Vital
Quality of life
Connectivity
Meeting places (communication)
Diversity
Surroundings
URBAN SYMBIOSIS
INTERWEAVING TU DELFT IN A KNOWLEDGE ENVIRONMENT

P 5 REPORT URBAN SYMBIOSIS

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COURSE: MSC4 URBANISM - URBAN REGENERATION STUDIO

STUDIO: URBAN REGENERATION
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COVER IMAGE: BY AUTHOR
This final report describes the last project in my education at the faculty of Architecture and the master in Urbanism.

In September 2009 I started my graduation project at Delft University of Technology. Because of an interesting topic on the increasing shortage of student- and starter accommodation I was been doing for the municipality of Zoetermeer, I wanted to expand my knowledge on this theme by continuing it.

After my P1 I changed topic, because in my opinion the problem field was too Real Estate related, which is not my interest.

My problem field changed into the Delft University campus-case, which is isolated and not interacting with the city nor its direct surroundings and has potential to develop its regional strong position in the Randstad.

In my point of view the previous topic can be used as one of the tools to enrich academic life with urban life and to create synergy between university campus and city.

This urbanism topic is related to an urban regeneration process to increase economic-, social- and environmental contribution of Delft University of Technology.

The topic I have chosen does perfect match the Urban Regeneration Studio, which was lead by Paul Stouten, John Westrik and Herman Rosenboom during the first half year (MSc 3).

This report is a result of my graduation project (MSc 3 and 4). It covers my process, problem statement, analysis and design project in the graduation year.

I want to thank my mentors of Delft University of Technology, Urbanism department, for their input in my project:

**Spatial planning & Strategy:** Dr. Ir. P.L.M. Stouten  
**Metropolitan & Regional Design:** Prof. Ir. C. M. de Hoog  
**Urban Design:** Ir. W.J.A. Hermans

Hannes van de Ven,  
Delft, september 2010
Figure 01. Distribution of universities in the Netherlands

Figure 02. Interweaving the campus side

- Vital
- Quality of life
- Connectivity
- Meeting places
- Diversity
- Surroundings
SUMMARY

The Netherlands accommodates 13 universities. Common problem is that campus sides are mono-functional enclaves outside city centers. They almost do not contribute to liveliness of cities, while they are the ‘engines’ of knowledge cities.

This thesis researches current trends in designing campuses which are: Open up, upgrade connectivity, high quality of life, meeting places for exchanging knowledge and diversity.

Spatial research on campus settings is done to compare these guidelines and make clear how they can be useful for campus design.

Delft University is one of the campus settings, which is a mono-functional enclave. This campus side, located outside the city center is only attractive for knowledge workers. This thesis focuses on the interweaving of this mono-functional campus in the city of Delft, by adding program and attracting a wider target group.

Delft’s future plans are to become a knowledge city in the Randstad region. Its strategic location has potential to become an important knowledge centre of the whole Randstad.

Connecting the campus side and its related business with its environment stimulates knowledge-based activity and has to be upgraded.

This thesis focusses on the regional and local connections of the campus area of Delft. Future developments is changing orientation, from university campus side towards the complete knowledge area at the border of Delft. Besides these knowledge-based activities, it is important for Delft to create local business and contributes to city economy. This means that a broader target group has to be attracted and the area not only is attracting for students and employees.

The connectivity aspect plays an important role in this thesis, because it gives direction to the developments of Delft and it takes existing policies into account. Most important is that the side is interweaving with its environment on different scales and principles.
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A revolutionary shift in knowledge, is caused by the innovation of electronics which made 'the digital world a reality' (Sassen, 1991). This is confirmed by Knight (1995) who states that there was a shift in the last decades of the twentieth century, from the industrial to a post-industrial economy: ‘knowledge based’ and service economy. This has been made possible by innovating information and communication technology, which increased the mobility of people and simplified worldwide communication (Knight, 1995). These cities that are being innovative by generating new knowledge will be economically more successful.

Instead of industrial matters, knowledge is now seen as ‘strategic tool’ to keep economy running. Governments often develop strategies which are knowledge based. According to Knight this can turn knowledge resources into local development (Knight, 1995). These ‘knowledge cities’ are described by Alraouf as “cities that possess an economy driven by high value-added exports created through research, technology, and brainpower. Technological innovations have shaped and are still shaping the economic-, social- and physical development of cities all over the world.”(Alraouf, 2006, cited in yigitcanlar et al., 2008, p. 240).

Cities are attractive (figure 03), “cities are, above all, business nodes where knowledge exchanging takes place.” (Jacobs, 2000, cited in Franke and Hospers, 2009, p. 59). Also van den Berg et al. (2005) regards cities as places where knowledge is produced, innovated, exchanged and marketed. This is often encouraged by networks of academic institutes that cities have. These networks create well educated citizens. To stay competitive, cities are using the universities to promote themselves and attract high educated citizens for being innovative (figures 04 and 05).

It is a statement that it is essential to educate, attract and retain ‘knowledge workers’ in our present ‘knowledge-economy’ to keep countries competitive. Therefore, the importance of universities has become high-rated in order to keep this economy running. According to Ergazakis et al. (2004) the knowledge city aims at knowledge-based development by encouraging the continuous creation, sharing, evaluation, renewal, and update of knowledge.

Often, these knowledge ‘engines’ are enclaves, away from the city centre. (Knight, 1995 ; Markusen, 1996).

A large part of today’s economy is based on knowledge. According to Castells and Hall (1994), cited in Yigitcanlar et al. (2008), universities in knowledge cities are as coal mines in an industrial economy. A lot is written about these knowledge cities and how they can be succesfull. Less is written about University campuses, which function as ‘engine’ in a knowledge economy.

I wonder how a campus can be better placed into a city that calls itself a knowledge city. Are campuses only interesting for their traditional target groups or can they contribute to a broader strategy for the knowledge city? I wish to analyze the campus development based on the point of view an of urban structure. Integrate the campus by adding housing, facilities and upgrade connectivity?

This project fits best in the Urban Regeneration studio.

Guidelines, based on the urban regeneration process that meet today’s trend in university campus design are generated in the theory paper, important guideline (supply of users) will be analyzed in a case study. Comparing the theory and practice, conclusions will be used to design a location in order to enhance campus setting and acting.
1.2 Problem Statement

The graduation project is entitled "Urban Symbiosis: Interweaving TU Delft in a knowledge environment". The title covers the design and research objective. The changing role of Dutch university campuses is becoming a high-rated issue in the Netherlands. 'The Campus of the future' is an important instrument to achieve the strategies developed by Dutch Universities (Heijer, 2008) and may also work as tool for spatial strategies developed by local governments in places where large educational institutions are located.

