literature will be done in the form of a review paper, which will generate input for the design principles.

In this research project research by design will be the main method used. Drawing the possibilities and optimize the potentials will lead to the optimal solutions of the problems/questions.

The project is limited by an explicit future situation: there will be a high-speed rail connection to Lisbon. The question is where the tracks and station(s) should come and what other interventions in the city are necessary to help this intervention lead to durable urban development.

The nature of this project requires work on many different scales. The scales that will be used are regional /metropolitan, city and local scale. This easily translates to: Lisbon region, Lisbon city and the HSR station area.

The first weeks of the project were devoted to the analysis. I took the opportunity to work together with the Lab of Hybrid buildings to benefit from eachother, because we had the same location. The hybrid building group had divided their analytical work into subcategories, namely 1. hard infrastructure, 2. soft infrastructure, 3. functions, 4. people and 5. morphology. This would allow a more complete picture of the locations, which were for them the Entrecampos area in Lisbon and the Zuid-as in Amsterdam.

To be a valuable addition for their group I had my own subcategory. I made a historical analysis of the railway tracks and the stations, the development of new lines and future developments. And I also made final conclusion maps of the other subcategories. To choose the best location for a high speed train station and to improve the integration of that station area into the urban fabric, it is important to analyse the spatial network of streets in the city. Space syntax method provides tools to calculate the integration of all different points in the public space through sightlines and axes within the public space. The program Depthmap can be used for these analyses, but also to test new strategies.

For the empirical study, field research is necessary. Also interviews with different disciplines and organisation dealing with the subject of High Speed Train and the urban environment in Lisbon will prove useful for further information on the existing knowledge on the subject. This was also done together with seven fellow students from Hybrid buildings.

On an excursion to Lisbon we made a determined schedule to be sure to really get to know the city in the short amount of time. At first we used a day to explore the city on a touristic way. For this we visited all the touristic hotspots, took the characteristic trams and observed the city from the high vistas.

Then we visited the Entrecampos location and attended presentations from the municipality and a local architectural office, Promontorio.

Finally we first attended a presentation at the technical institute. Afterwards visited the Expo area, the new hotspot area of Lisbon, and ended the day by taking the train and explore all the different train stations.

For a deeper analysis of the Entrecampos station area, in the center, we mapped every piece of the area and analyzed the following points: functions, orientation, public space & parking, building heights, impressions, public transport and street profiles. At the end a SWOT analysis was made.

An interview with an expert is a research method which can be used to get procedural knowledge or information which is not easily retrievable via literature. The technique can be used to get contextual information from people with great knowledge about a location or about the field of study.

Use of case studies will show what others have done when dealing with the HST in urban fabrics. It is usefull to compare good examples with bad examples, in order to take a well underpinned conclusion for the next steps of the design.
2.5 Relevance

Societal relevance
The European high speed train network is expanding in all directions. This means that in the future more cities will be connected to it. All these cities will face the same dilemma of which location is most suitable and the question how to deal with it in such a way that both the city and the transport mode can benefit from it and lead to synergy between them. Although each city has a specific context there are generic spatial elements that apply to all cities.

Scientific relevance
Mobility on rails is acknowledged to be one of the most sustainable means of transportation between cities and towns. Therefore, a railway stations location in a built environment and its degree of accessibility is essential to reach as many travellers as possible. As stated before, it is believed that a railway station attracts economic activities such as shops, retail and offices. However, the spatial configuration of the local street and road net in a railway stations vicinity is seldom taken into consideration. (van Nes and Stolk, 2010) A local area’s degree of vitality has to be spatially supported by a local well-connected and integrated street and road network (Kusumo, 2005).

This project will be researched by design. Although it will be a design for a specific location, the solutions found can be generalized to interventions and principles that can be used by others when faced with a city that will be undergoing a big infrastructural change.
2.6 Phasing

**THEORY**
- Project definition
- Motivation
  - Context Analysis
- Problem statement
  - Objectives
  - Literature study
  - Review paper

**RESEARCH**
- Research questions
  - Urban & architectural Analysis
    - Empirical study
    - Expert Interview/presentation
  - Case/ comparative studies
  - Effects/ impact
  - Thesisplan
    - Design principles
    - Strategy

**DESIGN**
- Alternatives
- Masterplan
- Architectural design
- Evaluation
- Master thesis
Going High Speed

Lisbon metropolitan area
Bird’s eye view
3.0 Research & Mappings

Lisbon’s metropolitan area
3.1 Context Lisbon’s metropolitan area

Focusing on the employment concentrations in the metropolitan area of Lisbon, there is a clear polycentric system visible. However, it is clear that the city of Lisbon has the biggest employment concentration of the region. The other concentrations are mostly in the other smaller city centres of the metropolitan area.

The demographic data clearly indicates that the city centre of Lisbon is the main centre of activity, with the highest population density, culture activities and workplace density per km². Even though the city centre has the highest population density, the population of Lisbon has decreased with 40% over the last twenty years, while the population of the metropolitan area of Lisbon has increased. This is also visible in the map with constructions made outside the city center.

The road network in the metropolitan area of Lisbon shows a ring road which connects the cities form both sides of the Tagus river. The city of Lisbon has a radial structure towards the Western Atlantic Front.

The railway network in the region has a lot of termini’s, with four of them in the city of Lisbon. The railway only has one, quite recent, connection over the Tagus river, which triggered the development of the south and west side of the region. Lisbon’s public transport network (bus, trams and trains) is extremely far-reaching and reliable and has its metro as its main artery, connecting the city centre with the upper and eastern districts, and now reaching the suburbs.
### 3.2 Space syntax analysis

To choose the best location for a high speed train station and to improve the integration of that station area into the urban fabric, it is important to analyse the spatial network of streets in the city. Space syntax method provides tools to calculate the integration of all different points in the public space through sightlines and axes within the public space. The program Depthmap is used to map Lisbon in a different way and also underpin new interventions. The maps show axial analysis with radius ‘3’ and ‘n’. The lines in these drawing are sightlines. The maps show how many other streets are reached after three and N ‘sightline-steps’. They represent the local and global integration of streets in the city of Lisbon and a part of the south connected by the bridge: red is well integrated, and blue is not well integrated.

The conclusion that can be taken from these maps, is that the area around the entrecampos station has the highest integration of streets and therefor the highest potential on the global and the local scale. Many people use this space to move from the station to the hotspots and businesses in the area. Redevelopment of this area can only strengthen this area even further, to create an economic center that can compete internationally.

The segment analyses for 300 and 900 meters show that the main roads, the avenues, are well integrated. The station of Entrecampos is well connected with the historic centre, as well as the high way, through these avenues. A lower scale will show good integrations in the historic city center. These maps are irrelevant, because we are discussing the railway areas.
3.3 Context City scale

The railway tracks run completely around the centre: the so called waist belt. At the river sites and the north part of the city this forms a barrier in the built environment.

At the north-east and west part of the city the railway tracks have caused an introvert orientation of the city.

In the north the railway cuts through the city and runs right through a couple of neighbourhoods. The closeness of the trains is a real problem for the comfort of living. Not only do the passing (freight) trains make a lot of noise, also the emission of polluting substances contribute to an unhealthy environment.

For the infrastructure in the city the railway also forms a barrier. There are few crossings in the area where the tracks are elevated or lower than the surrounding area. Because of all this and the limited capacity for expansion, a solution should be for the railway to go underground.

It is clear that the city can only expand towards the north between the parks and along the railway towards the north-east.

Putting the railway underground can also strengthen the connections of centralities and improve the centrality on the railway track, namely Entrecampos.

The functions of the main axe, which connects the Entrecampos station area with the historic city centre in the south and the highway on the north, with the program shows that this is axe can be seen as the backbone of the city.
3.4 Railway & station analysis
In order to have an underpinned choice for the station location, a clear understanding of the whole railway and individual stations in the city is also necessary.

Imaging the usage of the tracks shows on the one hand were most users come from and on the other hand gives an idea which stations are more important. The most people who use the train come from the west and the south. The stations with the most capacity are the 4 stations in the north of the waistline and the stations to the north along the river. The Gare the Oriente station, in particular, is designed as a TGV station and has the opportunity to expand easily with two more tracks for the HSR. These two tracks will then take over two bus platforms.

Compared to the surroundings the railway zone has several levels, because Lisbon has a lot of hills. Especially the levels on the waist line are very diverse. The three levels indicate if the railway track is a barrier or not. Level -1 of the track is underground or can be bridged and is no barrier. Level 0 of the track is a physical barrier and Level +1 of the track is no physical barrier, but a spatial barrier.

The map with the public rail transport reveals that Lisbon has a quite extensive public transport system. There is also a bus network in the city and ferryboats over the Tagus river connecting the city of Lisbon with the south. Important in this map are the hubs were you transfer from on system to another. The hubs on the `waist` line were constructed in the 90s, making a direct connection between train en metro system.

The matrix on the next page shows that there are different kinds of stations in the city. There are stations which are rather small and compact, leaving Entrecampos and Gare the Oriente station to be one the biggest station throughout the railway line of Lisbon, besides the termini's. In this matrix you can also see the similarity of the Entrecampos station and station area with the Gare the Oriente station in the Expo area.
## Station Analysis

<table>
<thead>
<tr>
<th>Location</th>
<th>Stations</th>
<th>Form</th>
<th>Station Type</th>
<th>Levels</th>
<th>Route Urban</th>
<th>Traffic</th>
<th>Access System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cascais Line</td>
<td>Cais do Sodré</td>
<td>Single Level</td>
<td>1</td>
<td>Tracks: 0</td>
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3.5 Possible HSR station locations

As seen in the matrix page on the left, two stations areas have the possibility to have a HSR stop. These two station area are located in a grid urban structure of Entrecampos CBD and Expo 98, with good connections to public transport. The two stations already have a great capacity of regional trains and will now be further discussed.

**Entrecampos railway station**
This station’s urbanic importance and visibility, crossing one of the city’s main avenues on a viaduct, dominated the project’s conception. Two decisions were taken first: to turn the viaduct into a building like an urban object and to impose this building as an example of the integration of the plastic arts. The interior is divided into three areas: the access area on the ground floor; a distribution area on the mezzanine and the other with the platforms. The ground floor and the mezzanine were treated as areas of movement, relating with the city through glass walls like a building were the visibility of the moving people forms part of the architectural composition. The floor with the platforms was treated as a filter, stretched metal allowing a glimpse of the people and trains from the outside.

