

Catching the Train

Sustainable development of a connection
to the European High-Speed Train Network
in Copenhagen

Colophon

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Preface

This booklet is, along with a presentation, the final product of my graduation project of the Urbanism Master of Science education at the TU Delft. The year-long graduation project is done individually and there are very few limits on the possible subjects. The reason for choosing this research topic is the combination of my fascination for strategical projects, where the effects are much larger than the intervention, metropolitan areas and the relation between large scale infrastructure and the urban fabric. The characteristics of the high-speed train guarantee all these subjects will play a part and Copenhagen is a city where the high speed train can have a big impact. The study is an exploration of the needed interventions, the possibilities and the potential using an integral approach for both the high-speed train and Copenhagen assuming that the European high-speed train network is extended north to and past Copenhagen.

I would like to thank all the people that helped me during this project. First of all my mentors, Daan Zandbelt, Willem Hermans and Roberto Rocco, for their support, inspiration and challenging questions. Ana-Maria Fernandez-Maldonado our graduation studio coordinator for her advice and support. Peter Minnema for being such a good fellow student. Marjolein Neuteboom for coming to Copenhagen with me and my parents for their support.

Tjitske van Erp

Delft, March 2009

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1 Introduction

1.1 The HST network in Europe

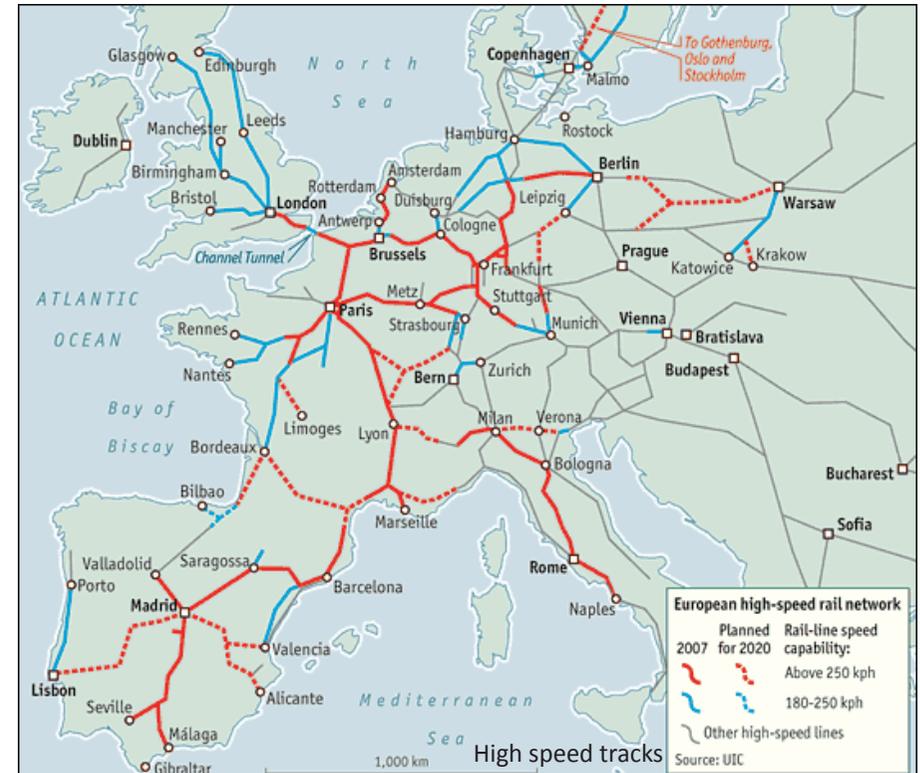
Introduction of the high-speed train network

High-speed trains (HST) were introduced in Europe over twenty-five years ago. France was the first to have one operational, the TGV came into service in 1981. Other countries followed some time later, for example the ICE in Germany in 1991, the AVE in Spain in 1992 and the X2000 in Sweden in 1998. International connections started in 1994 with the Eurostar connecting Brussels and Paris to London through the new train-dedicated Channel tunnel. Other international operations were set up, like the Thalys in 1997, significantly reducing travelling times between major cities in western Europe (UIC, 2006). The expansion of the different lines and the connections made between them mark the beginning of a network of high-speed trains through north west Europe. But the different technologies used, the high costs of standardizing these technologies, the many operators and the varying priorities delay the development of an integrated network.

By cooperation of the operation companies, standardisation of technologies on a European level and coordination and support by the European Commission through the TEN-T program the fragmented network is slowly being unified into a European network. This not only means the strengthening of the existing network but for instance also expanding it to Eastern Europe and through new bridges to Scandinavia.

The popularity of the HST

The success of the HST has several components. First of all it is fast. It has a high comfort level, amongst other things provided by the direct access to the centre of activity (which reduces transport before and after) and the minimal security hassles compared to air travel. Finally it is a clean way to travel compared to other modalities which is one of the reasons that makes it popular with governments.

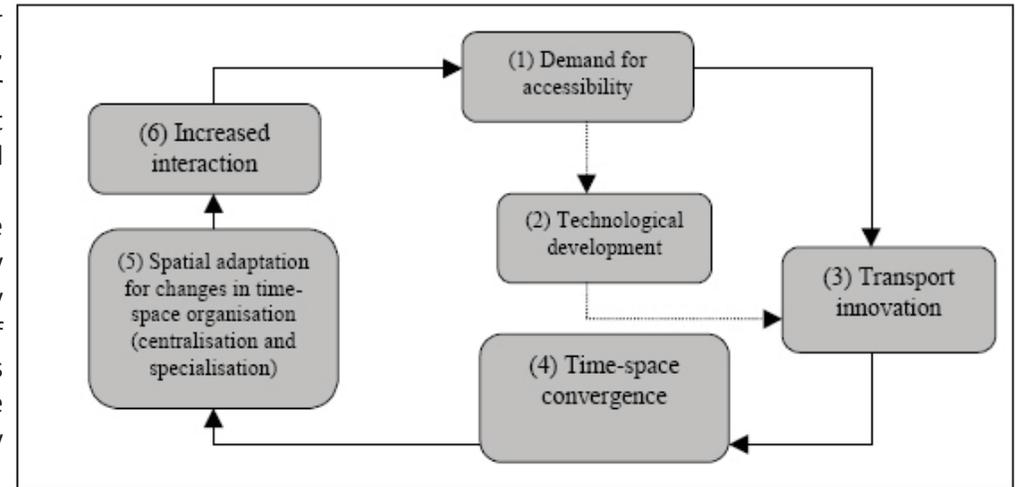


1.2 General spatial-economic effects of the HST advent on cities

New transport systems can have a big impact. Faster connections, like the high-speed train offers, lead to time-space convergence (Janelle, 1969 in (Pol, 2002), this changes the dynamics between and of cities themselves as the reach of their inhabitants (people and organisations) grows. The addition of this new transport system strengthens the position of the station and can attract economic growth and can lead to urban development.

But high-speed trains and the accompanying infrastructure and buildings have a relatively permanent character and require a big investments (of time, money and effort). Therefore the profits and costs of such an intervention are carefully scrutinized for all the different fields involved, not only the financial feasibility of the project itself, but also the gains, losses and consequences for related topics that cannot always easily be expressed numerically or monetarily such as the environment, the competitive position of the cities involved and the spatial quality around the station/tracks.

In paragraph 1.2.1 the larger (in)ternational and regional scales will be discussed, the changing (economic) relationships between cities and the consequences that will (in)directly influence the urban development of the city. Paragraph 1.2.2 will focus on the city itself the opportunities and threats that come along with the high-speed train connection, and the theories that can make this intervention lead to sustainable development in the city.



Time-space convergence processes (Janelle, 1969 in Pol, 2002)

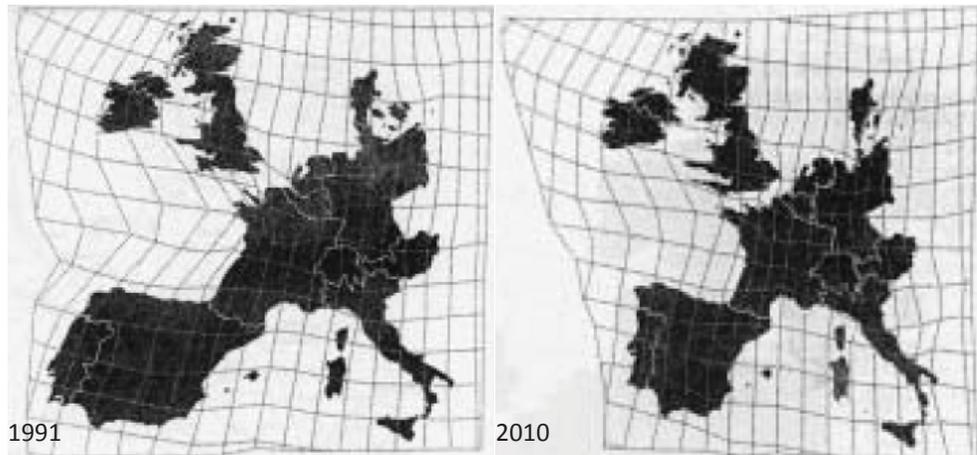
1.2.1 The changing position of a city within the large scale networks

The HST as an image for a city

‘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). This means that a high-speed train station gives a city a certain image, an image of good and reliable (international) accessibility and a modern and dynamic environment. 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).

Hierarchical reorganization

But it is not only about a perception of status. 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



Spiekermann and Wegener (1994)

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 clearest example of this phenomenon is Lille which transformed from an regional centre unimportant and unknown outside the most northern part of France to a node in the HST network.



New position of Lille

This leap up is maybe not as important as the disadvantage the cities are put at that are not connected. Their competitive position is marred as a tunnel or corridor effect occurs, which means that only the areas around the stopping places profit from the transport system (van den Berg and Pol, 1998). In the Dutch national network for instance, Den Haag and Rotterdam could be seen as cities of comparable importance. But because Den Haag will lose its connection and Rotterdam does not a clear gap is created between these cities. This has further consequences than just missing out on this form of high-speed transport. In his theory of Scale-free networks Barabasi (Barabasi and Bonabeau, 2003) states that some networks are scale-free (this does not mean that the network has no scale but that a clear categorization of the nodes in terms of scale is not possible). One of the characteristics of scale-free networks is that the big nodes attract the most new connections. Translated to the networks of cities this could imply that the fittest nodes (the places most accessible and the most able to fulfil the current needs) will attract the most development. This complies with the theory of Janelle: the urban regions with the highest interaction are the first to face congestion and the first to get new infrastructure (Pol, 2002). Applied more specifically this means that one city is more attractive than another, but also that location A within a city is more desirable than B, which can lead to a shift in orientation. This is underpinned by the importance of the image mentioned above.

The consequences of a greater reach

Where there are winners, there are always losers. The Fit get Fitter principal leads to polarization of a network (from an international to a local scale) (van den Berg and Pol, 1998, Trip, 2007) with the peripheral areas losing the most. This is caused by the relatively decreasing accessibility and can result in the Backwash-effects (Pol, 2002): Companies and inhabitants moving to places with better access to the European market/network. Better accessibility to the growth-pole (by feeders) can improve this accessibility to the European network, but can also enlarge the Backwash-effects.

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 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 size of the impact of the HST

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).

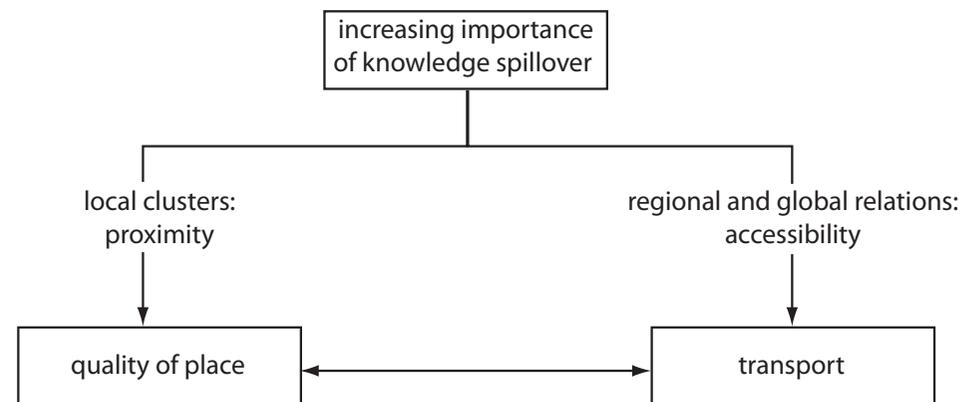
Another thing that influences the size of the impact is the kind of station, the type. There are 4 types of HST nodes or stations that can be hierarchically distinguished: the HST junction station, the stations along a HST-line, HST terminus stations and the pseudo HST stations (not along a dedicated line, but linked by a branch line). The impact 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). This option value is further enlarged if a line connects to a major airport.

The third variable on the impact of the HST is how big the improvement is compared to the existing options for travel. In the generalised transport costs (GTC) not only the monetary transport costs are taken into account but also time (travel and waiting times) and the effort (discomfort, risk of property theft, risk of delays) (Pol, 2002). Depending on the preferences of the traveller the different values are weighed, and a transport mode is chosen. For instance the distance covered in a certain amount of time by airplane might be outweighed by the comfort and direct connection to the city centre of a high-speed train. In this way the congestion of the roads and the vicinity and size of an airport influence the impact of the HST.

1.2.2 How the HST influences a city

The attractiveness of the HST

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 (Trip, 2007). The desired companies increasingly depend on knowledge and the exchange of information between firms and individuals. This knowledge spillover is very much dependant 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 a 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 trains characteristics: the enlarged accessibility and the image, can help in achieving these qualities (Pol, 2002).



Multi- scalar knowledge spillover (Trip 2007)

Sustainable urban development

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 straight forward 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. In the case of Brussels Midi station the developments around the station destroyed the urban fabric and negatively influenced the existing social structure. 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. Both lean heavily on the theory of Jane Jacobs on the need for diversity.



The development around Brussels Midi

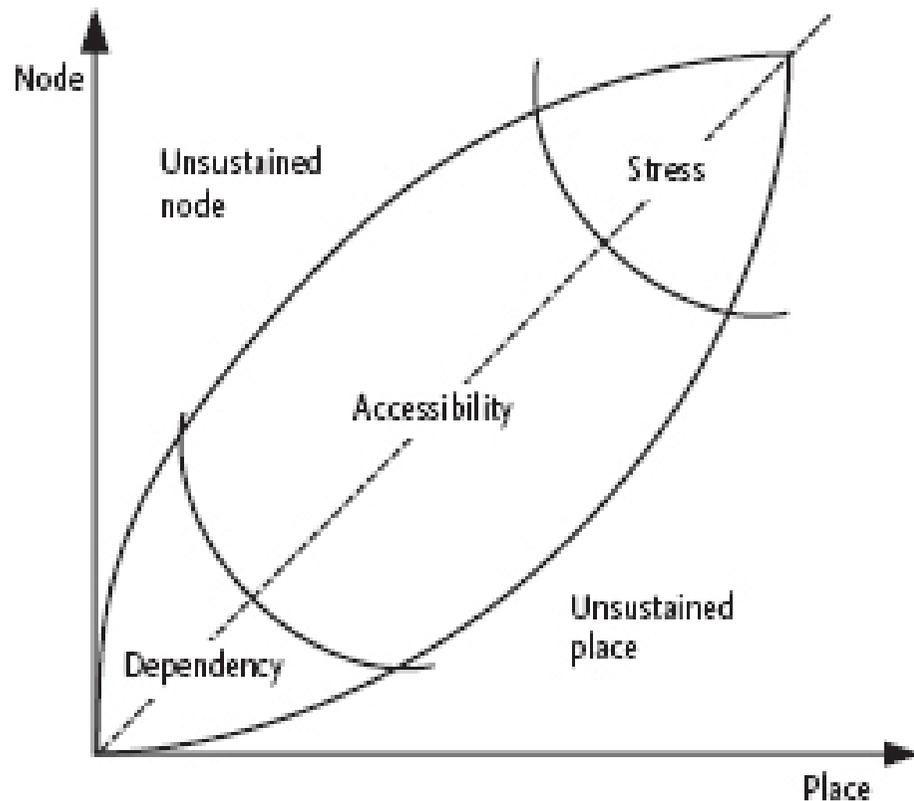
Path dependency

Whether sustainable urban development or the quality of space is achievable is very much dependant 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.

The need for integration

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 is not only essential for the functioning of the station itself but also for the cohesion of the city to prevent polarisation, where the success of the station area drains other areas. This polarisation 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. Lack of feeders can make more distant districts peripheral as proximity is measured not only is distance but also in time (Pol, 2002). 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. 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 so 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.



Bertolini's model of the station as a node and a place (Bertolini, 1999 in Trip, 2007)

1.2.3 Conclusions

It is clear that the connection to the HST network requires a big (financial) investment, but that the impact of the HST can be big as well. The profits can be huge for the whole city if it is thought through carefully and the possible threats are acknowledged. The largest threat is not looking outside the station area and beyond the short term. This can have devastating effects on the cohesion of the city and on the position of the city in the networks of cities as the HST can have a polarizing effect. This danger of becoming peripheral calls for integration, of the station in the city and of the city in the networks. Integration in the network of European cities is a necessity to remain a player in the international (economic) field. The hierarchical 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.

1.3 Copenhagen

Why Copenhagen

Copenhagen is the location for this study because of the potential change the HST can bring to the city. Currently it is at the edge of the existing European HST network. The ICE (Inter City Express) and EC (Euro City) high-speed trains go to Copenhagen from Hamburg in north Germany but they do not travel at high velocities. The journey from Hamburg takes 4.43 hours and the train even has to board a ferry for the 18 kilometre crossing into Denmark. There are plans for a bridge from Puttgarten in Germany to Rodby in Denmark which will hopefully open in 2018 (Sylvan, 2008). This will significantly reduce travel times to Copenhagen from the main part of Europe. Combine this with the Øresund bridge to Sweden opened in 2001, and it is possible to extend the HST network into Scandinavia. The position of Copenhagen in this future network can become that of the node of the north and the gateway between Scandinavia and the main part of Europe. The big change in position enlarges the potential impact on the city making Copenhagen an interesting location.

Introducing Copenhagen

The capital of Denmark was founded in 1167 and has played a major role in the Scandinavian politics since then. As the capital it houses the national government and is the home of the Danish royal family whose residence is in the middle of the city. The name of Copenhagen (Danish: København) means merchants harbour. And for a long time trade was the main source of income.

The city is located on the eastern shore of the island of Zealand (Sjælland) and partly on the island of Amager. Copenhagen faces the Øresund to the east, the strait of water that separates Denmark from Sweden, and that connects the North Sea with the Baltic Sea. Currently Copenhagen has 500.000 inhabitants and the greater Copenhagen area houses over 1.8 million people which is over a quarter of Denmark's population. The Øresund region has a population of over 2.5 million inhabitants. The city's economy is based on the service and knowledge sectors. Copenhagen is a centre for business and science, not only in Denmark, but also in the Øresund region and Scandinavia.





1.3.1 Copenhagen in its international context

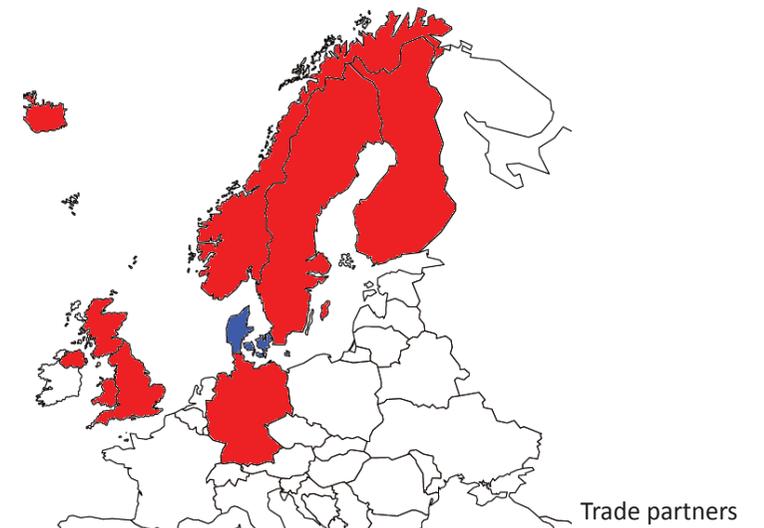
Economic and competitive position

Denmark has a well established competitive position. According to the world economic forum (2008) Denmark is fifth in the global competitive ranking of 2007-2008, scoring well on the functioning of its institutions, the infrastructure, health and education. The biggest problems seem to be the tax rates and tax regulations.

The main trade partners for import and export are Germany, Sweden and the UK, with around 70% of the im- and export traded within the EU (The economist, 2008). The Danish economy is closely linked with that of Germany and the other Scandinavian countries.

Copenhagen has a special position in this network as it is the gateway between Scandinavia and the rest of Europe, a node on the routes from north to south. It is also the gateway between the Baltic sea and the Atlantic Ocean providing a lot of activity for the ports of Copenhagen and Malmö. Copenhagen main airport of Kastrup is the main hub for the SAS and the biggest airport in Scandinavia.

There is quite a lot of interaction between the big cities closest to Copenhagen: Hamburg, Berlin, Oslo, Goteborg and Stockholm, because of they complement each other in their main activities. The long distances and travel times mean that at the moment they do not immediately compete with each other for the less specific activities.



1.3.2 Copenhagen in its regional context

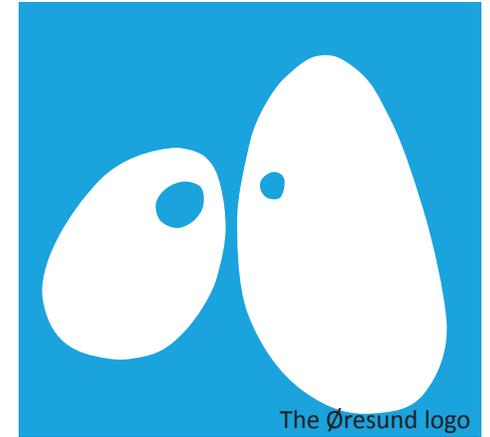
The Øresund region comprises of the islands Zealand, Lolland-Falster Møn and Bornholm in Denmark and the province of Skåne in Sweden. The two most important cities are Copenhagen and Malmö. Although presently divided over two countries these areas have historically always interacted due to their vicinity and have at times even belonged to the same country.

Since the opening of the Øresund Belt (bridge and tunnel) in 2000 the interaction between the two sides of the strait has grown enormously, not only between organisations like the ports and universities, but also the huge numbers of commuters searching for jobs in Copenhagen and cheaper living conditions in Sweden. The whole region uses the big scale facilities of Copenhagen like the airport. This presents problems as well: the two currencies, sets of legislation and social security systems stand in the way of an easy route to further cooperation.

The region has its own policy body: the Øresund Committee comprising of members of local, regional and national authorities.



Øresundsregion



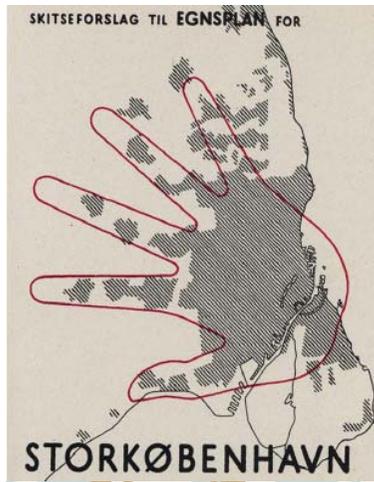
The Øresund logo



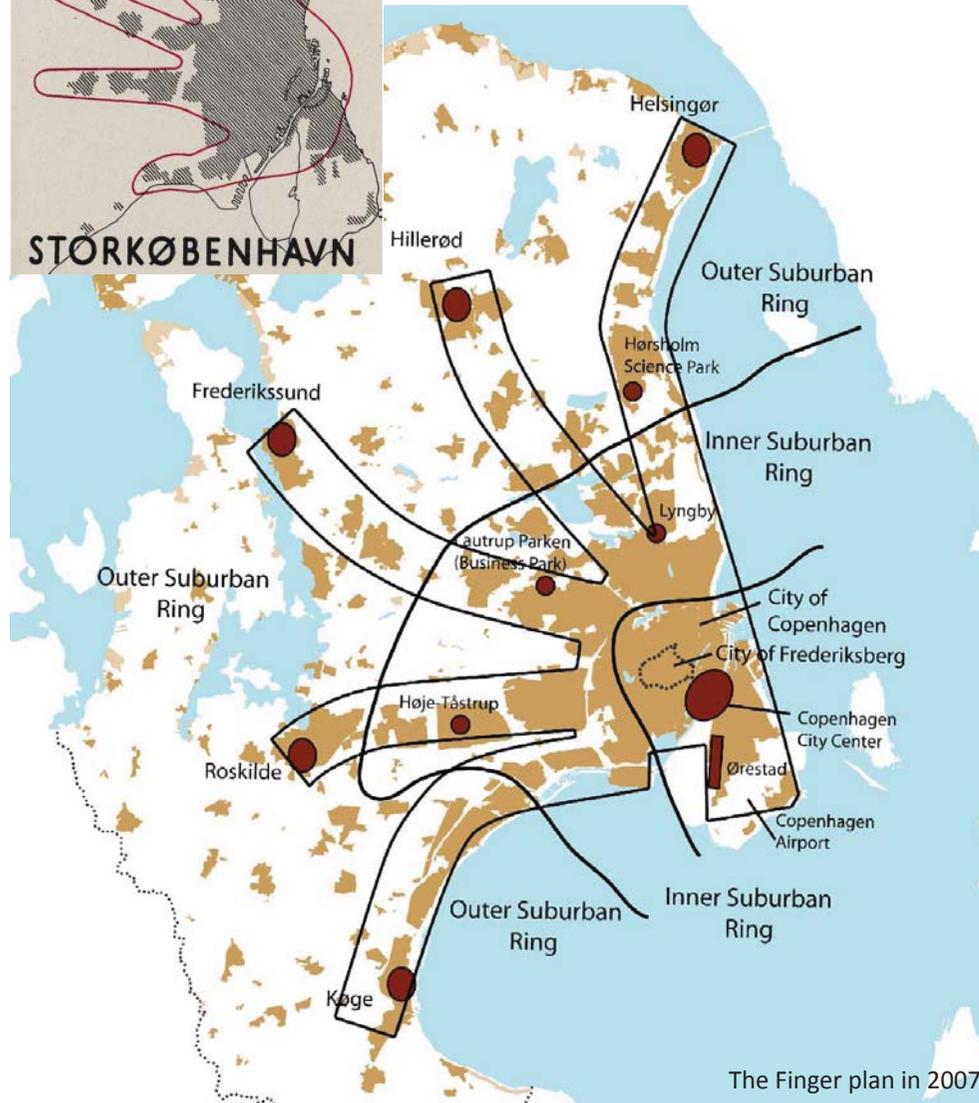
The Øresund bridge



The Øresundsregion



The Finger plan in 1947



The Finger plan in 2007

1.3.3 the city itself

The Finger structure

The greater Copenhagen area has been organised by the finger plan concept since 1947. A concept of radial urbanised 'fingers' stretching out from the historic centre with green wedges in between. The fingers were developed along the already existing S-train lines linking towns to the city of Copenhagen. Centres were to be created along at the stopping places and nodes of these lines. Highways would also follow these urban fingers, with ring roads providing the necessary cross links. Today the Finger plan is still the leading organisational principle, with urban development concentrated around stations and very strict protection of the green wedges.

Municipal plans

In the last Municipal plan strategy (2007) the concept of the thinking metropolis is introduced. Handling the growth in a sustainable way, creating a internationally stronger, more cohesive city with a high living quality. The strategy consists of 4 themes: the sustainable city, the city for everyone, the city at the water and the dynamic city. Priority is given to keeping the city moving: cycling and public transport and reducing the housing shortage.



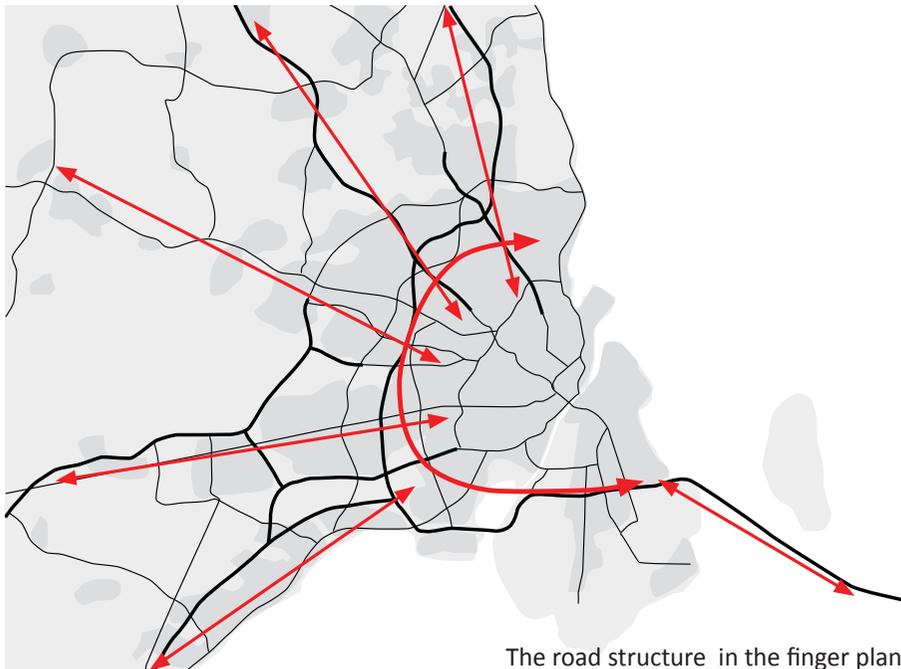
The historic centre

The Infrastructure

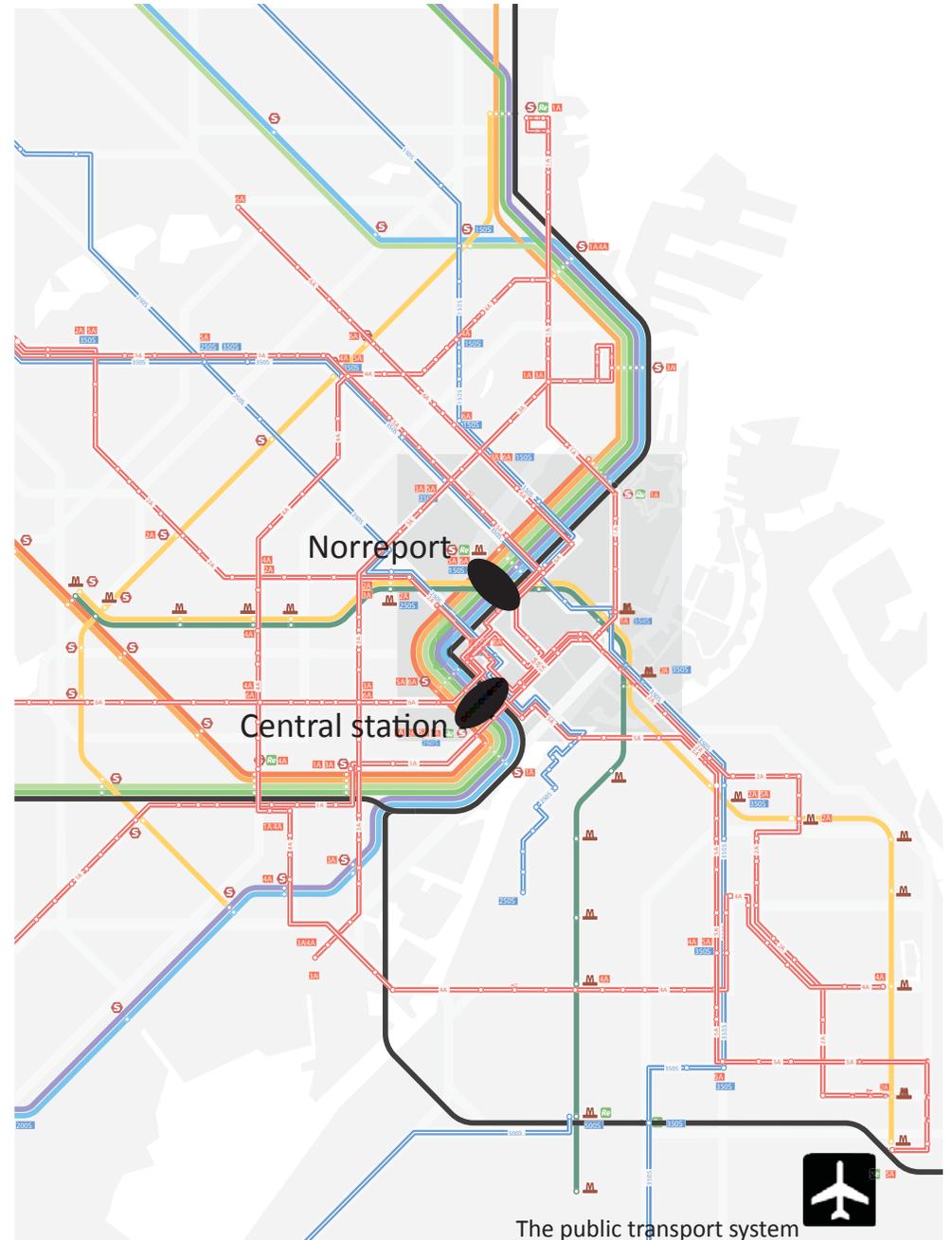
The aim of concentrating the urban development around public transport stations is related with to aim of shifting the modal split to less car traffic as the radial arterial roads to the centre are getting more and more congested.