In many cases these knowledge intensive activities are concentrated or clustered in limited spatial areas (Knight, 1995; Markusen, 1996). According to Bender (1988, p.190) "there certainly is no symbiosis, between city and university." In other words, the relation between concentrated university campuses and the city is often very complex and conflicting. Their former mentality was to settle away from the chaos of the city and free from distractions of modern civilization (Figure 06). This is the reason why university campuses nowadays profile themselves as mono-functional, unattractive enclaves, while the trend is the opposite: 'The future campus as a meeting place' related to the city (Ekkelboom, 2008).

Perry and Wiewel (2005) cited Shills (1988) who wrote that it is impossible for Universities to be self-contained. This means that they have to interact with their environment to be successful.

Over the years, the campus university has had many contextual urban forms in relation with its environment. Starting with the universities interwoven in the urban fabric. As said before, the mentality of the universities changed and moved away from the chaotic city (figure 06). Currently there remain three of these models in Western Europe (Heijer, 2008; Christiaanse & Hoeger, 2007):

- The campus as a separate city (outside city borders)
- The campus as a 'gated community' in the city (independent area).
- The campus integrated within the city (Connected to its environment).

These campuses are set up as mono-functional entities on isolated locations beyond the city limits (Christiaanse, 2007). The university buildings are directly used for educational and research purposes: lecture halls, classrooms, laboratories, libraries, and etcetera. As said before, the new trend of campus design is focused on integrating them and opening up, which can stimulate economic development and interaction with the city.

There is almost no interaction between these concentrated university campuses and the city, which is not providing economic-, social-, physical- and environmental development of a knowledge city.

Problem statement for this thesis will be (Figure 07):
There is often complex, physical interaction between university campuses and the surrounding city areas, caused by urban development through the years. This causes a lack in economic-, social- and spatial development.

Figure 06. Campuses of Dutch universities in twelve Dutch cities, showing the complex interaction between university campuse and city. ("univer-cities") - land property dark blue, buildings light blue (note: Amsterdam has two universities) (Den Heijer, 2008)

Figure 07. General Problem Statement: No Interaction between university Campus and the City.
This chapter debates the aim and research questions of the project.

1.3.1 AIM OF THE PROJECT
Aim of the graduation project is to analyze the problems stated in the previous chapters and find ways to answer them in order to generate better interaction between cities and university campuses to stimulate knowledge-based economy for being competitive to other knowledge cities. The project will generate better understanding of campus planning and their socio-economic effects in knowledge cities in order to meet today’s trend, which is open up these campus sides, stimulating knowledge-based development, which is also good for local economy and surrounding neighborhoods. Guidelines and instruments will be created in order to improve the functioning of a university campus in a city and its region, which increases social-, economic- and physical interaction with the knowledge city. Enriching academic life with urban life can stimulates this interaction according to Hoeger, cited in Christiaanse (2007)(Figure 08).

Hoeger (2007) explains it as an attempt to create a sustainable and lively sense of urban community. Opening and interacting a university campus is regarded as potential for institutions to integrate in urban surroundings. It will bring structural and infrastructural changes in advance of long term economic growth.

To achieve exchange and innovation of knowledge, continuous interaction between homeland citizens and foreign citizens is needed.

1.3.2 RESEARCH QUESTIONS
Many university campuses are dealing with the problem mentioned before. The university campuses dealt in the graduation project are focussing on the Western Europe models. Finding solutions for opening these isolated enclaves is timeframed during two semesters (MSc 3 and MSc 4). To frame the academic research and finding ways to fight the problem, relevant research questions are important to narrow down the graduation project.

MAIN RESEARCH QUESTION
What urban plans, are needed to upgrade TU Delft campus resulting into a higher performance and contribution to the ‘knowledge environment’?

SUB RESEARCH QUESTIONS
1. What are main guidelines for designing university campuses in knowledge cities related to economic-, social- and physical development?
   This will be researched by writing a literature review, in order to be aware of nowadays campus trends. These guidelines can bring more focus to the design direction.

2. What is Delft and University its position in the south wing of the Randstad according to policy documents?
   Also this research can be done by reading literature.

DESIGNING PART:
3. What program is needed in the area to create an accessible, connected and attractive node on different scales within the city and its region?
1.4 SOCIETAL AND ACADEMIC RELEVANCE

1.4.1 SOCIETAL RELEVANCE

Investing in the ‘engine’ of a knowledge city is investing in its economy. Christiaanse (2007) sees the ideal university campus, as “an interconnected deconcentration” of specialized clusters, which together constitute a network of knowledge and individually function as catalysts for their immediate surroundings”. He believes that this creates symbiosis in environment and everyday life. It promotes social activity because of diverse building architecture and lots of public activities. Social conditions are being generated and affected by physical and economic elements. Social elements are results of a high-quality living-environment which is created by high-quality environmental elements and opportunities in economic development.

Regenerating and expanding existing university campuses can have a significant effect on surrounding neighbourhoods. These campuses are providing housing, social activities and support services continue to grow. Effects in these surrounding neighbourhoods are mainly the improving of appearance, safety and socio-economic status.

Students are all-important for a city, for retaining knowledge in this current knowledge economy. They also create liveliness, giving new impulses, energy and have a high economic value. A knowledge based city has to give opportunities to develop themselves and maintain knowledge. On the other hand, this innovative and dynamic city will give an economic perspective.

Investments in university campuses does not only create education and employment by attracting businesses, but brings liveliness. With this project, I want to show that investing in university campuses can contribute to a socially diverse urban environment.

1.4.2 ACADEMIC RELEVANCE

Lots of conclusions were written along the trend of the future campus. Several reports are written about campus design from a Real Estate point of view. This project will discuss campus design from an urbanism point of view which will result in a list of criteria for successful campus design regarding to the physical and vital interaction between university campuses and the city.

This graduation project for the department of Urbanism of Delft University of Technology deals with research, finding guidelines which are important for campus design and meet today’s design trends. Aim is to develop spatial design interventions for integrating university campuses into their environment in order to contribute to the overall development of the city.

Figure 09. Adding jigsaw can link all individual areas
Starting the thesis with literature research. The research for the graduation project is covered by a theoretical review, empirical research and a location analysis.

The first research question will be answered doing a literature research. By answering this question, an academic review will be written according to fundamentals of a knowledge city and the physical contribution of university campuses in it. It creates better understanding of campus planning and their socio-economic effects in knowledge cities in order to generate better interaction between cities and university campuses.

Summarizing studied academic literature has to generate a list of guidelines in order to redesign a university campus, which increases social-, economic- and physical interaction with the knowledge city.

Literature used for defining the knowledge city and its fundamentals is wrote by Van den Berg et al. (2005) and Yigitcanlar et al. (2008).

The position of university campuses in knowledge cities will mainly be researched based on literature of Christiaanse et al. (2007).

The review will result in a review paper which contains several guidelines for designing university campuses meeting today’s trend.