The idea for the interior attempted to allow good visual contact between the floors. The exterior attempted to relate the itineraries of entrances and exits of people through a subsystem of ramps and steps.

**Gare do oriente station**
As foreseen before the tender, the station created a physical barrier between the city and the river. This was a barrier Lisbon did not want it wanted to strengthen this connection and, at the same time, use the present dynamism as a catalyst for the creation of a new and higher quality of life in the city.

The project is a challenge at various levels - in terms of town planning and architecturally- as it includes two new avenues created in order to connect the station to the city and also, an adjacent square which intends to accentuate and make the most of the longitudinal axis of the building. This multimodal platform centralises transport structures for the different transport systems which will service the whole of the intervention zone and much more. There are five main nuclei, each corresponding to the various systems. Specifically the train station (with its public areas), the metro station, the underground carpark, the inter-relating public areas and the underground gallery, which unites and articulates the three previous nuclei.

Putting the focus on the two possible locations for a HSR stop, stationwise, the Gare the Oriente station would be a logical choice.

Yet research has shown that stations alone are not enough to attract shops and investment in the vicinity. A local area’s degree of vitality has to be spatially supported by a local well-connected and integrated street and road network (Kusumo, 2005).

The map with the current station integration shows that the Gare the Oriente station is better integrated at the moment, at least on the riverside, with a clear orthogonal grid structure. The area on the westside of the tracks is also planned to be developed. The Entrecampos station is at the momentless integrated, but research will show that it has the potential to become well integrated, because the area has similarities in structure, namely the grid structure. Jacobs (1992) has suggested the importance of small-blocks in generating diversity in the city. The potentials of the Entrecampos area will be discussed later on the thesis.
3.6 Possible routes HSR

Lisbon already had a route planned for the HSR through the city, with a stop at the Gare the Oriente station, designed by Calatrava, in the Expo 98 area. Besides the changed location for the airport and the exclusion of the city center, there is another remark on the proposed HSR route. The proposal requires the construction of another new bridge of at least 12 km long. The HSR route will need big interventions anyway, but other alternatives could be more beneficial in this case.

An alternative route which does not need a new connection over the Tagus river makes a loop alongside the southern cities, entering the city of Lisbon threw the existing ‘25 de abril’ bridge. This route is leading the HSR over the current railway. The complication here is the different tracks measurements, compared to the European network. Spain had the same complication and managed to adjust the their tracks in a way that both HSR and regional trains can use the same track routes. The question then will be if the size, costs and risks of the intervention can be underpinned.

Another alternative route is one on the northside, where the river is narrow, and needs the construction of a significantly shorter bridge of about 2 km. The two possibilities here can be only a tangential station at the airport or a route along the airport, Expo 98 and the city center. This route will have its own track, partly alongside the current tracks in the city center, for reaching the desired speed.
3.7 Recent developments & future plans

During the last few decades Lisbon has reinforced its international orientation with events like the Expo 98 and the treaty of Lisbon (EU), but also by increasing trade with other Portuguese speaking countries around the world. All this has had an effect on Lisbon’s infrastructure. In the last decade new developments were noticeable on the outskirts of Lisbon. Further growths in these areas are already planned, especially because of the proposed new international airport and the construction of the HSR.

Over the last twenty years the population of Lisbon has decreased with 40%, while the population of the metropolitan area of Lisbon has increased. In order to change the population decrease in Lisbon over the last twenty years, the government has realized and proposed a series of strategic projects which should improve the mobility in Lisbon as well as the mobility in the metropolitan area, the connectivity between the cities, urban rehabilitation and re-housing programs, territorial development and planning and the relationship between the cities and the Tagus river. These projects should make Lisbon a more attractive city to work and live in as well as to make Lisbon more competitive in the network of European cities.

For the masterplan of the city of Lisbon, the future plans are the creation of for example a new waterfront, areas to be decommissioned and districts to be clearly defined.
3.8 Conclusion

Over the last twenty years the population of Lisbon has decreased with 40%, while the population of the metropolitan area of Lisbon has increased. In order to change this the government has realized and proposed a series of strategic projects which should improve the mobility in Lisbon as well as the mobility in the metropolitan area, the connectivity between the cities, urban rehabilitation and rehousing programs, territorial development and planning and the relationship between the cities and the Tagus river. These projects should make Lisbon a more attractive city to work and live in as well as to make Lisbon more competitive in the network of European cities.

There are also plans for a new metro connection between the north and the south of the river. As an edition to these projects I propose a high speed line coming from the north, creating a new network expansion, which will lead to an urban development towards the north.

Having a HSR stop at the city center will only strenghtening this main center of activity. The airport and the Expo 98 area will have shuttle stops. Should the airport area develop even further into a business center, the HST could stop there as well. This chapter partly revealed the answers to the first two sub research questions:

- What is a strategic location for a HSR station, which will benefit both the city and the transport node?
- Which route should the HSR take to have an optimal, sustainable effect on the the whole city?

The route of the HSR and the location of the HSR station is now strategically chosen. If this is indeed beneficial for both the city and the transport node and have an optimal, sustainable effect will be further discussed later on the thesis.
Going High Speed

Entrecampos
Bird’s eye view
4.0 Research & Mappings

Railway zone: Entrecampos
4.1 Scale of redevelopment zone
Transformation of the modern city is building on what the city already has (J. Coenen, 5x5)
Paying attention on the accessibility the area shows that the Entrecampos area is in fact on the main entrance of the city by having a strategic location on the main axis. While the north-south avenues are straight, the secondary roads are not all straight and have a deflected structure. As stated before the current railway cuts through the city in this area, which means there is no space for expansion and the railway should go underground. In this area the city can expand and the inner city can connect with the outer city.
In the 19th and 20th centuries, the city had spread progressively to the North and New Avenues were added. The main axis of Lisbon as Parision boulevard symbolizes a certain progress from the past. Even though well connected, this axis represents the development from past to future, from traditional routes to open spaces.
The city of Lisbon is dominated by several block typologies. As the development went from traditional to open, the blocks, in every European city also got bigger with wider courtyards for more light and public space.
The blocks around Entrecampos do not have wide courtyards and look more like a square shaped mass, yet the innerspace is like in all the other blocks private and only the outside space is public. The structures of the areas between the main roads are all perpendicular to the avenues. The area of Entrecampos has two main grid structures, because it is between two main avenues.
For the empirical study, field research is necessary. Interviews with different disciplines and organisations dealing with the subject of High Speed Train and the urban environment in Lisbon were useful for further information on the existing knowledge on the project area.

The Entrecampos station area is mapped on the following points: Functions, Orientation, Public space & parking, Building heights, Public transport and also Street profiles and Impressions were made.

The map with functions, clearly illustrate the multifunctional area with mixed program. The functions close to the station become less mixed and more focused, namely offices. The residential areas, on the other hand, are also clearly visible. The railway divides two residential areas on the east side. Retail functions are mostly along the wide lanes and have their orientation towards the public spaces, the round building (arena) in particular.

There is a variety of building heights in the area. The buildings along the primary road system and railway are quite high and function as a sound barrier for the lower buildings within the neighborhoods. The highest buildings are around the Entrecampos station and are mostly offices or hotels. The arena is a recognisable object visible from everywhere. The blocks on the south side of the railway also show height variations.

The orientation map shows the entrances of the buildings. The public entrances are mostly on the primary road system. Remarkable is the fragmentation between the primary road system, around the railway area. This shows the lack of good connections between public areas.

There are quite a few nice public spaces, but also a lot of fallow lands where some are used as large parking spaces. This because of the lack of sufficient parking facilities. At the moment the cars park everywhere.
Trains, busses, taxis and the metro stop around the station of Entrecampos. The station is not exactly a hub, because the different public transportation systems run along each other and stop at quite a distance from each other. Yet, the metro is directly connected through underground routes. The same goes for the other stations around the north of the “waist” line, like the Roma-Areeiro station on the east-side of Entrecampos. The busses drive along the primary road system, while the metro lines go under the main avenues. The busses do not enter the local streets, which also have smaller width and less public functions.

4.2 Architecture and typology in Lisbon

Lisbon had a few historical turning points which influenced the development of architectural typology in the city. The most important aspect is the relation between private (inner) space and public (outside) space. This emphasis is apparent in the typologies, from single housing to large building blocks, whether it is part of a social housing project or an expensive private housing project.

As stated before the city had spread progressively to the North and New Avenues were added in the 19th and 20th centuries. The main axis of Lisbon as Parisian boulevard symbolizes a certain progress from the past. Even though well connected, this axis represents the development from past to future, from traditional routes to open spaces.

The city of Lisbon is dominated by several block typologies. The traditional building typologies evolved into a more open structure with bigger courtyards. This transformation has led to more light in the courtyard and a semi-public space. The blocks around Entrecampos do not have wide courtyards and look more like a square shaped mass, yet the innerspace, like in all the other blocks, is private and only the outside space is public. Each block has a straight outside facade. The inner facade is diverse, which means that the buildings inside a block have different depths. The separate buildings also vary in height and width. This makes each block different, with mix functions, but it also depends on the location/orientation of the block. For example the blocks around the station (mainly offices) are different from the blocks around a public space.

The blocks can easily be transformed, because it consists of separate buildings. At the moment there are gaps visible in the blocks that are being renovated.
4.3 Latest block design

In the area of Entrecampos the latest block has been developed by the Promontorio architects, which symbolizes the need for more public space but also the culture of Lisbon. This new blocktype has a wider semi-public courtyard, but also the outside space between the blocks are wider than the previous typologies. The block itself has a stairshaped roof, because it is placed on a slope, like the most blocks in Lisbon. The buildings in Libon are mostly made of stone and prefab elements which are cheaper and easier to built with. In the past buildings had all simple shapes which could be easily and cheaper built. The design of the area is another cluster of mix programs. The differences of the functions in are made by details and colour, but the concept and facades of each building is the same even though they have different shapes.