The public transportation system of Copenhagen consists of commuter trains (S-tog), buses, and a metro system. The S-trains form the basis of the transportation network, stretching to most areas of metropolitan Copenhagen, with their main hub at Copenhagen Central Station (København H). Regional trains supplement the S-train services with lines extending further such as to the Copenhagen Airport, and Malmö. The Danish State Railways' Intercity network has its eastern terminus and main hub at Copenhagen, with most trains extending to Copenhagen Airport. This used to make the central station the busiest station of the city, but since the opening of the metro in 2002 it is overtaken by the Norreport station serving around 300.000 passengers a day. The metro system is planned to extend its current two lines with a city ring line due to open in 2018.

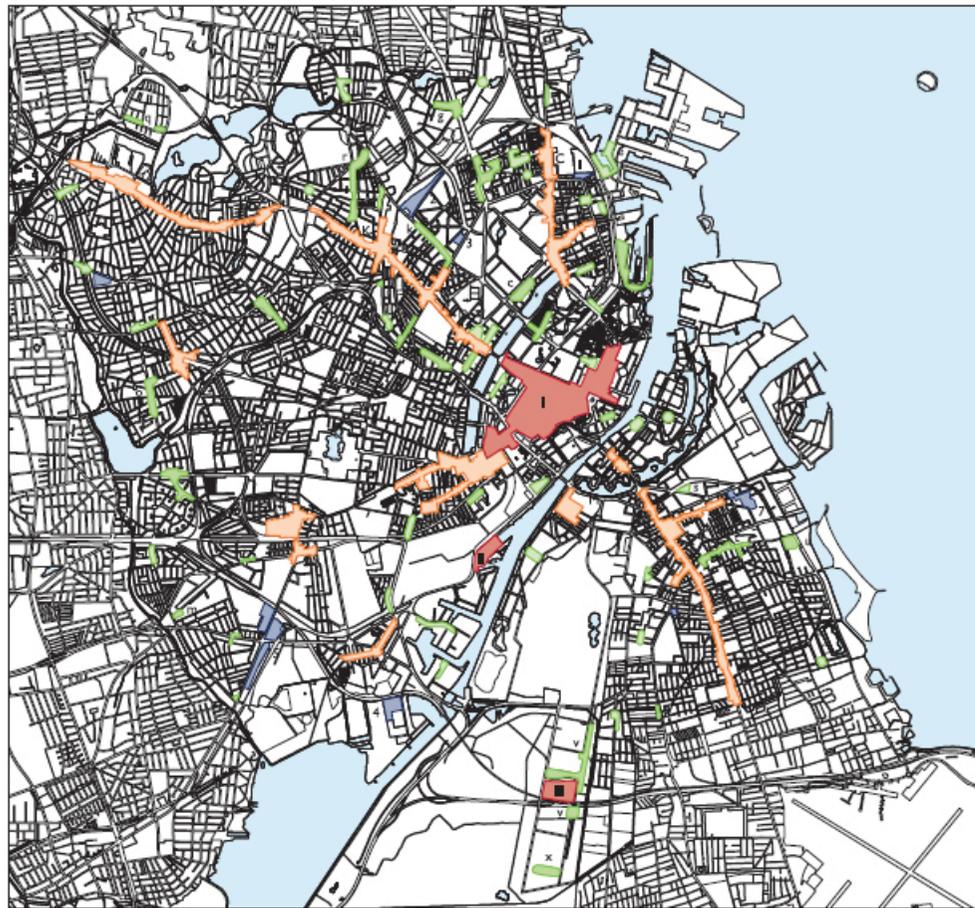
Travel across the Øresund to Malmö and the rest of Sweden is possible by car or by train. The train tracks are used by commuter lines to Malmö and the national train to Stockholm.



The road structure in the finger plan



The public transport system



DETAILHANDEL

- Regionale centre
- Bydelscentre
- Lokalcentre over 3.000 m²

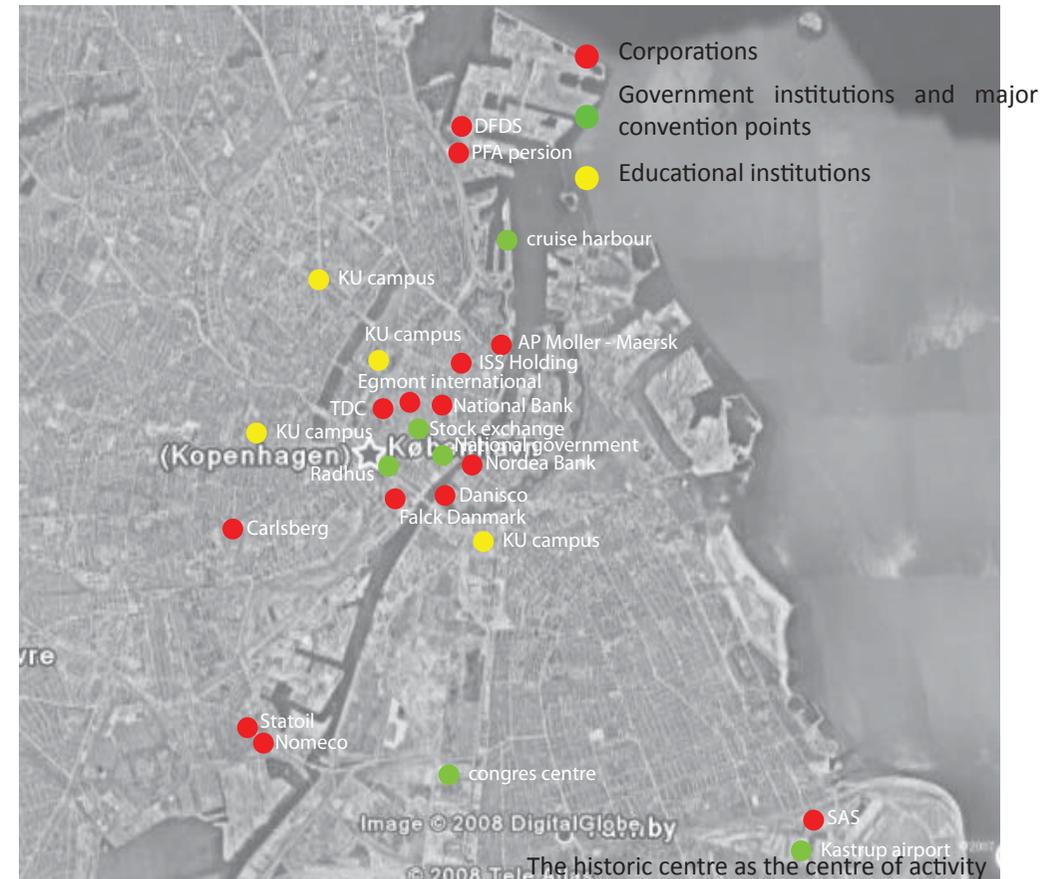
(Kommuneplan, 2005)

The programme

The finger plan concept is also very much visible in the distribution of the program over the city. The gravity point is in the palm of the hand, the historic centre. The radial routes of the fingers are the place where the rest of the activities are concentrated.

This focus on the centre is not only true for the retail trade, but also for the educational and governmental institutions. The major corporations also tend to reside in the historic centre, the harbours and along the canal.

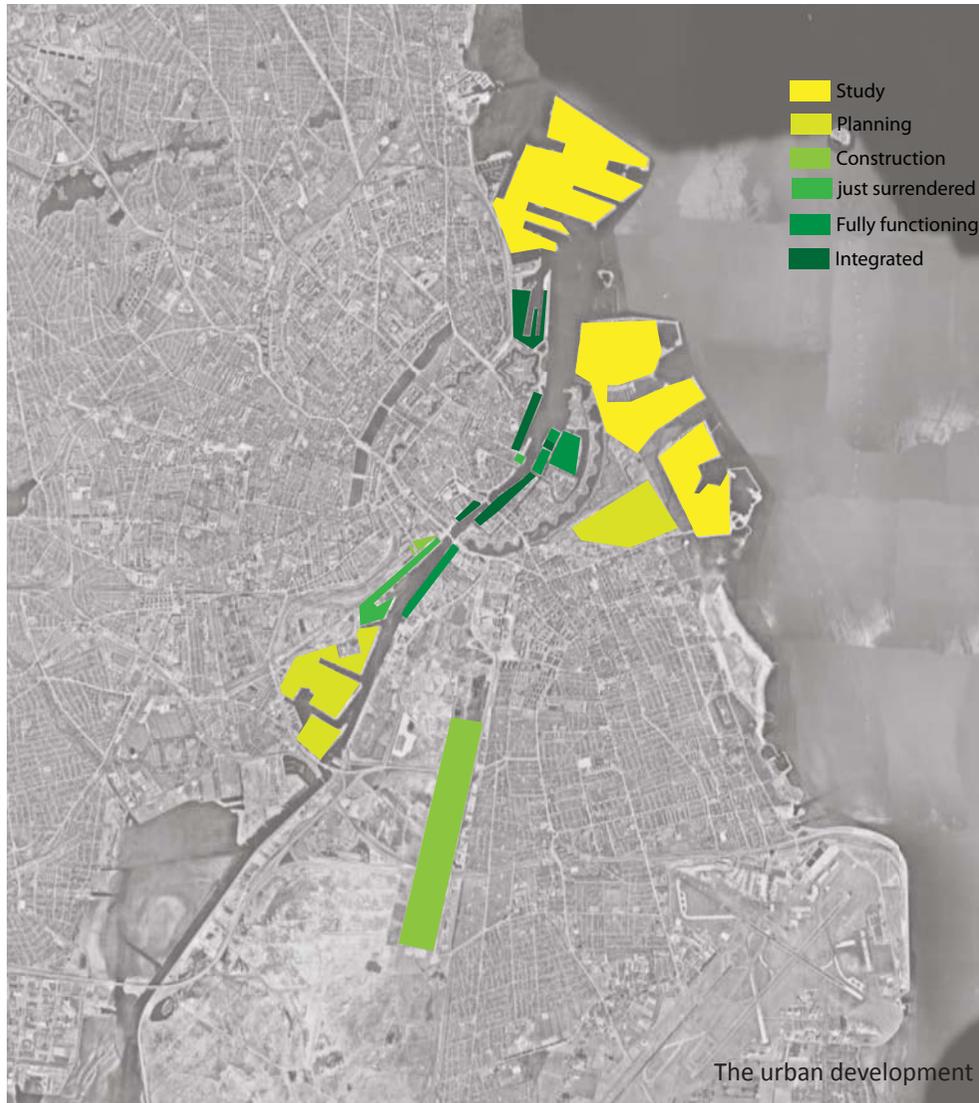
Specialized clusters of IT and pharmaceutical companies can be found outside the centre at the highway intersections near towns further toward the ends of the fingers. But in general it can be said that the historic centre is still the centre of activity



The historic centre as the centre of activity

Urban development

The urban development in the city consists mainly of the redevelopment of the waterfront. Old harbour and industrial areas are being transformed from the inner city outwards. The Danish are well aware of the living and recreational qualities of the waterfront and are intent on using them.



1.4 Project definition

Problem statement

With the expanding High Speed Train network of Europe, more and more cities are queuing up to get connected to it. They see the potential of the people and prosperity that could come with a fast connection to their city. But the consequences are not only economic and positive. The city can also be affected spatially, the structure/networks of the city can change. This has to be anticipated in order to minimize the negative effects and to obtain an integrated and sustainable city.

Project aim

To improve the HST network around Copenhagen in a way that also benefits the urban development of the city.

To show that an integral approach of infrastructure planning and urban development can benefit both the city and the transport mode and lead to synergy between them.

To identify the general spatial requirements and tools for the integration of HST networks in existing urban fabrics on different scales.

Societal relevance

The European high speed train network is expanding in all directions. This means that in future more cities will be connected to it. All these cities will face the question how to deal with it in such a way that they maximize the profit, now and in the future, and minimize the negative effects. Although each city has a specific context there are generic spatial elements that apply to all cities.

Scientific relevance

This project will be researched by designing. Albeit that 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 infrastructure change.

Methodology

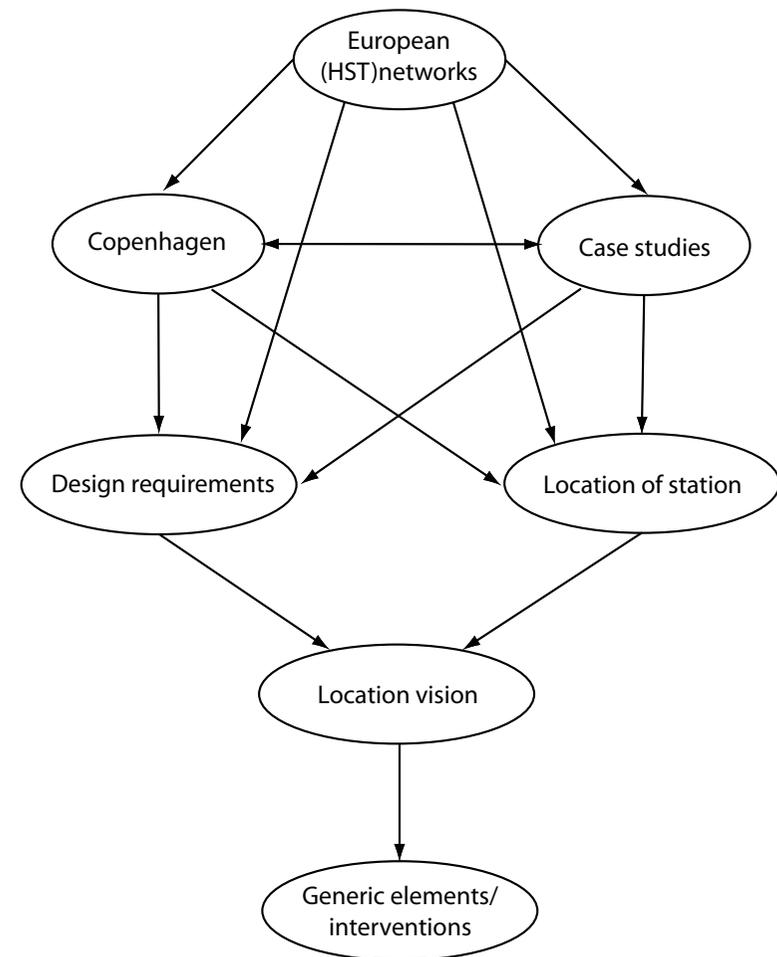
In this research project research by design will be the main method used. Drawing the possibilities and predicting and weighing their effects will lead to the optimal solutions of the problems/questions.

The project is limited by an explicit future situation: there will be a high-speed train connection to Copenhagen from the north west European network, 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 (sub)continental, regional, metropolitan and neighbourhood level. This easily translates to: Northern Europe, Øresund, Copenhagen and the HST station area.

Literature studies, spatial, functional and morphological analysis, a field trip and case studies will be the most used methods to provide input for the designing.



1.5 Thesis structure

The thesis starts with the case studies to see what others have done when dealing with the HST in urban fabrics. The Copenhagen specific part of the project can be described as a 2*5 matrix, with two elements: the high-speed train and the city, and 5 scale levels. All the individual research pieces fit into this scheme to give the full overview of the project. The different scale levels provide the main organisation of this thesis, within each scale level the two elements will be discussed. On some levels one element is more relevant than the other so the division will not be equal. At the end of chapter 3 and 4 the effects of the intervention and the benefits for the city will be discussed. The effects of chapter 5,6 and 7 are related and therefor will be discussed together as the effects on Copenhagen in chapter 8. Finally the step will be made from the specific case to more general to principle and tools that can be applied in other situations.

| | Urban development (Copenhagen) | Infrastructure mode (HST) |
|---------------------------------|---------------------------------------|----------------------------------|
| International (Northern Europe) | Chapter 3 | Chapter 3 |
| Regional (Øresund) | Chapter 4 | Chapter 4 |
| City (Copenhagen) | Chapter 5 | Chapter 5 |
| Local (Redevelopment area) | Chapter 6 | Chapter 6 |
| Local (Station area) | Chapter 7 | Chapter 7 |

What will be discussed in each chapter is not only defined by the two elements and the scale levels. A further limitation is made by adding the specific aims of the elements on the different scale levels. The aims dictate what will be studied and guide the choice for the intervention.

| | Urban development (Copenhagen) | Infrastructure mode (HST) |
|---------------------------------|---|--|
| International (Northern Europe) | Good competitive position related to other cities. | Good competitive position related to other transport modes. |
| Regional (Øresund) | HST fits in regional vision. | Few, but qualitative stops. |
| City (Copenhagen) | HST fits in with vision and contributes to the realisation. | Fast and safe route. Good connection to feeders and centre of activity. |
| Local (station area) | Quality of (public) space/ place. Use momentum and spinn off. | Potential to regain investment. Functioning as a node. |

2 The Case studies

The cases of this study are chosen such that together they give a broad spectrum of the options for the route of the HST, the location of the station and the development of the station area.

The position of the station in relation with the centre of activity and the airport is different in each case. The same goes for the developments around the station. This is of course because all the locations are different, all the cities are different, as is their place in the HST network. These differences have led to tailor made solutions for each city, which points at the wide array of possibilities.

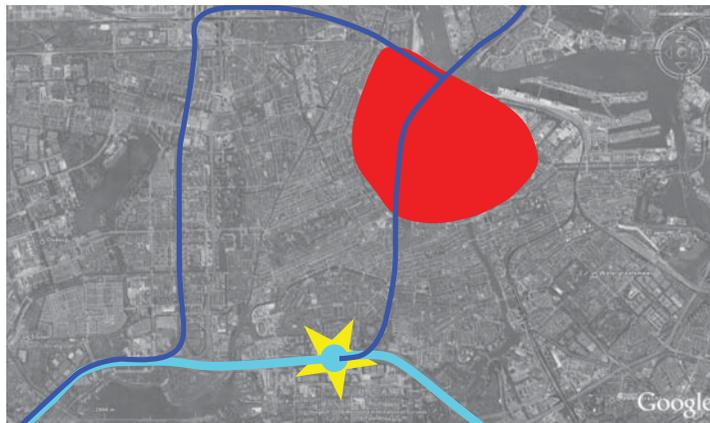
The cases, London, Amsterdam, Brussels, Lille and Lyon will be discussed individually, but along similar lines. Where specific information about the case is essential to the understanding it will be provided too. The Copenhagen case is also shown to be able to relate the cases to the project.

Since the opening of the Øresund bridge and tunnel combination in 2000 Copenhagen has to be studied in combination with the city of Malmö as well. Therefore a quick analysis of a case on a higher scale is also made.

From the cases several characteristics of a HST station location can be derived as starting points for the research on the Copenhagen case.



2.1 The station location related to the city



Amsterdam

Essential in the Amsterdam case is that in the future (2012) the HST will not go to the inner city. This has been a subject of debate for a long time but seems to have been decided as the HST operators are planning the upgrade of the Amsterdam-Zuid station. The connection from the HST to the inner city is made by a national rail connection from Schiphol airport and in the future (2015) also by metro from the Amsterdam Zuid station, both will take about 15 minutes. The reason why the HST will not go to the Central Station is related to the developments in the South-axis area. Here a large scale urban development is taking place, this multifunctional area will house major (international) companies, which prefer this very accessible location above the 'overcrowded' inner city. The employees of these companies are an important target group for the HST. It is important to get clear that in this case the HST follows the urban development, but that it will be beneficial to its success. It looks as though Amsterdam is a through station, but in fact for high-speed trains it is not. It is a combination of two termini because of its 'peripheral' location in the HST network and the distribution of the services over two companies (Thalys and ICE). One line goes south towards Rotterdam, Brussels and Paris, the other goes east to Utrecht, Arnhem and Germany. There are possibilities for the extension of the eastern line to Schiphol which will be profitable for both the HST and the airport. This in turn can strengthen the position of Amsterdam in the International network of cities.

Lyon

The big bypass of the city centre stopping at the city's airport St. Exupery means that little time is lost for the trains travelling between Paris and the Mediterranean. At the same time other high-speed trains to the city of Lyon from both the north and south travel to the centre station of Part-Dieu. Most striking is the bad connection of the city with the airport, at the moment the bus shuttle takes 45 minutes. However, here are plans to extend the city's metro system to the airport.

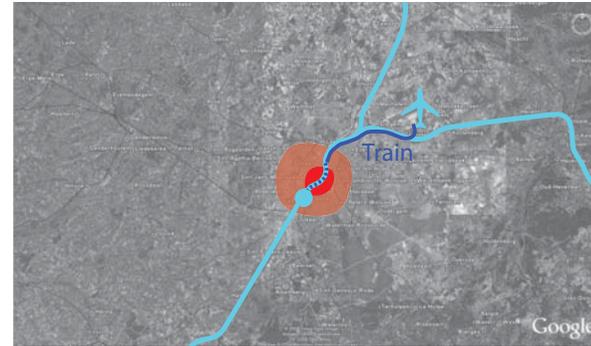
Brussels

Interesting about the Brussels case is the fact that it is a node in the HST network, and that there were several options as to which station to use as the HST stop.

The fact that it is a node in the network makes it an important station, and a wanted location.

This centrality combined with its proximity to for instance Amsterdam and Paris has a negative impact on the Brussels airport Zaventem. Not only does it not have much opportunity to expand its activities due to its proximity to the built environment. The fact that it does not have a HST station means that it is losing passengers to bigger airports nearby which offer more flights to more locations and with their HST connection also offer a quick connection to the centre of Brussels.

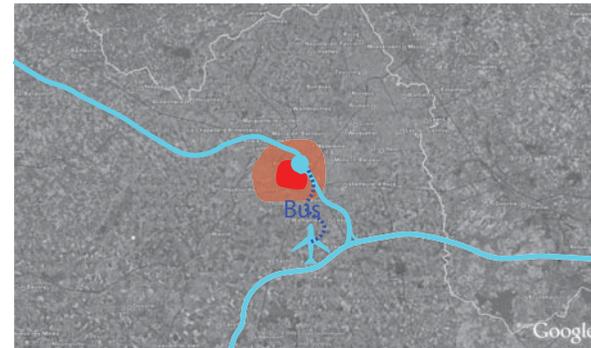
There were several options for the HST stop. The possibility to develop the area around the station to balance the costs of the HST was the main argument to not use the central station in the inner city. The decision to use the northern or southern station was influenced by the presence of public transport to the South/Midi station and the possibility to at the same time offer improvements to the impoverished areas around the station (Albrechts and Coppens, 2003).

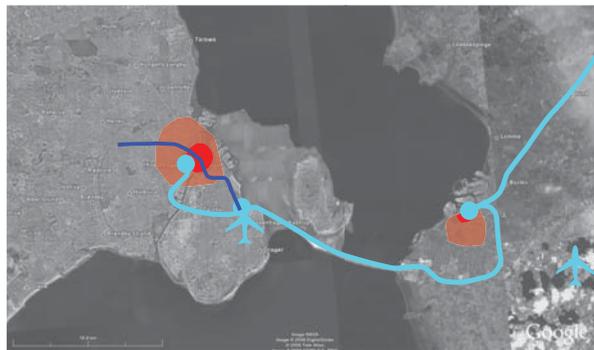
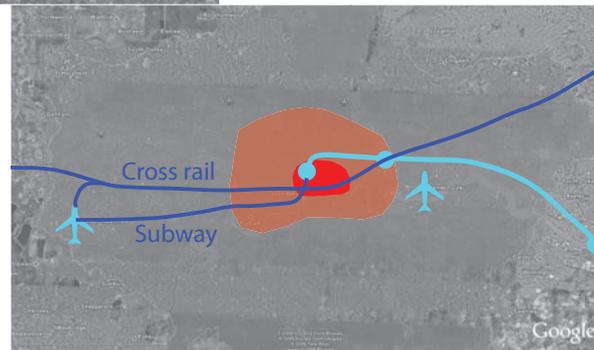


Lille

The most important observation that can be made about the Lille case is on the subject of centrality. It has the image that it has a single place that connects the lines to Brussels, Paris and London. It is true that from Lille all these destinations can be reached by high-speed train, but there is no single node which connects all the lines. For instance the line between Paris and Brussels does not go to a station in Lille but bypasses the city a few kilometres away. This means only the lines going to London from Brussels or Paris actually stop in Lille. Zooming in this idea of centrality is further put to the test as there are two stations in use. This was cheaper than a new station that facilitates all trains. The old Flanders Station is being used by regional trains and the TGV from Lille to Paris, 800 meters further down the road the new Europe station facilitates the international trains. At the moment transfer between the stations has to be done by foot through the Euralille development area. The Europe station is also the place where the bus shuttle leaves for the Lille airport taking 20 minutes.

It was the idea that the international trains stopping in Lille would attract a lot of companies to the Euralille area, this has not happened to the degree that was envisioned, but it has attracted a lot of residents profiting from the fast connection to several capitals and the relatively low house prices.





London

The London HST situation has two conspicuous characteristics: It is a terminus station, and there is no direct link with the most important airport of the region, Heathrow. That it has a terminus station instead of a through station has consequences for the extending of the network into the rest of the UK, but what is more problematic is that it is one of many terminus stations of the city. From the station of St. Pancras/King's Cross only the north-east of the UK is served (the east-coast main line to amongst others Luton airport, Sheffield, York, Newcastle and Edinburgh). For all the other directions one has to transfer (usually by metro) to one of the other 8 terminus stations. This means that the infrastructure organisation of London forms a barrier between Europe and the rest of the UK.

St. Pancras station is on the edge of the inner city and well connected to the whole city through the extensive metro system of the metropolis. The connection to Heathrow is made through the Piccadilly line and takes about 45 minutes. A second connection to the centre and the airport will be made from Stratford station when the new Cross Rail comes into service in 2017 (Crossrail, 2006).

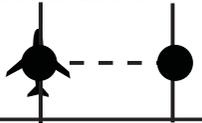
That there is no direct connection of the HST with the airport (yet) is viewed as a missed opportunity by Givoni and Banister (2006) as this has potential for growth of both the airport and the HST as a consequence. Collaboration can enhance the accessibility of the city and the airport from the rest of the country and Europe, but the government does not share that opinion yet, even though it supports the view that rail transport is "the way to go".

Copenhagen

Since the opening of the Øresund connection to Sweden a high-speed train travels to Copenhagen from Stockholm. This train stops at Malmö, the last stop in Sweden, the Copenhagen airport of Kastrup and the Copenhagen Central Station, a terminus station at the edge of the city centre.

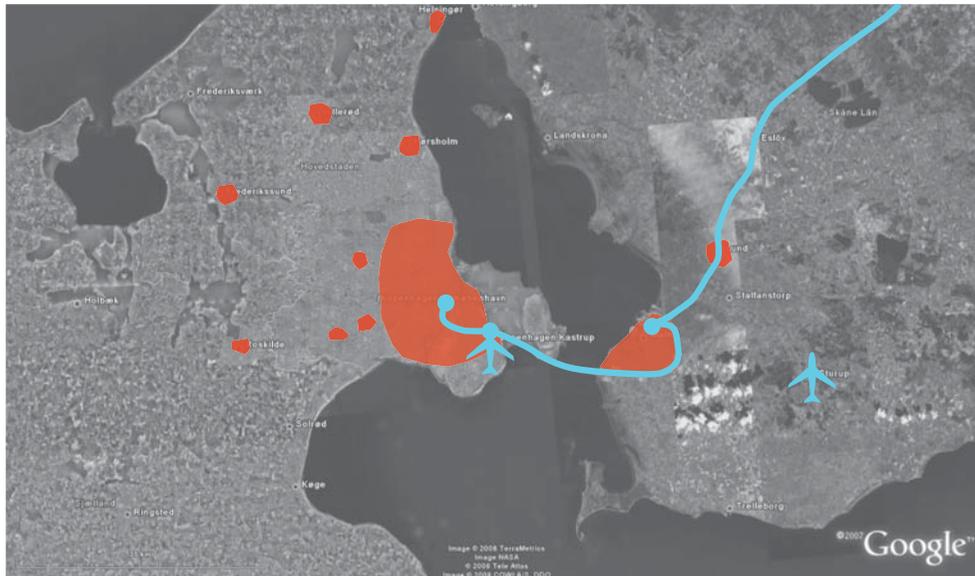
Kastrup airport is the biggest airport in Scandinavia and will be shortly be connected to the city centre by the new metro system taking 15 minutes.

As discussed before there is a train connection to the rest of Europe (through Hamburg) from Copenhagen, It is run by the ICE with high speed train but the tracks do not allow high speed travel, across the Fehmarn Strait the train is even loaded onto a ferry. There are plans for a permanent connection but that is still a long way away.

| | London | Amsterdam | Brussels | Lille | Lyon | Copenhagen |
|---|---|--|---|---|--|---|
| population | 7.500.000 | 750.000 | 1.000.000 | 200.000 | 450.000 | 500.000 |
| GDP in billion US\$ (2005) ¹ | 452 | 42 | 39 | 27 | 56 | 41 |
| Type of City | ISC | ISC | ISC | CiT | CiT | ISC |
| Type of HST Station | Terminus  | Terminus  | Junction  | Junction  | Line  | Terminus  |
| HST relation with centre | Direct  | Indirect  | Direct  | Direct  | Semi-direct  | Direct  |
| HST relation with the airport | Indirect  | Direct  | Indirect  | Indirect  | Semi-direct  | Direct  |
| The intervention | Station adjustment | Station adjustment | Station adjustment | New station | Station adjustment | Station adjustment |
| | Tunnel | Station area redevelopment | Station area redevelopment | Station area redevelopment | New station | |
| | New train route | Existing train route | Existing train route | New train route | New train route | Existing train route |

¹(http://en.wikipedia.org/wiki/List_of_cities_by_GDP)

2.2 The Randstad and Øresund



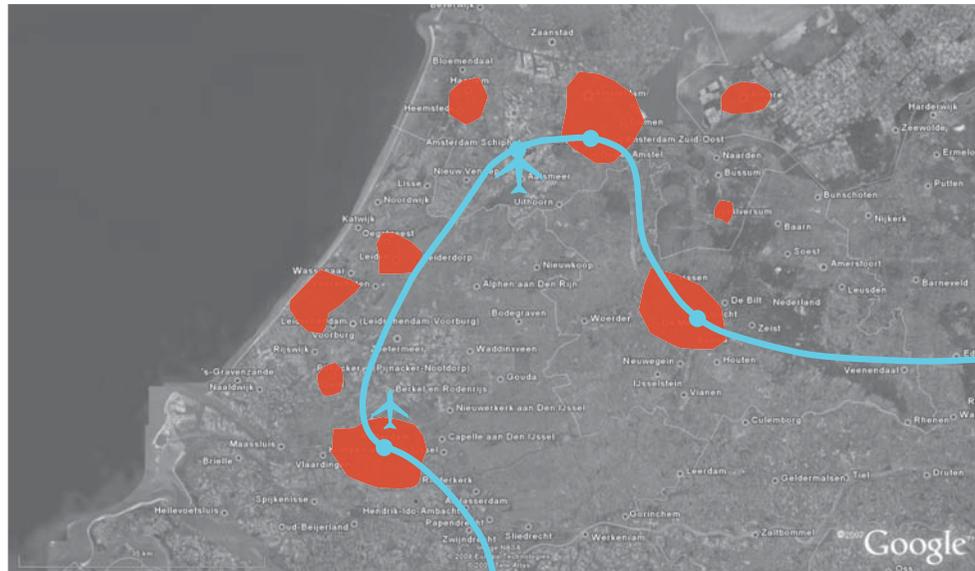
When the Øresund bridge and tunnel combination was finished in 2000, for the first time there is a permanent connection between the island of Zealand in Denmark and the Region of Scania in Sweden. In other words there is a stronger connection between the cities of Copenhagen and Malmö that previously were only linked by ferry. This new connection has not only led to more traffic movements but also to collaboration between the institutions on both sides of the Øresund, for instance the universities and the ports. Cooperation has led to up-scaling of the metropolitan area which strengthens both cities in their competitive position.