Besides extensively research on nowadays campus trends and function of campus sides in knowledge cities, case study research is done on three different campus settings; greenfield campus, city campus and technology campus.

All over Europe, different campus settings appear. Research is done on location of the campus side compared to the city, how the campus developed through the years, what program these sides facilitate, how spatial setting is and what is the city context.

Not only general literature has to be read, but also contextual research has to be done. What is Dutch policy according to campus sides, but also policy models of South Wing region and local policies?

The framework of literature that is created, is main instrument for background study of the thesis. Besides the research technique of literature review, lots of information about campus development, Dutch urban regeneration and different strategies to use, is gathered by discussing with mentors, teachers and professionals. Interviewing them specified my research and goals even more.

After having lots of information about the problem statement in general, spatial research of the design location and its region is done. By analyzing regional and local structures (history, geomorphology, infrastructure, urban environment, nature, water), the area its layers were disconnected to get a perfect overview of the characteristics and surroundings. This improved understanding of the project location.

TU Delft college van bestuur (2010) TU Delft Campus Visie2030 made a vision for TU Delft campus in general, by analyzing it, principles of this vision framed the designing direction.

The design is based on knowledge gained from literature, local and regional influences, interviewing and the Campus Visie 2030.

The Campus Visie2030 and the campus guidelines, set up in the literature review, framed the design direction.

Empirical research is done (Case study) comparing three different tramlines in the Netherlands researched on:

1. Public transport network design
2. Urban design
3. Public transport system functioning
4. Urban planning and policy

All information gathered made it possible to create a concept, based on background literature, spatial context of the area and case study research.

Visual research of a design by making a flexible maquette for creating different layouts based on different campus setting models brought me to a final project location design. Scale blocks with possible amount of program were cut out. With the ‘lego-blocks’ different variations could be puzzled.

One of the variations is worked out in the design location. Program was linked to the specific variant and an urban plan, based on campus guidelines and casestudy research is designed and detailed.

To link the final design, an evaluation is done after the design was worked completely out. Researched guidelines were checked if being used in designing a new campus environment.
1.6 THEORETICAL FRAMEWORK

The relation between concentrated university campuses and the city is often very complex and conflicting. This paper is written, based on an academic literature study to find an answer to the following question: What are main guidelines for designing university campuses in knowledge cities related to economic-, social- and physical development?

By answering this question, an academic review will be written according to the fundamentals of a knowledge city and the physical contribution of university campuses in it. It creates better understanding of campus planning and their socio-economic effects in knowledge cities in order to generate better interaction between cities and university campuses. Academic literature treated in this paper will cover the fundamentals that are needed for knowledge cities to be sustainable, attractive and innovative; what role university campuses play in knowledge cities based on economic-, social- and physical development; and which physical urban planning elements are mainly needed to affect the contribution of university campuses.

URBAN REGENERATION

‘Urban Regeneration is about providing a better physical environment and social and economic opportunities for citizens. The studio of urban regeneration is concentrated on methods of public intervention, urban design, sustainable development, and strategic plans and policies behind urban renewal strategies’. (Roberts and Sykes, 2006) (Figure 10)

The key to an urban regeneration process is, according to Roberts and Sykes (2006) model, the many factors that are supporting the conditions in a city. However, they are close to what many academic institutions are currently attempting to do; integrate themselves into the urban environment from an ideological (economic and social) and physical point of view, resulting in mixed use and economic developments with local and public functions as discussed by Hoeger, cited in Christiaanse (2007, p19).

KNOWLEDGE CITIES

Knowledge cities and university sides are related to each other. Universities are the ‘engines’ of knowledge cities. They keep them running by staying innovative. Knowledge cities have to be sustainable, this means that not only university related business profit from the university, but also inhabitants of the city can. By doing research on different variants of knowledge cities, hopefully all target groups will be taken into account.

SUSTAINABILITY

The individual term ‘sustainability’ in this thesis has an environmental meaning. Not only a knowledge city has to offer chances for all inhabitants, it also has to fight nowadays’ milieu aspects, which are related to clean transport methods, using milieu friendly material and enlarge the life of a design and the use of it.

URBAN SYMBIOSIS

As the title of my report is clear ‘Urban Symbiosis’, I introduce a new term where I would like to find a way in which TU Delft Campus can contribute to its environmentits surroundings, and making a stronger unity by creating synergies between TU Delft and the city of Delft. Symbiosis means the cooperation of two individual organisms, which can not survive separate, but can survive when cooperate. Can university campuses environments create a more bearing function, according to an overall city network?

NETWORK CITY

Network cities are agglomerations of urban areas which are connected through transport networks. The focus of a network city is more on different networks, flows and nodalities.

Investing in economic-, social- and environmental aspects according to Roberts and Sykes model will have outputs that are sustainable for a city. By designing en stimulate the inputs, outputs will be stimulated as well and can be self-contained.

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<th>Environmental</th>
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<th>Training &amp; Education</th>
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<td>Enhance skills, enhance research and development, support schools and academic-based facilities</td>
<td>Urban design and quality, improved urban spaces, access to, housing improvement, enhanced urban design and quality</td>
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<tr>
<th>Economic Development</th>
<th>Environmental Action</th>
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<td>Support for new and existing firms, improved skills, innovation, economic diversification</td>
<td>Urban greening, company-based action, stimulating green growth</td>
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Figure 10. Framework for Urban Regeneration Process (Roberts & Sykes, 2006, p.20)
AN ISOLATED CAMPUS

The University of Delft, is one of 13 universities located in the Netherlands. It was set up in 1842 in only one building inside the city centre. In 1901, the University expanded and several faculties were occupied in the city centre. Because of an exploding number of students and employees, but limited space, the University was forced to expand outside the city centre, Wippolder. Not all faculties moved outside the city centre. However, at the beginning of the twentieth century some technical faculties chose to cross the river Schie.

In the beginning of the 1950s, the university planned to realize a campus in an area with educational buildings along the ‘Mekelweg’ (main road). In 1997, the central library of TU Delft was delivered on the campus. TU Delft left the last building they occupied within the city centre of Delft. Some old buildings on the campus were demolished and some were transformed into student accommodation. (Mácel et al., 1994) Recently, the main road (Mekelweg) was transformed into a central park for pedestrians and bicycles. On or around the campus itself some knowledge based businesses is located. As it is close to the highway exit this is an interesting location. Technopolis is very attractive for the research and development businesses.