The cluster has a different levels of public spaces. Semi-public courtyards, carfree squares and an event terrain. The program inside the buildings are typically Portuguese. On the ground floor the outside plint has shops and the inside plints have offices. On the upper floors the living areas of the dwellings are aimed at the inner courtyard and the bedrooms are aimed at the busy streets. This is different compared to for example the blocks in Holland. Every block also has two layers of underground parking facilities.
A cluster of mix programs, with different levels of public space
4.4 Railway area analysis

The railway is central in the abstract diagram of the current situation. It shows the infrastructural network and the hotspots in the direct vicinity. The different scales of street network can be divided in:
- XL: The main city axis & backbone of the city
- L: The primary city road system
- M: The secondary city road system
- S: The neighborhood road system

The XL- and L- scales hold the most economic activities and public transport. The M- and S-scales hold the more local activities.

One of the future plans of the municipality of Lisbon is linking green areas and connecting historic public places with a pedestrian friendly network which is independent from the car network. Taking a look at the hotspots in the area shows that there are quite a lot of places outside the dwelling areas. On the map below you can see the current connections of the hotspots, which seems, for the most places quite good. Yet this is especially the car network and not specifically a pedestrian network. The area around Entrecampos has the weakest link, which is also because of the railway track.

The railway tracks show different levels compared to the surroundings. This because of the fact that Lisbon has a lot of hills. Especially the levels at the waist line of the railway are very diverse, while the track itself is quite straight. The three levels in the map indicates if the railway track is a barrier or not. Level -1 of the track is underground or can be bridged and is no barrier. Level 0 of the track is a physical barrier and level +1 of the track is no physical barrier, but a spatial barrier. Moving the railway underground is better for the urban quality above, making it barrier and noise free. There is on the other hand no space for expansion, because the railway already cuts through the city.

In the schematic section you can see the location of each station and also the underground crossings of the metro lines. The station types are also diverse because of the height differences. The depth of the metro lines depends on the position of the railway and ground levels. The new underground railway will have to go under the metro lines, which is about 20 meters underground.
When the railway goes underground, it will leave new open space above. One part will be the area of Entrecampos, which has a lot of derelict space along the tracks. There are also future plans to demolish the current hospital alongside the railway, which can also be taken into account for a new urban design plan. The whole area can have a huge transformation. The other part is the area of Roma-areeiro, which is a linear open space of just the tracks.

This new open space that was never there changes the whole orientation of the area. All the streets are oriented on the primary road system and hotspots. The railway is a barrier and not considered as a place. The orientations are on the station or the roads alongside the railway. Only the primary roads go over or under the railway tracks.

Now that the railway will not be a barrier anymore the objective will be to change the orientation of the streets in a way that the new open space is a place were the streets are oriented on in order to make new connections and a coherent area.

The area along the railway also shows different characters. From a green area to dwelling and business areas. This means that the two parts need different approaches. The question here will also be if the different areas should be reinforced or blend in to eachother.

The profiles of the railway tracks show the height differences around the tracks, and the perpendicular roads that pass underneath the tracks. While some profiles show the different levels of the tracks compared to their surroundings, other profiles show different heights on one side of the tracks compared to the other. The first profile shows the wide higher situated fallow land on the north and the flat lower situated hospital terrain on the south side of the tracks. The profile of the main avenue shows in what way the avenue is also considered a barrier. This is because of the car tunnels, which are only covered on the intersections, but also because of all the different traffic systems on the 8 lane street.
Research & Mappings

1. Higher area
2. Derelict space
3. Railway
4. Soon vacant area

Bridge over the tracks

Roads alongside the tracks

Public space on top of the tracks

View on viaduct building and several barriers
4.5 Conclusion Railway area analysis

The two maps below show the SWOT analysis of the area, which consist of the conclusion of the analysis of Entrecampos station area. All the different topics that were mentioned in this chapter are visually concluded in these maps. The color red shows the strong points, orange the opportunities, blue the weak points and purple the threats.

The east-side of the station has the most strong points, like the nice residential areas surrounded/sheltered by higher buildings along the primary, busy road systems. The problem here is the lack of public space for the residential areas, the weak connections between the two sides of the railway and the fact that the main orientation of the streets are on the only public space and primary road system.

The west-side of the station has the most weak points, but on the other hand the most opportunities. The strong point is the vicinity of the university campus, hospital and new block design of a mixed cluster. The weakness/threats and on the other hand opportunities are the development of the non-used areas, removing the barriers, connecting the fragmented areas. Also the parking is a problem. At the moment the cars park everywhere, with few central parking facilities. The design of new buildings with underground parking can lead to with less street parking, which only made the streets narrow and lead to better quality of the public space.

The other conclusion to be made is the development a new railway station which can be part of the city as a place and not just a node of public transport and spatial barrier.
WEAKNESSES
- Physical and spatial barriers
- Derelict areas
- Congestion & Parking

THREATS
- Weak connections
- Few public spaces
- Orientation on one
- Hotspot
5.0 Urban project
Railway redevelopment
5.1 Vision railway area
The vision for the redevelopment area consists of two station zones. The zones are divided into four subareas with individual characteristics. From east to west there is a green area, residential area, business district and again a residential area. The subareas overlap to have a smooth connection between the subareas.
Because the railway tracks are moved underground, new routes and connections with surrounding areas can be made. This makes the area more accessible and active, having the opportunity to create a continuous system. The crossings of different sight lines and routings will be good locations for new hotspots, in order to have a network of public spaces. The hotspots will be station buildings with special program, squares with facilities or important roundabouts. The network of hotspots with new straight routes will make walking and possibly cycling more attractive, especially on the previous railway route. This linear route is quite flat, which makes it easier to walk through.

Design criteria
The following design criteria is determined:
- Propose location of new underground station
- Recover and reconnect derelict areas above for a continuous system without barriers
- Improve pedestrian routes and crossings
- Improve/ create spatial quality
- Reorganize parking spaces and public transport
- Propose possible program
5.2 Starting points for the redevelopment area

In this chapter the design will be explained. The conclusions derived from the research mentioned in the previous chapters, together with the research questions form the basis for the design, showing elements in the area that can be improved or emphasized.

From the research I came to the conclusion that the railway should move underground, creating a new open space above. The underground railway tunnel will have to go under the metro lines, which is about 20 meters under ground at the station area of Entrecampos. Because of the height differences that vary up to 25 meters, the tunnel can also be at 40/50 meters under ground level at some parts. The regional train will keep stopping on the current stations and has a low speed, which means the tunnel does not have to be very deep and does not have to go directly to the lowest point.

The high speed train on the other hand only has one stop and because of the speed and length of the train it will need a longer run-up than the regional train. This means that the HSR will have a separate tunnel which only stops at the Entrecampos and then go further to the next city. A more economical approach can be a single tunnel for both the HSR and the regional train.

The new open space above can be divided into two station areas, namely Entrecampos station and Roma-Areeiro station. The Roma-Areeiro station area is a linear space cutting through a residential area. The linear space starts at the Bela Vista park in the east and ends at the Entrecampos station area. The open space changes from linear to a large terrain, surrounded by grid structures and several block typologies. This terrain consists of several derelict areas and also a vacant area by the demolishing of an old hospital complex.
5.3 Location underground HSR station
Because the railway is placed in a tunnel underground, the buildings above ground level can be fully integrated to the surrounding. The tunnel does not necessarily need to be placed underneath the obvious current railway line. You can look at the underground connections on the one hand and the over ground connections on the other.
At the moment the metrostation of Entrecampos is connected to the railwasy station by a 200 meter long underground station hall with separate retail functions. The station can not be considered a hub in this way. Placing the new railway tunnel closer to the metrostation can ensure the design of a new station with access to both underground tracks and a cluster of facilities. In this case the tunnel will go partly 30-40 meters under the urban fabric, which will be a larger intervention. Considering the phases of the intervention, the current railway can keep functioning and only be demolished after the tunnel and new station is in use.
The over ground connections will be with the surrounding area and the public transport. The advent of a high speed rail will increase the amount of travellers and therefore the need for more and better bus transportation. The bus stops are now spread along the main avenue. They are not all easy accessible because the avenue has few crossing points which makes the access to the bus stops on the other side of the avenue unclear.
The primary road network and main axis come together at one point above ground. This central point will be the entrance to the bus station, which is connected to the railway station with access to the underground tunnels.
The new hub of train, metro and bus is therefore centrally located in the urban fabric, thanks to the new connections made on over ground level, while the trainstation is the link between metro and bus terminal.
5.4 Objectives and tools surface construction

The aim of the project is to make a sustainable, spatial development of the railway area, which will also benefit the whole city. In order to achieve this, I aim to give the ‘former’ railway area a more active role in the city of Lisbon. The redevelopment area will be redefined and designed.

The results of different layers formed the basis for my concept of the design to make a coherent whole. Sightlines, routing, grid organization and new program were the methods to create a new structure and new connections.

The orientation of the streets were on the primary road system and public spaces. Now that the railway area is an open space, the orientation will change. By creating sightlines I want to make the railway area more visible from other places, like the existing hotspots in the area with special program. The areas were sightlines cross each other have good potential to create another public space or hotspot.

By making clear routes, pedestrians will be more likely to use the routes to reach other places. These routes can strengthen the sightlines and create the preferred coherent whole. The station area will play an important role, centrally located on one of these crossing points.

The business district is dominated by block typologies and has a few orthogonal grid directions. These directions are perpendicular to the primary road system. The areas between the sightlines and routing, connecting existing hotspots in the area, will form a grid structure as well. This is the main structure of the area and will also contribute to making a coherent whole.

As stated before there are two areas. Adding new public program on both sides of the linear space will activate this space. This space will not only be a barrier free space with more crossings, but also a vibrant place to stay, connecting the HSR station area with the Bela Vista park.

Conclusion Goal Entrecampos & Roma-Areeiro
5.5 Design railway area

The urban proposal seeks to logically connect with the existing structure, where the station occupies a central place. New cohesion has been provided in the public space. The vacant area is now visible from other locations, such as existing hotspots in the area with special program, by created sightline. The places where lines of sight cross eachother, have become new hotspots and created an integrated network combined with the existing hotspots. The station area plays an important role, centrally located on one of these intersections. Thanks to the new barrier-free routing through the integrated network, pedestrians will be more likely to use these routes to reach other places. These routes enhance the sight lines and the new network of hotspots offers the desired coherent whole.
Design zone Roma-Areeiro

The new station area has a direct connection to the Bela Vista Park in the east, thanks to the linear public space. Especially this part reveals the differences in level of the area in relation to the former railway area. The track itself is nearly straight and ends at the station as a viaduct over the city.