The phenomenon of cities gaining importance when viewed together with neighbouring cities can also be seen in other places, one of the most well known examples is the Randstad, where the inhabitants and economic activity of the different cities combined produce big enough numbers to matter on the international level. Of course some cities are more important than others. Amsterdam is already important on the international level on its own. The Rotterdam port is also an important player on the global level, but it is hardly related to the city nowadays.

When comparing the Øresund combination with the Randstad a few observations can be made:

Both have a leading city which is becoming more and more important as the mobility grows. The secondary airport (Rotterdam and Malmö) is turning into the low budget- charter airport for which there is no room at the main airport.

But there are important differences as well. Although the Randstad has its organisational difficulties with the many actors involved and the scarcity of land, the Øresund region has to deal with two currencies and two sets of laws. The spatial organisation of the two regions is also very different, not only is the proximity of the important centres in the Øresund region greater, the activities are also more focused on one point, (Copenhagen) than in the Randstad where they are more evenly distributed over the different cities.



2.3 The urban development

The developments in Amsterdam

The urban developments at the Zuid-as of Amsterdam were initiated because of the lack of space in the old city centre for the growing need for offices and the problematic accessibility of the area. As a consequence the route of the HST will follow shift of focus from the old centre to the new business district. The integral development of the area with the station offers possibilities to realize a station optimized to cater to the HST. This together with the bypassing of the city centre will save travel time and increase the comfort level for the many business travellers. Good connections to the inner city and the central station is a requirement for the businesses located there and the tourists who also use the train. Without this connection the critical mass of users needed for a positive exploitation of the line could be under threat.

Plans are for the new station to be underground, below a new high rise neighbourhood with a mix of functions. The enormous scale of the project and the constructions needed, covering a highway and railway lines and building a new centre on top, is its biggest threat. The number of actors, the huge costs and risks make the plan almost impossible.



The developments in Lyon

The developments around the Lyon airport station are much smaller than in the other cases. One of the reasons for this is the modest size of the airport and the amount of activities located there. There are few offices at the moment and besides flying no other activities. Because the airport and the HST are relatively young this might change but at the moment it cannot be called urban development.

The other HST station in the city centre, Lyon Part-Dieu, was built as part of a new neighbourhood that was to become the second centre of the city. It was developed in combination with a shopping mall and a government complex and is now the busiest station of the region and a major hub in France.



The developments in Brussels

The location in Brussels was chosen for the development potential, the local public transport connections and the boost it could give the surroundings. That the result is not as good as planned has several reasons. Development by private parties led to development for short term results (Albrechts and Coppens, 2003). This led to an office zone without much urban quality. The developments pushed out the preexisting residents and activities, in effect destroying instead of helping the existing community. The station itself also lacks quality making it an unattractive place to be. In the Brussels case the space of flows wiped out and replaced the space of place (Albrechts and Coppens, 2003).



The developments in Lille

In the vision for Lille it could become the centre of the world, a place where businesses would want to locate because of its central location between London, Paris and Brussels. The implications for Lille would be huge. In reality the businesses had to be lured; who came willingly instead were new residents attracted by the lower house prices. The TGV meant they could live in Lille and work in any of the three cities. For Lille the competition of the three cities caused by the HST was too big and businesses even left Lille for them as a consequence. The advent of the HST was not a bad development for Lille, but the new competition meant it had to rethink its position and strategy.



2.4 Conclusions

The developments in London

The relocation of the HST station in London is not a free-standing intervention. The route was very much influenced by politicians who saw the opportunity of supporting the redevelopment of the eastern parts of the city. This redevelopment not only encompasses the docklands but also the more general goals of a more balanced economic distribution between the 'rich' west and the 'poor' east. The Crossrail connection, due to open in 2017, is part of this strategy of redistribution and a shift of focus. The same goes for the idea to locate the 2012 Olympics in this part of town. The HST will have a stop here and should become an important feeder for the event.

Large scale urban development around the terminus station of St. Pancras is planned in an area behind the station. A triangle enclosed by railways filled with some industrial activity will be transformed to a complete new neighbourhood. The 19th century station itself is under renovation and houses shops, restaurants and take-aways, a hotel and a fresh food market. The idea is that the station will function like a local high street for the Kings Cross neighbourhood and give the area a boost.



The cases, for all their differences, have shown not only the wide array of possibilities of how to deal with the HST in a city, but that there are certain similarities too. First of all **three types of station locations can be distinguished: the inner city, the airport and a new development area**. All of the locations have all or a combination of the following characteristics. These can be seen as guidelines for the HST development.

The **balance between direct access to the centre of activity and the fastest route** has to be right. In some cases this means bypassing the city (centre) in favour of a more peripheral location. But it can also mean one region has to have multiple routes and (alternating) stations.

Second is the connection of the HST to the regional network. This encompasses both the transfer to the **centre of activity** if the train does not go there directly, and to the suburbs and the other town in the area. **Good feeders** are a necessity not only to provide enough users for the train but also to make sure that travel time is kept to a minimum and the total journey is as comfortable as possible.

The third is the **possibility for (real estate) development** around the station has to be taken into account as this is one of the primary ways to recover some of the cost for the HST infrastructure.

The **positive effects on the urban surroundings** of the station stops can also be an argument in deciding on a station location. On the other hand the HST might be necessary to facilitate a location that is already developing.

On the international level the HST **does not have to be a rival for air travel**. A cooperation can enhance the accessibility of the city and the capacity of the airport when the more local flights are substituted by train journeys because valuable runway slots are freed up for longer flights.

From the urban development a few conclusions can be drawn as well. The bigger and more complicated the intervention becomes, the less likely it is to happen. There has to be enough critical mass of activities already present for the HST to be a catalyst. The long term and existing qualities have to be kept in mind for the urban development to be successful for everyone, the station can even play a role in the daily lives of people who do not use the train. The effect of new competition has to be taken into account.

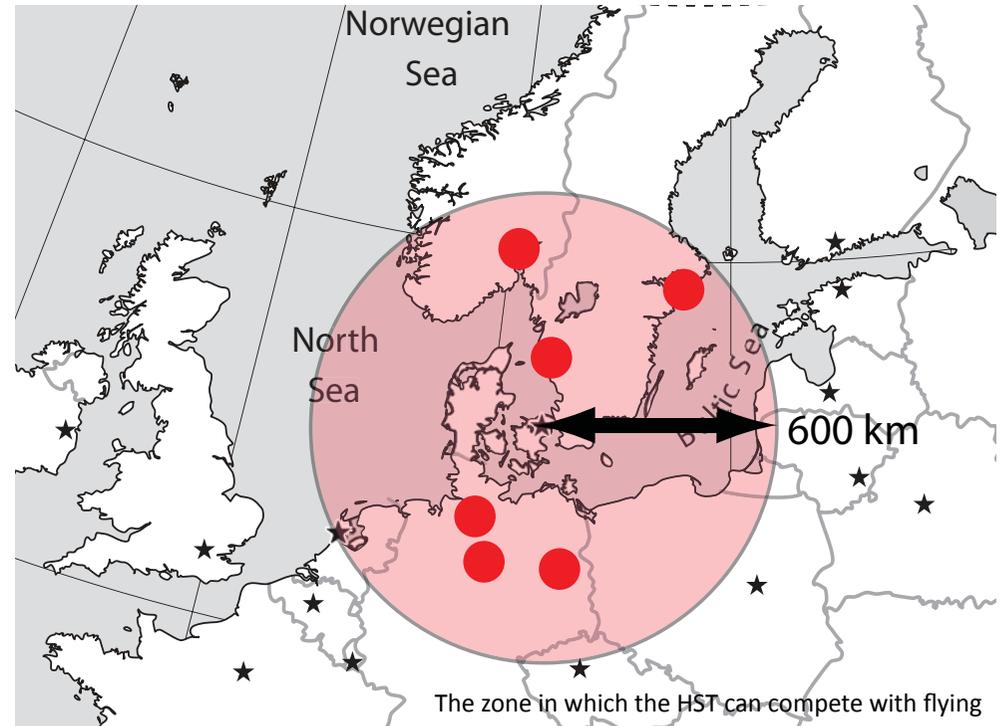
3 The scale of northern Europe

3.1 The network of cities

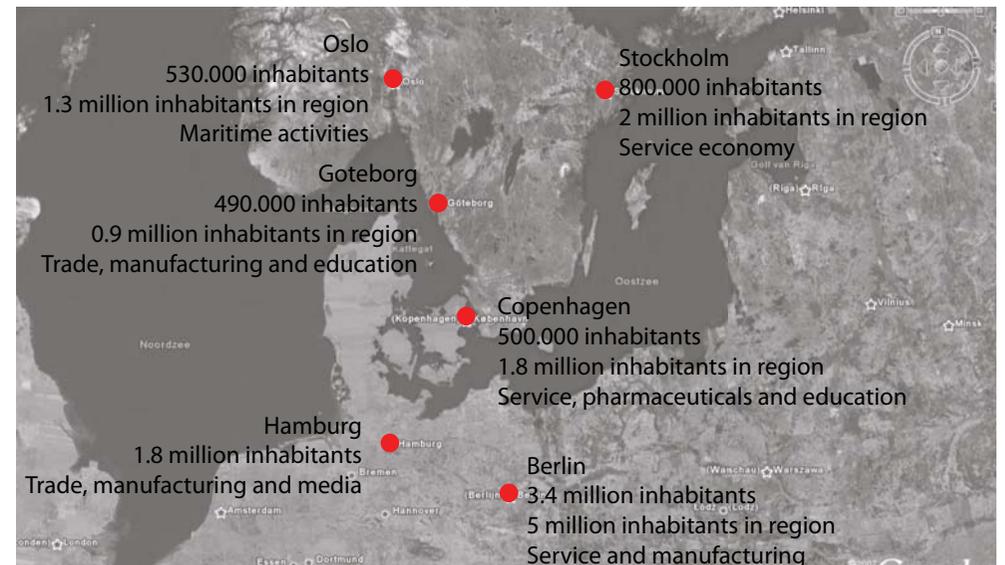
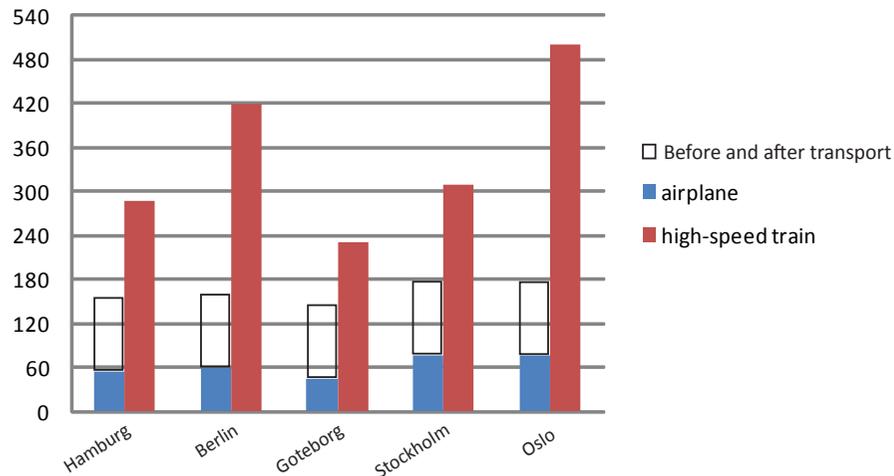
With the completion of the Øresund and the Great and Small Belt bridges for the first time travel to and from Copenhagen does not have to involve ferries. As a consequence traffic flows increased drastically, not only between the island of Zealand and the major cities on Jutland, Arhus and Alborg, but also between Germany, Denmark and Scandinavia.

The distances between the big cities around Copenhagen are so great that at the moment they only compete with each other for some marine activities and some activities which are not place bound. To assess the influence of the HST on this competition is, it is necessary to see to which cities the HST will reduce the travel time between them the most. For this the train has to be faster than flying. The rule of thumb according to Givoni and Banister (2006) is that up to 600 km if the train route is less than 20% longer than the air route, the train can be competitive. This means that the train can influence the relations between Copenhagen and Oslo, Stockholm, Goteborg, Berlin, Bremen and Hamburg. At this moment train travel is not competitive with flying between these cities by a long way. The differences between the cities and the current amount of air travel also imply that there is demand for more travel and therefore a HST.

The effects of the HST on cities depend on the time gain and the future travel times. The growing mobility increases the reach of a city and when the reaches start to overlap competition between these cities grows.



Traveltimes from Copenhagen in minutes



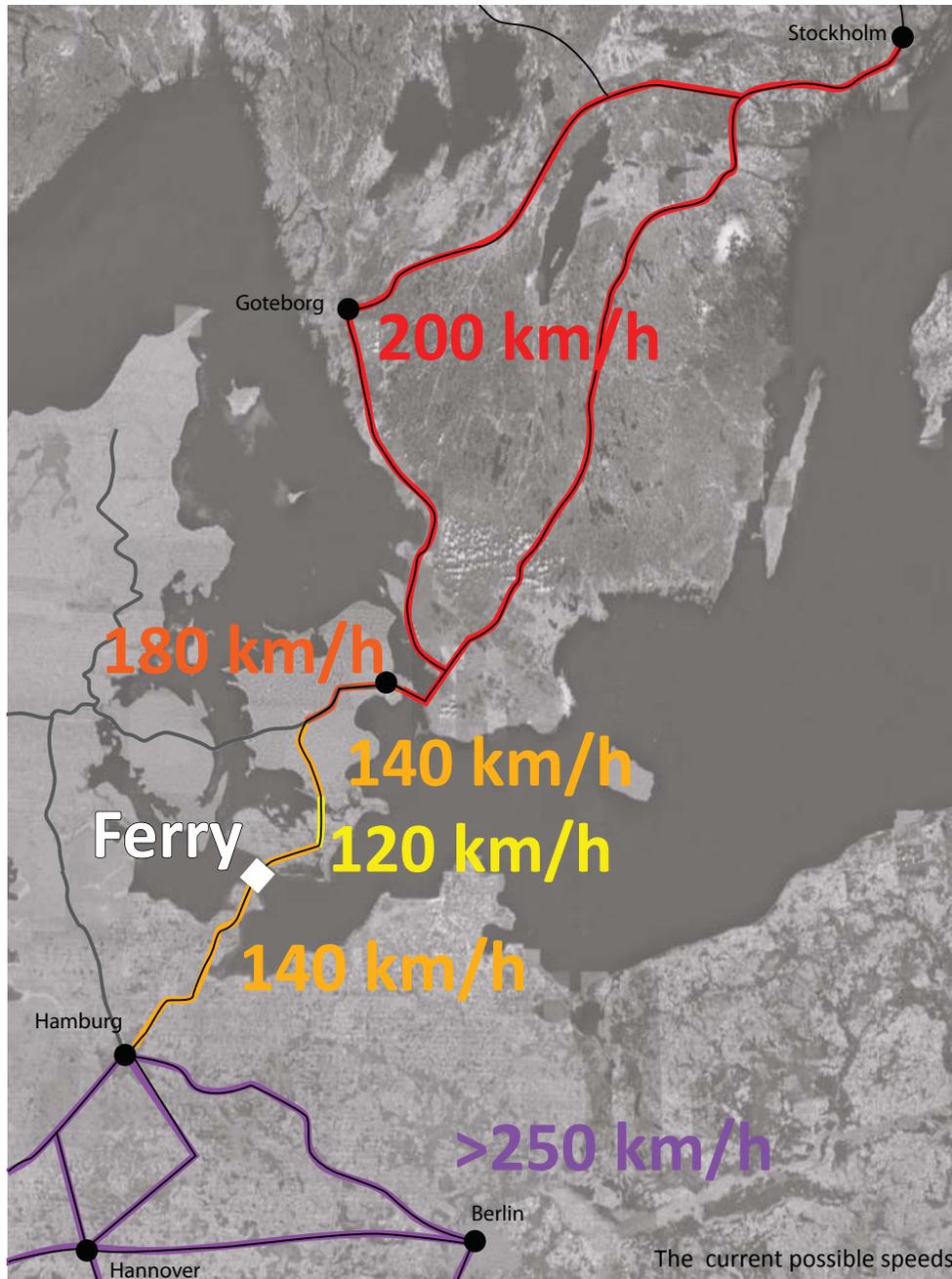
3.2 The HST network

3.2.1 The current network

The current rail network north of Hamburg is not suited for real high speed travel. The average speed possible on Danish tracks is low and reduced even further by the need for a ferry on the 18 km sea crossing between Germany and Denmark. The Swedish tracks allow higher speeds mainly because they are already used by tilting trains. These trains can tilt so they can take a curved track at higher velocities.

In all three countries and Norway new tracks are needed to reach the speeds of 250-300 km/h to compete with air travel. For the X2000 network in Sweden plans for an upgrade to 300km/h on certain routes. The Danish government does not have plans to upgrade their route at the moment. (Silvan, 2008)

Both networks meet in Copenhagen central station, but different signalling and safety systems prevent them from travelling further than Copenhagen. The two network are also not really attuned to one another. As a consequence there are long transfer times in Copenhagen.



The principle of the tilting train

3.2.2 Improving the network

To make the train network north of Hamburg suitable for high-speed all the lines need new tracks. This means over 2000 km of new tracks are needed. As these tracks for safety reasons cannot be shared with normal trains they will have to be laid alongside the old routes. Safety also requires split-level crossings and make the new tracks even more costly and the assignment more complicated. For an even bigger travel time reduction new, shorter routes have to be found, but this complicated the task even further.

Phasing is possible and makes the project and the costs more manageable. The first stage could be the connection from Hamburg to Copenhagen. As an extension a 50 km bypass of Hamburg would create a fast link to Berlin with a relatively small intervention (there are already plans for this). The connection from Copenhagen to Goteborg would be the second stage, soon to be followed or developed at the same time as the lines from Goteborg to Oslo and Stockholm. This would create the basic network in Scandinavia and connect it to the European network. It is important when developing these new lines that European standards/systems are used so they are compatible with the existing network. In future this could theoretically mean that you could take the train from Stockholm to Marseilles without changing trains.

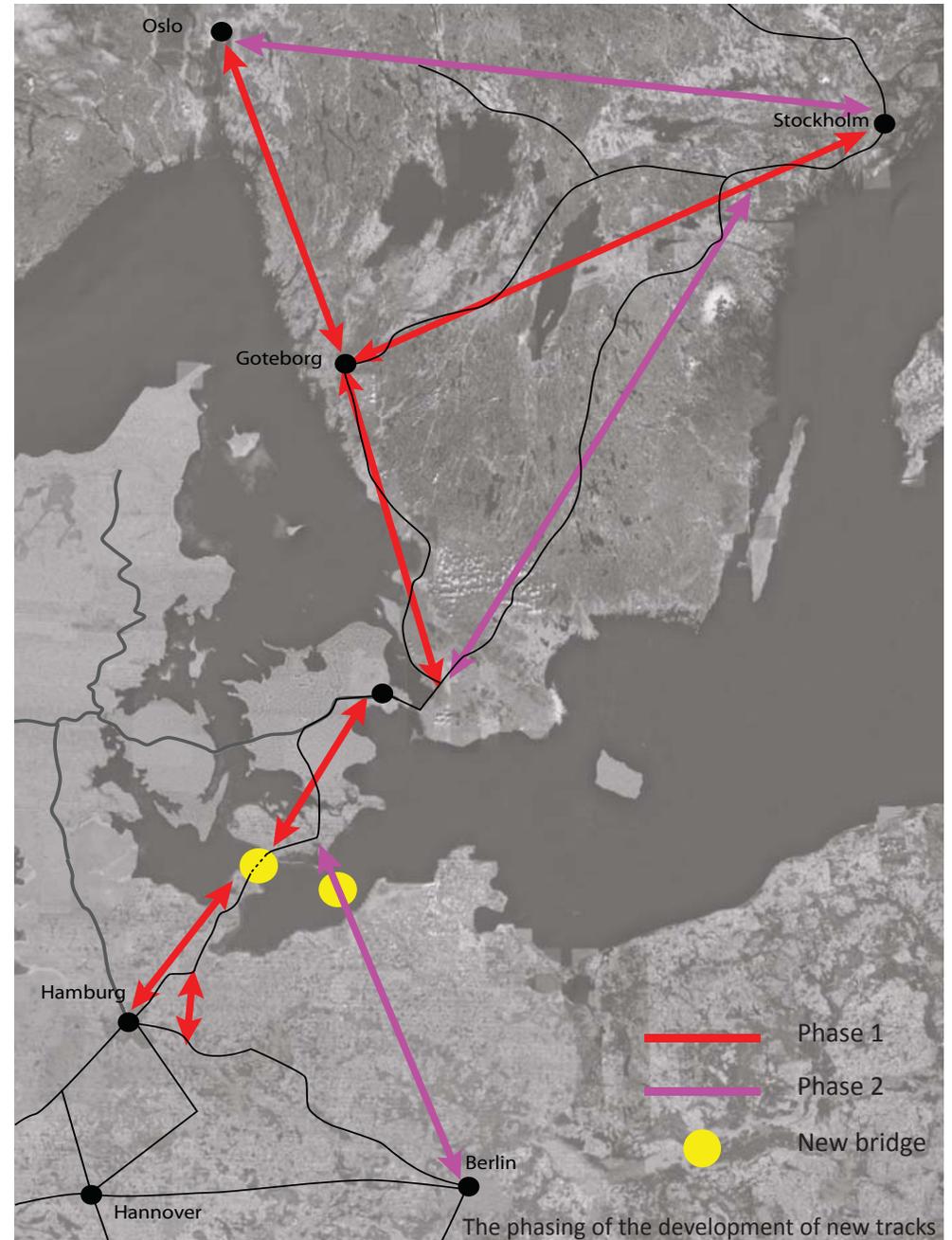
The third phase consists of lines which would reduce the travel times even further but are not necessary. It is questionable whether the costs would outweigh the time gain. Especially the new route to Berlin which would need another new bridge, this time between Gedser and Rostock. There are ideas for this line and bridges but only as an alternative to the planned Fehmarn Belt crossing.



New tracks



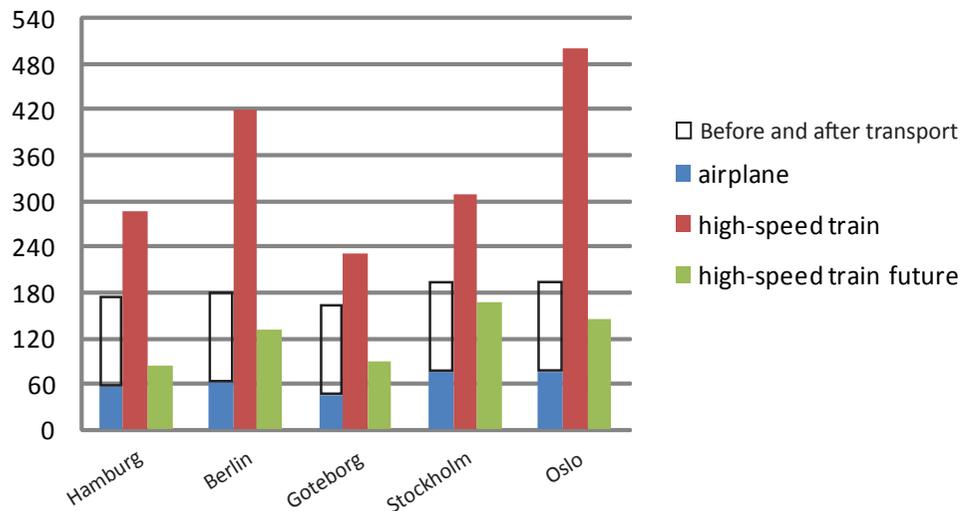
The new Fehmarn bridge?



3.3 The effects of the intervention



Traveltimes from Copenhagen in minutes after phase 1



If the HST interventions are realised the journey to the for Copenhagen relevant cities will take less or about the same time as flying. The travel times combined with the high comfort level (directness and few security hassles) strengthen the competitive position of the HST related to flying. If the effect on the environment is brought into the equation by subsidies and/or taxes the modal split could go even further in favour of the HST.

This is not necessarily bad for the aviation industry. Less local flights means more capacity for longer, more profitable flights. If an airline becomes a shareholder in the HST they can combine services and grow through both modalities.

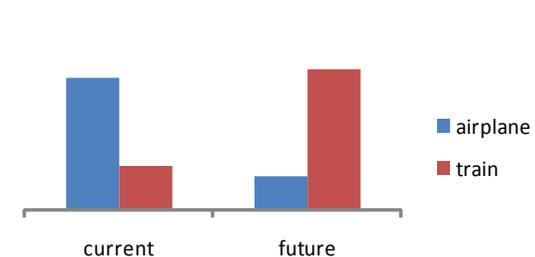
The integration of the lines in Scandinavia with the lines in Germany and Denmark can make Copenhagen a station on a line and a node in the network instead of an endpoint. This is beneficial for the quality of the network as it enhances the service level of the network.

The size of the effects on the city depends on a number of things. If only the high-speed connection between Hamburg and Copenhagen is implemented it leaves Copenhagen at the edge of the network. This means the effects of the HST will be much smaller than when it becomes a node and the gateway to Scandinavia.

The reduced travel times means cities get a bigger reach. This can mean that the reaches of cities can come to overlap which increases the competition between these cities. Hamburg and Goteborg could become competitors of Copenhagen for the location of some activities. This implies that Copenhagen as well as the other relevant cities need to create their own unique set of qualities to differentiate themselves from each other and create their own niche.

Its geographic location and its place in the future HST network, together with the qualities of the city can give Copenhagen this niche. The network position combined with the image the HST gives a city and the urban developments that can come with it the HST can help Copenhagen equip itself for the future.

Modality split to relevant cities



4 The scale of the Øresund region

4.1 The relationship with Malmö

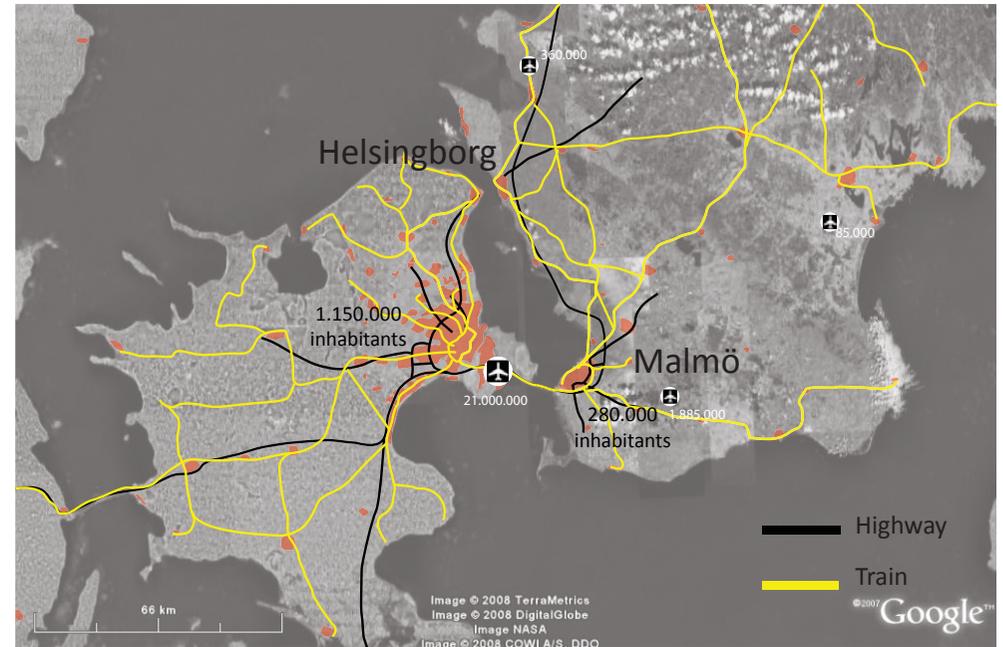
The region known as Øresund has functioned as a region at different intensities for centuries depending on whether both sides of the water belonged to the same country or not. The opening of the Øresund bridge and tunnel combination in 2001 helped with the bringing together of the two sides of the region even though they are in different countries.

This permanent connection has strengthened the interaction between Copenhagen and Malmö because now the easiest route from Denmark to Sweden is over the new connection instead of the short ferry crossing further north at Helsingborg. The expensive tolls charged for the new connection and the shorter route north have made sure that there is still demand for the ferries.

The growing interaction in the region can be seen in the merger of the port companies of Copenhagen and Malmö and the cooperation of the 12 universities in the region. In a way the cities of Malmö and Copenhagen complement each other. Lower housing prices in Sweden and tax benefits combined with the jobs in Copenhagen results in a growing number of commuters. The amenities the bigger city of Copenhagen can provide draw people from Sweden, while on the other hand a trip to Malmö is seen as a nice weekend outing for the Danish.

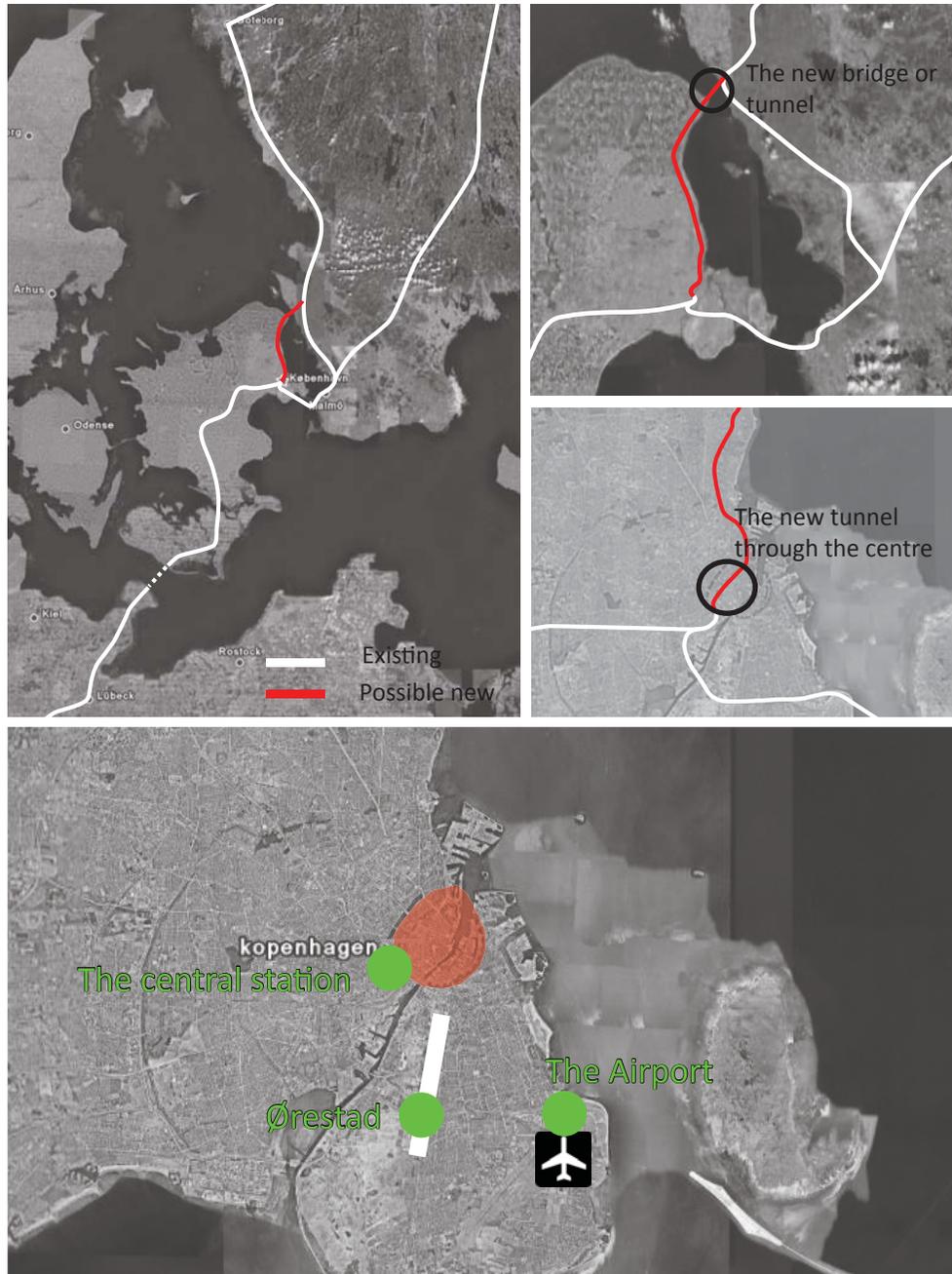
The scale differences between the cities means that Copenhagen is the gravity point of the region, the new connection only strengthens this position. This implies that Malmö can gain the most of the development of the Øresund identity. The new connection leads to up scaling of the catchment area for both cities individually, but the scale benefits also work on the higher scale. The Øresund region can have a better competitive position than the individual cities.