Because of the movings, Delft campus lies isolated from the city. The physical perceptible lack between the city centre and TU Delft campus, only attracts target groups (students and employees). The TU Delft Campus is not connected to the rest of Delft city, although it creates the biggest brand aware name of the city. The university is independent and physically, socially and culturally isolated. (Knight, 1995)

By creating an isolated campus with a concentration of educational buildings, inhabitants of Delft are avoiding this area. As there is nothing for them to visit, they show a social lack of interest in knowledge institutes and business. Fernández-Maldonado & Romein states that also students and employees are not connected with Delft City and become a commuter flow. (Yigitcanlar et al., 2008)

Figure 11. Schematic view of the development through the years of the university campus of Delft

“THESE CAMPUSES ARE SET UP AS MONO-FUNCTIONAL ENTITIES ON ISOLATED LOCATIONS BEYOND THE CITY LIMITS”
The city of Delft, with 96,000 inhabitants apart from the international TU Delft university, is positioned in the South Wing of the Randstad (Figures 12 and 13). The municipal authorities introduced the term ‘Delft Kennisstad’ (Knowledge City) because of the important role of Delft University of Technologie, profiling itself as economic ‘engine’ contributing to the city’s economic development.

The Spatial Structure Vision 2030 of Delft focuses partly on the role of the university in urban development. The municipality is aware of the enormous attraction of Technological business and educative institutions caused by the Technological University. Further development is needed to strengthen the strong international position of Delft, by creating an attractive working and living environment (Ontmoetingen met Delft, 2009).

The Hague, Dordrecht, Zoetermeer, Leiden, Gouda and Delft all are part of the southern network in the Randstad. Delft accommodates a high-quality knowledge centre. Other qualities this network presents and wants to intensify are, (inter) national centre of justice and government in the Hague and main maritime and logistics cluster in the port of Rotterdam.

In the South Wing, three universities are settled: University of Leiden (Life sciences), Delft University of Technology and Erasmus university (business) (Figure 13). Delft University of Technology has two concurrents according the Technological discipline: Eindhoven University of Technology, University of Twente.

Public transport and highways do function as backbone for attracting and developing business and accommodation, with accessibility as a main goal. Because of this central position in the South Wing, all larger cities (Rotterdam and The Hague) can be reached within half an hour by car and within 15 minutes by Public transport. International connections are available via Rotterdam Airport and Schiphol Airport.
Figure 14: Position of Delft city centre and University campus

Problem of the plan area is that it is enclosed by strict borders; railway, canal, highway.

- Ground surface TU: 170 ha.
- TU Buildings: 12 ha.
- Parking places: 4,000 = 12 ha.
- Students: 15,500
- Employees: 5,000
SPATIAL PROBLEMS
The contribution of Delft university campus to economic-, social- and physical development in the knowledge city is minimal. Knowledge workers have to be attracted to innovate, create, retain and exchange knowledge. To attract knowledge workers quality of life has to be provided. Also infrastructure of the campus is only focussed on the area itself and not on its position in the city's urban fabric. Today's trend is to open up the campus side for being competitive and be connected to other universities. It will stimulate knowledge-based development, which is also good for local economy and surrounding neighborhoods.

SOCIAL PROBLEMS
Social segregation is influencing economic development in a negative way. Adding non-university functions to encourage diversity and social interaction will discourage the risk of further isolated, mono-functional sides. But, when generating a campus, away from the city with a complete range of amenities for living, working, shopping and leisure, it will turn into an autonomous compound with all characteristics of a gated community. In other words, there has to be interaction between university campus and its surroundings to be not isolated. Campus universities also attract Research and Development related business and can create services which surrounding neighborhoods can use and which creates jobs for inhabitants of a city (Christiaanse, 2007).

The city of Delft disposes of a large number housing knowledge workers are not allowed or cannot afford to live in. It is causing an enormous commuter flow. Because of the lack of suitable accommodation, many graduated students move away, which influences economic development.

CONNECTIVITY PROBLEMS
Connectivity is important for commuters between Delft university and both railway stations. It is the most important gate to the rest of the Netherlands and has to be high quality. The specific target groups of students and staff are the only ones using the campus area with almost no connection to the rest of Delft city nor the region. The current location of TU Delft is in between two train stations with almost no connection to the city centre. (Inter)national students do not make use of the city if not necessary. Public transport is neglecting the historical city centre causing almost no attraction for commuters in Delft. Staff of TU Delft, travelling by car is using the highway, which is next to the campus, this causing no relation with other parts of Delft at all.

PROBLEMS ACCORDING TO QUALITY OF LIFE
This lack of interaction causes that, quality of life on the campus is poor. These mono-functional enclaves does not connect to the liveliness of a city and does not offer facilities, which can be used by people besides students and staff. University campuses have to open up and share their services with surrounding neighborhoods to create urban symbiosis. Academic institutions have to be open clusters, because it is easier to exchange knowledge in clustered areas. This openness brings quality of life and contributes to diversity, which is according to Jacobs, cited in Franke & Hospers (2009) important to be inspiring and innovate knowledge.

“THERE CERTAINLY IS NO SYMBIOSIS, BETWEEN CITY AND UNIVERSITY.”
The project consists of six phases as shown in the scheme below. Every phase of the project will be discussed in a separate part of the master thesis report.

Part 1 is the introduction and this part describes the proposal of approaching my graduation project. This part is about the problem field, scientific and societal relevance, aim of this project and the motivation.

Part 2 will discuss the literature research which is done according to the project.

Part 3 is the spatial analysis part where all location research is used to generate a masterplan for the project location.

Part 4 is the vision frame, where a vision and conceptual design is created according to the final design.

Part 5 is the frame of design. Different design layers are explained here.

Part 6 is a review of the design according to the current location.

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1.8 INVOLVED DISCIPLINES

1st **Spatial planning & Strategy** specialist: Dr. Ir. P.L.M. Stouten
For framing my research and manage the planning, phasing and writing the thesis booklet.

2nd **Metropolitan & Regional Design**: Prof. Ir. C. M. de Hoog
For designing phase and structure. He takes part of the management that wrote the Campus Vision 2030.

3rd **Urban Design**: Ir. W.J.A. Hermans
For using different design strategies and tackle urban design problems.

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1.9 READING GUIDE

The project consists of six phases as shown in the scheme below. Every phase of the project will be discussed in a separate part of the master thesis report.

Part 1 is the introduction and this part describes the proposal of approaching my graduation project. This part is about the problem field, scientific and societal relevance, aim of this project and the motivation.

Part 2 will discuss the literature research which is done according to the project.

Part 3 is the spatial analysis part where all location research is used to generate a masterplan for the project location.

Part 4 is the vision frame, where a vision and conceptual design is created according to the final design.

Part 5 is the frame of design. Different design layers are explained here.

Part 6 is a review of the design according to the current location.

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**Figure 15. Graduation year split up in six phases**
STRUCTURE

The graduating thesis starts with defining a problem. How to handle it, what methods are going to be used and what research is going to be done?

Second stap is to do literature research. This theoretical research can already get specific by reading policies related to the project location. This thesis researched the main focus of universities in knowledge cities, different interpretations of what knowledge cities are, about campus settings in general, campus guidelines and nowadays trends in campus design which are important to deal with regarding my final design and a more specific literature research on the project location its policy.