For the design of this public space, with a linear composition, the main tasks were to recognize specific qualities, re-use existing elements and organize activities and programs for new interactions. By means of landscape architectural elements, the qualities in this area will be optimally utilized, and coupled to each other. The area also shows various characters, a green area to residential and office areas, where public spaces are connected by this will to move progressively from green to urban.
LANDSCAPE ARCHITECTURAL ELEMENTS

1. Rondpoint
2. Lane
3. Bridge
4. Patte d’oie
5. Hippodroom
6. Ravine
7. Wall/Terrace
8. Gate
9. Pilotis
10. Sculpture

Design of a public space:
- Recognize specific qualities
- Re-use old
- Organize activities to create new interactions

3. Bridge
9. Possibility under overpass: A8erna, Zaanstad
4. Square: Patte d’oie as structural element, Rdam
6. Ravine: Boulevard Scheveningen
7. Walls: borderline with terraces
11. Garden for VSB, Utrecht
Barrier becomes new public space

Tracks cut threw the city

New public space
Zone Entrecampos

The design on the vacant area west of the station area has a grid structure and connect in a logical manner to the existing grid structure in the area. The integral network of hotspots has led to a coherent whole. The hotspots include major public buildings, squares or parks. The road network consists of three types of streets. From broad central avenues for possible parking to narrow streets with parking on both sides. In the design area car parking has been placed underneath the new blocks, which offers more space above ground for pedestrians. The program in the new city blocks will be arranged following the road network. At the main avenues, most offices, while the residential functions are arranged along the side streets. These block types are semi-public courtyards. The city blocks at a intersections, like the station blocks, are public both on the inside and outside.

COMPOSITION

GRID
Layers Entrecampos

**Green/ Typology street**

- 3 lanes
- Parking
- Tree line
- Steps

**Parking**

**Program/ Typology block**

- Boulevard
- Destination
- Tree line
- Slow
- Fast
- Slow
- Steps
Station area

Placing the railway underground takes away an existing barrier in the city. This creates an area free for urban development and green and provides the opportunity for new cohesion in the public space. The new location of the HSL station is centrally situated in the business district of Lisbon, near the ring road and the historic center. The urban proposal seeks to logically connect with the existing urban structure, where the station takes a central place.

The underground station is located at - 20 meters below ground level, beneath the second of a series of four new building blocks which give the area a new identity. The train station, and also the tunnel, is placed next to the current station of Entrecampos. This place makes it possible to develop the new station in phases. On the other hand, a hub will be created by linking the current underground metro station of Entrecampos to the new railway station and underground parking. The station is divided between the two southern city blocks. The other two blocks in this part with more housing functions are oriented to the university campus and the surrounding “Campo Grande” park and field events.
Zone Entrecampos

Looking at the transport networks, the tracks are no longer a barrier and the car network forms a more coherent whole. For pedestrians, there are now several pedestrian-friendly areas, separate from the car network. The presence of a new bus station, provides a customized bus network. All the busses now arrive, through the new main roads along the hotspots, at the bustation.
MODELS 1:5000 AND 1:2000
7.0 Architectural Design
Entrecampos station
7.1 The station of the 21st century

Obtained form several lecture series and the interviews of the 5x5 projects I have drawn a conclusion for the station of the 21st century. With the traffic going underground and having a link with new urban development above is the definition of a station of the 21st century. A good station has a good balance between node and place, because nowadays it is not only for travel but also a place to stay. The station is multifunctional and is now considered a centre in the city. The first place people see when they enter the city, so it should be iconic in a way that you recognize the city you arriving in. In a multifunctional station as a public building the other functions should not be an obstacle for travellers and the transfers should run flawless. The commerce have to be subservient to the travellers.

The difference of a high speed station and a regional station is the international use and the program, which is more economically oriented. It is on the first place for businessmen and in the second place for everybody else.

Because the infrastructure goes underground, the next question to be asked is if the station should be a building or a space. In the past the station was always a building, monumental man-made landmarks were the construction was seen as a visible artwork. This big public and mostly transparent hal is the stationtypology wich catches our eye.

The station as a public space in the urban structure can function as a spatial node as well as a public transport node. This way the station can be a part of the city in stead of just a transfer machine. This public space basically does not need a buildingshape but just a gate and an empty interior.

7.2 Problem statement station area

The map of the conflict points in the station area shows the strong and weak points of the infrastructural system. The entrances of the station are not on a logical place, namely a small street, with a lot of conflict points. The main axis as a barrier is also clear in this map. There is only one crossing point for pedestrians within 500m, besides the secundairy exits of the station.

The current station is a viaduct building with the front side on a small street and the backside facing a derelict area. The images below show two periods in the history of the station’s location, namely the derelict area. The first one shows a monumental public building, the second a funpark which was demolished quite recently. The conclusion taken from this is that this site is destined to have public program.

Research will lead to how and where the new station building should be located. What is already certain is the fact that the underground transportation have to make a link with the urban development above.
Problem statement station area

Station is not a ‘place’ in the city

Railway station attract economic activities such as shops, retail and offices. However, the spatial configuration of the local street and road net in a railway stations vicinity is seldom taken into consideration. (van Nes and Stolk, 2010)
7.3 Concept station building
In order to make the station more a place and part of the city, making sure the streets converge in the station area. This means the station building could for example be at the end of an axis. The entrances should at least be on a main route, instead of a small street, to create a better integration with the area. The conclusion for a underground station is that the entrance above can be a building or a space. Because of the dominating blocktypologies in the area, this building type could become an iconic version for the area of Entrecampos. This concept for the station building and area formed a basis for further development of the masterplan.
7.4 Urban integration
The underground station is located at -20 meters below ground level, beneath the second of a series of four new building blocks. The blocks build on the legality of the remaining blocks in this district. The station is divided between the two southern city blocks. Despite a clear orthogonal grid, there are exceptions. The station is situated at a junction so that the blocks are more trapezoidal. Due to the urban axes and stairshaped roofs, the ensemble is anchored in the urban structure. The other two blocks in this part with more housing functions are oriented to the university campus and the surrounding “Campo Grande” park and field events.
Concept building volume

- Block typology
- Anchorage
- Entrance gates
- Deformation/ Daylight optimization
- Elevated public square
- Rooflights
7.5 Block typology
The architectural ensemble is situated along a boulevard, which is a key entrance to the city. At the same time this axis symbolizes a historical development. It reveals a progress from past to present, from traditional streets to avenues in a grid structure. The traditional block typologies developed into larger open blocks with semi-public courtyards and mixed program. The station is the next step / upgrade in the development of the regular city block. It builds on the regularity of the existing blocks in this district, with the distinction that not only outside but also inside of the blocks is public domain. Despite a clear orthogonal grid, there are exceptions. The ensemble is situated at a junction resulting in trapezoidal blocks, because it follows the alignment of the city. The ensemble is anchored in the urban structure due to the urban axes and stepped roofs.

Summary block typologies Lisbon

<table>
<thead>
<tr>
<th>Development</th>
<th>New station</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional</td>
<td>Open</td>
</tr>
<tr>
<td>Open</td>
<td>Open</td>
</tr>
<tr>
<td>Semi-public</td>
<td>Open</td>
</tr>
<tr>
<td>Private</td>
<td>Semi-public</td>
</tr>
<tr>
<td>Closed</td>
<td>Closed</td>
</tr>
<tr>
<td>Dwelling</td>
<td>Mixed</td>
</tr>
<tr>
<td>Mixed</td>
<td>Mixed</td>
</tr>
</tbody>
</table>

Spatial layout
- **Underground metro station**
  - Existing
- **Underground train station**
  - 11,152 m² (15.5%)
- **Underground parking**
  - Block 1: 14,546 m² (20%)
  - Block 2: 46,183 m² (63.5%)
- **Underground parking**
  - Block 1: 1,772 m² (6.6%)
  - Block 2: 6,193 m² (6.5%)
- **Facilities**
  - Block 1: 5,113 m² (15.9%)
  - Block 2: 31,510 m² (30.1%)
- **Elevated square**
  - Link with park
- **Office space**
  - Block 1: 3,113 m² (42.8%)
  - Block 2: 31,510 m² (32%)
- **Hotel**
  - 8,498 m² (8.5%)
7.6 Station typology
The advantage of an underground station is the ability to have more entrances on the most favorable places. Typologically seen through stations usually have two entrances, while termini's often have three entrances. The station is hidden from view and thereby has no more direct link with the city. The image of the new station is striking entrances in a ‘regular’ city block with a ‘plinth’ of urban facilities and office spaces as ‘mass’ on top. The new station has four entrances, two of which are prominent on the street. These two entrances are cut out of the building mass as large gates. To reveal the station in the city, to be an important public building on a striking position, the adjacent block is functionally (by means of a bus station), and visually connected to the station in question. At the corner of the adjacent block a similar expressive entrance gate is cut out of the building mass, indicating a pedestrian route to the station through the bus station and elevated courtyard. The sculptural openings in this block are a starting point and the endpoint of two urban axes. The location of these gates makes sure that this architectural ensemble has a good visual and physical connection to the city. Furthermore, this sculptural adaptation of the gates is repeated in the Side Street and interior facades of the building blocks for more daylight and spatial quality.
7.7 Station hall

Placing the railway underground raises the question of the identity of the new station Hall. It should create a connection between the station and the city, but entirely indoor. The station is on ground level designed as an urban center with public functions, such as shops and restaurants, oriented to the city outside and the entrances to the station inside. This gives the station the quality of both a node and place: The city will continue in the station. This is further emphasized by extending the typical pattern of streets of Lisbon to the inside. The space in the block is divided into two parts, each with its own destination. The station in the center of the block, with the floor on level -2, is constructed as an eight stories high atrium. The central void is defined by a concrete aesthetic core with holes and a glass roof. The concrete, with visible junctures of the elements, gives the station a robust look. The concrete underground construction will make a link with the steel over ground construction. Escalators, staircases, bridges and floors pierce high holes in the concrete construction and thus represent the passageways. The station hall is on almost every level surrounded by a corridor and composes an arcade with a view on the trains and a visual connection to the other levels. The surrounding public functions behind glass fronts and offices on the upper floors are accessible from these corridors. The ‘urban interior’ is covered by plastic panels with the look of stone, in the same dimensions as the aluminum panels on the outside facades. Due to the fact that the station core is not only self-supporting, but also bears the surrounding floor, the columns narrow towards the top, because they have less load. The heights of the floors vary also, because of the diversity in program: over ground consists of offices and commercial functions; underground consists of the station with higher areas. By means of the diagonals, at level -4, the loads of the station core are transferred through the columns on the platforms. The shape transitions are smooth so the station hall forms a visual unity. The diagonals are, at the same level, repeated under the stability core for the transfer of loads.