However, the fact that the cities have different nationalities and the stretch of water dividing them means that they will always be two separate cities. Malmö will not easily go along with developments that clearly put it in an inferior position to Copenhagen.



| Benefits of the connection | | |
|--|--------------------------------------|--|
| Copenhagen | Malmö | Both |
| Living in Malmö: House prices and tax benefits | Urban facilities of Copenhagen | External: scale benefits: image and competitive position |
| | The hub of the international airport | Internal: scale benefits: market size and catchment area |
| | Working in Copenhagen | |

4.2 The route through the region



That the X2000 in Sweden travels to Malmö is logical, as is the extension to Copenhagen and the stop at the airport when the Øresund connection opened. But seen in a bigger context it is not the shortest route and three stops in less than 40 kilometres seems a bit much for the size of the area.

The shorter route would cross from Sweden into Denmark at Helsingborg and bypass Malmö completely. The stop at the airport would also be cancelled. The new route would need big interventions. A new 5 kilometre bridge or tunnel at Helsingborg, new tracks between Helsingborg and Copenhagen and a new 2 kilometre tunnel underneath the historic centre of Copenhagen.

The travel distance between Göteborg and Copenhagen would be reduced by 50 kilometres which translated means the journey will take around 12 minutes less. The size, costs and risks of the intervention do not seem to weigh up to the 12 minutes, so using the existing routes and bridge is the most logical way to go.

4.3 Three possible station locations

The choice for sticking with the existing route means Malmö and the airport are still on the HST route as well as the central station of Copenhagen. The question is whether the HST should stop at all these stations for the direct connections and accessibility. The time loss is too big and the size of the area, however, only justify one stop at a main station. In this case of one main station the question is where it should be.

Because Copenhagen is the biggest city of the region and has a higher concentration of activities that can provide users of the HST (international headquarters, national government, tourist attractions etc.) the main station should be in Copenhagen.

Three types of possible station locations were derived from the case studies: the airport, the new development area and the inner city. In Copenhagen these three locations all have a station and are all already on the HST route. A study has to show which one is the most suitable to become the main station of the HST for the Øresund region.

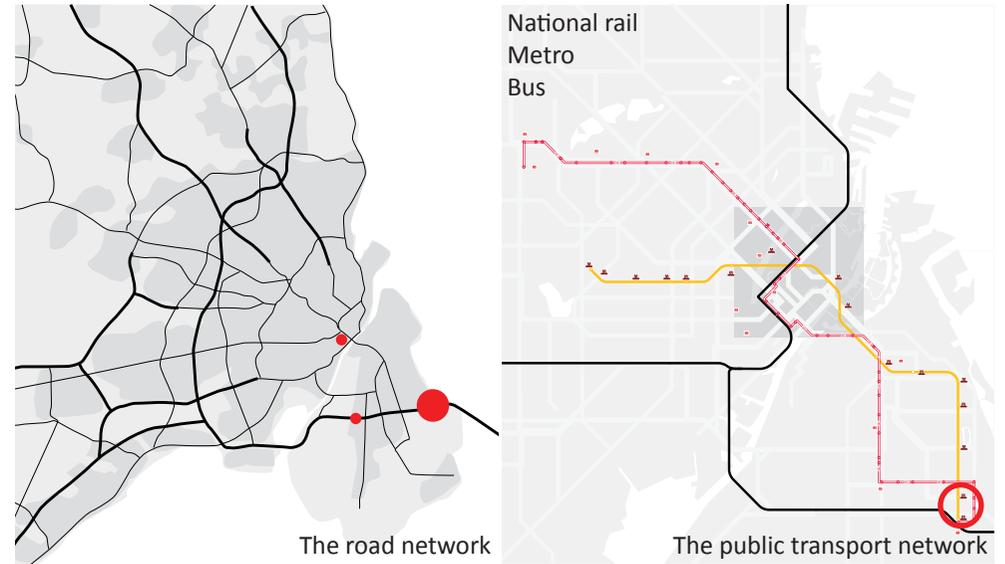
The topics of this study have also been deduced from the case studies: The optimal route for the HST, the accessibility by feeders and the vicinity to the centre of activity, and the potential for (real estate) development. As all the stations are on the HST route the first criteria will not be studied further.

4.3.1 The airport (Kastrup)

The airport is located south of the city at the edge of a suburb and at the side of the highway connection to the bridge over the Øresund. Therefore it is very well accessible by car from the Danish highway network and from Sweden and there is enough parking space. Accessibility by public transport also benefited from the opening of the Øresund connection. It is a stop on the Danish national railway network and on the lines from Sweden to Copenhagen. With the recent opening (2007) of the second metro line in the city accessibility from the city centre has been greatly improved. However, the station only has two platforms and is not a node in the network. For many destinations in Denmark a transfer is needed at Copenhagen central station. The underground location of the station and the limited space between the airport and the highway make it difficult to extend the stations capacity.

At the moment there is not much activity around the station, from the entrance of the airport you can see the suburb at the other side of the highway.

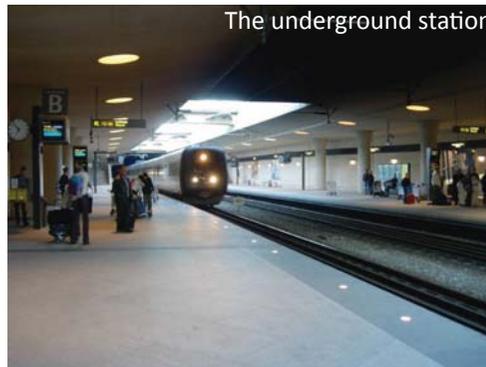
The lack of space also limits the spatial development potential of the area. The outer suburbs are maybe not the most desirable location to establish activities and on the airport side there is little room for development near the station/ airport terminal.

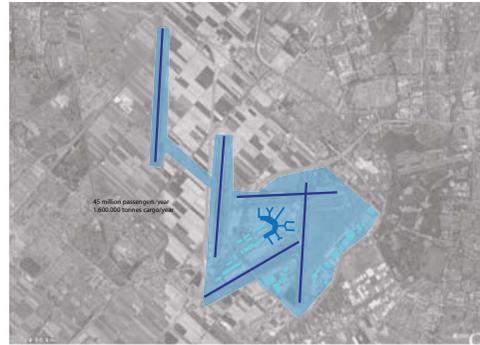


The view at the front of the airport



The underground station





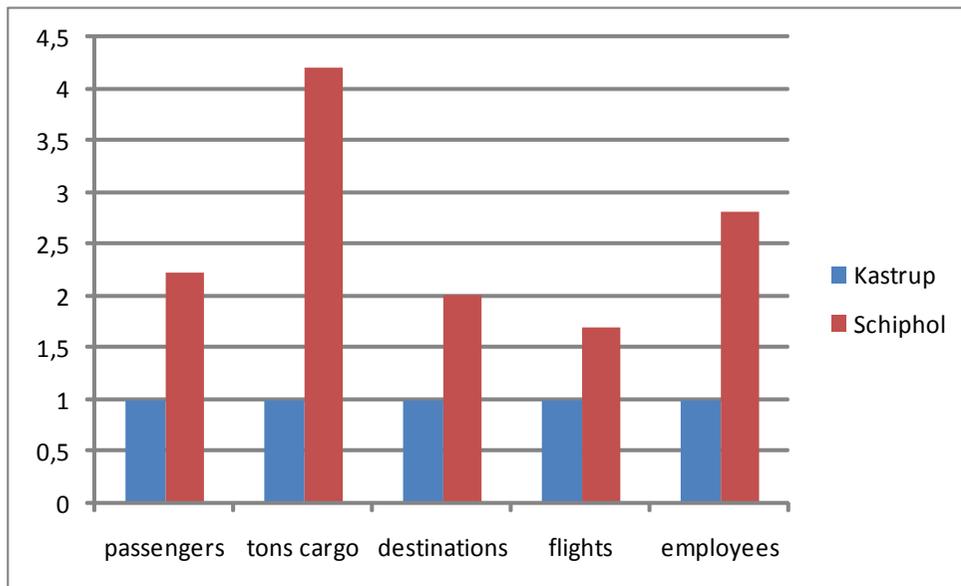
Kastrup compared to Schiphol

To get a grip on the size of the airport and the related economic potential for development the airport has been compared to Schiphol, an airport which has many economic activities. In this comparison it can be seen that Schiphol is bigger in area and the number of runways, but more importantly it is bigger in the none spatial numbers. Schiphol is twice the size in almost every aspect which means that it is much more attractive as a location for establishing activities than Kastrup. It is even the question if Kastrup has enough critical mass of activities at the moment to trigger further development even if it becomes the main HST station.

| | Kastrup | Schiphol |
|-----------------|------------|------------|
| Passengers/year | 21.000.000 | 47.000.000 |
| Tons cargo/year | 380.000 | 1.600.000 |
| Destinations | 132 | 267 |
| Flights/year | 256.000 | 436.000 |
| Employees | 22.000 | 62.000 |

Conclusions

The accessibility of the airport is good although in public transport a transfer is nearly always needed to reach most of the city and other destinations in the country. The development potential is quite poor because of the lack of space and the lack of existing activities in the area. This make is not ideal for the main HST station but a secondary stop at the airport could strengthen the gateway function of the city and lead to more passengers for both the HST and the airport, just as Schiphol.

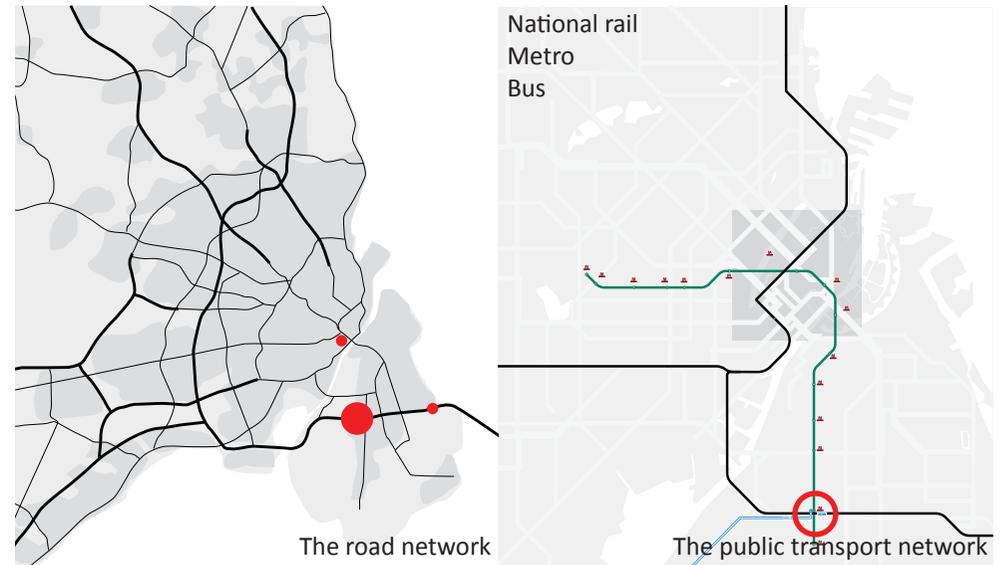


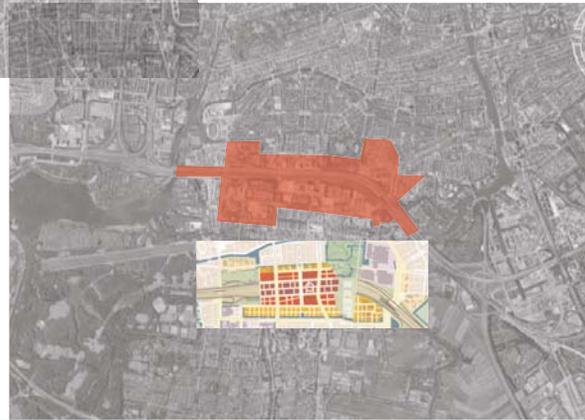
4.3.2 The Ørestad expansion

The Ørestad expansion is a large scale urban development to the south of the city. This new city district developed on an old military site will house 20.000 people, facilitate education for the same number (innovative high school and parts of the university) and should have 60.000 jobs. It is also the location of a big exposition and conference centre and the biggest shopping mall in Scandinavia. The linear expansion zone has M1 metro line as a backbone, and is bound by the existing suburb to the east and a nature reserve to the west. This new zone is on the one hand a new type of suburb, but in the other hand has some activities which are attractions on a high scale.

Located 5 kilometres away from the airport along the same highway and rail line the accessibility is the same apart from the air transport of course. Again with public transport for most of the city and other destinations in Denmark transfer at another station is necessary. The station consists of two open air platforms without amenities directly related to the station.

At the moment the area around the station is very open, there is are only a few offices and only one (international) headquarter. But if and when all the plans for big residential buildings and some offices are realized there will be little room left for development of a HST-worthy station and activities that go with it.





Ørestad: Compared to the Zuidas

To see whether Ørestad has the potential to become a main HST station it is compared with the Zuid-as developments in Amsterdam. In surface area the Ørestad expansion is 1.5 times the size of the Zuid-as. In m2 of program the plans for Ørestad are less than the plans for the Zuid-as, which means that the density will be a lot lower. The percentage of dwellings is higher in Ørestad which also indicates a different type of development. The fact that spatially only the southern half of the Ørestad expansion is focused around the Ørestad station (the northern part where the university is, is more focussed on the inner city) accentuates the differences even more.

This raises the question if Ørestad has the character which matches that of the HST. Why should the HST stop in a more or less residential area?

Conclusions

The accessibility of Ørestad is good although in public transport a transfer is nearly always needed to reach most of the city and other destinations in the country. The lack of space and of critical mass make it a difficult breeding ground for development of HST related activities. A HST station might even be undesirable for this mostly residential area.

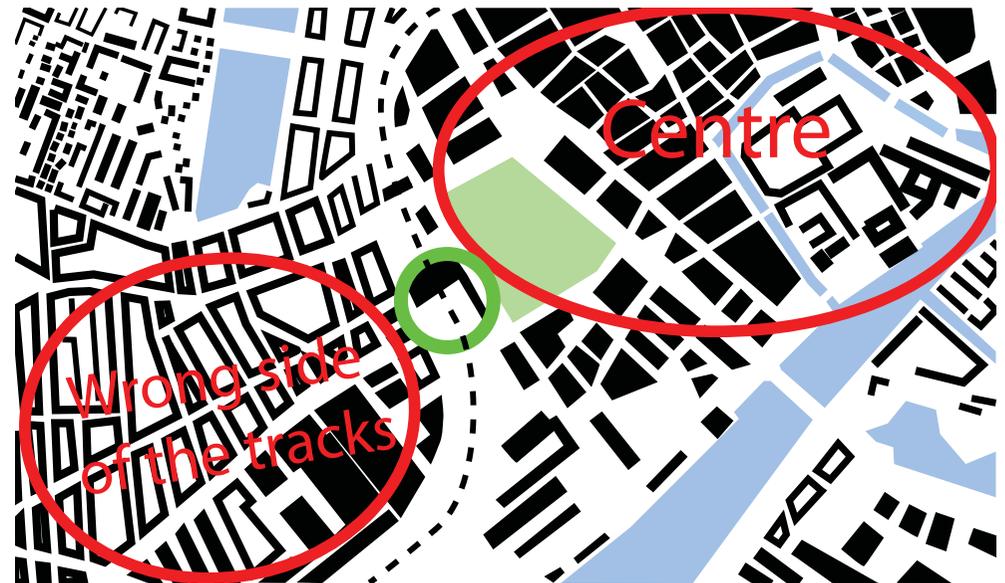
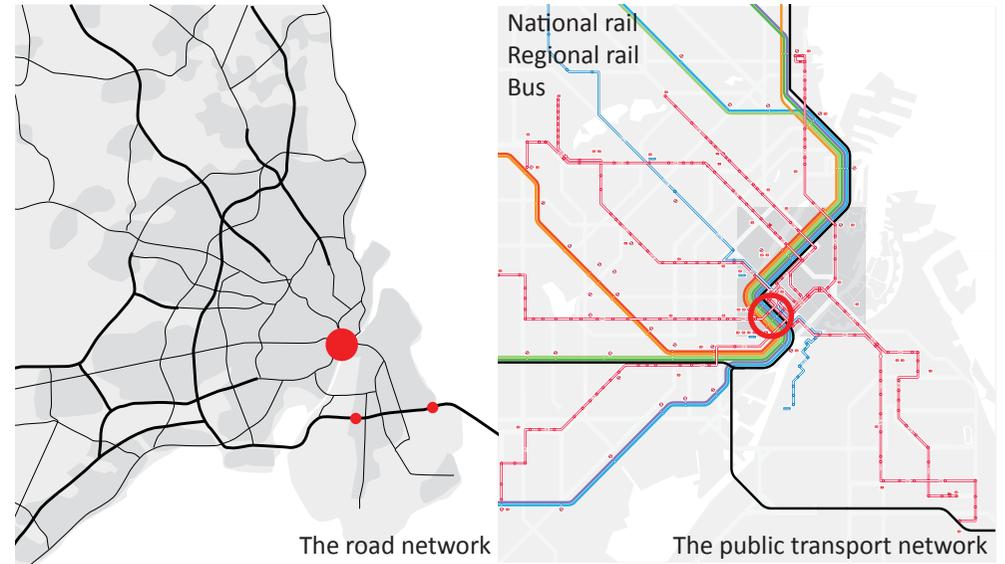
4.3.3 The central station

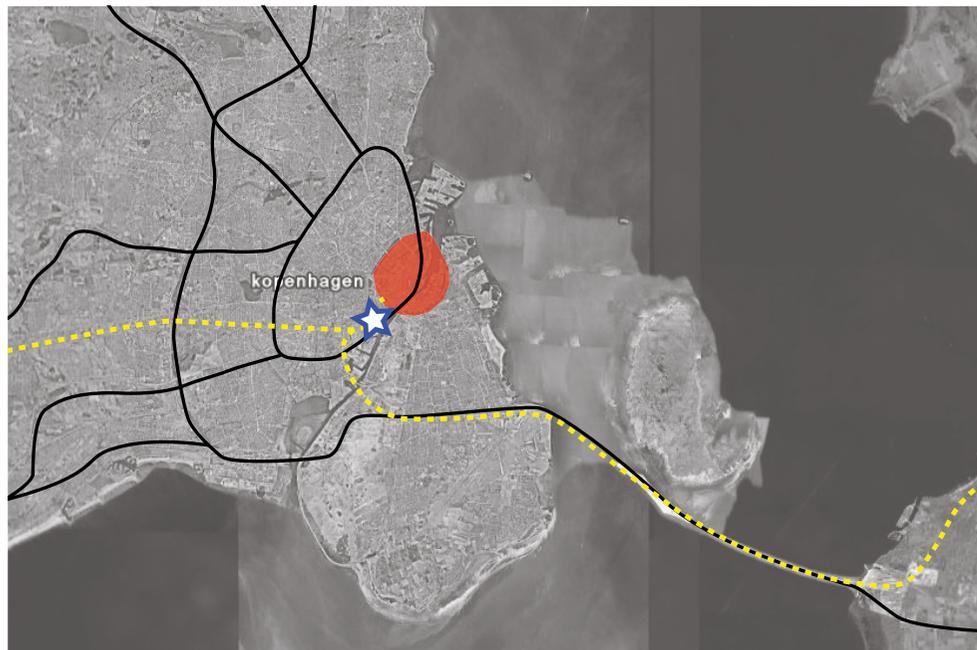
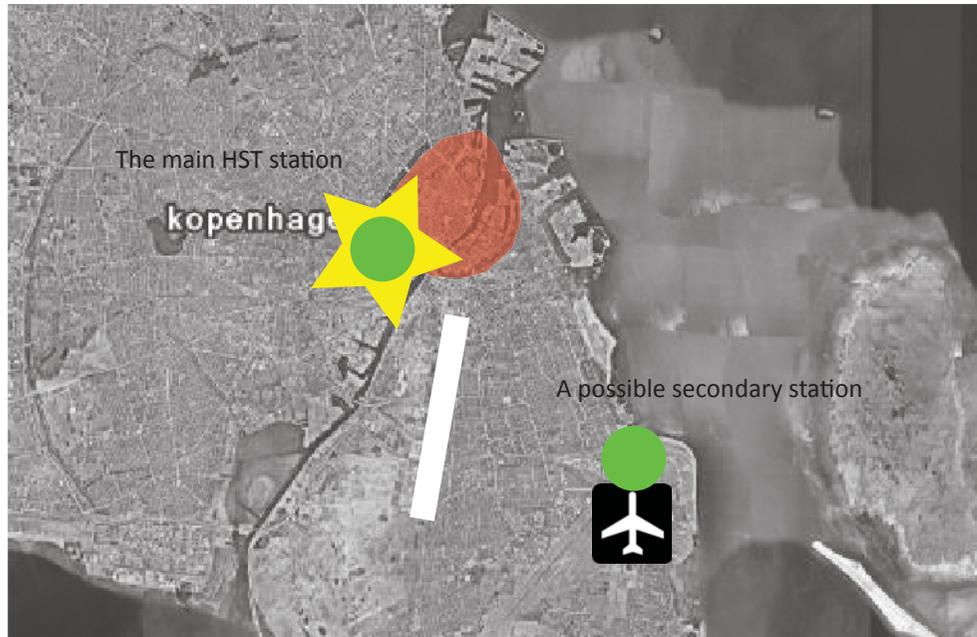
The central station is located at the edge of the inner city. This old station building lies just of the inner ring road at the waterfront which means it is reasonably well accessible by car. As with most inner city locations parking is a problem though. As the central station of the city it is very well accessible by public transport from both the metropolitan area and the rest of the country. A small disadvantage is that it is not a station on the two metro lines. The fact that it is a terminus station might also not be ideal for the HST.

Its inner city location means that is in a built up area, with the amusement park of Tivoli on the one side and a residential area on the other. The development potential in the direct surroundings is therefore small. There is development potential a little bit down the tracks: a railway shunting yard and an area with some industrial activities. Development will not be straightforward but is possible also because it is at walking distance of the centre of activity it has enough critical mass to attract more activities.

Conclusions

The accessibility (by public transport) and vicinity to the centre of activity make it a good HST location. Nearby space for development has to be found to be able to develop it as the main HST station.





4.3.4 Conclusions

The study shows that even though none of the locations score very well on both the accessibility and vicinity point and the development potential, one location scores better than the others.

The Ørestad location can be written off as the main HST station location, its character just does not match with that of HST. The airport is an attractive location because of the opportunities of mutual benefits for the HST and air travel. But the lack of development potential combined with its suboptimal public transport connections with, and distance from the centre of activity make it a lesser candidate for the main HST station location than the Central station. It can be a secondary stop to the main station.

The main HST station should be located at the Central station but a big complicated intervention is probably necessary to be able to develop the desirable real estate.

4.4 Stops and shuttles

Now the location of the main HST station is decided, the question remains where, if any, the other stops should be. The two candidates are the airport and the central station in Malmö.

The consideration of where to stop deals on the one hand with the service/comfort level by direct transport to the destination location and the number of passengers that can be attracted because of this. On the other hand stops take time and the existence of the HST is justified by the short travel times.

The system where the HST always stops at the main station and some trains also stop at the airport or Malmö combined with a shuttle system between the three stations seems to be the best balance between time and accessibility.

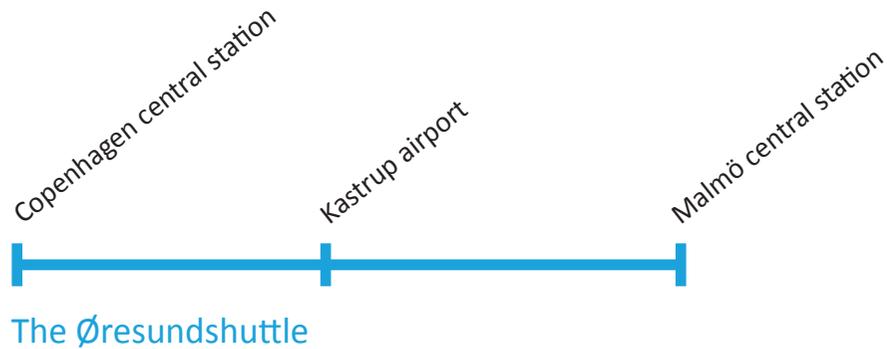
This means all locations are reachable and the traveller decides what is most important to him/her when choosing which train to take.

This system make it possible to cooperate with the airport so that the HST and the airlines profit. It also provides potential for development of the area around Malmö station and makes sure that Malmö is still an attractive place to locate activities.



| | 1 stop | 2 stops | 2 stops | 3 stops |
|-----|--|---------------------------------------|--|--|
| | Copenhagen central | Copenhagen central Kastrup airport | Copenhagen central Kastrup airport or Malmö central | Copenhagen central Kastrup airport Malmö central |
| PRO | Time | growth potential for airport | growth potential for airport | direct to/from destination |
| | encourage cooperation between cities | potential of cooperation with airport | potential of cooperation with airport | growth potential for airport |
| | a shorter route possible | encourage cooperation between cities | growth potential for Malmö | growth potential for Malmö |
| CON | restricting potential of airport | time loss through extra stop | time loss through extra stop | big time loss |
| | reducing potential cooperation airport | time loss through route through Malmö | competition between stops | competition between stops |
| | devaluing Malmö | competition between stops | | discourage cooperation between cities |
| | loss of passengers | devaluing Malmö | | |
| | | loss of passengers | | |

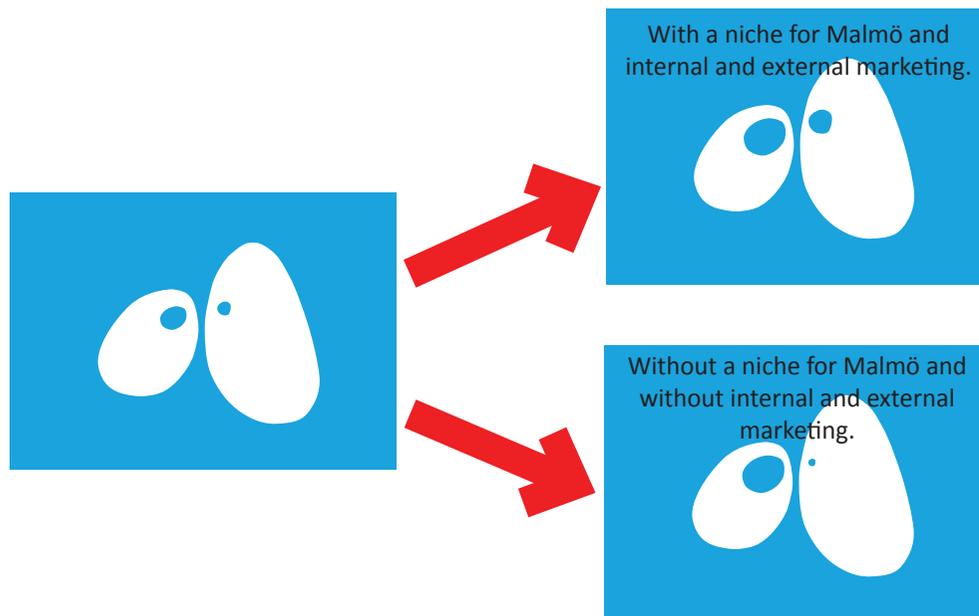
4.5 The effects of the intervention



The new HST network can bring profits to the whole Øresund region. Although the biggest effects will be in the primary development zone, the growth in the number of jobs and amount of amenities will benefit the whole region.

The spread of the benefits over the region depends on the amount and quality of internal connections. On the Danish side the metro and S-train network provide good connections to the region. The Swedish side is dependent on the connection over the Øresund. This takes time and is relatively costly. For the Swedish area to maximize the profits this will have to be addressed. A special shuttle between Copenhagen central station, the airport and Malmö central station on the HST track can provide this fast connection. This shuttle service and the possibility that some high-speed trains stop at Malmö central station means there is potential for growth and development around this station as well. Essential for the growth to also take place in Malmö is that it creates its own set of qualities that differentiate it from Copenhagen, its niche.

One of the biggest factors in the effects on the Øresund region are not spatial however. Cooperation of the two sides of the Øresund and internal and external marketing is essential. Strengthening the Øresund image internally and externally is needed to spread the growth over both sides of the straight and to make sure that Copenhagen does not get a more dominant position over Malmö. Marketing of the two cities and region together can strengthen the international competitive position toward other conurbations/cities.



5 The scale of the city

5.1 An area for redevelopment

The area

The potential for real estate development around the central station can be found along the railway tracks just south of the central station. This is a big area: over 120 hectare currently used for activities that do not need to be in such a prime location: at the edge of the inner city, besides the ring road and near the waterfront. The activities consist of a sorting station of the Danish Mail, some light industry on a former abattoir terrain, an old shunting yard (for rearranging trains), some businesses and small scale container transfer, and a dozen dwellings.

Both the former abattoir on the north side of the railway and the business to the south are orientated to the roads, away from the railways.

There is a lot of open and derelict space which influences the “look and feel” of the ring road beside it. This is not a desirable image to portray as the face of the city along one of its main entrance routes.