Next step is to get to know more about the project location and its development, interaction with environment and in what shape the problem occurs here.

A more detailed policy is read; Campus vision of 2030, which listed me principles to build a vision according to the campus design. This vision covered the connectivity factor, which is studied by doing case studies, which gave conclusions that could be overlayed with the campus designing trends.

Finally, the vision is more and more worked out, towards a local design. During this process, interaction between design scale levels repeatedly improved the design. This means that the design is not created by one way designing (high scale to low scale) but continuously interaction between scale levels.

After designing, conclusions which discuss the earlier stated problems, are quoted. An evaluation at the end gives a review towards the research that is started with, to check is the research was useful and really is used during the design process.
Figure 17. Graduation year split up in three phases
2.1 INTRODUCTION

As shown earlier in the introduction of part one, the project is separated in three parts (Figure 17). This chapter presents the second part, founded up on a theoretical research according to the project (Figure 18). The first part of the theoretical background is concerning the definition of a knowledge city and the important role of university campuses in it. The second part is about different spatial campus side settings. Part three discusses several guidelines to be concerned, while designing a university campus according to nowadays trends. These guidelines will help to frame the focus of the designing object.

The fourth part will focus at the policy of the city of Delft and its position in Randstads south wing.

This chapter will be used to frame the designing direction and create focus, regarding to important guidelines of today’s trend in university campus design, which is opening up to generate interaction with its surroundings.

The chapter contains parts, used to understate the literature review paper (the full version can be found in the appendix).

THEORETICAL FRAMEWORK

1 Different approaches on knowledge environments
2 Different campus sides
3 Guidelines for designing University Campuses in knowledge environments frame designing focus (LITERATURE REVIEW)
4 Dutch Policy Models

Figure 18. The theoretical framework
2.2 KNOWLEDGE ENVIRONMENTS

To clarify the importance of university campuses in knowledge cities, it is essential to analyze those two forms separate.

This chapter ‘knowledge cities’ will explain different approaches of knowledge city theories.

DIFFERENT APPROACHES OF KNOWLEDGE ENVIRONMENTS

2.2.1 THE KNOWLEDGE CITY

Because of the development on the level of ICT, the internet technologies, banks and business make people less dependent on time and place (Rooij, 2005).

Van den Berg et al. (2005) distinguished seven fundamentals representing economic, social and environmental values. The same aspects are confirmed by Yigitcanlar (2008) as important to build up a successful knowledge environment.

As shown in figures 19 and 20 the first fundamental stone is, a city that is knowledge based. Creation of knowledge mainly appears in cities and according to van den Berg et al (2005, p. 15) are "quality, quantity and diversity of universities, other education institutes and Research & Development activities determined to a large extent of the starting position of a knowledge city." Florida (2002) says that it is also important for cities being innovative. To innovate, cities try to attract ‘knowledge-workers’. Florida (2002) states that these ‘creative’ thinkers are the backbone of the economy with their knowledge, innovation and creativity. As important is to transfer, share and use this knowledge, also for creating success in other sectors and increasing the job-amount for different social-layers (Roberts & Sykes, 2006). From this point of view it opens opportunities for local-level business to interact with international corporations. This represents the second fundamental stone: the economic spin off (Wiewel & Knaap, 2005)

Attracting knowledge workers can contribute to economic patterns, which encourages the economic growth in cities even more. Key factor to attract them is mainly quality of life in cities, the third fundamental stone (Castells, 2000, cited in Van den Berg et al.; Florida; 2002 ; Luijtjen, 2005). By creating good accessibility like an international and national network, knowledge-workers from all over the world can be attracted. This stimulates global connections but also promotes face to face contacts generated by fast and efficient infrastructural networks, representing the fourth fundamental element. Jacobs (1969) describes this ‘diverse city’ as a dynamic, enterprising city, which is built in an intricate structure of different actors. This introduces the fifth fundamental stone; Urban Diversity. It brings inspiration and promotes creativity, which is according to Jacobs (1969) and Florida (2002) the key factor to a socio – economic successful and attractive knowledge environment.

By upgrading cities intellectual fame, more and more knowledge workers can be attracted (Castells, 2000, cited in Van den Berg et al.; Florida, 2002 ; Luijtjen, 2005). By creating good accessibility like an international and national network, knowledge-workers from all over the world can be attracted. This stimulates global connections but also promotes face to face contacts generated by fast and efficient infrastructural networks, representing the fourth fundamental element. Jacobs (1969) describes this ‘diverse city’ as a dynamic, enterprising city, which is built in an intricate structure of different actors. This introduces the fifth fundamental stone; Urban Diversity. It brings inspiration and promotes creativity, which is according to Jacobs (1969) and Florida (2002) the key factor to a socio – economic successful and attractive knowledge environment.
Van der Voordt translated Maslov's model to spatial aims in a learning and working environment, figure 21. This environment has to support the working processes of students and staff. Van der Voordt (2003) also states that a learning and working environment has to be inspiring and attractive. This is confirmed in the creativity-chain of figure 22 by Saris and Brouwer (2005). It shows that inspiration, interaction and transaction are key factors for cities keeping competitive retaining knowledge, attracting knowledge workers and economic development. More opportunities are provided when interaction between creative sectors and other actors in a network can be stimulated.

As shown in Figures 19 and 20, urban scale is important for attracting knowledge workers. The bigger a city, the more variety of jobs to choose and for business the more suitable staff to find. According to Van den Berg et al. (2005) also agglomerations of smaller cities can benefit from each other. With good infrastructural connections, they can work together and operate even on global level. Last fundamental of a knowledge city to develop is based on social equity. Inhabitants and visitors want feel safe and healthy, also confirmed by Van der Voordts’ model, visible in figure 21. To grow and be attractive as a city, there should be no tension between cultures because of missing needs. Economic development is closely connected to cities where people are not feeling save.

By being able to offer these seven fundamentals (Van den Berg et al., 2005; Yigitcanlar et al., 2008) it is possible for cities to be knowledge-based and attract economic development. According to the scheme in figures 20 and 21, these fundamentals can apply to knowledge, attract knowledge-workers, create knowledge and develop growth clusters. According to Van den Berg et al. (2005), these growth clusters, like universities, have to interact with their knowledge-based environment and need to contain all seven fundamentals to be even as successful as its surroundings.