The other part of the interior space is a lounge and meeting point. This space is a void enclosed by arcades, interrupted by a colonnade with a floor at level +2. This colonnade forms a connection with the bus station in the other block. This linear connection extends to the street and is accompanied by light from above on both sides. This linear connection is also present at level -2 between station and parking garage and on level +2 between station and elevated courtyard. The offices on the upper floors are accessible through public entrances to the street, but also from the station through the galleries. The circulation spaces are also meeting places. They have a minimum width of 7 meters. Around the station hall travellers can sit inside the holes. The glass balustrades ensure a better overview and make the inner space a coherent whole that belongs to the station.

Visual connection between trains and other levels
7.8 Circulation system
Due to the fact that a station is primary for transportation, the other functions are not an obstacle for the traveler and the transfer runs flawless. The station offers travelers more ways to circulate through the building. If the block is accessed through the huge gates, passengers have two choices. They can directly descend from the entrance hall with escalators and staircases, onto the station hall on level -2 or move on to the lounge/meeting point and the mall around the voids. When entering from the side streets, bus station, and elevated courtyard, travelers can walk straight towards the central atrium, where they arrive, by escalators and lifts, at the station hall.

Furthermore, the transition from train, subway and parking runs from the central station hall on level -2 where ticket sales and passenger-related commerce are to be found. The trains are visible from every level thanks to the central atrium. The travelers are accompanied by signs. The design of the station with clear overview and circulation system makes the station a pleasant and safe place to move around in.

There is also a transition level at -4 between the platforms at the station level -6 and station hall. Besides the transition possibility between trains there are also service areas, such as first aid assistance and security, on this level. The platform level, with a length of 400 meters, has three exits. The light, which penetrates through the voids deep into the building, marks the central places on the platforms. The above-ground station is located above the middle of the tunnel. The two other exits are situated at the ends. The columns and vertical circulation are located in the middle of the platforms, creating a clear view on the trains. The repetitive nature, combined with the linear lighting, shows the length of the tunnel. The underground construction is, in contrast to the over ground construction, made of concrete. The interior is processed with tiles and stone, which is characteristic of Lisbon.
7.9 Facade system

The large gate-like cutouts and the facade give the block the appearance of a station. Although the architecture in the area is very diverse, the block will have a unique, distinctive and modern look by its materialization. The sculptural entrances are accentuated by the exposed trusses. Through colors, a distinction is made between the plinth with urban facilities and the mass above it. The entrance of the parking garage is naturally included in the plinth of the facade. The block has two sides, namely the inner and outer facades. The differences in color are used to distinguish between inside and outside. Although the mass of the block is carried out as a monolith, the verticality of the surrounding buildings is emphasized with the use of a series of elements. This is done by including various window sizes and loggias. The facade is built up of elements, consisting of aluminum panels with relief. The panels form a fixed grid pattern, for the creation of a rhythm which constitutes a unity in the whole façade. The façade also applies local shading elements, such as loggias, shutters with rotating blinds and (glass) louvres. The glass roof above the central atrium of the station is on top of a construction of image-defining trusses and castellated beams. On the outside floats a latticed construction of aluminum panels that keeps the heat outside the station. The solar design responds to the position of the sun. The east-west panels are larger and have an angle or rotation compared to the north-south panels. This structure is visible from upper floors.
MODELS 1:1000 AND 1:200
8.0 Structural Design
8.1 Technical Concept
The shape of the block is determined by the existing urban conditions and has a surface area of about 1 ha. The technical challenge is to build on top of a tunnel. The adjacent block also has a challenge of the same order, namely the expressive cut on the corner, resulting in a large overhang using trusses. Of this last task, only a schematic indication will be given of how it can be realized. The used option consists of four trusses parallel to each other. The trusses do not run all the way through to the other part of the building, but is kept in the vicinity of the actual overhang taken into account. An additional core over the entire width of the trusses is used to support the overhang construction. At the end of the trusses, on the side of the building, are also four vertical elements and diagonals present, which are placed in tension.
8.2 Grid system
The block with underground station consists of two buildings. There is a dilatation with on one side of the “cut” the building above the tunnel and on the other side the building above the parking garage. Because the two buildings together form one block, there is chosen for one grid system. The grid system is in the North-South direction determined by the underground tracks and in the east-west direction determined by the urban structures and over ground program. In the station building, the vertical loads are transferred through the columns on the platforms in the tunnel and the outside walls of the tunnel. Large trusses will span portions of the tunnel, above the voids of the gate-like entrance halls and the station hall, which divide the vertical loads.
8.3 Stability
The stability is provided by the cores and floors. The cores in the building adjacent to the tunnel run through to the foundation where the loads are transferred. This does not apply for the building above the tunnel, because the tracks run underneath. A part of the core, a plane in the longitudinal direction, runs through to the platform. The core is attached to the outer tunnel wall underground by means of discs (pinching). As a result, the core is eccentric, in which the vertical loads are transferred through the tunnel walls, and there is a moment caused by the horizontal loads. In order to create a counter-moment the loads are also transferred through columns of the platform in the middle, by means of diagonal under the core. These diagonals have the same dimensions as the diagonals of the station hall. The floors that extend to the other tunnel wall also work along with the stability.

8.4 Floorsystem on beams
The building has floorsystems on beams. There are three floor systems in the building: Precast concrete panels of 300 mm on the ground floor, because they are solid and separate functions (Span 8/10m); composite floor slabs with small spans, such as the sloping walls (span 2/4m); hollowcore panels of 320 mm in the majority of the building (span 8/10m). There are also three types of beams for the imposition of the floors and facade elements: Steel Hat Beams (span 8m), castellated beams (15m span) and trusses (span 25/32m).
Level -4

Level -2

Level 0

Level +1

Level +2

Level +3

Level +4

Level +5/+9

Steel construction above concrete base

Structural Design
8.5 Dimensions

CONCRETE CONSTRUCTION

Load pillars

Hollowcore floorsystem K320-4 = 430kg/m²

Pillars underground parking garage

A=F/15

F = 14x81,2 = 1136,8 m² => 488824kg

A= 570x570

F = 289,2 + 4x126 = 793,2 m² = 341076kg

A= 480x480

Pillars underground station

F = 1390+3x162,5 = 1877,5m² = 807325kg

A= 735x735

F = 3x45 = 135m² = 58050kg

A= 200x200

F = 1112+3x45 = 1247m² = 536210kg

A= 600x600

F = 50,7x8 = 405,6 + 14,8 = 420,4m² = 180772kg

A= 350x350

STEEL CONSTRUCTION

Strength pillar, stress

Pillar under truss adjacent block

Hot 500x300x20

N/A < ω x f c;d

A = 300 cm² = 30000 mm²

ω -> i = 18,2 cm = 0,182 mm

λ = lc / i = 5/0,182 = 27,47-> ω = 0,87

5409400/300000 < 0,87x235 = 180,31 < 204,45

Pillar under truss: Gate station block

Hot 500x300x20

N/A < ω x f c;d

A = 300 cm² = 30000 mm²

ω -> i = 18,2 cm = 0,182 mm

λ = lc / i = 5/0,182 = 27,47-> ω = 0,87

5977000/300000 < 0,87x235 = 199,23 < 204,45

Pillar office: mass station block

Hot 350x350x14,2

N/A < ω x f c;d

A = 189 cm² = 18900 mm²

ω -> i = 13,7 cm = 0,137 mm

λ = lc / i = 5/0,137 = 36,5-> ω = 0,83

3491600/18900 < 0,83 x235 = 184,7 < 195

Pillar hall space station block

Hot 400x400x10,0

N/A < ω x f c;d

A = 155 cm² = 15500 mm²

ω -> i = 15,9 cm = 0,159 mm

λ = lc / i = 8,5/0,159 = 53,5-> ω = 0,7

1243560/15500 < 0,159x235 = 80,2 < 164,5

Pillar round tube facade: mass station block

Hot 244,5x8,0

N/A < ω x f c;d

A = 59,4 cm² = 5940 mm²

ω -> i = 8,37 cm = 0,0837 mm

λ = lc / i = 5/0,0837 = 59,75-> ω = 0,6

688000/5940 < 0,0837x235 = 115,8 < 141

Pillar round tube facade: hall station block

Hot 244,5x12,5

N/A < ω x f c;d

A = 91,1 cm² = 9110 mm²

ω -> i = 8,21 cm = 0,0821 mm

λ = lc / i = 8,5/0,0821 = 103,5 -> ω = 0,35

688000/9110 < 0,0821x235 = 75,5 < 82

Stiffness/deflection of the beam

Hat beam THQ 320x290 (60529)

σ = M/W < 235

σ = 1/8 ql² / W

W = Elastic modular axis = 3926000

q = 40,85

L = 9700 mm

122,38 < 235 --> Beam is strong enough

Strength of the beam

Hat beam THQ 320x290 (60529)

σ = M/W < 235

E -> 2,1x10⁵ = 210000

l -> 60529x10⁴ (table profile)

L -> 9700 mm (span)

Lrep -> 9700 mm

36,99 < 38,8 --> Beam is sufficient
Denk bij kolommen om zeer grote afwijkingen!

Hout: uitsluitend voor lichte dakconstructie
- rond hout
  \( d = \frac{1}{30} \lambda \)
- vierkante hout
  \( h = \frac{1}{35} \lambda \)
- HE- en IPE-profijlen
  \( h = \frac{1}{40} \lambda \)

Beton: ter plaatse gestort; buigvast
- verbonden met de vloer
  \( A = f/8 \)
- geprefabriceerd
  \( A = f/15 \)

\( \lambda = \) kniklengte; \( h = \) profielhoogte; \( d = \) diameter; \( A = \) kolomoppervlak in mm²; \( f = \) puntbelasting in N.
8.6 Building services

Lisbon has warm summers (30 degrees) and mild winters (16 degrees). There must be actively cooled. The most efficient method to use for cooling is a cooling system with water. The system chosen for the climate control ZLTV systems with WKO. De installation spaces are located underground near the source. With a heat pump water out of the ground will be pumped through the building. The transport goes through the vertical shafts and horizontally through the lower ceilings. The spaces are cooled or heated by transmission through climate ceilings. The heat pump is also connected to the air handling units to speed up the cooling or heating in certain areas, by ventilation. The station hall is ventilated by diffusers. The intake of fresh air for ventilation is through the top floors of the building and is also thrown out through the top floors. Through the parking entrance, air is supplied to the garage. There are thrust fans in the parking garage that circulate the air. This is again transferred through the shafts. Rainwater is drained through hat beams, hollowcore slabs / lower ceiling and the shafts.