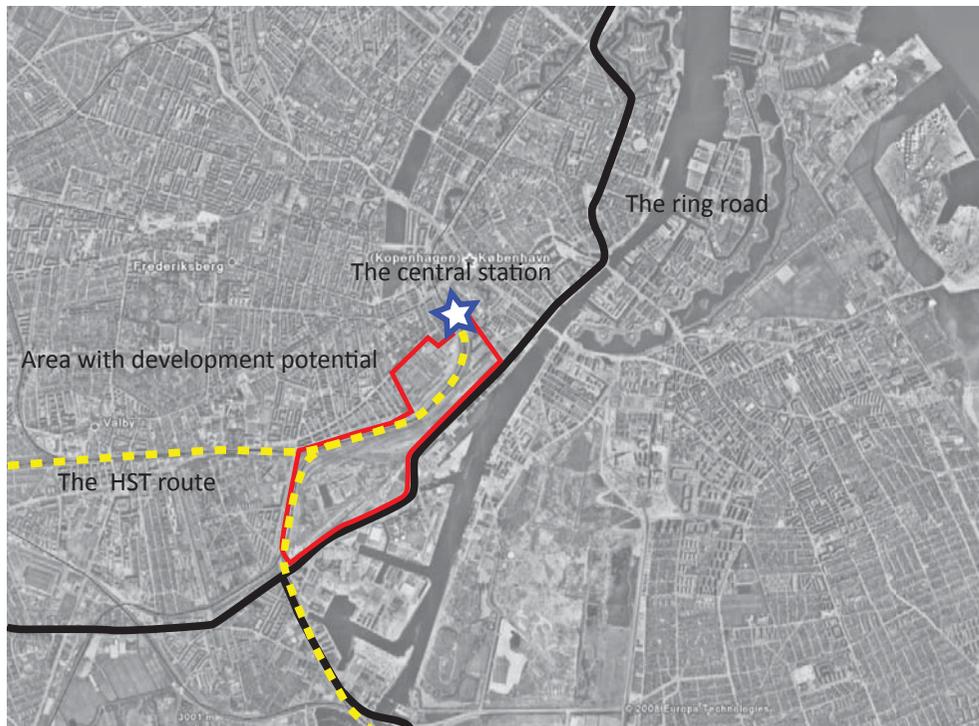
Derelict space at the ring road

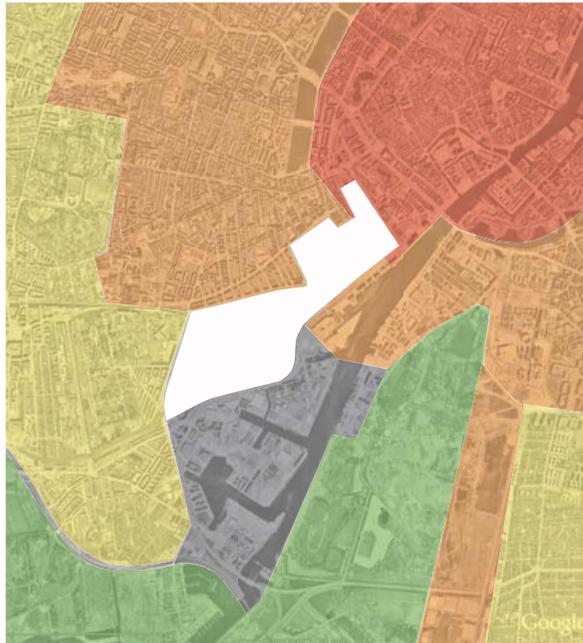


Light industry at the former abattoir



Open space and some businesses





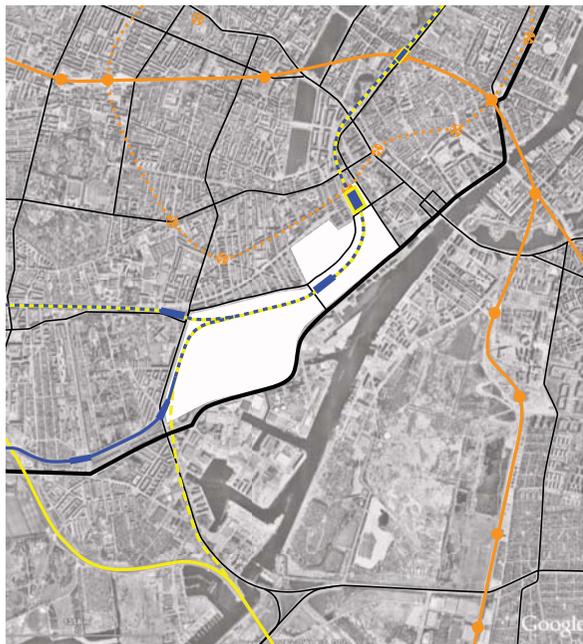
- City centre
- Urban
- Suburb
- Green
- Industry/under transformation

The context

This industrial area is located just outside the inner city. To the north and west one finds residential areas. The area to the south is used for industrial purposes and is partly being transformed into residential areas at the waterfront.

The area is at the moment mainly accessible from the ring road to the south. The regional rail has three stop at the edges of the area and one in the middle. The national rail only stops at the central station. The future ring metro line, planned to be opened in 2017 has a stop planned at the central station, but no other stop in the area.

The development of the area fits in with the strategy to redevelop industrial and harbour areas along the waterfront into qualitative residential areas even though it is not directly on the waterfront because it brings the city closer to the water. Development on this location supports the development of the waterfront areas and vice-versa, instead of competing with other developments.



- Main roads
- National rail
- Regional rail
- Metro
- Planned metro



- Study
- Planning
- Construction
- Just surrendered
- Fully functioning
- Integrated

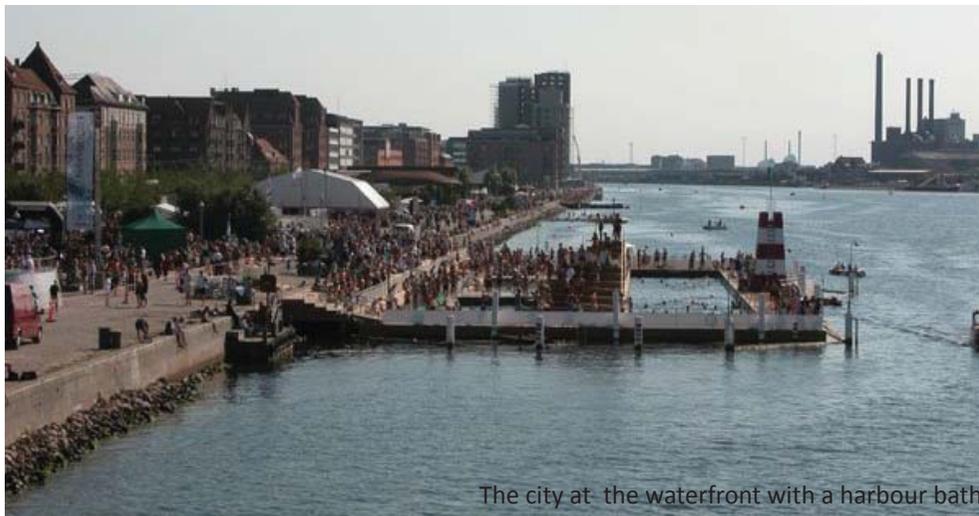
The municipal vision

The municipal strategy of 2007, in preparation of the municipal plan of 2009, is called the “Thinking metropolis” and focuses on growth with respect for the environment and the residents. It is based on 4 themes:

- Green: the sustainable city
- Diversity: the city for everyone
- Blue: the city at the waterfront
- New: the dynamic city

By this they mean several things: a compact, dense city with the focus on public transport, mixed functions and a mixed dwelling offer, use of the waterfront to create quality and offer recreational facilities, and become an international city of knowledge. Copenhagen also has a very big housing shortage which must be addressed in the near future.

Development of the industrial area around the railway tracks fits perfectly with this vision for a number of reasons. First of all the redevelopment of this area relieves pressure on more peripheral locations, keeping the city compact. Centre the development around public transport will help reduce congestion in the city. Redesigning the area can break the barrier it currently forms between the residential areas in the north and the waterfront. The size of the area makes it possible to make a big contribution to the housing contingent of the city. The HST and the related developments can be used to help brand the city and attract the foreign investment and knowledge workers wanted.

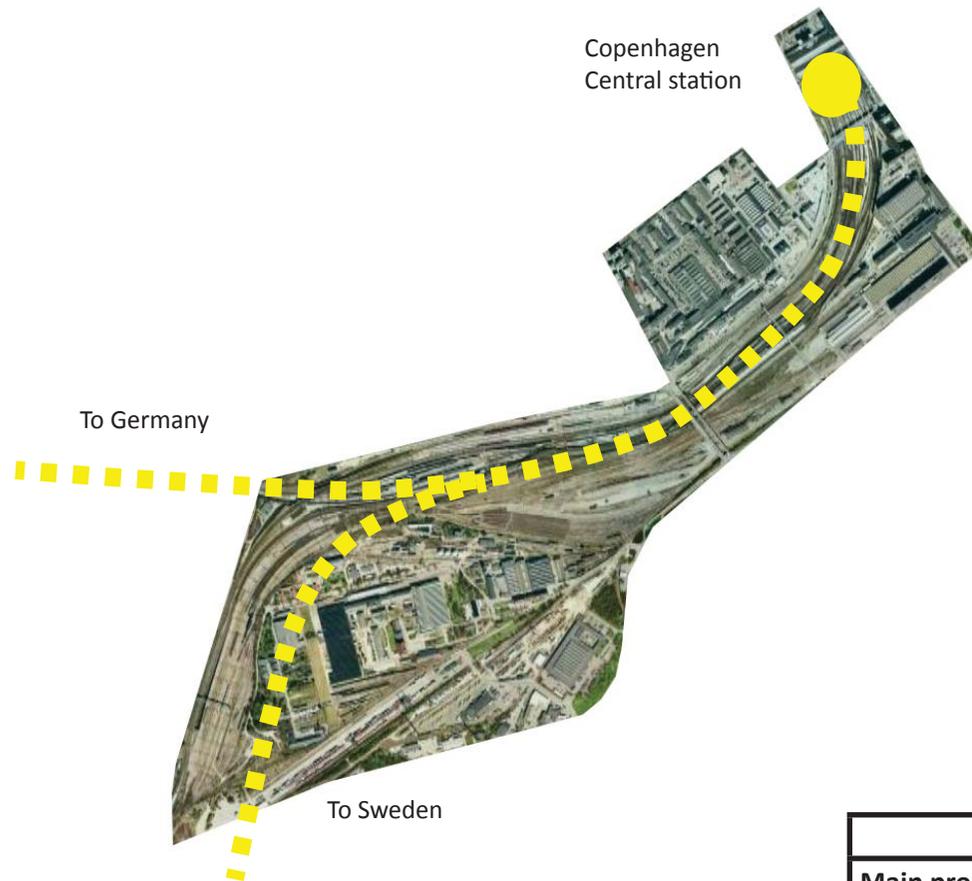


The city at the waterfront with a harbour bath



The only routes through the area at the moment

5.2 The HST through existing fabric



The type of station

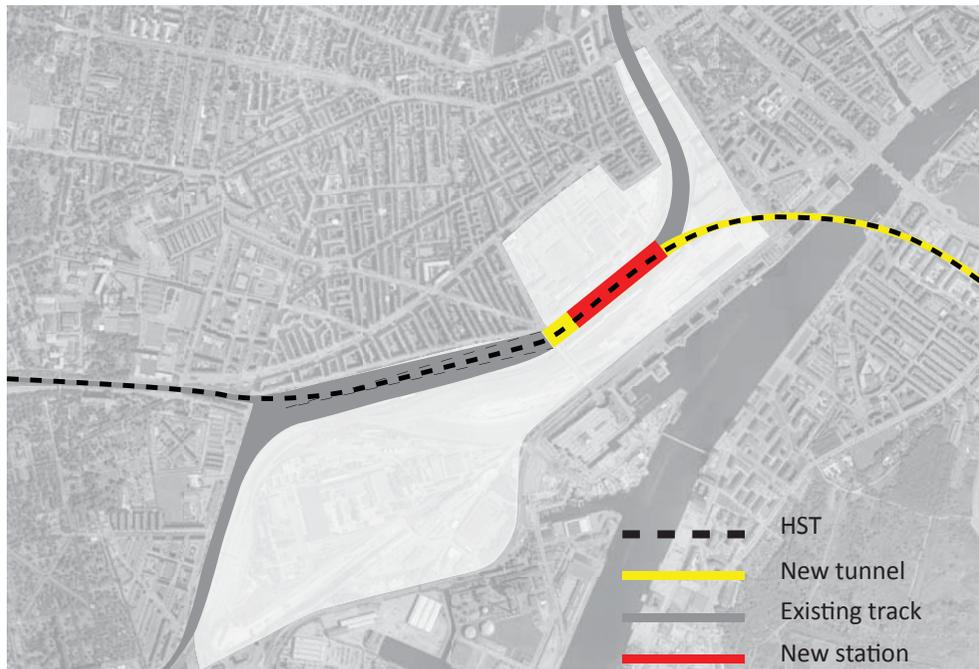
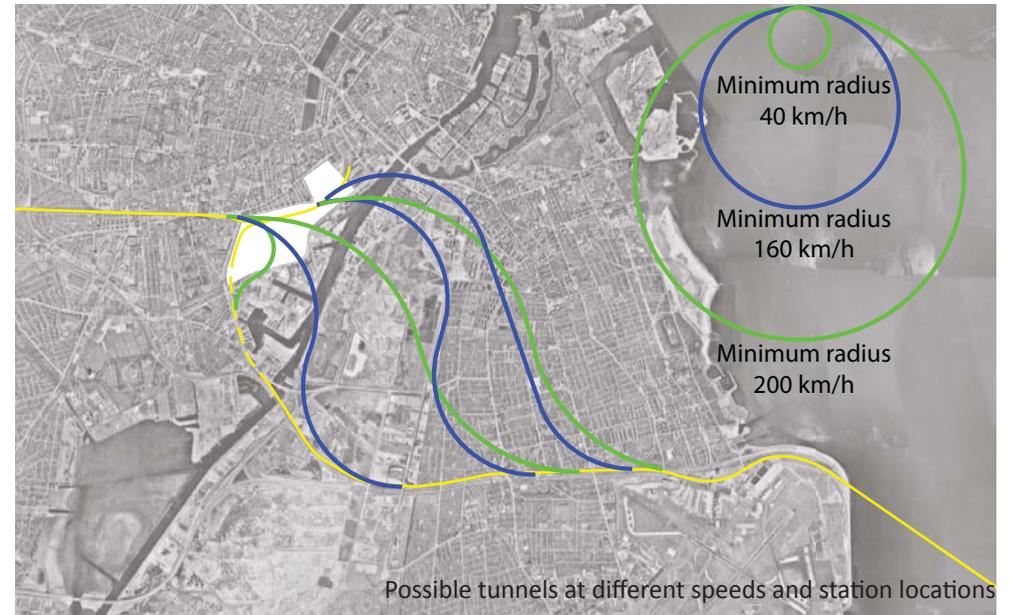
Copenhagen central station is a terminus station for most of the lines arriving in the city. Only the regional rail lines and a few national trains travel through the station and into a tunnel underneath the city to the north. The high-speed lines stopping at Copenhagen have to 'turn around' and go back the same way they came for 2 kilometres before the lines to Germany and Sweden split.

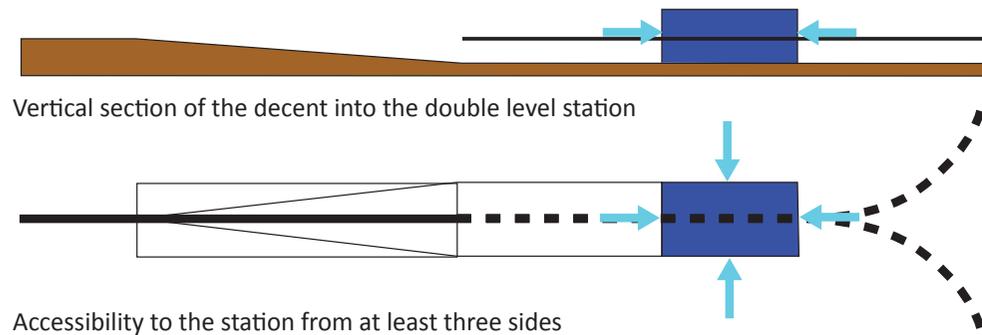
These extra kilometres combined with the time it takes to be able to drive the train means that valuable time is lost because of the type and location of the station. A through station could save time and because it uses the platforms more efficiently could also save space. This can create a more compact/user friendly node or enlarge the capacity of the station. A through station for the HST in Copenhagen would need a big intervention: new tracks through the city and maybe even a whole new station, but might be justified by the fact it seems better adept to handle future growth and innovations. If a new station is developed integrally with its surroundings the negative aspects of the (through) station can be minimized and the possibility is created to reorganise some of the urban public transport into an efficient multi modal node.

| | Terminus station | Through station |
|----------------------------|---------------------------------|---------------------------------------|
| Main pro | Potential for urban development | Station capacity |
| Pro | 3 attractive sides | efficient use of space |
| | easy integration with the city | |
| Copenhagen specific | no new route necessary | shortest route |
| Con | inefficient use of space | tracks can form a barrier |
| | | need for a tunnel/traverse in station |
| | | there will always be a backside |
| Copenhagen specific | longer route | new (route/)station needed |

The new tunnel needed for a through station

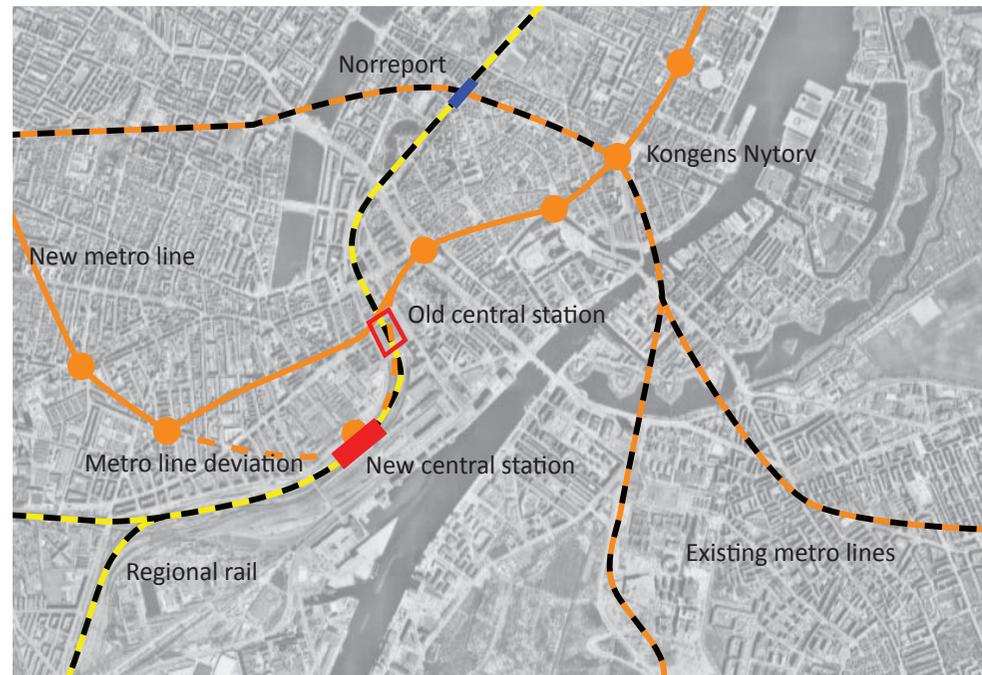
A new through station in the development area means a new stretch of tracks is necessary between the station and the old route to the airport and Sweden. This route crosses the river and the suburbs south of the city which implies that it would have to be tunnelled. The route of the tunnel is influenced by the idea that the station should be as far east in the development area as possible to be close to the centre of activity, by the fact that is easier and less risky to keep the tunnel out of the historic city (fortifications), and by the speeds desired in the tunnel. Disadvantage of placing the station as far east as possible and wanting to travel through the tunnel at higher speeds is that the tunnel and therefore the intervention becomes longer and larger.





Vertical section of the decent into the double level station

Accessibility to the station from at least three sides



The possibilities of a new station

Because the new station will be built in a redevelopment area there are chances to organize the station in such a way that the negative aspects of a station of the urban fabric are minimized. The fact that the HST will need to enter a tunnel combined with the barrier formed by the tracks and the need for a pedestrian crossing of the tracks on another layer make it logical to bring all the tracks of the station underground. Depending on where the tracks go underground the station is accessible from three of four sides and in the case the tracks are underground at the narrow middle of the area at least a third of the barrier provided by the existing tracks will be removed. The new station will not have a metro stop in the planned new metro line, but as this is still in the planning stage a small deviation from the proposed route should be possible. This will give the new station a stop in the metro line and increase its accessibility as well as that of the inner city.

The new station will put the existing central station out of use. The international and national functions will move to the new station. For the majority of the national lines the station will remain a terminus station, because the intervention moves the station down the line and does not change the national network. The metropolitan node function was partly lost to the Norreport station with the opening of the metro lines. This function can partly be regained with the new metro line. In the future the metropolitan system will have three nodes in a triangle around the inner city: the new station, Norreport station and Kongens Nytorv station. The existing station building is a beautiful building and should be reused.

The station without the new tunnel

Even if the risks and costs of the new tunnel outweigh the benefits of a trough station for the HST it is still a good idea to build the new station. It would still help the development of the area and partly break the psychological and physical barrier formed by the tracks. Phasing is also possible by building the new station as a terminus (with later extension in mind) and later turning it into a through station by digging the tunnel.

6 The scale of the redevelopment zone

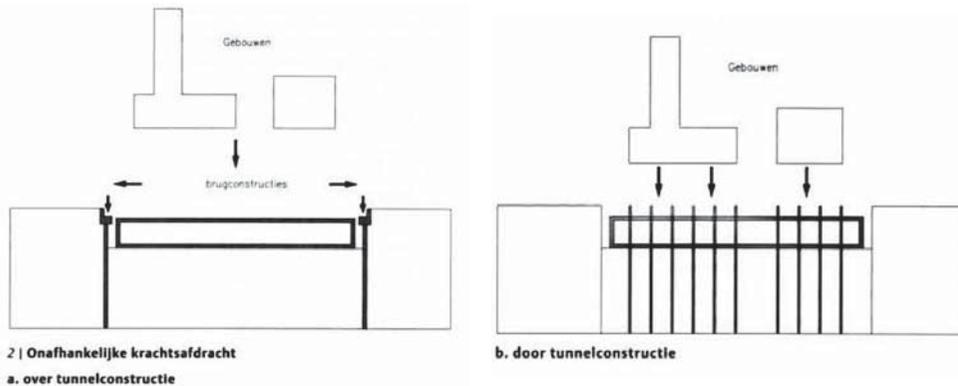
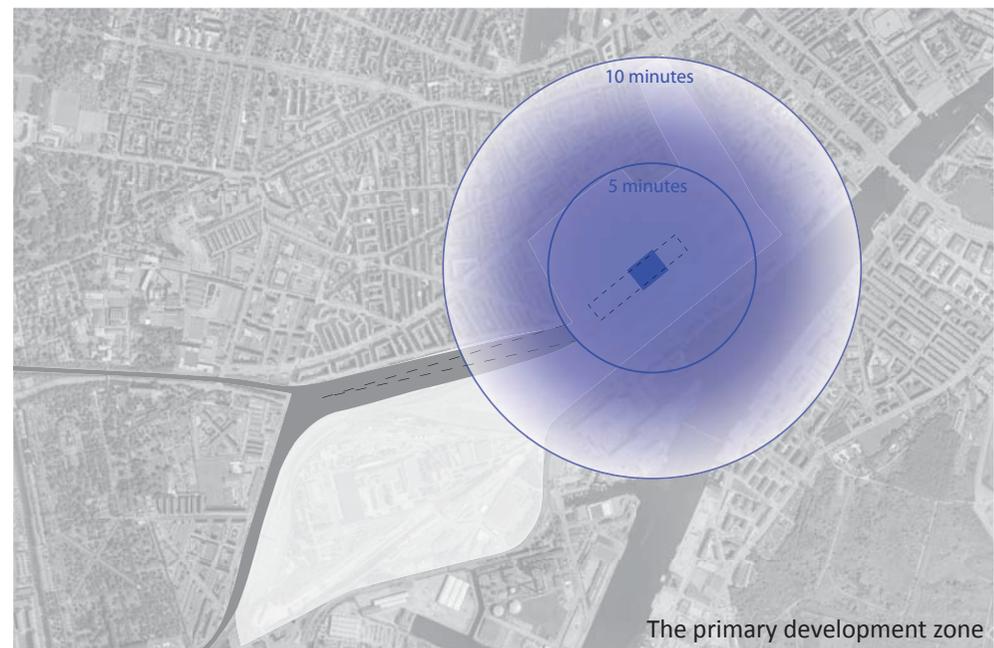
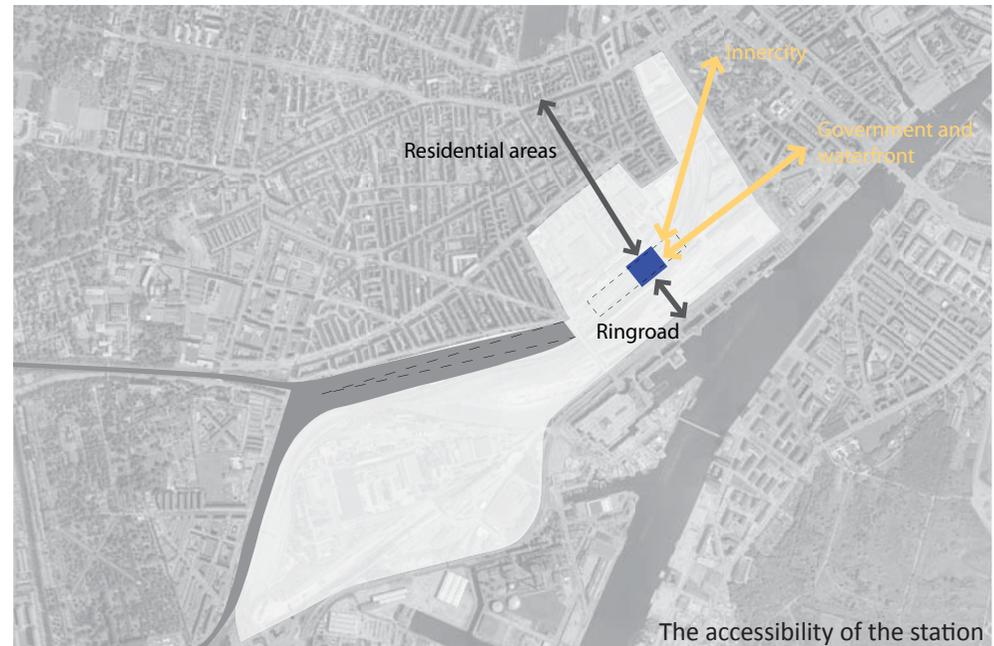
6.1 The starting points for redevelopment

6.1.1 The functioning station

For the redevelopment of the zone to be successful the workings of the station have to be understood. On the one side it is a space of flows. This means that the accessibility of the station for all urban modalities is important. The connection to the ring road and the suburbs is important to motorized and public transport. While for slow traffic the connection to the inner city, the national government area and the waterfront is essential. This accessibility has effects on the orientation and organisation of the station and the use and character of the public space around it. Safe, attractive and clear slow traffic routes are needed between the station and the centre. Presenting the station at the ring road and making it easily accessible from the ring road is necessary for motorized traffic.

On the other hand it is a space of place. Activities related to the station want to be as close to the station and the flows as possible to profit the most of these flows of people. The closer to the station the bigger the effect of the station is. The primary development zone (PDZ) is the zone within 5-10 minutes walking distance of the city. Within this zone the effects are the most pronounced. Therefore it is logical to concentrate activities in this zone.

Building on top of the tracks is possible, the technique to be used depends on the width of the tunnel. For the two track new tunnel piling around the tunnel is the best option. For a wide tunnel and the station itself piling through the tunnel is recommended. Both techniques are independent of the tunnel which means the tunnels can be made without knowledge of what will be built on top of them or restricting that.



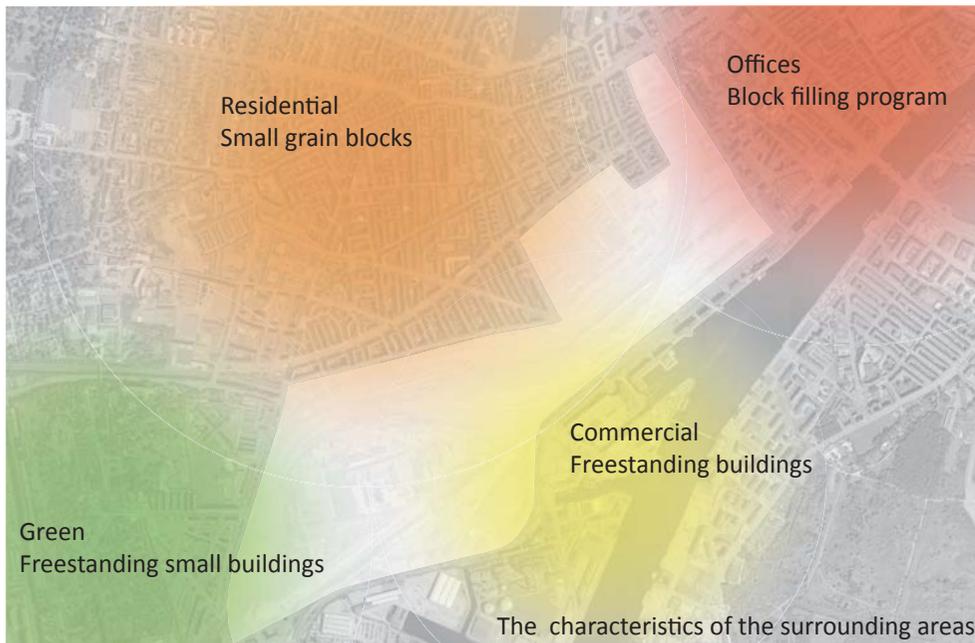


The roads and long lines around the zone

6.1.2 Integration with the surroundings

Starting point for breaking the barrier created by the current form of the zone, making it accessible and organizing the zone can be found in its surroundings. Connecting with the existing road structure can be used to create north-south routes. The long lines can be used to make the connection with the waterfront and locate the crossings of the railways.

Using the character of the surrounding areas helps to determine the programmatic mixtures and densities within the zone, it integrates and organized the zone. A high density area around the station with a high percentage of offices blends with the office and commercial areas to the east of the zone. A less dense area with mainly non- station related activities suites the western half of the zone outside the PDZ beside the residential and green areas.



Residential
Small grain blocks

Offices
Block filling program

Commercial
Freestanding buildings

Green
Freestanding small buildings

The characteristics of the surrounding areas



6.1.3 The building block

Copenhagen has a long history of building up the urban fabric with closed building blocks and is still using them today. The size and shape of the blocks vary from 50m*100m with an 11m street around it to 200m*75m surrounded by a 25 meter wide street.

This tradition combined with the relatively “blank canvas” of the redevelopment zone leads to the choice of a grid for the zone. A grid also provides a durable structure which can organize the zone as it evolves over time. The basic block chosen for the grid is 75m*175 with a 25m street around it. This is about the same size as applied in other modern developments like IJburg (in Amsterdam) and provides enough space to be adaptable to future changes in use. This basic grid is then rotated and scaled to connect to the surroundings and fit around the station.

The height of the blocks is also derived from the surroundings. Almost all the blocks in the city are 6 storey high.



Middle ages



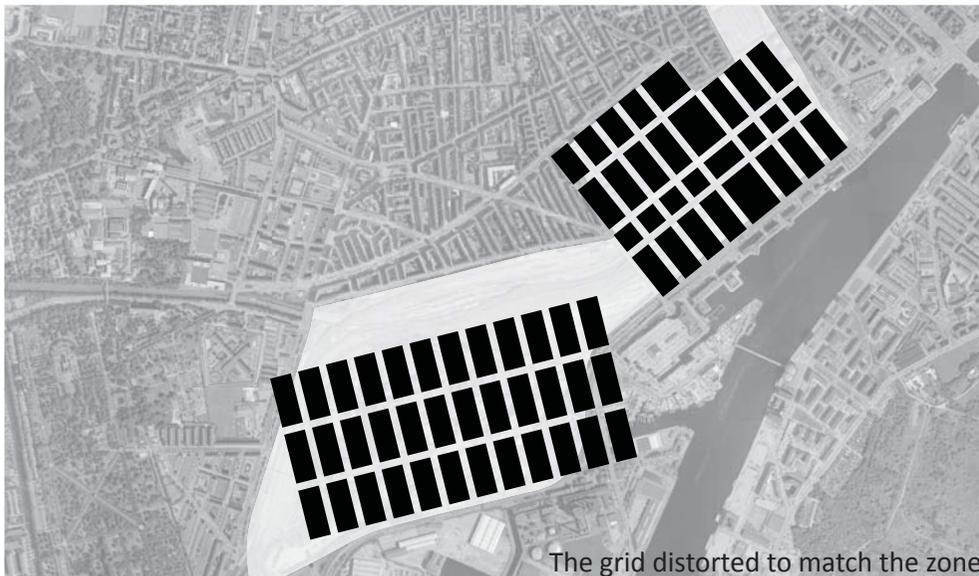
1st expansion outside fortifications



2nd expansion



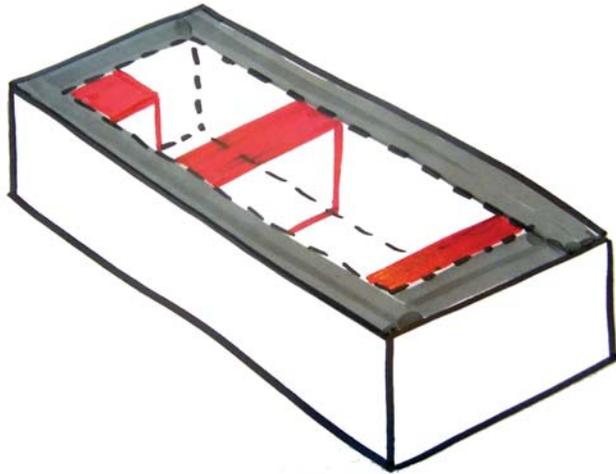
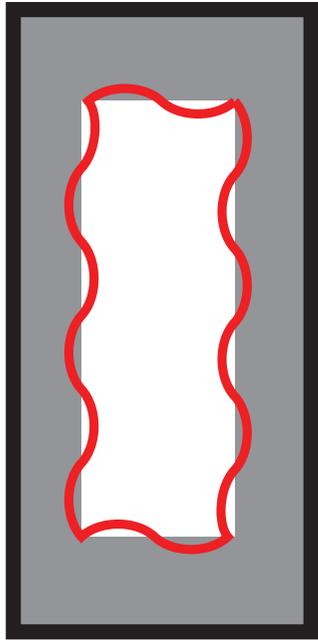
New blocks



The grid distorted to match the zone



6 storeys as the standard



Hard exterior line
Soft interior line



Mixed grain size

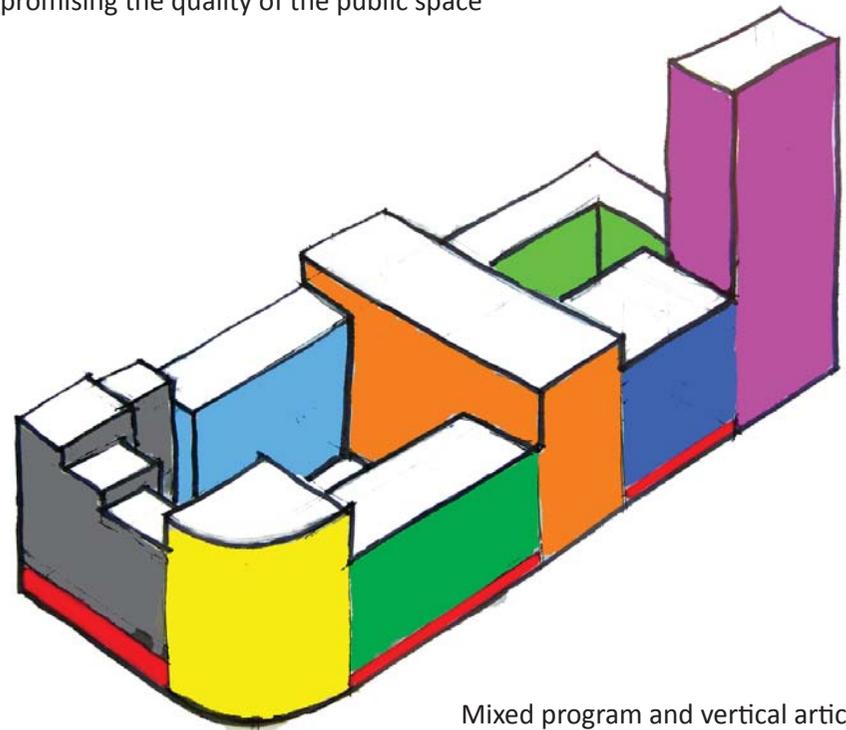
The guidelines for building of the blocks consist of three principles. The first is that the complete external facade of the block should be built on the line. The inward looking facade line is unregulated. This means the building depth can vary, the block can be divided and could even have freestanding buildings in the middle of the block.