**IMPORTANCE OF PHYSICAL INTERACTION**

The fundamentals of the knowledge city are untouchable elements, which are effects of physical elements in a city. The coherence of them is creating an environment where people are willing to live and are attracting more and more knowledge workers in an economic stabilized city. But why is physical interaction necessary if the ICT communication networks are increasing and what can be physical elements of a knowledge city? Ergazakis et al. (2004), but also in the scheme of figure 22 of Saris & Brouwer (2005) it is stated that interaction between people is necessary to produce, evaluate and exchange knowledge. Physical interaction between people generates knowledge. Also physical experience of the environment is needful to innovate and which is lacking when using ICT communication. As in figure 22 is mentioned that the sense of feeling the environment is inspiring for innovation. This is promoted by diversity in urban landscape. Besides it is not possible to do all interaction via ICT communication. Van den Berg et al. (2005) introduced two kinds of knowledge. Explicit knowledge, which is new information which is explicitly exchanged between people to gain knowledge. Second is tacit knowledge and is learned and experienced through practice which is exchanged via physical interaction.

Contrary to the increasing ICT communication, places to interact remains important for exchanging knowledge. Ergazakis et al. (2004) and Yigitcanlar et al. (2008) believe that knowledge environments need to be designed regarding to several guidelines.

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**Figure 21** Maslov’s ‘hierarchy of needs’ translated to spatial aims ‘hierarchy of space requirements’ (Van der Voordt 2003, cited in Den Heijer, 2006)

**Figure 22** Creativity chain: from inspiration to transaction (Saris & Brouwer, 2005)
2.2.2 THE LEARNING CITY

The goal of knowledge managements is to generate, distribute and use knowledge, in order to add value to business activity and to provide new opportunities for enterprise. The difference in comparison to other management approaches is that it manages an intangible asset that will be more valuable if it is used more. The main goals of this approach do not differ from other approaches proper to the business world: making profit and grow (Laszlo & Laszlo, 2007).

Knowledge management and knowledge-based development are international, mainly western, concepts. They are also used by cities and countries, in order to try to be successful in the new knowledge-based economy. These developments should focus mainly on citizens, providing them a good and inspiring environment for creativity and growth. People need to feel free and secure in their environment in order to work efficiently (Laszlo & Laszlo, 2007).

However, there is a different way of understanding and dealing with freedom and security between Americans and Europeans. Americans see freedom as autonomy, independence and growth of wealth. This gives them security. Europeans feel free if there are many options for living a full and meaningful life. Belonging to communities gives individuals security, as opposed to having security because of one's material assets. The 'American dream' is about economic growth, personal wealth and independence, while the 'European dream' is about sustainable development, quality of life and interdependence. (Laszlo & Laszlo, 2007)

The knowledge management approach is more similar to the American way of thinking than to the European one. The 'American dream' is very individual and the 'European dream' is more generous, which is more similar to knowledge management. The gross domestic product, GDP, is used to compare the economy of different countries. GDP is generally lower in Europe than in the United States, but this indicator is only about economic growth. Other factors, like quality of life or the quality of the environment, are not taken into account.

Looking at this from a sustainability point of view, it is clear that only the economic sustainability is at stake here. Social and environmental sustainability are not measured, although they are very important for freedom and security, especially in Europe. In fact, according to Laszlo and Laszlo (2007), Europe has a better quality of life in comparison to the United States. The better GDP of the US "masks the breakdown of social structure and natural habitat; and worse, it portrays this breakdown as economic gain". (Cobb, Halstead and Rowe, quoted in Laszlo & Laszlo, 2007)

In regards to the knowledge-based development, there are two recognised purposes. The first one is the "economic growth and the post-industrial development of cities and nations to participate in the knowledge economy". The second one is "the intention to increase the skills and knowledge of people as a means for individual and social development" (Laszlo & Laszlo, 2007).

These objectives will create an increase of intellectual and human capital, which will bring more creativity, innovation and entrepreneurship. This will stimulate the economic growth. The increase of individual capital will lead to more people who can participate in the knowledge economy, but in the knowledge economy, a lower amount of jobs is needed, because of the technological developments. In times of a growing population, the knowledge economy might not be the right solution (Laszlo & Laszlo, 2007).

These technological advancements began to play a major role in the middle of the last century in the creation of more leisure time, instead of working time. However, nowadays do people work even more than before. This is a disturbing paradox. The knowledge-based development (KBD) is not only based on economic growth, but it also demands a sustainable well-being of its community, similar to the goals of the earlier technological advancements. The KBD is going even further than the concept of the knowledge economy.
It has more to do with social sustainability. KBD should have, in comparison to the knowledge economy, a third purpose: “contributing to a socially and environmentally sustainable society as the enabler of an evolutionary future” (Laszlo & Laszlo, 2007).

This means that, besides the economic growth and individual development, the well being of the people is an important goal of this knowledge based development. Not only goals are important, but also the process reaching them. This process should be harmless to people and the environment. The three purposes of the KBD (economic prosperity, human development and social and environmental sustainability) cover three types of sustainability.

This different meaning of the knowledge-based developments leads to a need for a change of mind for policy makers and planners operating in the knowledge economy. The people who live in the knowledge economy are not only knowledge workers. Only a small part of the population is able to find a job in the knowledge sector. A better expression for people living under this new development paradigm would be ‘knowledge citizens’. Carrillo describes this group as “a better educated (formally and informally), critical and informed population that is ready to participate in civic life, is politically active, is interested in a better quality of life for itself and the next generation, including concern for healthy lifestyles and less dependence on consumption, is appreciative of artistic expression and cultural activities and is more competent in human relations” (quoted in Laszlo & Laszlo, 2007).

Therefore, in a knowledge city, attention should be paid to the whole community and not only to the most established knowledge workers. Another desirable change in the way we perceive the whole paradigm would be reflected in the substitution of the term ‘knowledge society’ to ‘learning society’.

Learning is about gaining and creating knowledge, as in a process, as opposed to knowledge as a product or objective of the learning process. Describing this change of paradigm, Laszlo and Laszlo (2007) describe the knowledge city as the hardware for the learning society. The knowledge city should be the infrastructure for the gaining and creation of knowledge. Without the learning society and knowledge citizens, a knowledge city would have only a selected group with access to the knowledge-based amenities. The universities, high-tech companies and research institutions would be ivory towers for small groups of people. (Laszlo & Laszlo, 2007)

The learning city should not have strict boundaries. The exchange of knowledge should happen through multiple scales, from a local scale to a global one. To make the exchange of knowledge possible, collaboration between regional and national governments, businesses and civil society would be required. (Laszlo & Laszlo, 2007)

**CONCLUSION**

For the design project, it means that all three purposes of knowledge management could be adapted in the plans. The amenities in the new campus setting should support economical prosperity, like knowledge-based companies, human development, like educational institutes, and social and environmental sustainability, like recreational facilities and green areas. This new development should not only focus on the high educated knowledge workers, but on the entire population: the knowledge citizens. There should be possibilities for all residents to profit advantages of knowledge cities. The campus side should focus on the learning process, instead of having the knowledge. There should be many possibilities for sharing, gaining and creating knowledge, accessible for all knowledge citizens of this learning society. The connection to different scales are very important for this learning process. There should be many connections between amenities, neighbourhoods, regions and other cities and countries.