To reduce heat as much as possible, there are shading elements in the facade that are applied locally, such as loggias, shutters with rotating blinds and (glass) louvres. Above the glass roof of the station hall floats a latticed construction of aluminum panels that keeps the heat outside the station. The solar design responds to the position of the sun. The east-west panels are larger and have an angle or rotation compared to the north-south panels. In the large gate-like entrances are large glass walls with enough outlets to prevent drafts. For the upper part of the glass wall, glass louvres are attached. The glass wall is also deeper in the gate. The other two entrances are formed by gates which stick out and act as a canopy. The row of trees around the ensemble also serve as shade for the lower layers.)
6.0 Effects of development
Railway redevelopment
6.1 Effects on station area: Three-step analyses
One of the objectives was to design a high-speed train station. The station area should become a stronger economic center, by optimizing the degree of accessibility and the spatial configuration of the road network in the railway area. The architectural design contributes to urban development. The 3-step analysis confirms that the new design has a better connection with the city and that the station has a greater reach compared to the existing station. In comparison with the oriente station the range of the new Entrecampos station is also larger.
6.2 Effects on local scale: Space syntax
The Space Syntax method provides tools for calculating the integration of all different points in the public space through sight lines and axes. The program Depthmap is used to edit, test and underpin new interventions.

All line analyses
Using “all line” analyzes the impact of intervention on the scale of the railway area is mapped. In the current situation were the most important axes were already visible. The map with the new situation indicates that the new exposed area also contains fairly major axes. The “all line” map indicates that the exposed area has an important position in the area and basically becomes an extension of the current business center is. The fact that the railway zone no longer constitutes a barrier is also visible on this map.
Point map analyses
The "pointmap" analysis gives the important hubs. The interventions have led to an increase of important nodes. The new axes in the vacant area creates intersections with the existing main axes and result in new major nodes.

Before/After pointmap isovist
Before/After pointmap global visibility

Effects of the development
Agent map analyses
The agent analyzes indicates where pedestrians are likely to walk and therefore the areas with the most pedestrian traffic. In the existing situation this was especially on the boulevards in north south direction. Removing the barrier gives a new situation where pedestrians also will walk in east-west direction alongside the boulevards in north south direction.
6.3 Effects on the city: Space syntax
Axial analyses
Thanks to the axial analyzes of the city of lisbon, the effect of the intervention on the scale of the city is demonstrated. The most visible effect of the intervention is that the main axes results in an even better connection in the city as before.
6.4 Effects on the metropolitan area

The effects of the intervention on the scale of the region will form an extension of a new network and lead to urban development in north east direction. The new HST station in the center of the city will strengthen the center of activity. At the airport and the Expo 98 site shuttles will also stop. When the airport area develops further into a business center, the HST will stop there as well.
9.0 Evaluation
9.1 Summary & Conclusion

With the expanding High Speed Train network in Europe, more and more cities are cueing up to get connected to it. Every city has (or will have) the dilemma of deciding which is the best route of the HSR and the location for a High Speed Train station. This thesis deals with the development of a railway area in Lisbon by the advent of a new High Speed Rail (HSR), with the station building as the architectural design.

The research questions formed a basis for the graduation project. The main Research question was: In what way can Lisbon benefit spatially of being connected to the High Speed Rail?

In order to answer this question, several sub research questions were formulated and answered by means of different approaches and methods:

- Literature study
- Research by design method
- Space syntax method
- Empirical study
- Expert interviews
- Case study

The aim of the project was to make a strategic plan for a HSR connection around the city of Lisbon, with a sustainable, spatial development of the strategically chosen railway area and station design, which will also benefit the whole city.

Demographic data show that the center of activity is located around the station of Entrecampos. Due to the theory of natural movement, this can be explained by a better spatial configuration of the local street and road net in this railway stations vicinity. The theory states that a higher integration of the street net attracts more economic activities and movement, which is essential for a station area to attract as many travellers as possible.

Placing the railway underground takes away an existing barrier in the city. The urban proposal seeks to logically connect with the existing urban structure, where the station takes a central place. The architectural design is an underground station type, with a station hall as atrium in a hybrid city block, which connects to the urban fabric above.

The development of Entrecampos, with the new station that contributes to the urban development, has created a better spatial configuration of the city center. This will lead to the attraction of more economic activities and movement and a stronger economic center that will be more internationally competitive.

This project, relevant on several scales, turned out to be a perfect combination of the different disciplines Architecture, Urbanism and building technology, what I, as dual graduate, was seeking for.

9.2 Recommendation & Reflection

Although the project provides a design for a specific location, the solutions found are generalized to interventions and principles that can be used by others when faced with a city that will be undergoing a big infrastructural change. The thesis offers general, spatial requirements and tools for the spatial integration of HSR networks in the existing urban fabric; design guidelines for a HSR station and its surrounding area; the tools and requirements to create an economic center of a railway area.

The project did not run as smooth as expected. Even though my project definition was clear from the start, it did take a while to finish the project. The urban project went as expected, with more than enough data, knowledge and tools to work with. The architectural design took a little longer than expected. Even though I had an interesting approach and concept form the start, it took me a while to start being the architect, instead of the urban designer. At long last I did manage to reach my goal as designer for this project.

What I noticed in this final period, is how the Msc period defines you as designer. The only disadvantage is the fact that every dual graduate of A&U is more experienced in urbanism, because of the fixed track (three urbanism projects vs one architectural project) we followed.
10.0 Literature and references
Literature


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Brief history of Avenidas Novas area and characterization of the present situation, included in a study on traffic tunnels and people circulation. http://www.aca-m.org/w/images/5/52/Tcpzan_eis.pdf


Railway infrastructure company http://www.refer.pt/

Railway real-estate company http://www.invesfer.pt/pt/home.htm

High Speed Railway infrastructure company http://www.rave.pt/

The plan in force now and the proposal for its review http://pdm.cm-lisboa.pt/default.aspx

Appendix A

Literature study
Abstract – ‘As one station planner stated, the list of cities that are relevant in Europe nowadays equals the list of cities included in the HST network; this may not be entirely true in fact, but it is increasingly the way things are perceived, which makes it a reality in effect.’ (Trip, 2007).

The high speed train links main city centers from hart to hart without transfers. Every city has had (or will have) the dilemma of deciding which is the best location for a High Speed Train station.

Railway stations in Europe, and especially those related with the High Speed Train, are embracing greater areas than the building itself. Some of these areas are inadequate for mobility, marginal to urban fabric and unattractive, (in-) directly showing social, economic and environmental burdens at several scales. This is an opportunity to rethink the station buildings as well as their urban surroundings, balancing their roles as infrastructural nodes and places in the city. (Introduction Graduation Lab: High Speed Train and transformations of European Stations. Cavallo, 2009)

Mobility on rails is acknowledged to be one of the most sustainable means of transportation between cities and towns. Therefore, a railway station’s location in a built environment and its degree of accessibility is essential to reach as many travellers as possible. However, the spatial configuration of the local street and road net in a railway station’s vicinity is seldom taken into consideration. (van Nes and Stolk)

The paper is aimed at studying why certain spatial transformations (should) occur after in particular having a High Speed Train connection. This paper contains a range of previous observations and analyses that may focus and guide the research and will generate input for the design principles. The results will be helpful in developing a spatial strategy for my graduation project which deals with a new High Speed Train connection from a regional context to the design of a High speed train station.

1 Introduction

My graduation project is the development of the railway area in Lisbon by the advent of a high speed train line, with the station design as the architectural project. Lisbon is the capital of Portugal, by far the country’s biggest city, with the seat of the government, many cultural institutions and a wide range of international companies. It is internationally orientated, but it has its own strong traditions and its own distinct history.

During the last few decades Lisbon has reinforced its international orientation with events the Expo 98 and the treaty of Lisbon (EU), but also by increasing trade with other Portuguese speaking countries around the world.

All this has had an effect on Lisbon’s infrastructure. In the last decade new developments were noticeable on the outskirts of Lisbon. Further growths in these areas are already planned, especially because of the proposed new international airport and the construction of the High Speed, direct rail link between Lisbon and Madrid.

Lisbon already had a plan of how the High Speed line should go through the city, with a stop at the Oriente train station in the Expo 98 area. In that plan the new airport was proposed in the north. But now that the proposed airport is moved to the eastside of the river, new alternatives are being purposed. Another issue on the table is the fact if the exclusion of making a High Speed Train station in the actual centre of Lisbon isn’t a missed opportunity.

Railway stations in Europe, and especially those related with the High Speed Train, are embracing greater areas than the building itself. Some of these areas are inadequate for mobility, marginal to urban fabric and unattractive, (in-) directly showing social, economic and environmental burdens at several scales. This is an opportunity to rethink the station buildings as well as their urban surroundings, balancing their roles as infrastructural nodes and places in the city. (Introduction Graduation Lab: High Speed Train and transformations of European Stations. Cavallo, 2009)

Mobility on rails is acknowledged to be one of the most sustainable means of transportation between cities and towns. Therefore, a railway station’s location in a built environment and its degree of accessibility is essential to reach as many travellers as possible. However, the spatial configuration of the local street and road net in a railway station’s vicinity is seldom taken into consideration. (van Nes and Stolk, 2010)

This paper is aimed at studying why certain spatial transformations (should) occur after in particular having a High Speed Train connection. The paper basically deals with literature about railway stations to form a basis for my graduation project. The focus will be mainly on station area development, in particular by the advent of a high speed train line. The
A connection to the HST network reinforces the existing hierarchical position of cities while on the other hand it promotes the formation of a network of cities. This can be seen in the way that the first cities to get connected were the cities that already had international importance. With the expanding of the network also cities of lesser importance got connected. A connection to the HST network for these cities can mean a leap up the hierarchical ladder of cities as they join in the international network. The size of the consequences for a city depends on a number of things. Although there is no proof that infrastructure leads to economic growth, it can be stated that sufficient infrastructure is essential for economic development (Zonneveld and Trip, 2003). ‘shrinking Europe’ by Spiekermann and Wegener (1994).