The zone has a mix of functions, this mix should be continued in the individual block. The balance of the mix is adjusted to the specific part of the zone.

There should not only be a mix in the function of the program but also in the size of the program elements. This mix of granular sizes means there is room for large scale program which otherwise cannot be accommodated in the inner city. The small grain ensures the link with the surroundings, the human scale and a qualitative environment.

Vertical articulation in the blocks keeps the scale of the block human and spitting it into units makes it easier to transform the block over time, changing with the evolving needs.

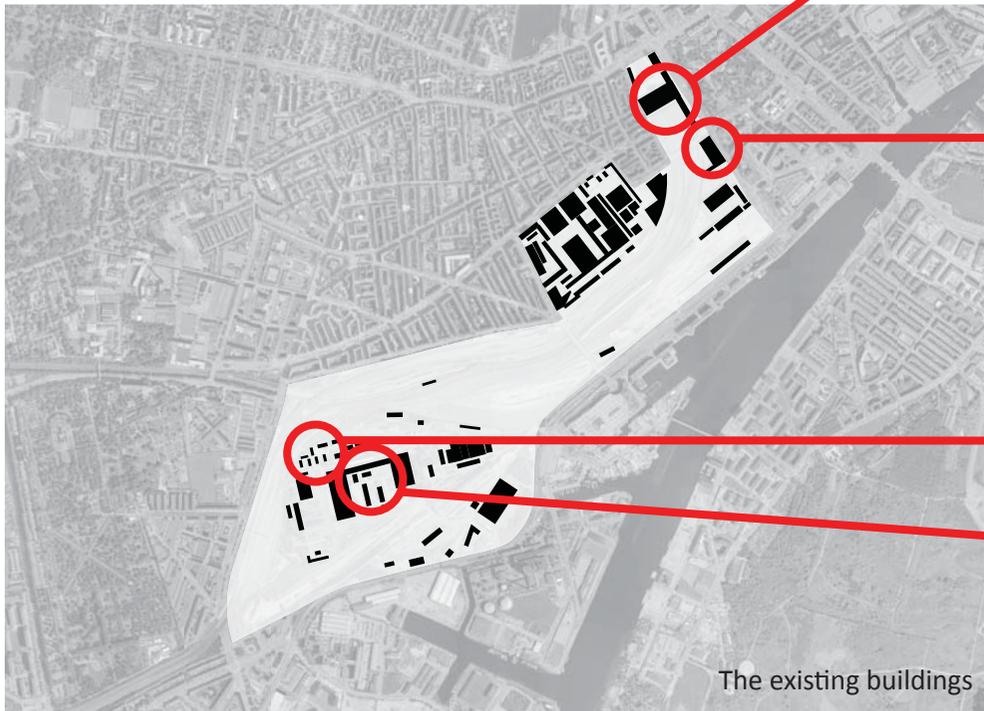
Underground parking underneath the block makes high densities possible without compromising the quality of the public space



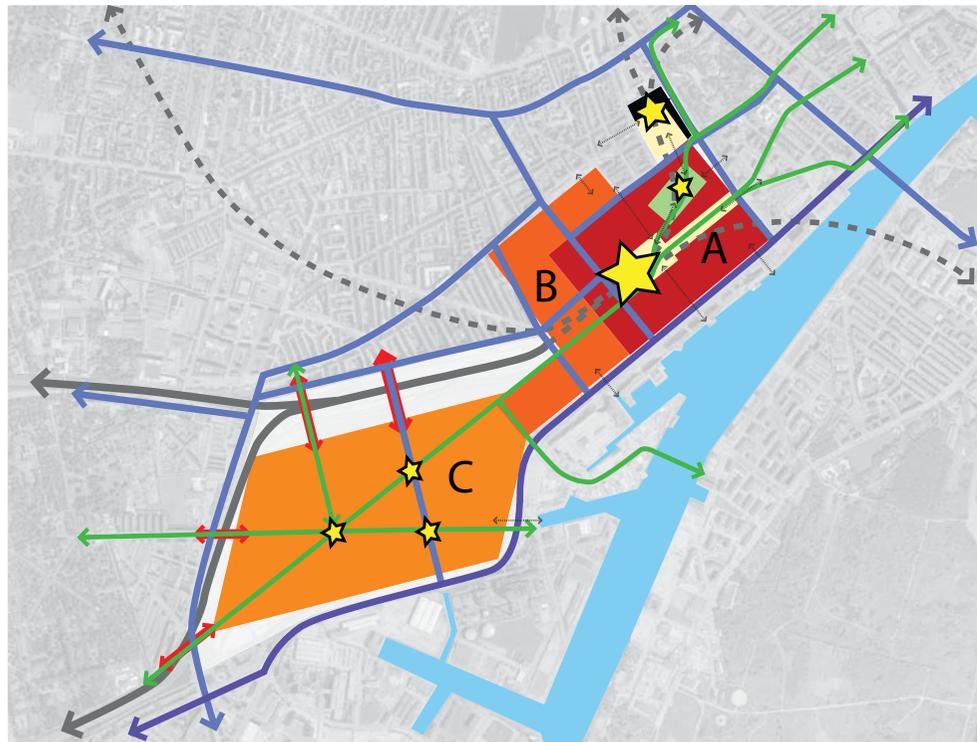
Mixed program and vertical articulation

6.1.4 The reuse of buildings

The variety of existing buildings in the zone is large in age, size, structural quality and architectural quality. Some of these buildings like the existing station building, The Danish Mail building and maybe some other buildings in the zone are of such quality that they can be reused if they fit in with the redevelopment plans. The reuse of these building can give the zone anchor points and character. Further research into the quality of the individual buildings is necessary to determine which would be suitable for reuse. The possible status as enlisted monuments should be factored in as well.



6.2 The vision for the redevelopment zone



-  Subareas
-  Ring road
-  Main road
-  Rail tracks
-  Slow traffic routes
-  Special program
-  Quality relations
-  New bridges

The vision for the redevelopment zone consists of three areas with individual characteristics, the main routes through and around the zone, the places of special interest and qualitative relations.

The three areas are the station area (A), the residential area (C) and the transition area (B) in between them. The barrier of the tracks is broken by covering them on the east side of the zone and bridging them on the west side. The north-south routes made possible by these interventions make the zone accessible and connect it to the surrounding neighbourhoods. In the zone the east-west connections for slow traffic guarantee a straight route to the station and the centre making walking and cycling more attractive. Extra bridges for slow traffic over the tracks and the connection to the bridge over the river should enhance this.

The places of special interest are planned at the crossings of routes. In area C they could be a park or a square with amenities. In zone A they are formed by the station itself and "special program" (see under 6.2.1) that is of interest for the entire city. Where possible the connection with the waterfront and with the public spaces of the surrounding neighbourhoods should be made.

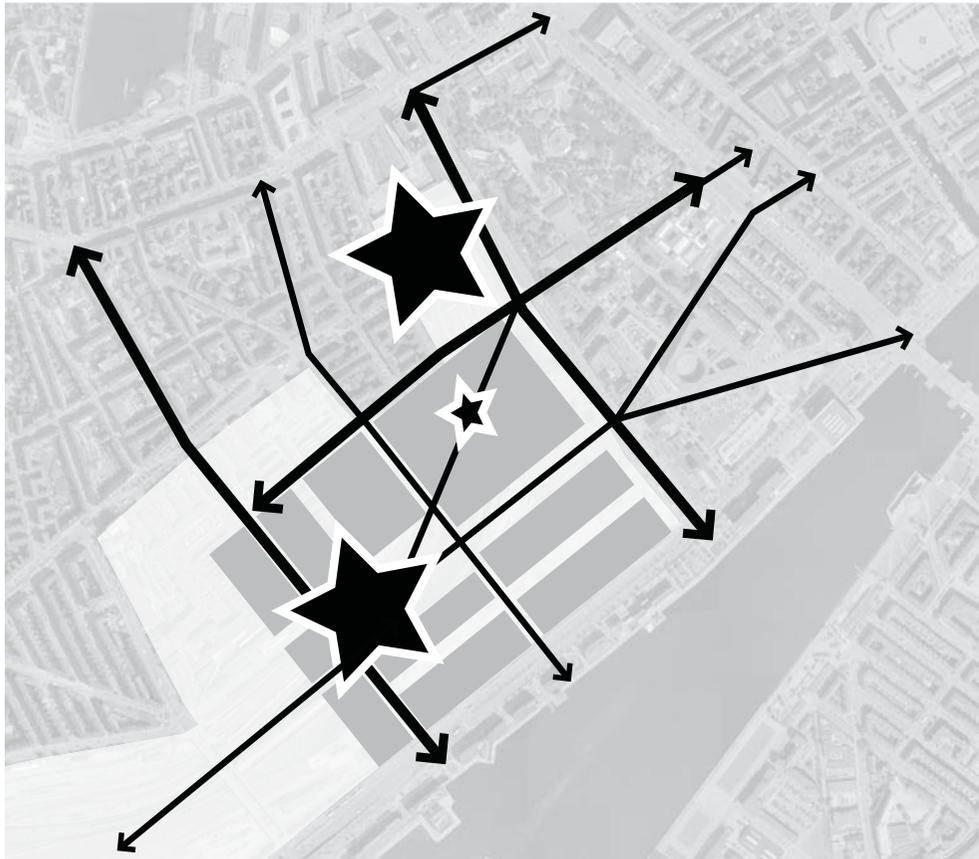
Minimizing the building over the wide stretch of tracks to the existing old station building reduces the costs and led to a series of public spaces between the old and new station building. On the other hand, building on top of the new tunnel and the stretch between the new station and the open air tracks supports the development and the potential return on the real estate. Not building over them could create a surplus of open/public space that would not be beneficiary to the zone and would threaten the economic viability of the plan..

In total the vision offers over 1.000.000 m² of floor space. Of this 400.000m² would be for offices and in addition around 10.000 dwellings can be created.

6.2.1 Area A

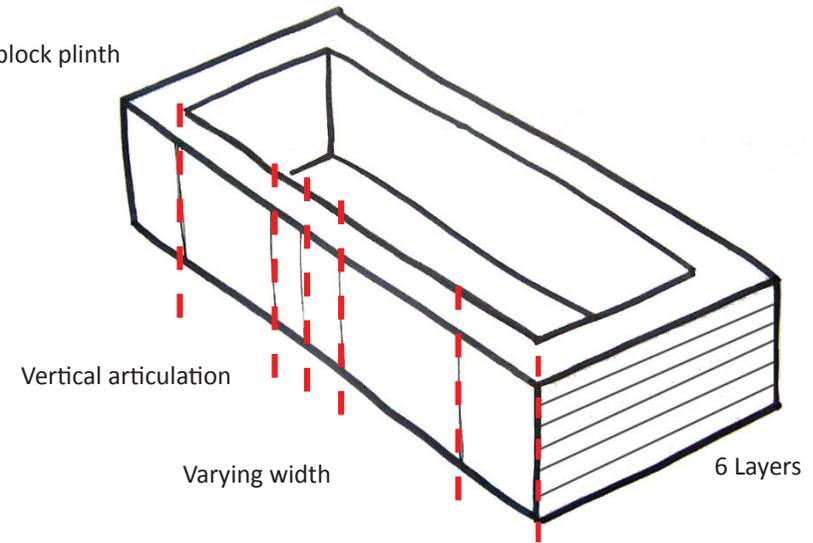
Area A is the station area. High density and a relatively low percentage of dwellings are the main characteristics. The presence of a station allows high rise constructions in the area according to the municipal guidelines, but they should be the exception instead of the rule. This allowed high rise offers area A the widest variation of the standard block.

The “special program” in the area consists of the old and the new station and the public space over the tracks in-between them. Accessibility of the new station, a clear slow traffic route to the centre and connections through the area to the waterfront organise the area.

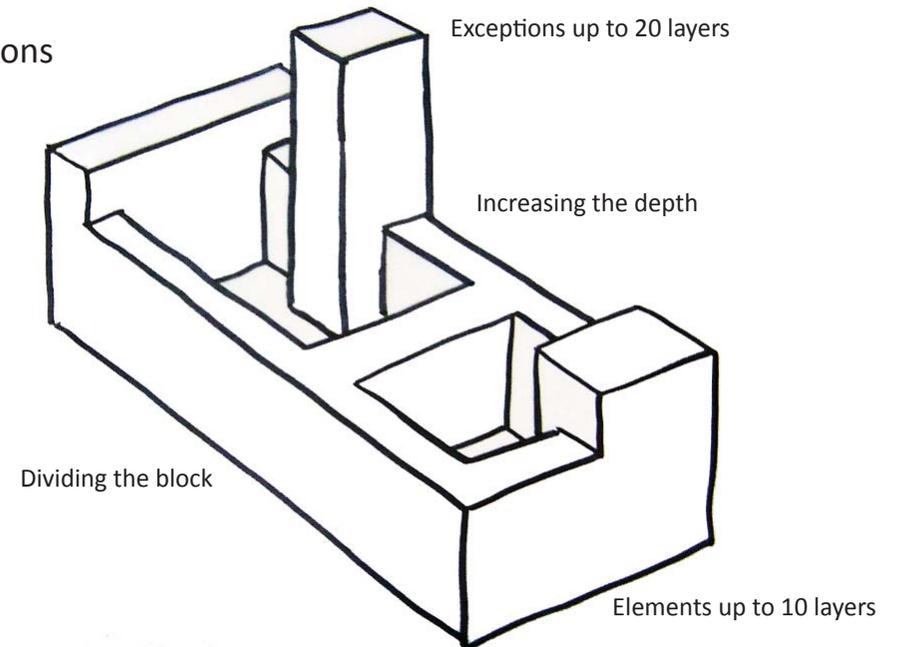


Basic block

No block plinth



Variations





The Turfmarkt in Den Haag

The 30 hectare area will have a highly urban feel. Quality of public space and public program in the plinth along the main routes help create an attractive and lively atmosphere. The area should provide at least 370,000m² of office space, 150,000 m² for commercial use and 220,000 m² for residential purposes (1800+ units). The nonresidential functions could be (international) headquarters attracted to the station and the high quality new development, but also shops attracted to the big flows of people to and from the station. Also big institutions who had to move out of the centre or find additional accommodation elsewhere for lack of space have the chance to comeback or reunite.



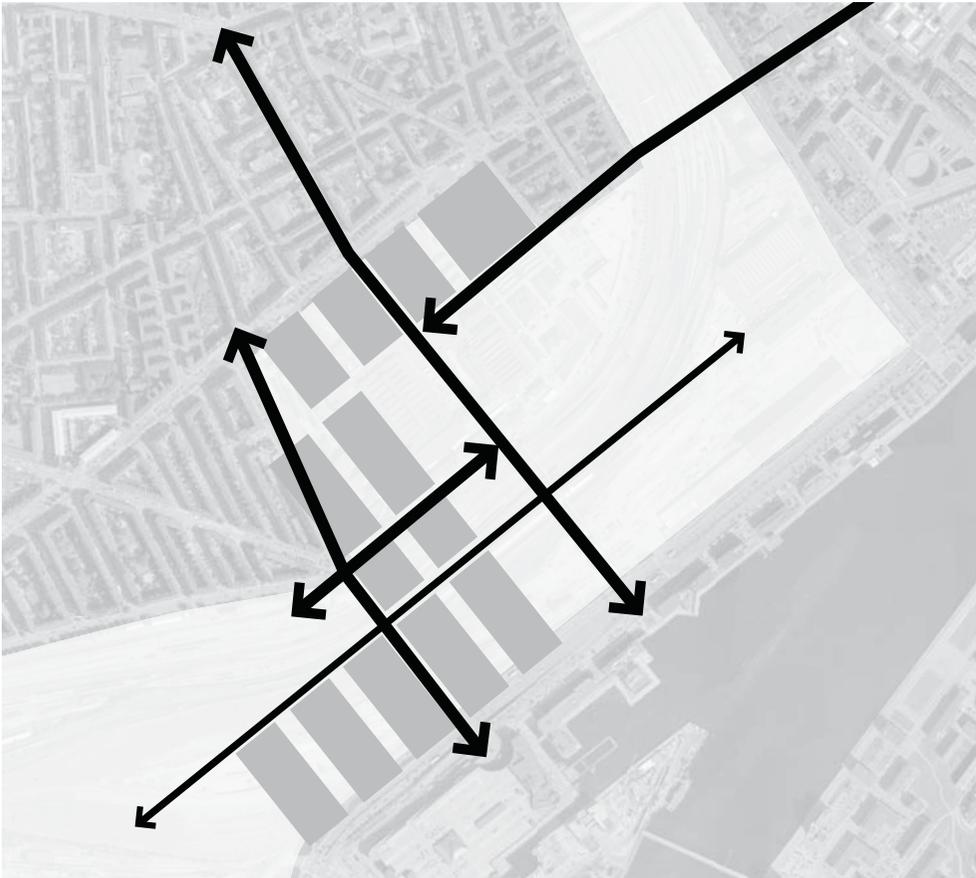
Offices with public plinths



Attractive and lively

6.2.2 Area B

Area B is the transition zone between the residential areas and the highly urban station area. High rise is no longer permitted and the area can house functions that operated on a higher scale than the neighbourhood itself but are not attractions on the metropolitan scale. The area plays an important role as a connector, both in the north-south direction as in the east-west connection.



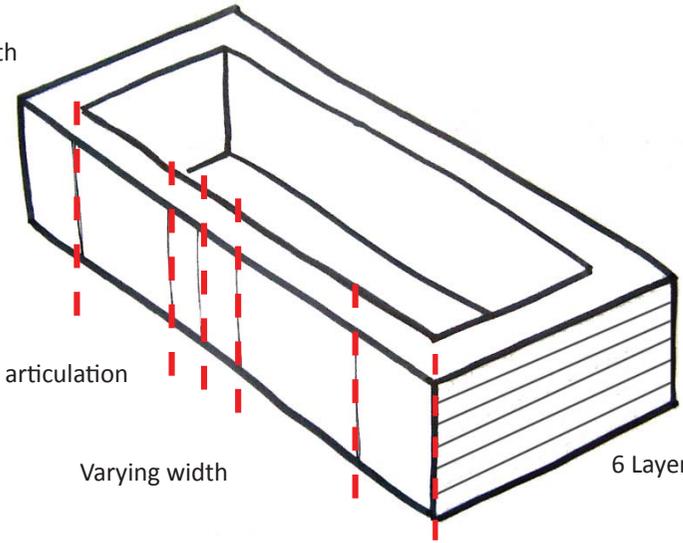
Basic block

No block plinth

Vertical articulation

Varying width

6 Layers

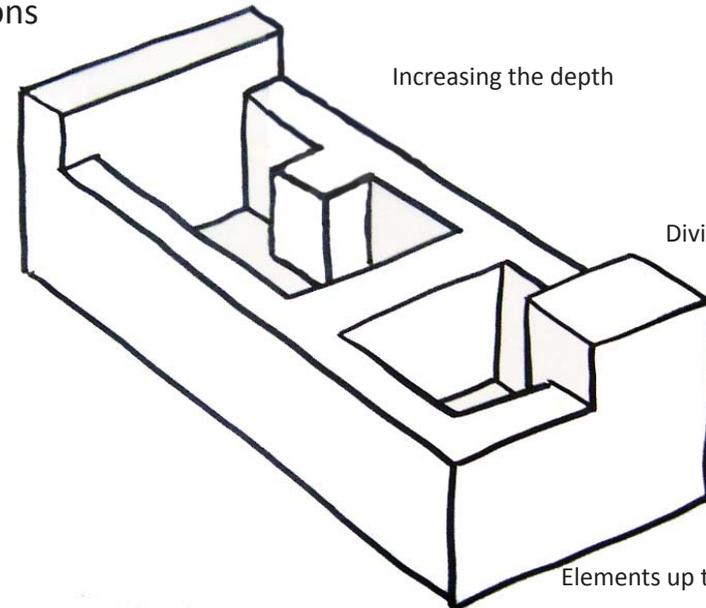


Variations

Increasing the depth

Dividing the block

Elements up to 9 layers





Flows trough the area

The 22 hectare area will have about 10 percent reserved for offices which translates to 40,000m². Commercial and cultural/social functions will play a bigger role in the program division respectively 20 and 15% resulting in about 130,000m². Educational facilities like high schools can play a big role in this area. The remaining 55% is for residential purposes which equates to another 1800 units. Because many flows run through the area it is important to make sure the area has its own attractions to guaranty the staying quality of the area.



Communal spaces inside the block



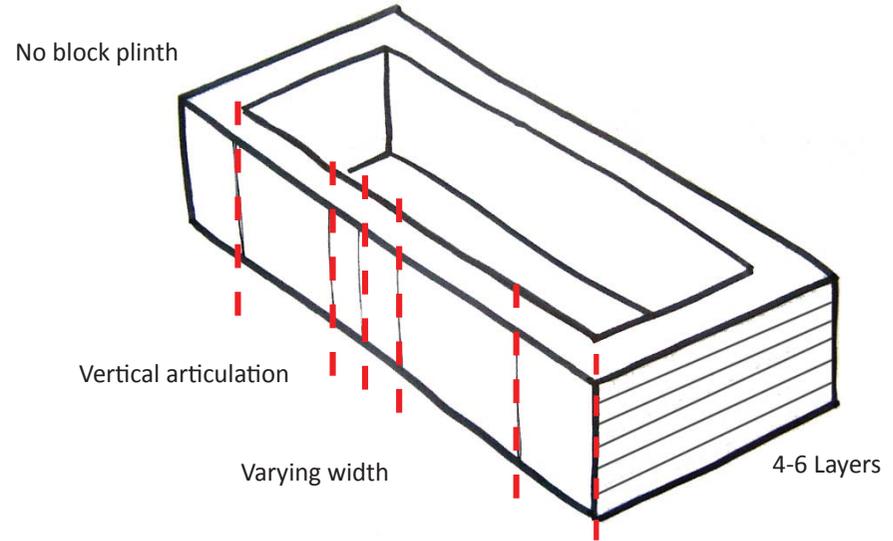
Staying quality in then area

6.2.3 Area C

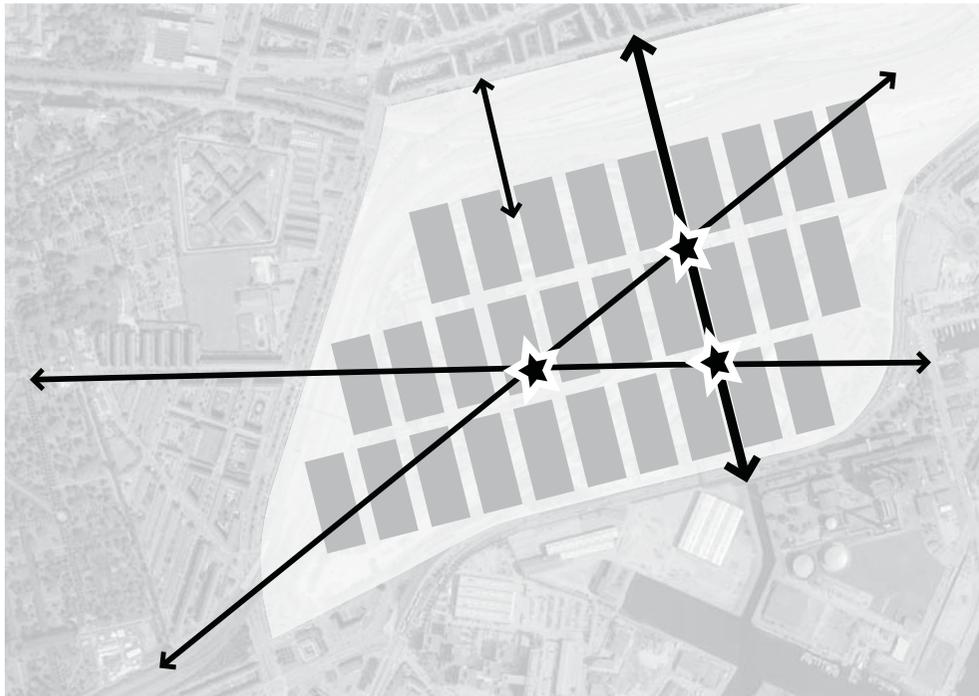
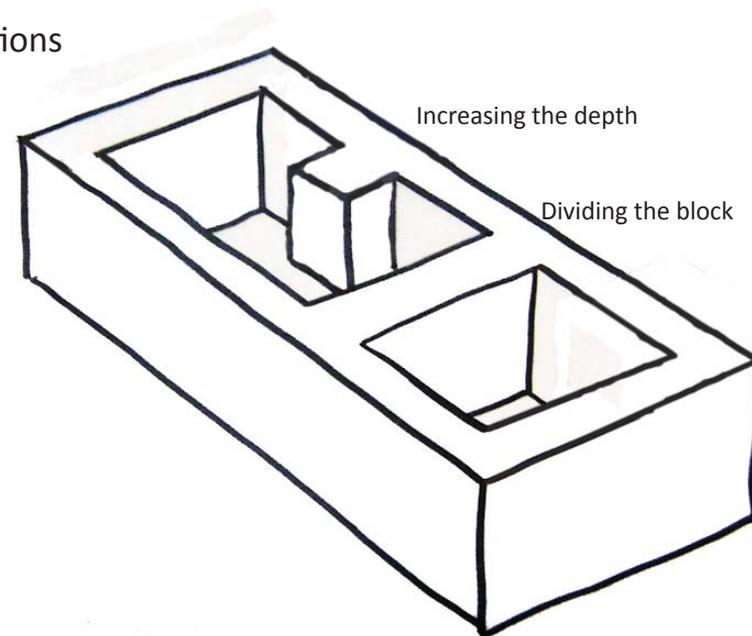
Area C is out of the primary development zone (PDZ) around the station and therefore developments and activities here should not depend on the presence of the station. The need for dwellings in the city should be the main theme for this redevelopment area. Because the area is located between the rail tracks and the ring road extra attention should be paid to connect it to its surroundings. The east-west slow traffic connections link different parts of the city bringing through traffic to the area making it part of the city. To give this residential area an urban feel without compromising the residential quality the building height of the blocks is limited between 4 and 6 layers.

At the crossings of the (slow traffic) routes special programs can be located to give focus to the area. This special program can consist of squares, a park or a community centre.

Basic block



Variations





Java in Amsterdam by Soeters

The size of the area (60 hectare) together with the residential character means that nearly 6500 dwellings can be realized in the a area. The other 25% (250,000 m2) is designated for commercial, cultural and social uses.

The space within the residential blocks can be organized in different ways: it can be divided up and privatized, it can be communal to the residents of the block, but it can also be truly public like the Java Island in Amsterdam. The waterfront to the south of the area is being developed along a plan of Sjoerd Soeters based on the concept of the Java Island. If the water in the streetscape is replaced with green this concept can be applied in the redevelopment area, connecting these areas with each other.