“CITIES ARE, ABOVE ALL, BUSINESS NODES WHERE KNOWLEDGE EXCHANGING TAKES PLACE.”

J. JACOBS
2.2.3 THE SMART CITY

The book ‘Slimme steden’ (Smart Cities)(Dijksterhuis, 2008) is based on the theories of the knowledge city. In the 21st century, cities with a creative and knowledge industry are expected to be successful in attracting residents, tourists and companies, as opposed to old-industrial cities which are losing industries. The cities in this book are called smart cities. They are similar to the knowledge cities.

Fifty European cities are described to emphasize the competition between different knowledge cities on the themes of culture, creativity and innovation. These criteria are important, because the knowledge economy needs new ideas and new knowledge. Producing new knowledge is a creative and innovative process. The knowledge workers who produce this new knowledge have high demands for their daily life in the city. The city should be attractive for them for living, working and recreating. For every city, descriptions are given of the most important projects attracting people and businesses, because of this new economy.

COMPETITIVE CITIES

The international competition to attract the creative class to a city is very difficult. More people tend to move to other countries more easy. This means that cities have a large target group, but the competition is also growing. Dijksterhuis (2008) describes the global-local paradox. In these times of globalisation, cities need to distinguish themselves by local qualities to be attractive.

In Europe, the competition is even tougher, because of the European unification. People and business can easily go from one country to another, from one city to another. The differences between the cities are small. Most important cities already have universities, research institutes, high-quality shopping facilities, music centers and theaters.

Cities in the ‘Blue Banana’ are becoming more and more similar. The ‘Blue Banana’ is an image to describe the area from Birmingham, via southern England, the Netherlands, Belgium, northern France, western and southern Germany, Switzerland, northern Italy, to Madrid. This area is known as the economic heart of Europe and has many large and important cities, like London, Amsterdam, Brussels, Frankfurt, Paris, Lyon, Marseille, Barcelona and Madrid.

The competition between cities in this area is enormous. Many cities invest a lot in projects to attract new talent and companies. In the competition between cities, a city needs to have a smart strategy. Sir Peter Hall is quoted from his book ‘Cities in Civilization’: “there are four types of creative, innovative or smart cities: the technological-innovative city, the cultural-intellectual city, the cultural-technological city and the technological-organizational city”. The smart cities should use the type of the city and strengthen it, to attract the talented people in that field of expertise.

Figure 24. The ‘blue banana’
Richard Florida says that the three T’s are important for smart cities: talent, technology and tolerance. (Idem)
The success of a smart city is unpredictable, but there are some important factors for success, according to Dijksterhuis (2008) and along former findings.
The first factor is human interaction. The city can not be smart, but its citizens can. People learn from interactions, so in a smart city there should be the so called ‘third places’. Places where people do not live or work, but meet each other in an informal way.
The second factor is the diversity in the knowledge and technology. It is important that the residents are willing to share those two elements. The built environment can help by offering a mix of old and new buildings, so every person or company can find a suitable building to settle in.
Mixing different people or companies in a coherent way lead to new ideas and combinations.
An important aspect in the competition between cities is the city branding.

2.2.4 THE CITY OF DELFT

The ‘Blue Banana’ covers the city of Delft, so it has to deal with a large competition. In our understanding, the city should not invest too much in city branding, because it costs a lot of money and the result is very low.
Delft should invest in building and facility development as a knowledge city to create a better city name. According to previous research, we have carried out that focus should be on how to distinguish the city from the other cities in the Netherlands and in Europe. As written earlier, human interactions and diversity are important factors for this new developments.
Examples of other cities are very useful as sources of inspiration. The example projects should be turned into projects that emphasize the identity of Delft.

EXAMPLES

STIMULATING ORGANISATIONS

Antwerpen, Belgium, started the association COCD (Centre for the development of creative thinking). This organization gives courses, interactive workshop, lectures and publishes articles on creative thinking. They help people and companies to think in a different ways, in order to find other solutions or innovations. There are many different courses and consults from the COCD for different problems (COCD, n.d.). In Bregenz, Austria, an organisation was founded for local furniture makers and carpenters: Werkraum Bregenzerwald.
Forests are surrounding Bregenz, resulting into many craftsmen working with wood. The craftsmen connected to the organisation have agreed on the basic principle that every product created by them will have a high quality, will be functional and beautiful. Every three years, a competition and exhibition are organised and this will attract many people from different countries. Besides, the organisation invests in an intern program for new craftsmen. (Dijksterhuis, 2008)

BUILDINGS AND PUBLIC SPACE
In Antwerpen, Belgium, design centre Winkelhaak accommodates multiple creative businesses: web designers, architects and industrial designers. These businesses share a library, secretary, photo studio and rooms for presentations. They even work together on competition (Figure 25). The companies have many advantages of this building, like the shared facilities, the lower costs and the exchange of expertise between the different companies. The surrounding neighbourhood also profits from the extra people who visit the area (Dijksterhuis, 2008).
In Bratislava, Slovakia, an old car workshop is transformed into the Design Factory. This old industrial building is the only building that is preserved in a large old industrial site. Many buildings were demolished to create space for new offices and housing. In the Design Factory, young designers and architects organise lectures, exhibitions and workshops. By doing these activities, they want to give attention to the need of creative companies in the new master plan for the complete area.
The Centre of Life is an important facility in Newcastle, England. In this centre, biotechnology, economy and daily life will be brought together, to make the knowledge better accessible for the people. This happens by giving lectures, creating exhibitions and showing dvds. This way, people will become more familiar with biotechnology and its possibilities.
Milan, Italy, is building a large complex of companies, showrooms, housing and a part of the technological university. The public space in this complex will be a ‘library of trees’. The streets and lines in this park will connect the different neighbourhoods with each other. Not only will the important fashion industry be settling here, but also other sectors. The diversity in companies should lead to innovation. (idem)
SPECIAL EVENTS
Aveiro, Portugal, has a technological university and has attracted a lot of knowledge-based companies. For graduated students, there are many jobs available. In order to attract more people, the municipality invested in luxurious apartments in the city centre which fit the target group. Aveiro wants to create a high living quality for their inhabitants. The city really became known when the European Championship football was played in Portugal in 2004. In Aveiro, a new football stadium was built. A lot of tourists visited the place and the city (Dijksterhuis, 2008).

The European Capital of Culture in 2005 was Cork, Ireland. In the city, many activities were organised for different types of culture: theatre, music, literature and architecture. This event attracted a lot of visitors during the event. The years after the event, the effects in the city were visible. A gallery was upgraded to a national institute and increased the number of visitors. Other cities that have used the European Capital of Culture status as a catalyst are Essen, Germany, and Liverpool, England.