Zooming in on the urban area many of the same issues play a part. We have seen that the urban economic competitiveness of a city is very important. This competitive position can be defined as the potential to attract firms which are the main source of employment and prosperity. The desired companies increasingly depend on knowledge and the exchange of information between firms and individuals. This knowledge spillover is very much dependent on face to face contact and informal, personal relationships as much of this is tacit knowledge or know-how and needs explanation (Trip, 2007). This implies that proximity is very important, and clusters of related companies and individuals will form. So it is important for a city to provide an attractive climate for businesses to settle there, but there also is another line of reasoning that is important in this case. Highly educated workers have high job mobility and thus will base their decision on where to live more on the attractive living conditions than on a specific firm. Providing these conditions as a city can attract or retain these workers and as they are very important to businesses these will follow.

As these effects of the HST are the largest in the primary development zone, the area within ten minutes walking distance of the station, both people and businesses will want to locate there. But this is not as straightforward as it looks because a high quality living environment and infrastructure are not easily compatible. Combining them brings great financial costs, which can only be recovered by high rent levels and the highest can be achieved with office buildings (Bertolini, 1996). A high density of offices will negatively influence the sustainability of the urban development when they are not balanced by other functions. The key elements of quality of space defined by Trip (2007): diversity, integration and quality of public space. Both lean heavily on the theory of Jane Jacobs on the need for diversity. Whether sustainable urban development or the quality of space is achievable is very much dependent on the local context or in other words the path dependency of a location. Path dependency can be described as a chain of successive events; these events have shaped the current situation and will influence the future. There are many kinds of path dependency but in this case the technical, geographical and the institutional are the relevant ones (Trip, 2007). They influence the possibilities and aims related to the effects of in this case the high-speed train connection of the city. The availability of space and of (public) funding, the local infrastructure (public and private feeders) and the local actors all affect the characteristics of the station area that need to/will be invested in (The node, the place, the spatial quality or the image (Trip,
The choices made can have a big impact on the city, not only on the functioning of the station itself but also on city as a whole. Integration of the station in different ways into the city is essential if the whole metropolitan area is to profit. The most obvious is the spatial integration, part of this means that people need to get to the station and from the station to the whole metropolitan area (multi-modality of feeders). This in not only essential for the functioning of the station itself but also for the cohesion of the city to prevent polarization, where the success of the station area drains other areas. This polarization is fed also by the phenomenon of the primary development zone. The zone within 5 minutes walking distance of the station is the area in which the development of the station has direct effects and thus will profit the most.

Functional integration (exchange of users with other areas) and mental integration (mental map, visual links and legibility of the spaces) also play a huge role, mostly on a smaller scale. The smallest scale is that of the station and railway and its direct surroundings. This is where the networks touch down, where the different scales and modalities meet and the flows get interrupted and where activities can take place (Trip, 2007). Flows and activities are dependent on and stimulate each other; this can lead to a growth spiral which continually strengthens the position of a station. But for a station to function there has to be a balance between the two. This is not easily achieved as they hinder each other as well. Activities can obstruct the flows, for instance shops in the interchange route between different modalities, but also flows and the accompanying infrastructure can be barriers for activities. Train tracks can divide the urban fabric and the local feeder infrastructure can negatively affect the quality of public space. The advent of the high-speed train will in itself not change this, but it can provide the momentum or boost necessary to bring all the actors together, give them a common goal and provide the financial investments needed to transform the area.

3 Degrees of Sustainable Location of Railway Stations

Writings on railway stations

It is often believed that a railway station attracts economic activities such as shops, retail and offices. However, the spatial configuration of the local street and road net in a railway station’s vicinity is seldom taken into consideration. Some stations are easily accessible by foot or by public transport, while others can only be reached by private car. When revealing the literature on railway stations, the focus is much on the role of the railway station in itself than the spatial layout of the urban fabric in their vicinity. Railway stations are points of transport interchange. In the main their purpose is to let people leave a place or to arrive at this place. Different kinds of people face each other and interfere with one another in buildings of this sort. Here, the drama of departure and arrival takes place. In essence, the station is a space between a particular place and the trains. Today, however, the station is no longer dedicated to travel alone. During the two last decades, several other and especially commercial functions have established themselves inside stations (Edwards 1997, p. 173) as well as in the station’s vicinity.

The most extensive industrial complexes of the 19th century were the huge locomotive carriage and the rolling stock works. These inventions created a new way of life, which changed the structure of society. It allowed people to travel over long distances in a relatively short time. The railway station was a new building type with a new function. There was no model to copy from or at least a preliminary source of inspiration (Betjeman 1972, p. 20). In all these respects the railway station was a building type particularly representative of the new problems of design caused by the industrial revolution. In each case every functional and technical solution had to be invented.

In the golden age of railway building, engineers had to deal with 3 major problems. Firstly, they had to build practical and solid stations. Secondly, the problem of perceptual continuity had to be solved. The building had to fit into the prevailing visual environment. Thirdly, the engineers had to create new constructions for new functions (Betjeman 1972, p. 13 - 14). The most characteristic contribution that railway architecture has made to the civic appearance of our built environment is the hall of concourse. The architects of that period were responsible for the building’s proportions, while the engineers were accountable for utility (Meeks 1957, p. 28). In this way the railway station became a reflection of the impact of technology on the mobility of the masses. The railway station is a good example for a primary element in the sense of Rossi’s theory of the architecture of the city. It is an artefact in Rossi’s sense for it conditions the further development of many towns and cities (Rossi 1984, p. 86). Many authors will say that the great passenger stations were one of the engineering miracles of that age and a highlight in urban design (Edwards 1997, p. ix). It became as important as the piazza and the
Betjeman expresses this as follows: "Railway terminals in the last century are the cathedrals of the railways" (Betjeman 1972, p. 7).

After half a century of a globally high emphasis on road construction and an equally widespread neglect of railway infrastructures, the last two decades were marked by a renaissance of the railway. Due to increased pollution, congestion of private cars in the streets, ecological movements and an increased public interest in sustainable development, public transport by rail has regained attention. The railway system can be regarded as a solution for the transport problem of the cities. The ecological benefit of travelling by train, combined with technical breakthroughs concerning new types of trains, as for example the fast French TGV trains running at 250 km/h, new types of suburban light rail systems, and new combined types of metro systems – all this has led to increased rail investment. Likewise, new high-speed rail links have been built between cities such that a throughout modernization of the old railway stations or the construction of new ones became inevitable. One was thus heading for a functionally smooth transport system. Basically, it seems that modern railway stations mostly have the same spatial structure as old ones. The textures of the material, however, are slightly different (Edwards 1997, p. ix). Modern railway stations appear to be lighter, safer, and more commercial than older ones.

The airport station is a new type of railway station, developed during the last two decades. Presumably, stations of this sort are more effective in use. Here people can easily find their way from the trains to the departure hall. On the other hand, railway stations in a city centre are slowly turning into being something between a railway station and a shopping centre. A railway station is open for everyone. It is a public place with a public facade to the city. It has a scale of human movement and a complexity of function inside the building. However, how it is connected to the local street net is often forgotten in most research projects.

At present, railway stations perform a variety of functions. They are not just giving access to trains. First of all, they are places where people change from trains to the pavement, to subways, buses or cars, to a bicycle, a taxi, the light rail, to other trains, or to airplanes. Otherwise they simply arrive at their final destination, which is in the immediate vicinity of the railway station.

Furthermore, train stations are also shopping malls, meeting places and urban landmarks. They are distinctive and complex places. They serve us in our social, cultural and functional interactions. The passenger's station is the architectural manifestation of the railway system and its connection with the urban fabric. It is both a gateway to a rail network and it is a threshold for passengers entering a city. “What gives the railway station particular significance as architecture and essential elements in the life and cultures of cities is precisely this interface between these two worlds - the railway system and the urban back cloth” (Edwards 1997, p. xi).

Transport is no longer the luxury it was during the last century. However, it is an essential component of the modern ages. Train lines connect urban centres to other urban centres, and stations are places where people travel trough. Interestingly enough, stations have become important economic catalysts for urban development. Their improvement has led to massive urban development around several station areas.

More recently, railway stations have changed their functions. The roles of waiting rooms are disappearing, and people go shopping or eating before they enter the trains. Railway stations begin to acquire the character of a covered market, where not only railway companies are selling a variety of services, but where retailers and restaurants are competing for the passengers’ "attention" (Edwards 1997, p. 7). Companies and shops establish themselves along the ways where people are moving. Seemingly, the increased popularity and effectiveness of train travel and the role of the station as a point of transport interchange have turned the railway station into a kind of leisure world. The drama of urban life can be witnessed to be in full flow. People can watch each other, and it is a resort for all kinds of people: the urban tourist, the shopper, the unemployed, the homeless, businessmen, salesmen, retailers, train spotters, commuters and train personnel. It is open for everyone, not only for travellers (Edwards 1997, p. 173).

“In the new urbanity of the post industrial age, the station with its open democratic structure, its public spaces inside and out, and its corridor of movement etched upon the face of the city, represents an important civilizing element” (Edwards 1997, p. 181). The combination of sustainable development and environmental considerations with social and cultural functions makes railway stations interesting kind of highly complex buildings and their relationship to the local place.

Due to noise and security mostly airports are placed outside city centres. Like airport stations, intermodal hub stations located in industrial areas are not connected to the local place where it is located. Larger railway stations are placed within or close to
a city centre. They are localized in its dense network of central facilities. It is even more a part of city life, with a smooth transition from the city street to a seat on the train (Edwards 1997, p. 26). In smaller towns or villages, the railway station tend to be one building located along the tracks. Often the architecture of the building mirrors the local building style at the place.

The smallest type of railways station consists of a track located along the rails with one shelter for the rain and a ticket machine. These stations tend to be located in the countryside or in post-war sub-urban areas.