Java in Copenhagen by Soeters



Special program at crossings



Public interior of blocks

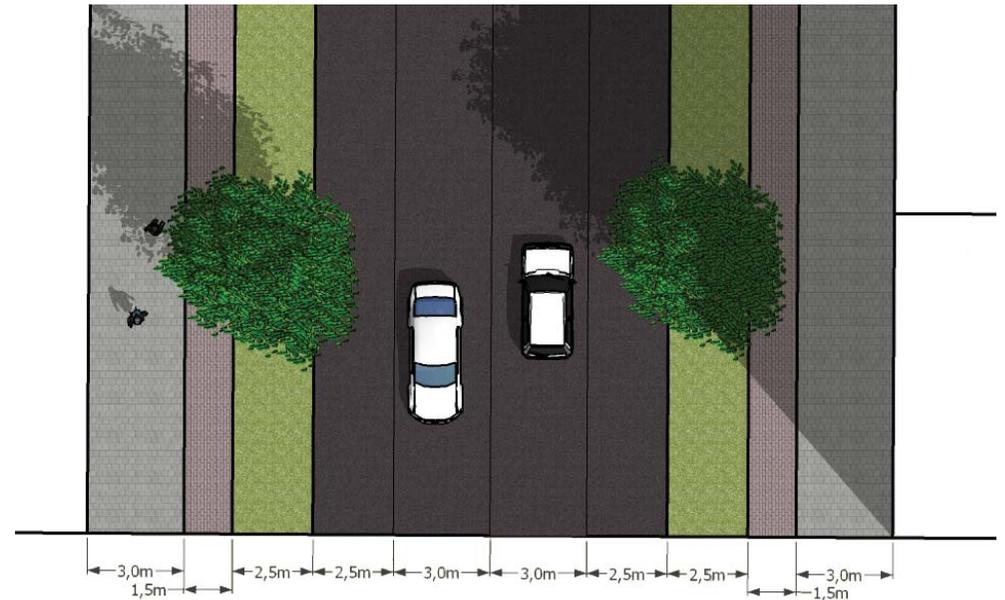
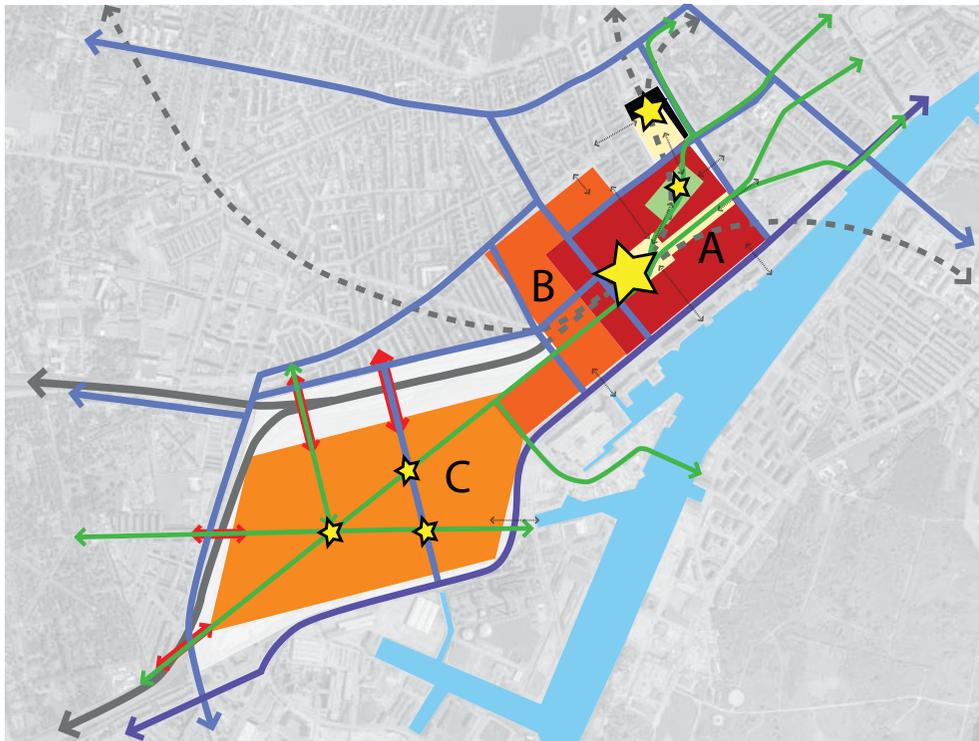
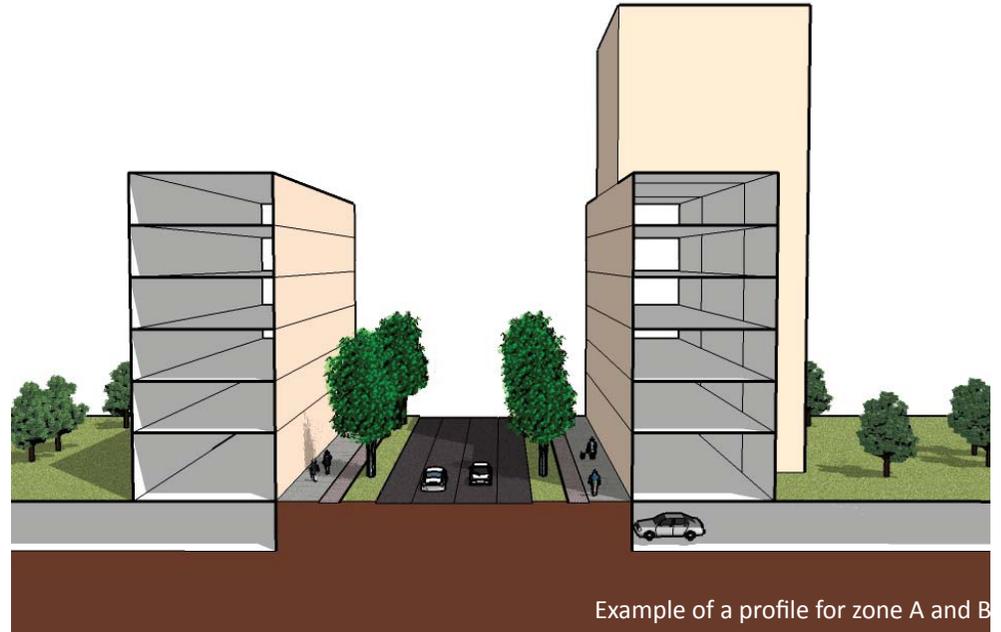


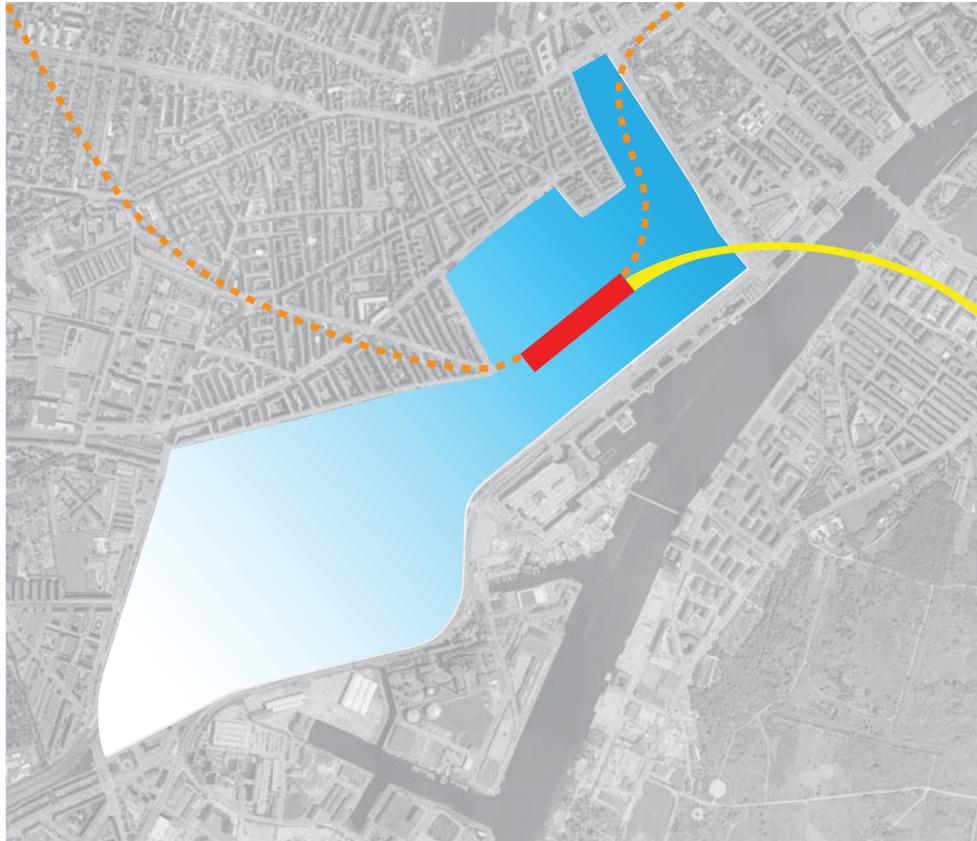
Residential streets with vertical articulation

6.2.4 Routes and profiles

The street network is designed to optimally connect to the zones surroundings. This makes the area accessible and stimulates flows through the zone. Slow traffic has the highest priority which is expressed for example by the slow traffic diagonal running all the way through the zone providing a direct and safe route between the residential areas and the city centre.

The standard street profile is 25 meters wide. This is wider than the average in the city with the same building height. The width makes various arrangements in the profile possible, making the urban structure more durable. The wide profile also guarantees plenty of sunlight in the street and buildings in this northern location. Variations in the number of lanes, with or without street parking and the location of green are all possible.





6.2.5 Phasing

The redevelopment of the zone needs phasing not only because of its size but also because of its complexity and the fact that there has to be a fully functioning station at all times.

First of all the new station has to be constructed near the existing tracks without obstructing the flow of the trains to the old station. Construction of area A can commence once the existing activities have been relocated and does not interfere with the station development. The same applies to area B but it might be prudent to wait until A is well underway in order not to stretch the resources too thinly. Once the new station is up and running the old station can be redeveloped.

Area C can be developed independently from the other two areas and the stations. Whether this should happen before, during or after depends on the acuteness of the housing shortage, the time it will take to develop the other areas and the available resources.

Whether the new HST tunnel should be built at the same time as the station or be added later depends on the desirability of the tunnel and the available funding. It should in any case be anticipated so it will be possible to add it at a later stage.

The plans for the metro line are already developed much further. To give the new station access to the metro system these plans should be amended as soon as possible.

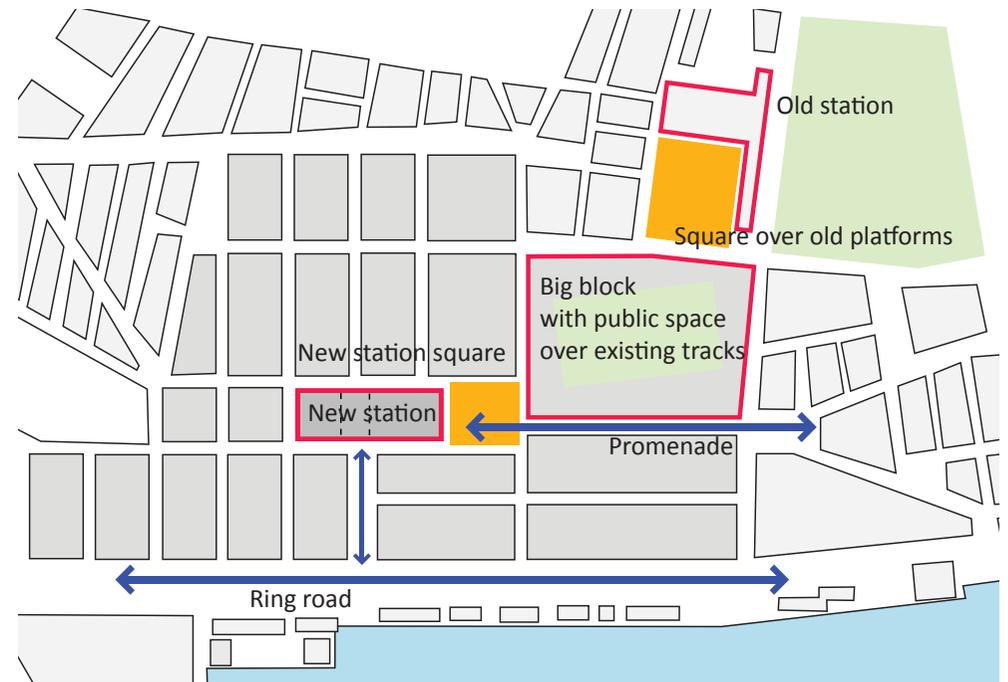
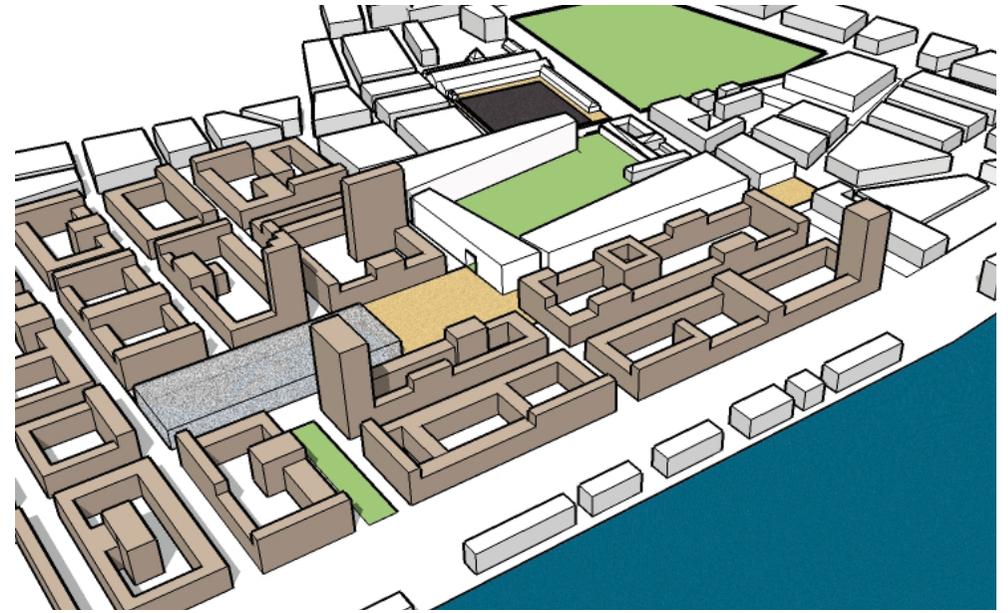
7 The scale of the station area

7.1 Area A

The area around the station is based on the standard block grid. This grid is manipulated in order to let the new street structure line up with the surrounding streets.

To most of the building blocks and streets the standard principle for area A and the profiles apply as discussed in the previous chapter. There are a few exceptions: The station building block and the big block with a public space in it over existing tracks. The third exception is of course the existing station building. The guidelines for these buildings/blocks will be discussed in the following paragraphs.

There are also exceptions in the public space. The new station square and the square over the old platforms will be new spaces for the whole city. The promenade will be a pedestrian zone linking the new station with the inner city. The other route of special interest is the ring road, the connection of the station to the ring road and of the area to the ring road and waterfront.



7.2 Danish Architecture

The station area will be the new grand entrance of the city and is the first impression of the city and the country for many visitors. This makes it an ideal location to showcase Danish architecture.

Danish architects are well capable of designing landmarks for the area, the new station for example, but also the buildings that make up the standard blocks. The different architecture firms have their own style so it is important to keep in mind who is the most suitable for each individual assignment and to make sure the end result is coherent. Not all the buildings can or should be landmarks/icons.



BIG

3xNielsen

Arkitema

Henning Larsen Architects

7.3 The new station

The organisation of the building

The new station building is organized around several principles. The first is the vertical separation of rail traffic by putting the tracks and platforms underground.

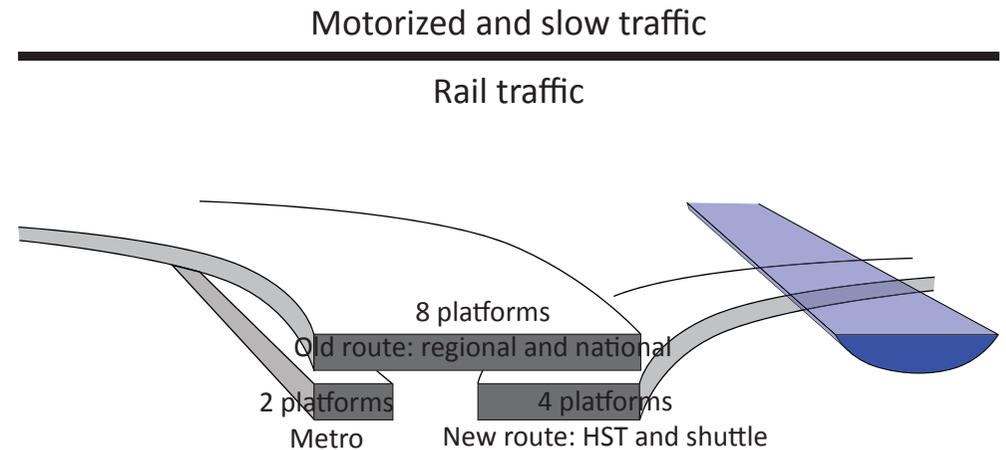
The rail traffic is further organized through separation of the different routes and kind of trains. This leads to three parts: the relocated activities of the old station comprising of the national and regional rail lines, the new metro line and the international section with the HST and the Øresund shuttle. Stacking of these parts in two layers is applied for several reasons. It keeps the node compact, which is good for both the travellers and constructions that has to be built over the tracks. It also makes it possible for the metro line to cross the national and regional lines. The HST needs to go underneath the river so has to be at a low level anyway.

For the regional trains and metro line the station will be a through station as well as for a few national train to the north. For most of the national trains, however, the new station will remain a terminus station. The HST and Øresund shuttle part can be either a through or terminus station depending on whether the new tunnel will be built.

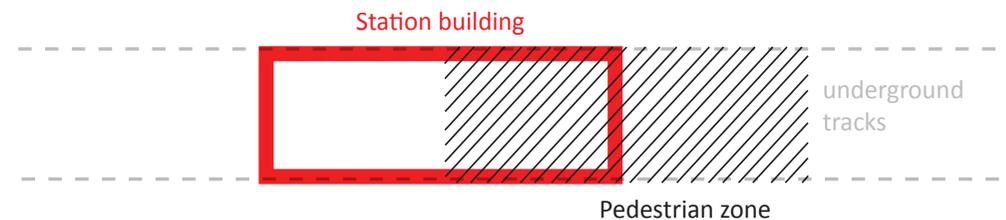
The horizontal organisation above ground is led by the position of the station related to the centre and the accessibility from the ring road and the residential areas. This means the main entrance, station hall and square are on the east side, and motorized access should be organized from the north and south.

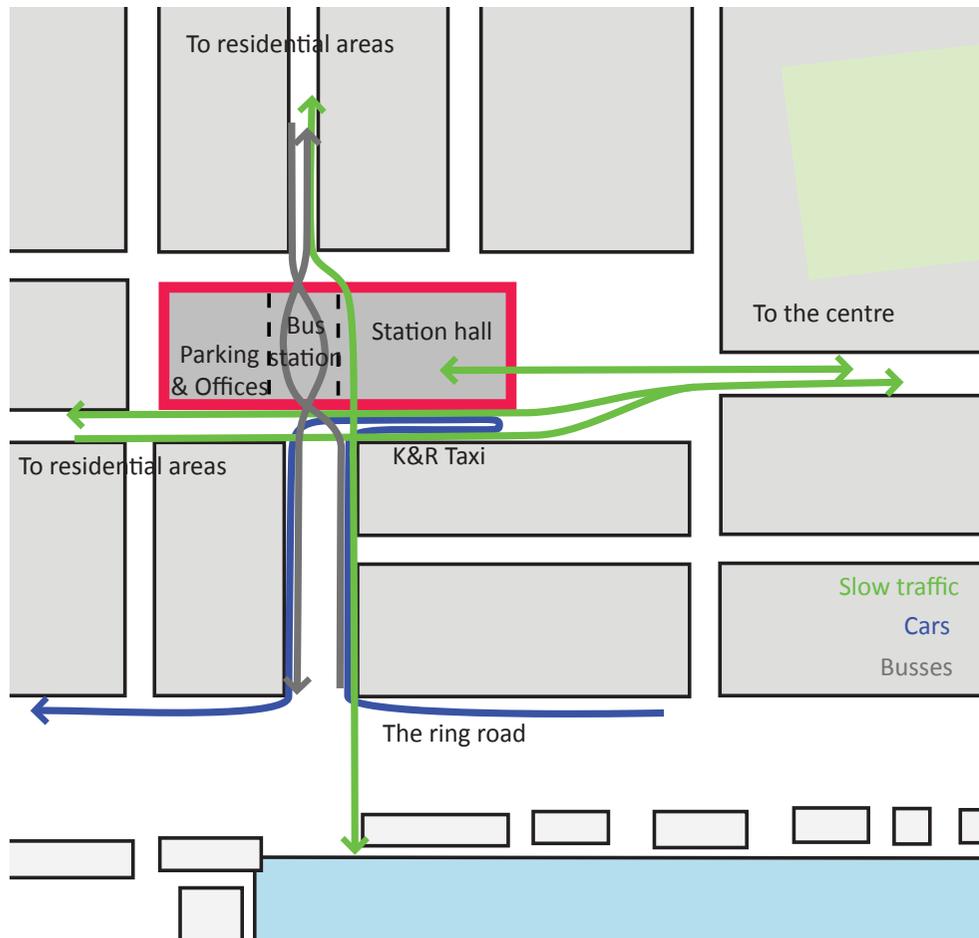
Because feeders are so important to the success of the station and (inter)national rail transport the bus station will be incorporated in the station building next to the station hall. The footprint of the building is so large that there is also room for parking, offices or other functions that are directly related to the station on the west side of the building. To give an idea of the size it could house around 900 parking spaces or 20,500 m² of offices given the area of 75*75m and 4 storeys. Depending of the design and height of the building this could be more or less. Cycling is common in Copenhagen so bicycle storage should be realised in or around the station as well.

Vertical organisation



Horizontal organisation





The flows around the building

The main directions of the flows have already been explained in the previous section. In more detail the flows are little more complicated. The main pedestrian flow is not only between the city centre and the station, but also past the station, on the south side, toward the (new) residential areas. There is also a north-south flow through the station to the waterfront.

Busses access the station from the north and south side, round the island platform, and exit the building on the other side or the way they came in. For cars the main entrance is from the ring road and gives access to the “kiss and ride” area just outside the station hall on the south side.

The architecture of the station

The station should have its main entrance in the east facade. An important secondary entrance is that on the south side, presenting the station on the ring road.

The station is the most important building in the area and its architecture should reflect this, the block principle do therefore not apply.

The station should reflect the modern character of the HST as well as that of that of Copenhagen. It should embody the transition between then space of flows and the space of place. This means it should have the facilities and qualities for staying as well as facilitating the flows. A transparent facade and big, open space is often used to accomplish this but is maybe not the only way.



Amsterdam Zuid



Den Haag nieuw Centraal



Utrecht Centraal

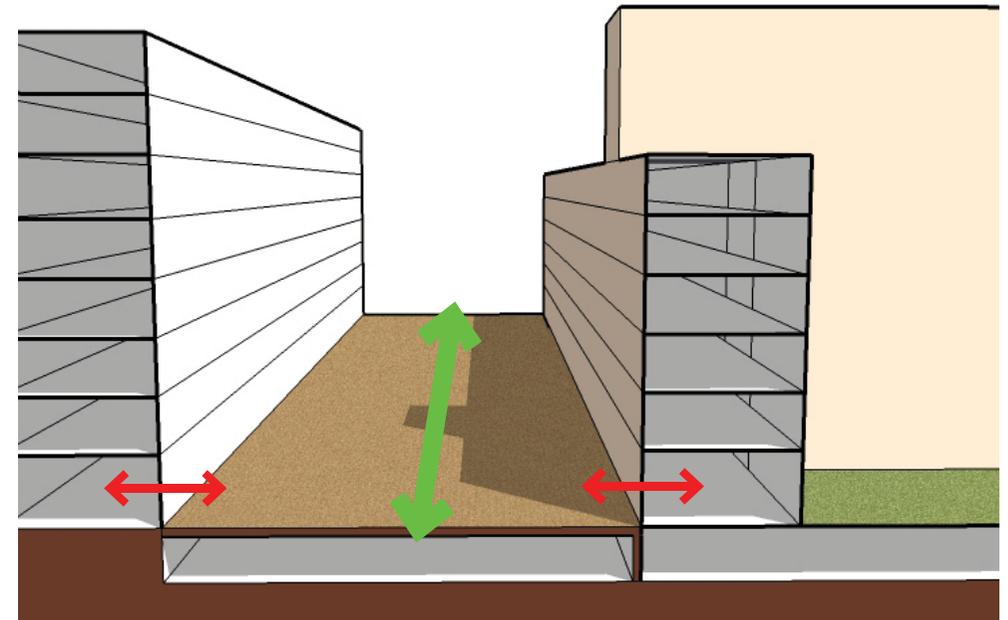
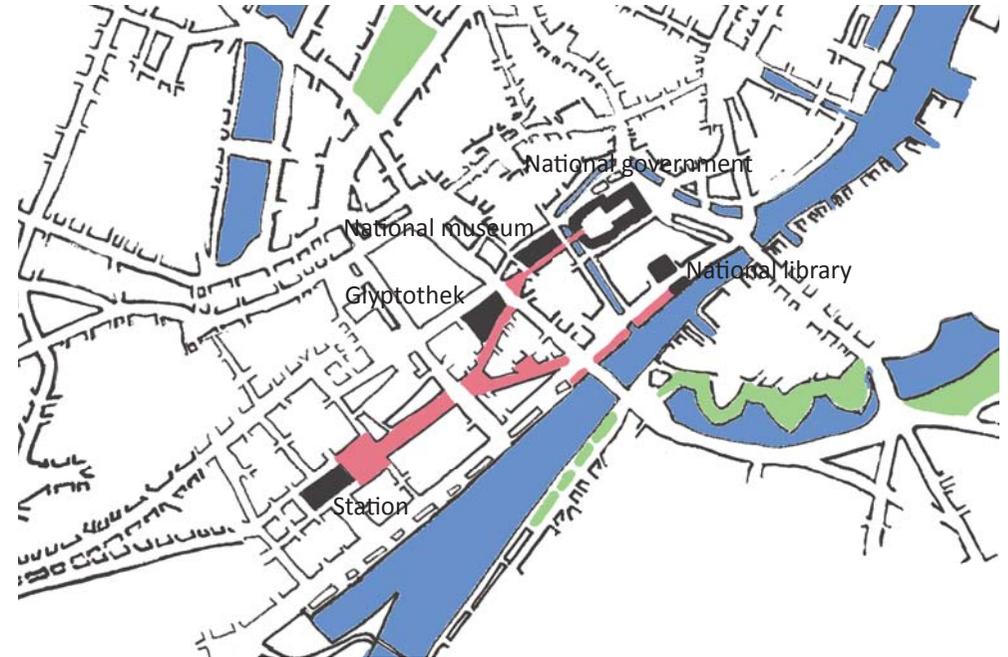


Utrecht Centraal

7.4 The new station square and promenade

The new station square is located outside the east facade of the station. This square should be the extension of the station hall, but should also be an “autonomous” space defined by the station building. The space is further determined by the other buildings around it.

The square should be an attractive place which helps orientate visitors and guides them down the promenade towards the city centre. The square is the first element of the series of public spaces that is strung between the station on the one side and cultural and governmental activities on the other. Halfway the imposing building of the police station splits the route. Past the police station the routes are no longer only for slow traffic but they will have a prominent place in the profile.





The feel of the new station square

Many slow traffic flows cross the station square which leads to a lot of activity livening up the space. Public program in the plinth of the surrounding buildings should enhance this liveliness and facilitate staying in the square and promenade, making it a destination in itself.

Important is that the space of the square and the promenade is not only for through traffic. The staying quality is very important as well. Ample seating and adequate lighting at night, a comfortable micro climate, socially safe and visually attractive are all requirements. The public program in the plinths can have a positive influence on the quality of the square and the promenade with outside drinking and dining facilities. Again the balance between facilitating smooth flows and staying has to be found.



Grote marktstraat Den Haag



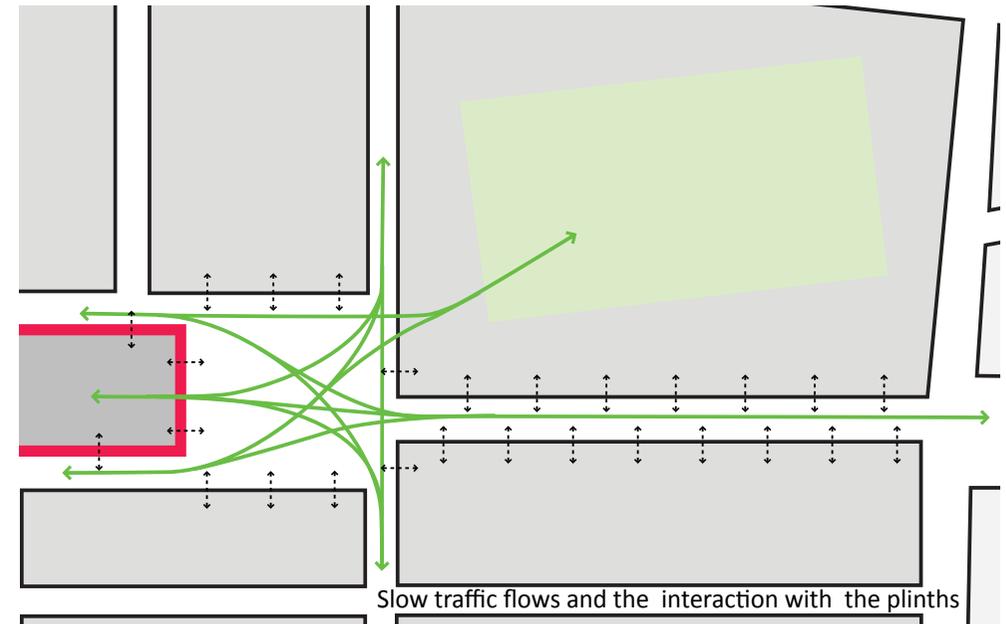
Ramblas, Barcelona



Seating at Zuidplein, Amsterdam



Outside drinking and dining

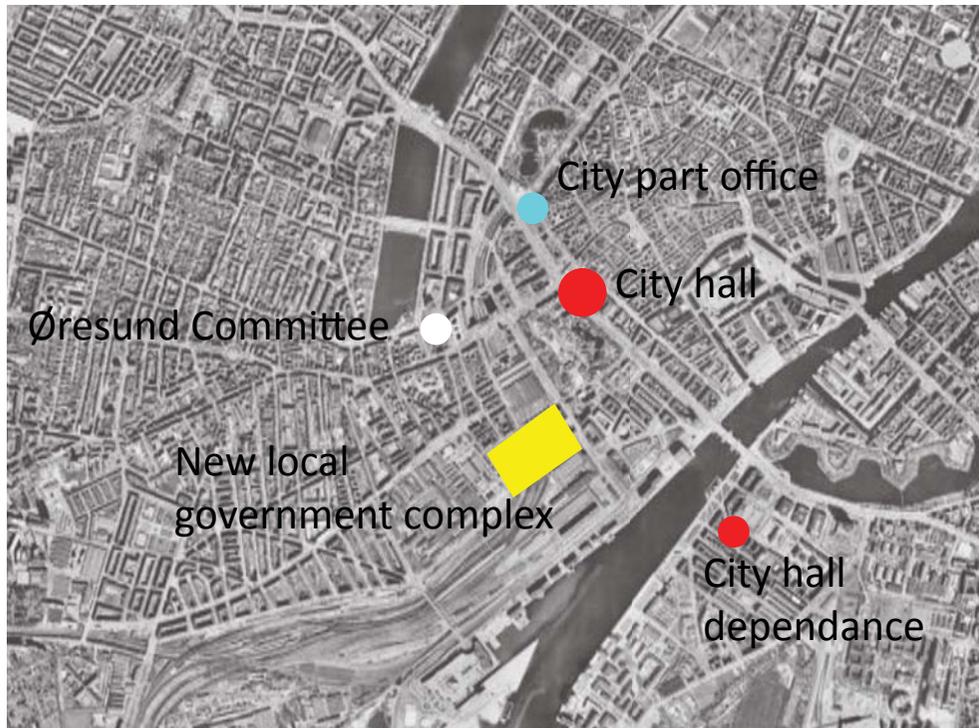
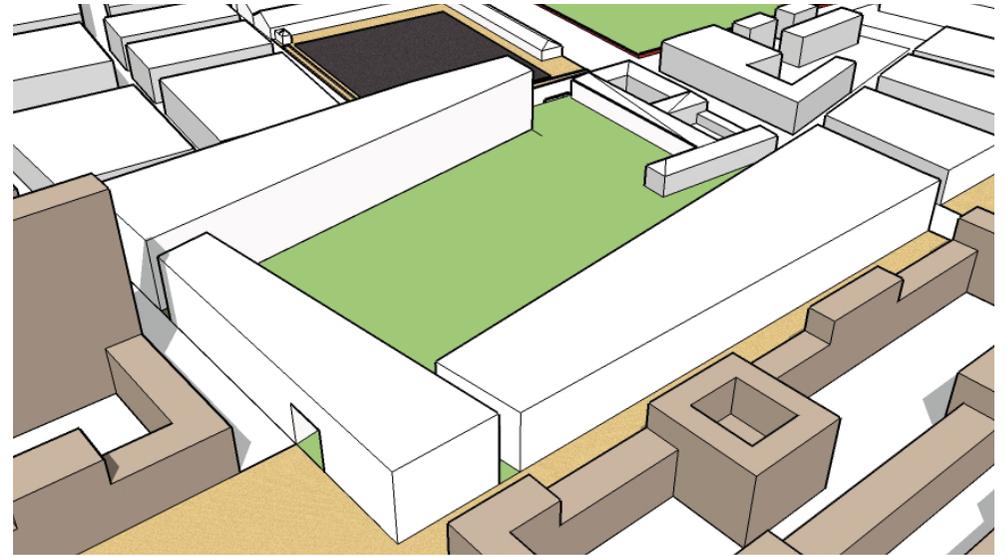


Slow traffic flows and the interaction with the plinths

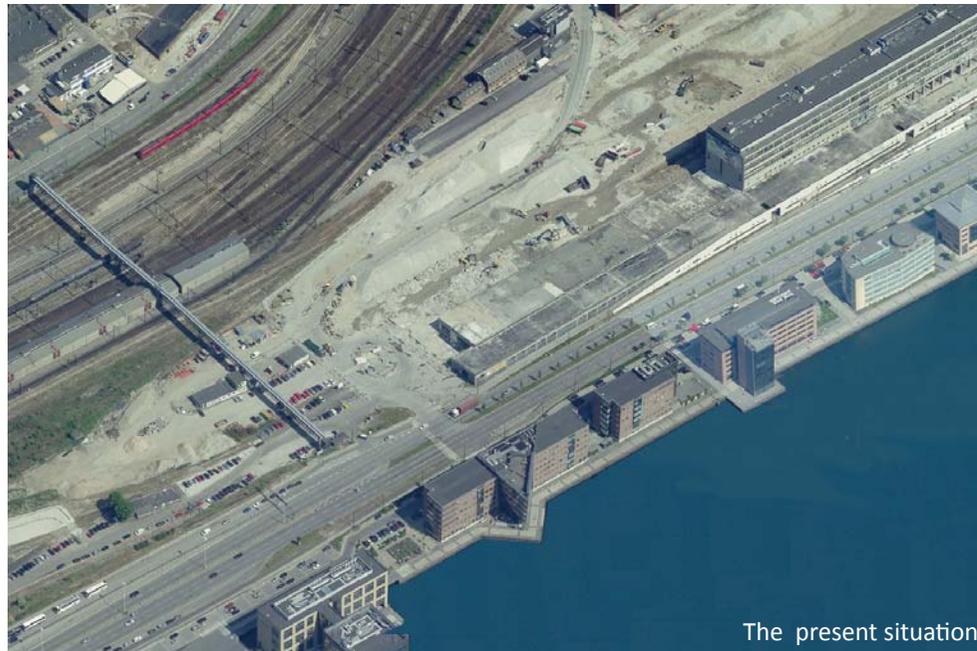
7.5 The local government complex

The second block released from the guidelines is the big block between the two stations. The size of the block combined with its very visible and central location and the vision for a public space above the tracks in the block make it ideal for an important public function. Almost all the big cultural institutions in Copenhagen have recently moved into new accommodations, but the local government bodies are spread over several locations. This is a change to bring them together, not only to improve cooperation between them but also improve the service level and visibility to the public.