Analyses methods for a successful railway station area

Mobility on rails is acknowledged to be one of the most sustainable means of transportation between cities and towns. Therefore, a railway station’s location in a built environment and its degree of accessibility is essential to reach as many travellers as possible. However, the spatial configuration of the local street and road net in a railway station’s vicinity is seldom taken into consideration.

Two methods were used in order to reveal the correlation between a street net’s degree of spatial integration and the value of a railway station, the space syntax method and the Node Place value model.

The Node Place value model, developed by Bertolini, aims at correlating the degree of functionality and degree of local place qualities for nodes (Bertolini 1999). According to this model, a station functions well when the node value and the place value correspond. The parameters for deciding the node value are the variation in the mobility types, the frequency of the public transport system of a hub, the accessibility of the network connected to the node, and the mobility means that can reach the hub. The parameters for the place value are dependent on the number of functions accessible in the vicinity of the node, such as dwellings, offices, public buildings, leisure activities and shops and the way these functions are connected to each other. A mono-functional node with for example only offices has a low degree of place value than a node with dwellings and offices.

The Node Place value model illustrates therefore the optimal correlation between place value and node value. If there is a balance between this correlation, it is defined to be a successful node and place. Often railway stations located in these kinds of places tend to be successful. As soon as either the place value or the node value is dominating, these places are defined not to be successful for nodes.

The aim with using the space syntax method is to get insights on how the spatial structure of the street and road net affect human activities in built environments. The space syntax method, developed by Hillier and his colleagues at the University College London, is able to calculate how a street relates to all others in a town or city. The recent versions of the Depthmap software are able to calculate topological distance (how integrated a street is in relationship to all others in terms of the number of direction change), geometrical distance (how integrated a street is in relationship to all others in terms of the angular relationship between them), and metrical distance. Moreover, the software is able to both describe and visualise a built environment’s spatial inequalities, and to simulate and trace movement routes of computer-generated agents. The way these agents move is based on research in a present urban context (Turner 2004).

Since the space syntax method analyses pure spatial relationships quantitatively, the results can be correlated with numerical statistical data such as pedestrian flow rates, crime dispersal, land use values, etc. The software uses colour codes for the various integration values.

In this way, one can see in one glance the spatial structure of settlements. As research has shown, there are correlations between a built environment’s spatial layout of its street and road net and the location of economic activities, crime dispersal, land use along streets, and property values (Hillier et al 1998). Therefore the degree of spatial integration affects mobility flow rates. Moreover, it also affects the location of various economic activities such as firms and shops (Hillier et al 1993, 1998). If the structure of the street and road net changes, the mobility flow and the location pattern of economic activities are affected (van Nes 2002). In this respect, a station or a node’s place value can be quantitative measured on the various degrees of spatial integration of the street and road net.

The spatial parameters can be correlated with the social and technical parameters indicated in the Node Place value model.

4 Spatial configuration study of retail distribution pattern around railway stations

The railway station area as a new central place in the city has similar necessity as a centre in the city. Paksucharem (2003) argued that the key to the successful creation of an urban place out of a transport node is the same as that which prevails in general, namely that spatial configuration is critical. Bill Hillier and his colleagues at the Space Syntax
laboratory propose that the live centrality is related to its spatial context; thus an urban centre is never stable, but consists in a process. He also argues that while we may find movement and attractors (land-uses which benefit greatly from movement and are capable by themselves of generating movement, such as retail shops) highly related to each other, we cannot assume that movement can be explained by attractors until we are sure that the configurational properties of the grid have not influenced both the presence of movement and the presence of attractors (Hillier, 1984).

Based on Space Syntax theory, Read studied the centrality issues on Dutch cities (Read, 1996). He argued that configurationally, cities consist of different scales of movement. These scales are layered, distinguished by the scales of mobility, and are designed to convey different scales of movement. The hierarchy or functional layering built into the shape of the urban grid of Dutch cities involves firstly the regional movement network which conveys movement at a scale which cities as points or destinations within it. Secondly, it involves the city-scale movement network, a set of spaces in the grid, which are suited by their geometry for carrying traffic over the medium and longer distance. And thirdly, it involves the grid at the neighbourhood or local scale. The regional scales appear locally most often in a nodal node - e.g. stations, metro stops or parking garages. The city scale is mostly linear and continuous, and is differentiated and 'formed' by its level of integration into the local scale. It is suggested that in order to produce that sort of real urban centrality, we need to integrate locations into the urban system at a variety of scale levels. The centrality is a product of layering of scales. This means that real urban centrality depends not only on the contribution of a regional context, but also on a context at a 'city' scale as well as at a local scale. In other words, the location needs to be systematically connected to the more traditional urban scales as well as to the new ones (Read, 2000).

At the local scale, Jacobs has suggested the importance of small-blocks in generating diversity in the city (Jacobs, 1992). This idea has been further elaborated by Siksnas (1997). He found that some block forms and sizes were better than others in making city centre layout more amenable to adoption, or more robust in meeting varied development needs over time. Small square blocks, 50-60 meters, perform better than larger blocks because they produce finer-mesh circulation patterns, more potential frontages, more coherent block fabrics and finer-grained, continuous urban fabrics and both low and high-rise buildings. Thus, he argued further, if certain block forms have worked well, or have produced particular effects in the past, there is a reasonable expectation that they will perform similarly in other cases in the future. ‘Sketch from Jacobs (1961): the long and short blocks.

How about the centrality of railway station locations? Many railway station locations are attractive as retail location, due to their high accessibility on regional scale, but whether they have the 'real' effect on the distribution of retail location still needed to be investigated. This article concentrated therefore not on regional accessibility and centrality, but on the other scales required to provide an urban centrality around the station and to create an attractive location for street-edge shopping activities.

The study of Camelia Kusumo investigates spatial integration of railway stations in the existing urban fabric and analyses the influence of the railway station’s location on the distribution pattern of retail and service firms. Station areas in the cities of Delft and Leiden in the Netherlands were analyzed by the grid configuration analysis using Space Syntax techniques to uncover space-structural detail within urban fabric as a field of movement and activity. These different case studies are subsequently compared, to analyze how the different street configurations affect the economic activities around those stations. The findings demonstrate that the distribution of street-edge shopping, and the local qualities which support this function, appear to be determined very powerfully by spatial-configurational factors, which are the ‘area-integration’ and the integration between the “city-scale” structure in the local fine-grained fabric.

5 Conclusions

This paper was aimed at studying why certain spatial transformations (should) occur after in particular having a High Speed Train connection. It deals with literature about railway stations to form a basis for my graduation project. The focus was mainly on station area development, in particular by the advent of a high speed train line.

It is clear that the connection to the HST network requires a big (financial) investment, but the impact of the HST can be big as well. Integration in the network of European cities is a necessity to remain a player in the international (economic) field. The hierarchal position that the HST gives a city is an essential element of the competitive position of a city, but it has to be accompanied by a sufficiently high quality of living conditions and an economy
that can handle the competition of other cities as
their relevant regions can overlap due to the new
proximity in time.
It can be concluded that the advantages of the
advent of the high-speed train are mainly indirect.
As stated previously infrastructure does not lead to
(economic) growth, but sufficient accessibility is a
necessity (Zonneveld and Trip, 2003). The gains can
be divided into two main parts: The gain for the city
as a whole, the improved accessibility and therefore
the image and competitiveness. And on the other
hand the momentum it gives for the redevelopment
of the station area and to a lesser degree to the city.
The size of the impact both positive and negative is
very much defined by the path dependency of the
city itself, the current position in the networks, the
spatial possibilities in the city, the available funds
and the local actors.

As the results from van Nes and Stolk’s inquiry show,
main railway stations in large towns and cities have
high local and regional inter-accessibility, while
railway stations in smaller towns and villages have
mostly high degree of local accessibility.
These two station types have in common to have
lively and vital streets in their vicinity. Correlations
were also found between the frequency of the
timetables and a station’s degree of accessibility.
The more regional and local the station is to the
local street and road network, the higher frequencies
of the timetables. The various types of station areas
and dwelling areas require different strategies
for generating sustainable means of mobility in
the planning and urban design practice. From a
sustainability perspective, the two methods applied
in this inquiry contribute to make a priority list of
urban tasks in the provincial plans.

Such basic qualities do not depend on the number of
shops, tracks, railway companies, the density of the
built mass, or on the size of the piece of architecture
in which they figure. It is the spatial structure of
the street and road net on various scale levels in
the vicinity that generates the degree of sustainable
means of mobility. It can be measured in terms of
inter-accessibility, interconnectivity and the density
of the street and road net in the stations’ direct
vicinity.

Kusumo investigated to what extend railway stations
attract investments and vital shopping areas in their
vicinity. She analyzed the local street pattern and
correlated the degree of spatial integration with
the location pattern of shops. Her case study shows
that stations are not enough to attract shops and
investment in the vicinity. A local area’s degree of
vitality has to be spatially supported by a local well-
connected and integrated street and road network
(Kusumo, 2005). She applied the traditional space
syntax method, where only the number of direction
changes from each street to all others is taken into
account.

Railway stations seem to be a direct product of
the transportation modes of the society. New
technology relating to new kinds of trains or to
public transportation in general might come about in
due course. Developments of this sort will probably
set new claims on railway stations. But until now,
a sustainable well-functioning station generating
sustainable means of mobility depends on having a
good connection to the local street net in its direct
vicinity.

According to Kusumo, designing a central location
of economically dense and supportive environments
around the railway station must be done with the
knowledge that the main determining factor is not
the station’s regional accessibility, but its integration
with the local urban structure.

From this paper I gained knowledge of methods and
tools required to recognize and perform necessary
spatial transformations that should be done to
develop a successful railway station area. My
graduation project is the development of the railway
area in Lisbon by the advent of a high speed train
type, with the station design as the architectural
project. This paper is a theoretical framework for my
graduation project, which shows previous scientific
investigations on the lack and need of attention on the
vicinity of railway stations for urban development
instead of just the railway station.

6 Recommendations
This framework can be used in future research
and planning on railway station. This paper gives
a good example in how to reach a well-integrated
railway area. The main problem is the lack and
need of attention on the vicinity of railway stations
for urban development, instead of just focusing
on the design of the railway station. No solution
is the same, because every station area in a city
has an integral approach as how to reach its goal.
Narrowing it down to high speed train stations does
give more similarities in European cities, which is
also discussed in this paper.

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