The space in the centre of the block should be a high quality, green public space for the people that live and work in the surroundings. It should be accessible from all sides with routes through the space but it should also remain a quiet and secluded sanctuary, in its busy surroundings. For safety reasons and to help maintain the quality it should be closed at night.



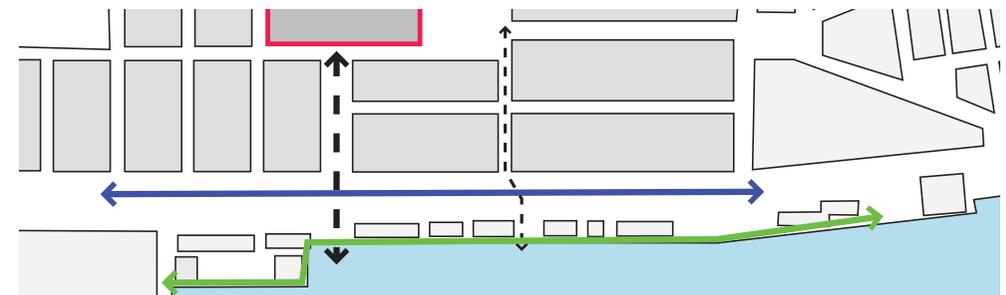
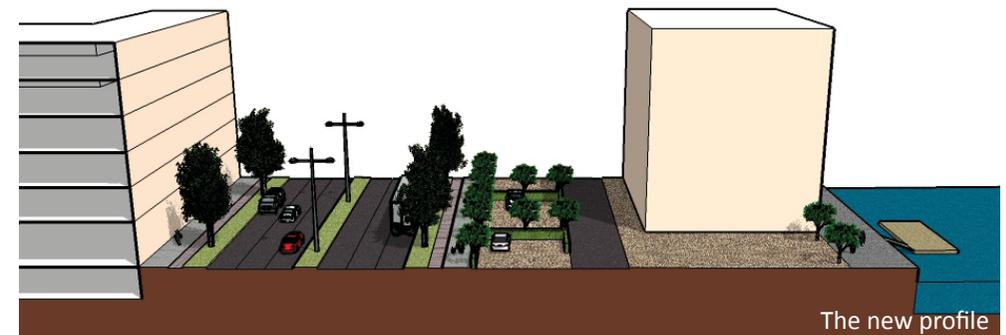
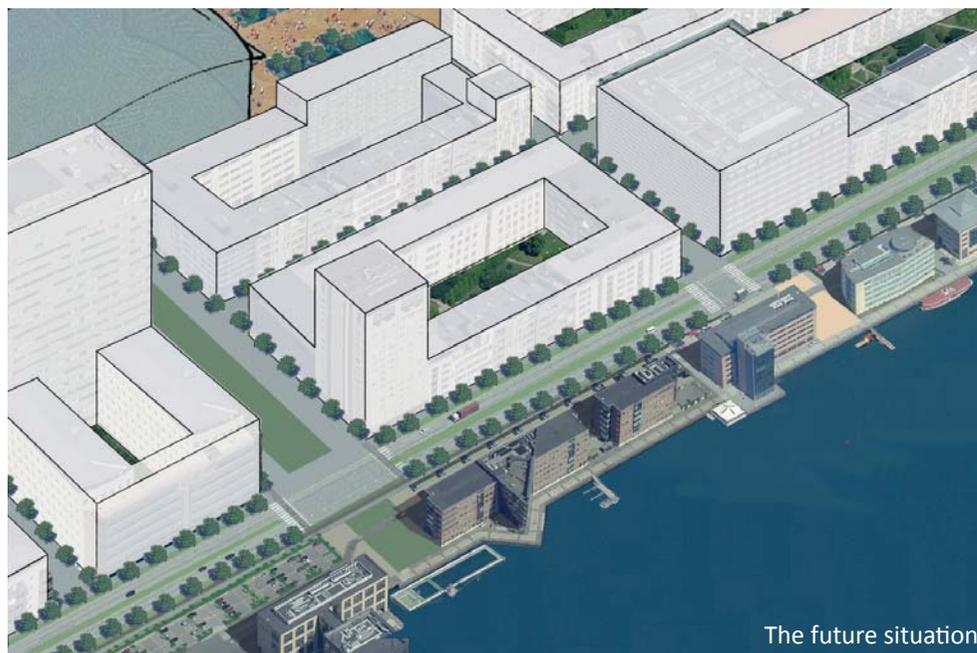
7.6 The urban boulevard



At the moment the ring road that forms the south boundary of the redevelopment area is an unattractive route to the inner city. By lining the road with buildings, optically reducing the width, and redefining the profile this road can be transformed into an urban boulevard. This brings the city to the waterfront and lets it profit from the qualities of the waterfront without compromising the functioning of the ring road.

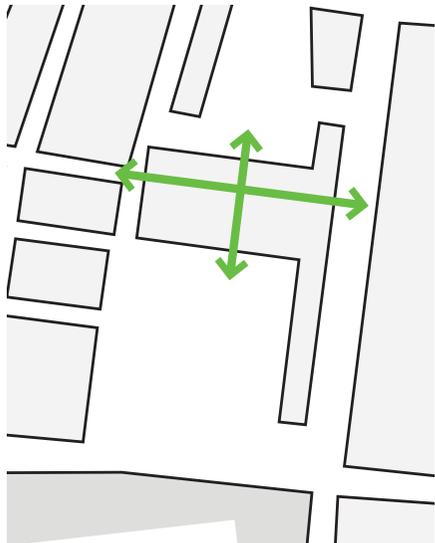
The space between the waterfront buildings and the ring road will be redesigned adding quality and structure to space and making the waterfront more accessible in strategic places. The waterfront will become the (recreative) route for pedestrians with new facilities at and on the water like harbour baths and floating cafes. Because of the abundance of waterfront in Copenhagen and the special attractions on other parts of the waterfront this part will probably mostly be used by local. This is the reason that demolition of the relatively new waterfront buildings to widen the waterfront boulevard is not justified.

Lowering the ring road at the crossings with routes to the waterfront for example the station road crossing can make the water even more accessible and enhance the flow of the ring road but the amount of traffic does not really justify this intervention.

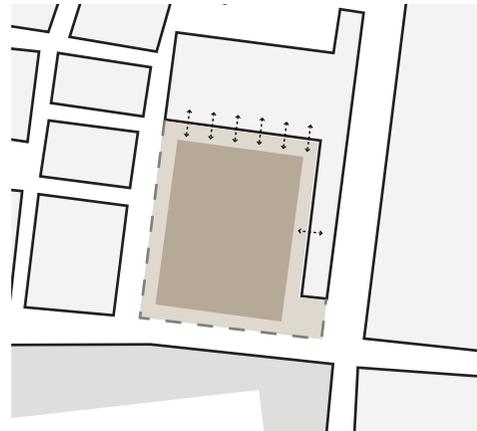
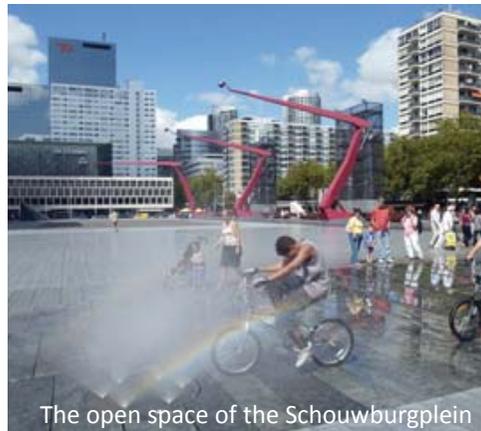


7.7 The old station reused

The architectural quality of the station building give it potential to be reused after it loses its function of a station. The big open spaces make it suitable for a number of uses like exposition space or a space for events. But neither give a constant stimulus to the surroundings which at the moment could use a boost. A permanent indoor marketplace would create activity and stimulate the local economy constantly. A market suites the cultures of the immigrants in the area providing them with a familiar way to make a living and help them integrate in the Danish society where fresh and biological food is very popular. The location between the centre and the residential areas and layout with entrances on all sides of the building make it very accessible and give it the potential to become a local meeting place and an attraction in the whole city. Transformation of the station will not be too difficult as not much has to be changed structurally. Trains will still run underneath the building but the entrances leading down to the platforms will now be entrances to a new square on the same level as the market hall.



7.8 A new square above old tracks



Because the station building has lost its function so have the platforms and their roof. Replacing the redundant roof with a flat surface can create a space at street level while the trains can still travel below.

The new space created will be big, about 125*150m meters. The size makes it suitable for big events and the city does not have and totally open space for them at the moment. It would therefore be an addition to the variety of public spaces in the city but more importantly increases the range of possible activities in the centre. On normal days people can use it for skating or enjoy the sunshine, but it can also be used for fair, the circus or open air concerts. Being besides the Tivoli amusement park could lead to temporary use by the park as well.

The open character of the square and on the other hand the desired staying quality demand a clear definition of the space. On two sides the space is defined by the station building, but on the other two sides the square needs spatial containment not to seamlessly transform into the street. A heightened walkway and rows of trees are one way of achieving this.

As stated before the square is not only accessible from the street but also from the old station building. Activities from the market hall can spill out onto the square as long as the open and multiple use character is not compromised.

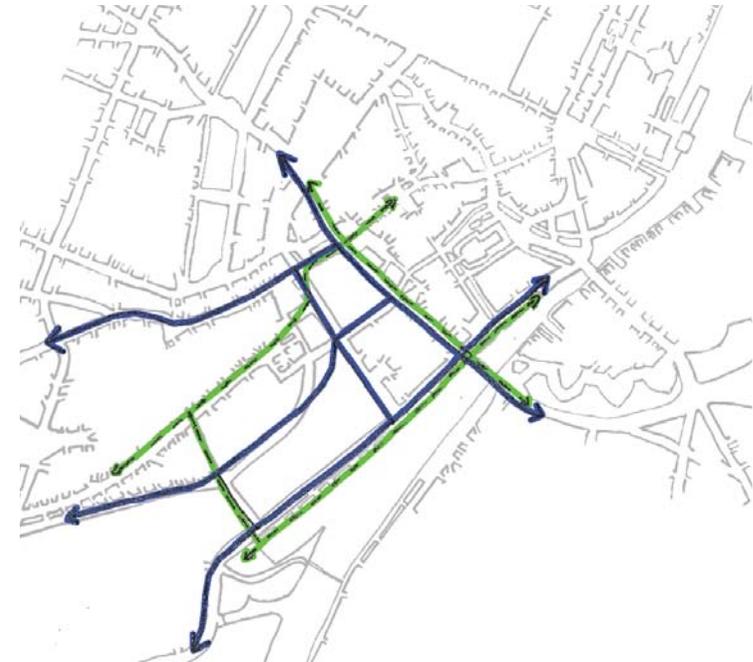


8 The effects on the city

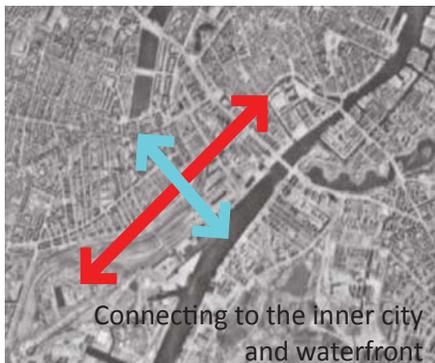
8.1 Changing the station area surroundings

The physical change and feel of the area is enormous. It will transform from an industrial and open area to an urban and dense city part. The creation of whole new neighbourhoods is an effect in itself, but the changes to the surrounding neighbourhoods are just as important. The redevelopment of the area breaks the barrier formed by the area in its current state. The residential areas to the north and the area itself will be connected to the waterfront and the area and residential area to the west will be better connected to the inner city. This is done by improving the current routes and creating new ones. By connecting well with the surrounding road structure the intervention can be seen as the piece that completes the puzzle. Effects on the slow traffic will be the biggest as this was the most hindered by the current state of the area and is given priority in the redevelopment.

Present



Future





The development of the area is a big intervention. This will produce nuisance to the inhabitants of the surrounding neighbourhoods during construction but will also bring them benefits on a longer term. The amount and diversity of amenities will be bigger in the city part, as will the amount and quality of public space. Jobs and entrepreneurial possibilities will be created, not only during construction but also after completion. The growth and development in the station area will also attract investment to the surrounding neighbourhoods, improving the area and raising house prices.

But this can also have negative effects when the area becomes so attractive that the present inhabitants are “pushed out” by the “more affluent”. This process of gentrification can destroy social structures or activities, leaving the local inhabitants in a worse situation than they were in before. Redevelopment then leads to moving instead of solving problems. It is therefore important to protect existing qualities and residents. One way to ensure that the surroundings can profit is a guideline prescribing that a number of the jobs are to go to locals.

Gentrification

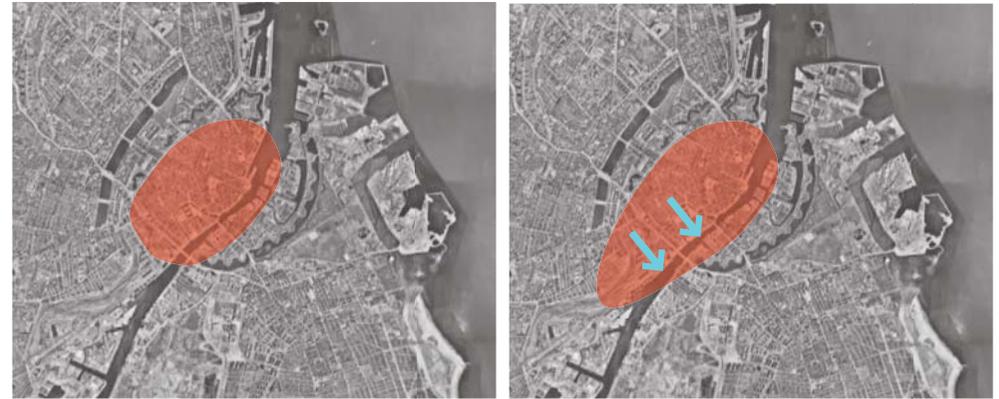
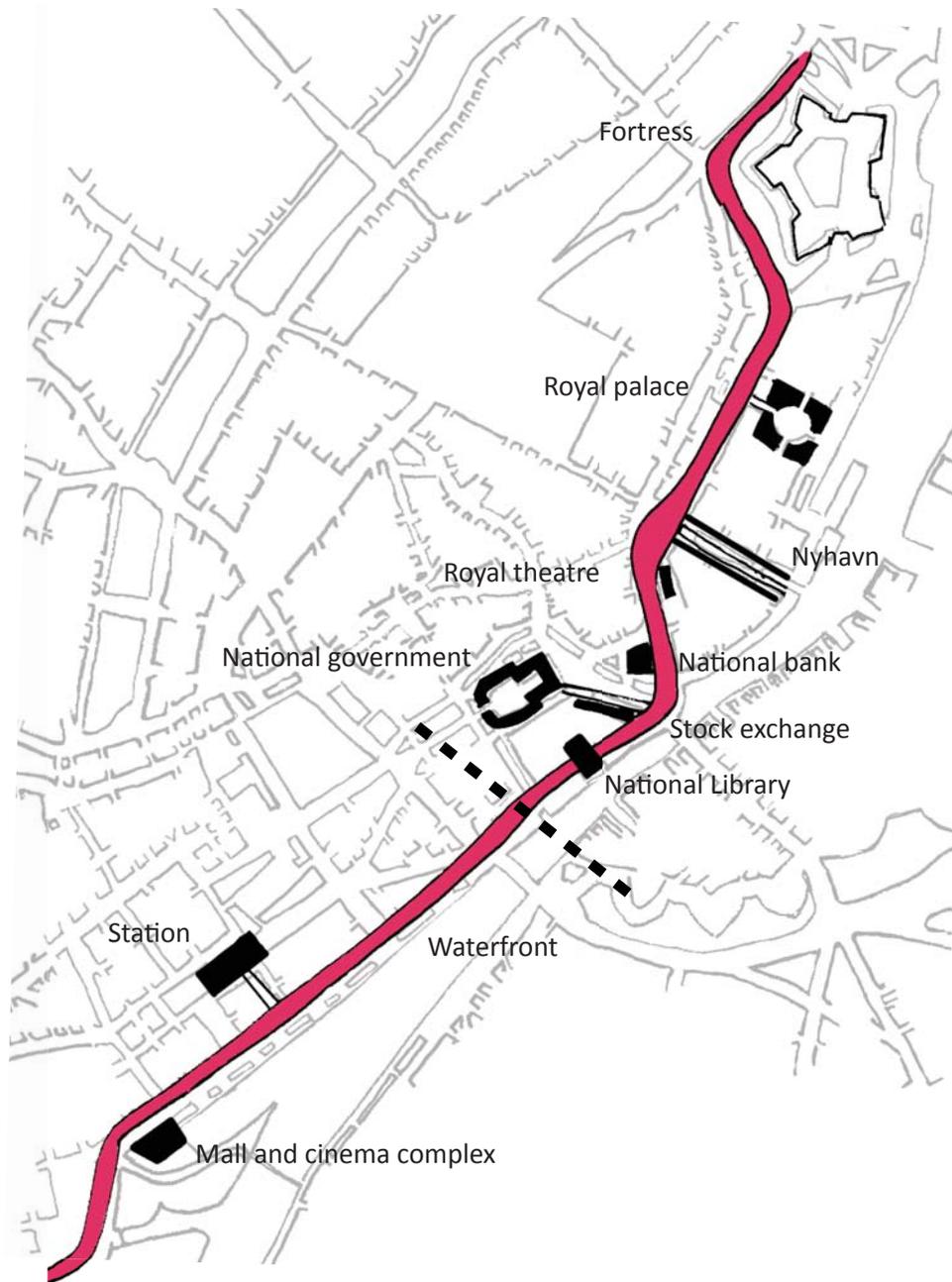


8.2 Changing the city centre

The redevelopment of the area creates new public spaces with importance on a city level. The pedestrian spaces and routes are not freestanding but connect to the existing network of pedestrian spaces in the inner city. This addition of public space moves the centre of gravity south, to the waterfront, and creates “new” routes parallel to the waterfront. The Slotsholmen Island where the city was founded becomes the gravity point once again. This shift does not mean the northern areas will become quieter, because the (historic) attractions between which the routes are strung will of course remain. Bringing the city closer to the waterfront is in keeping with the municipality vision.

The addition of public space also fits in with the tradition started in the sixties of reducing the number of cars in the centre and creating pedestrian spaces. The tradition in Copenhagen is not to address only certain key places like in Barcelona, but to address the whole city. In small steps extending the pedestrian zone, starting with streets followed by the spaces they connect, creating “pearls on a string” (Gehl, 2000). The new spaces created with the redevelopment can be seen as a continuation of this tradition.





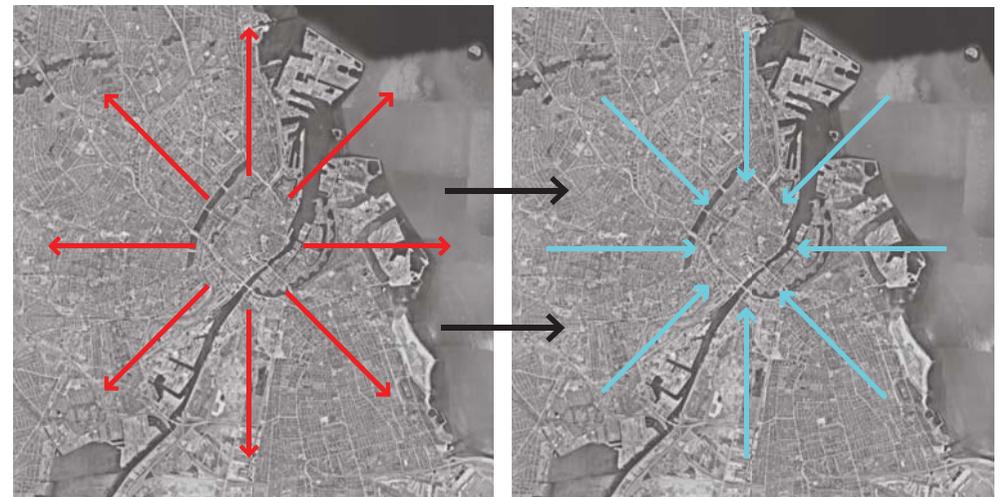
The shift to the waterfront brings the ring road in view. Between the fortress and the national library the ring road goes through the urban fabric and is integrated in the city. It is a busy road, but the traffic lights make it relatively easy to cross and the public program it connects cause it to be used by slow traffic as well. South of the national library it is a different story, not because the ring road itself changed character but its surroundings have. With the redevelopment of the station area and the redefining of the waterfront zone this stretch of ring road can have the same function as the northern part: a connector of public functions. With enough attention and priority to slow traffic the ring road could be a backbone of the inner city for all modalities.

8.3 Changing the city

The redevelopment of the area influence the city as a whole as well. The redevelopments is a step in realizing the vision of the municipality in several ways. The grand new entrance to the city can attract more tourists and businesses which stimulates the city's economy. The new development can house big or different program that previously could not be accommodated in the inner city, diversifying the city (centre). Offices and other facilities for research and entrepreneurship will be realized to help create the dynamic city, desired because it can help the international competitive position of the city.

But just as importantly the redevelopments improves the city for the residents as well. First of all the creation of over 9000 dwellings is a big contribution to the housing stock. By redeveloping an industrial area near the centre around a public transport node, instead of expanding on the outskirts of the city, the city can be kept compact and travel by public transport, cycling and walking is encouraged.

Overall the development of the station area supports the vision and helps create a sustainable and (internationally) attractive city but there are a few possible down sides as well. The redevelopment of the station area competes with other developments like Ørestad for some activities. The growth and concentration in the centre could attract so much activities that the improved transport system still becomes strained and further interventions are necessary (for instance access roads into the city).



9 Evaluation

9.1 The intervention

The integral approach of urban development with the advent of the HST have led to a big intervention in the city, probably bigger than the interventions would have been if the city and the HST were developed individually, but the benefits for both are also bigger.

The interventions have many effects on different scale levels as discussed in the previous chapters. When they are put together the effects seem to be mainly positive for both Copenhagen and the HST. The possible negative effects can be avoided if they are anticipated on and given enough attention and effort to prevent. Examples of this are the protection of existing qualities on the station area level and relating the station area developments with other developments in the city. On the bigger scales the in- and external marketing of the Øresund brand and the creating of a niche for Malmö related to Copenhagen and for Copenhagen related to for example Hamburg and Goteborg.

The advent of the HST is not a positive development for the individual position of everyone. Businesses and residents will have to be expropriated and relocated to create the new routes and tracks, and redevelop the station area. The new infrastructure will go through agricultural areas and will probably effect ecological structures and habitats. Unforeseen problems with the new tunnel through the city can lead to nuisance and property damage to the people living above the construction. Already mentioned are the development projects that experience competition from the station area development for loans, tenants etc. Malmö and the aviation industry can profit or lose out depending on whether they participate and embrace the possibilities or fight the unavoidable changes.

The better accessibility of Copenhagen will be profiting for the businesses in the city, especially the tourism industry will benefit, but also the visitors. Businesses, people and special program can find accommodation in the extension of the city centre. The living quality of the inhabitants of the surrounding neighbourhoods will improve, noise and air pollution can be reduced. The modality split shift to from the car and the airplane to the train can reduce CO2 emission and benefit the environment.

| Scale | Effects |
|-----------------|--|
| Station area | Connection the area with the centre and the waterfront. Jobs, amenities and spatial quality for inhabitants. Revitalisation and of neighbourhoods and higher property values. Gentrification: marginalisation people, activities and social structure. |
| Copenhagen | Improving public transport network. Extending centre of activities and relieving pressure on periphery locations. Competition for other development locations. Relieving dwelling shortage, adding to and diversifying the amenities and public space. Improving the spatial organisation of the city and creating a grand entrance to the city. |
| Øresund | Strengthening international competitive position toward other conurbations/cities. Growth of number of jobs and amenities. Potential growth around Malmö station. Strengthening dominant position of Copenhagen over Malmö. |
| Northern Europe | Stronger competitive position of the HST towards other modalities. Copenhagen is closer to the centre of activity in Europe. Stronger position of Copenhagen as the node and gateway of the north. Possible loss of activities to Hamburg. |



The scope of the intervention

For the HST to bring about all the envisioned effects, we have seen that big interventions are necessary:

- New HST routes and/or tracks through Germany, Denmark, Sweden and Norway (+/-2000km)
- New bridge over the Fehmarn Belt (+/-18 km)
- New tunnel through Copenhagen (+/-7 km) OPTIONAL
- Covering of existing tracks (0,5 km)
- New station building
- Relocating existing activities (Danish post, shunting yard, industrial activities)
- Rerouting future metro line
- Development of an 120 hectare area with +/- 2million m2 of built program
- Development of several public spaces for the city
- Redefining part of the ring road and waterfront

It can be concluded that for the quality of the city of Copenhagen and for competitive position of the HST these interventions are desirable. The realisations costs of these interventions are largely left out of the equation however, because an estimate of the costs is almost impossible to make and the economic feasibility is less relevant to this study than the intervention with the most potential of improving the HST network and the city of Copenhagen.

Where possible the potential to generate investment from additional shareholders (SAS or Kastrup airport) and to generate returns from real estate development is created. Interventions where the (time) benefits clearly do not outweigh the costs or risks are not advised (a new bridge at Helsingborg) or optional (the new tunnel through Copenhagen).

The size of the interventions also results in a big number of actors: 4 national governments, dozens of municipalities and several railway companies, but also the EU, environmental organisations, pressure groups and construction companies.

The scale, costs and number of actors of the interventions means that the timeframe will consequently be big as well. It can take decade of planning before a spade is put into the ground, and by then the situation for which this vision is made might be radically different.



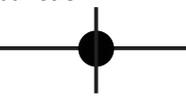
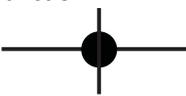
The intervention compared to the cases

The future situation in Copenhagen will not be radically different from the cases, rather a combination of the best elements of the different cases. It will be a junction like Lille and Brussels, boosting the potential. Unlike Lille it has a relatively equal connection to the cities it is connected with, so negative effects from scale differences will probably not be relevant.

It has the direct connection to the centre of activity, the redevelopment of an industrial area and the boost it can give surrounding neighbourhoods in common with London. But where the redevelopments in London have an effect on the local level in Copenhagen the whole city can profit.

The development of a dense mixed use area over underground tracks is conceptually the same as in Amsterdam. But because the intervention in Copenhagen is smaller, so are the risks, making it more feasible. Another difference is that in Copenhagen it will be an addition to the existing centre and not try to create a new one.

The lesson of feeders and enough critical mass to grow from is learnt from Lyon. It can be concluded that the Copenhagen case is a continuation of the HST tradition, learning from its predecessors and evolving the “species”.

| | London | Amsterdam | Brussels | Lille | Lyon | Copenhagen | Copenhagen new |
|---|---|--|--|---|--|---|--|
| population | 7.500.000 | 750.000 | 1.000.000 | 200.000 | 450.000 | 500.000 | 500.000 |
| GDP in billion US\$ (2005) ¹ | 452 | 42 | 39 | 27 | 56 | 41 | 41+ |
| Type of City | ISC | ISC | ISC | ciT | ciT | ISC | ISC |
| Type of HST Station | Terminus  | Terminus  | Junction  | Junction  | Line  | Terminus  | Junction  |
| HST relation with centre | Direct  | Indirect  | Direct  | Direct  | Semi-direct  | Direct  | Direct  |
| HST relation with the airport | Indirect  | Direct  | Indirect  | Indirect  | Semi-direct  | Direct  | Indirect and Direct  |
| The intervention | Station adjustment | Station adjustment | Station adjustment | New station | Station adjustment | Station adjustment | New station |
| | Tunnel | Station area redevelopment | Station area redevelopment | Station area redevelopment | New station | | Station area redevelopment |
| | New train route | Existing train route | Existing train route | New train route | New train route | Existing train route | Tunnel/ existing train route |

¹(http://en.wikipedia.org/wiki/List_of_cities_by_GDP)

HST development

From the research on the Copenhagen case several recommendations can be made to cities, governments and railway companies contemplating extending the HST network to or in their country and cities. First of all HST development is only advisable when the distances to relevant cities makes the HST competitive with flying in the broad sense. When the distances are too big the HST will not generate enough passengers to be profitable. When the HST is competitive with flying, cooperation between the HST and the aviation industry can lead to more passengers for both. Substituting “local” flights for train journeys creates demand for the HST and frees up runway slots for more profitable longer flights. The HST can also become a feeder for the airport.

The growing mobility associated with the HST increases the reach of cities. A specific set of qualities makes a city unique, it creates a niche strengthens the city's competitive position towards other cities. The need for niches not only goes for cities connected to each other through the HST but also for a metropolitan area with multiple centres where probably only one centre has a HST stop.

On order for the whole metropolitan area to profit, besides the niches, good internal connections are important as well as the internal and external marketing of the whole area the HST stop services as one.

The success of the HST greatly influenced by the location of the stop. There are three main requirements for a station location. (Stations can operate without meeting all the requirements, but usually the effects of the HST will be smaller and extra measurements will have to be taken to make them successful.) The first requirement is an optimal route for the HST: a balance between the shortest route and the smallest intervention. The second is the accessibility by feeders and the proximity to the centre of activity. A stop at the centre of activity with good access for all modalities and from the whole region is the ideal situation. Development possibilities of the direct surroundings of the station is a way to get some return on the financial investments and generate an area that matches with the character of the HST (program mix, density etc) and which in return create demand for the HST. Development potential and open space in the area can make it easier to create an “ideal” node from the perspective of flows (HST) and the place (the city).

Urban development

Because the effects of the intervention have a much bigger reach than the area of the redevelopment, the advent of the HST can in many cases be seen as an urban project. Within the urban project there is the need for other documents like a masterplan for the redevelopment area.

Big interventions like the HST urban project should be seized to realize the future vision for the city: a big step in the right direction, a chance like this does not come around often!

With an intervention like the one on Copenhagen, because of its size and the duration of the project, it is a good idea to not design the whole plan. Instead guidelines that can guarantee the quality of the development and at the same time make it flexible and leave room for market processes should be made.

Integration of the new developments with its surroundings is necessary for the area and the station to function and to become part of the urban fabric. The most important way to do this is a good connection to the existing road structure. The system of public spaces and the local tradition of dealing with public space are important too. Grain size, building height and typologies can help with the fitting in as well. On the other hand the possibility to be different, to add to the diversity of public space or available accommodation can enrich a city.

Sufficient densities, a good program mixture and attention to slow traffic are necessary to provide enough critical mass for the station and the amenities, besides providing liveliness and social safety in the area. Program can create and direct flows, so it is important that the location of program corresponds with the public spaces to achieve the intended use (amount and kind) of the public space.

The existing situation can be used to give the area character, identity and diversity and starting points. Existing buildings, constructional restraints give potential to do something special.

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