CONCLUSIONS
Main lesson which can be learned is, that a knowledge city needs different types of projects, in order to attract businesses and companies. These projects can be divided into organisations, the built area and the events. A single project would not lead to success. For the case of Delft, there should be a combination between these types of projects. An organisation could be founded which would stimulate the developments and the communication and exchange of knowledge between different actors in the city.

The design location has some monumental buildings (Figure 26) which could be used as inspiring, attractive environments. There could also be a function for starting companies, which can share certain facilities.

Events can work as a catalyst for the knowledge city. An event can have many spin off projects. For Delft, the event of the European capital of Culture is not really feasible, because it is more a technological-innovative city, instead of a cultural-intellectual city or cultural-technological city.

The design should adapt to the discussion on creating the knowledge city versus making space for projects. There should be both top down and bottom up projects.
2.2.5 THE SUSTAINABLE KNOWLEDGE CITY

As mentioned in previous chapters, the city of Delft presents itself as a ‘knowledge city’. The city council pays a lot of attention to attract knowledge-based businesses. However, they tend to forget the citizens who are not working for, contributing to, or having benefits from the knowledge city (Fernández-Maldonado & Romein, 2008).

This graduation project focuses on creating an environment attractive to all citizens of Delft: students, employees and inhabitants. This strategy needs to be knowledge-based on one hand and (socially and spatially) sustainable, because all citizens should profit from it.

In order to gather information on sustainability in knowledge cities, this research is done.

Rogers and Gumuchdjian (1997) describe their view on the sustainable city in the book 'Cities for a small planet'. Their concept of the sustainable city will be compared to the requirements of the knowledge city, as covered in the preceding chapter. The requirements were divided into two groups:

1. Formal spatial requirements
   - Scale
   - City structure
   - Infrastructure
   - Urban appearance

2. Functional spatial requirements
   - Knowledge-based activities
   - Quality of life
   - Urban diversity
   - Meeting points

For each topic, the conclusions will be compared to the seven criteria for a sustainable city of Rogers and Gumuchdjian (1997). These criteria are:

- a just city
- a beautiful city
- a creative city
- an ecological city
- a city of easy contact
- a compact and polycentric city
- a diverse city

This comparison uses the criteria for the sustainable city. Each criteria will be described in comparison to requirements of the knowledge city, analysed earlier.

A JUST CITY

A city where justice, food, shelter, education, health and hope are fairly distributed and where all people participate in government.

In most cities in North Western Europe, people have fairly equal rights and more or less equal access to facilities. Our Delft case can be considered a Just City, despite the obvious differences between some of the neighbourhoods. Some more attention should be paid to the poorer areas of the city, to fairly distribute opportunity and aspiration over the inhabitants. A good number of nonwestern immigrants lives in the area with a lower income and higher unemployment rate. Nowadays, many immigrant job seekers have more problems finding an internship or a job than Dutch job seekers.

It is not possible to change this problem in urban planning, but the society needs to change. However, the unemployment rate is higher for low educated jobs, so creating these type of jobs could improve the situation. In the knowledge city, the most important element is continuous education. All people in a knowledge city should have an equal chance to be educated, so there should be opportunities on all levels, from primary school to university. This is already happening: even more colleges are coming to Delft, next to the university.

It is important that the colleges and the university will collaborate, so students can more easily go from college to university. Education should also be available on lower levels to all people. Participating in the government is mainly a matter of democratic elections in the Netherlands. All citizens older than 18 years are able to vote for European, national, regional and local governments. These elections occur usually once every four years. However, the participation in government can be increased through participatory tools.

In some planning theories, the influence of the people is high, because every citizen can legally object to building plans. With many projects Delft city tries to involve their citizens (Rogers and Gumuchdjian, 1997).

AN ECOLOGICAL CITY

City which minimises its ecological impact, where landscape and built form are balanced and where buildings and infrastructure are safe and resource-efficient. There are three main kinds of sustainability: environmental, social and economic. They relate to the themes planet, people and prosperity.

The ecological city is part of the environmental sustainability. However, the knowledge city is not focusing on this type of sustainability, but can be important to generate creativity. The other two are more relevant here, because the knowledge city is about creating an attractive working environment in which people feel good and use their knowledge, therefore contributing to social cohesion and economic development.

However, the environmental sustainability should not be forgotten. The natural environment plays a major role in the quality of the urban appearance and the quality of life. The balance between the constructed
and natural amenities is necessary for a successful knowledge city. So the balance between the landscape and the built form of the ecological city of Rogers (1997) is a bit similar to that. Ecological connections can for example be combined with natural amenities, such as parks and recreational areas.

In addition, nowadays a lot of knowledge production is about finding sustainable solutions. Sustainability is a hot topic and it inspires people to be creative and inventive to search for solutions for a sustainable planet. The source of these studies can be found in environmental sustainability, because people want to create a world which can provide for future generations (Rogers and Gumuchdjian, 1997).

A CITY OF EASY CONTACT
City where public realm encourages community and mobility and where information is exchanged both face-to-face and electronically. This criterion of the sustainable city is a very important requirement for the knowledge city also. New knowledge and ideas are created when people meet and exchange their knowledge. This requirement is equally important for the knowledge city and the sustainable city. Besides, different kinds of contact are needed in both cities. Not all knowledge can be transferred electronically. As said before, there are basically two kinds of knowledge: explicit and tacit knowledge. Explicit knowledge can be transferred easily in text, for instance. People gain tacit knowledge in a more inductive and spontaneous way. Tacit knowledge is gained by practice or by acquisition of skills. This type of knowledge needs to be transferred face to face (Helbrecht, 2004). This is why space still matters and this is an essential argument to provide quality public spaces of a certain kind in a knowledge city.

In the graduation project, it is important to create many places where people could meet, the so-called ‘third places’. These are the places that are not places for living or working, but the spaces for meeting and interacting, sometimes in unplanned and unexpected ways. Naturally, there should be different kind of places for different kind of people leading different life-styles. In this way, knowledge can be exchanged by many people who are not normally in contact with each other and do not normally exchange different kinds of knowledge. This way, they may acquire knowledge in informal ways. Besides facilities, there should also be the right infrastructure for personal transport and for digital connectivity (Rogers and Gumuchdjian, 1997).

A COMPACT AND POLYCENTRIC CITY
City which protects the countryside, focuses and integrates communities within neighbourhoods and maximises proximity. There are some similarities between the knowledge city and this compact and polycentric city. The most important aspect is proximity. In the knowledge city, the functions ought to be mixed, because they should be closer to each other. This proximity leads to shorter travel times, which is the base of the compact city, and to more intense face-to-face contacts. Some researchers, like Abu-Anzeh en Ledraa (2007) describe the knowledge city as a network city, because it is more about flows and streams, than about zones. The nodes between the different flows are important centres. These nodes can be used for knowledge based activities. In this way, a knowledge city can be seen as a polycentric city.

A DIVERSE CITY
City where a broad range of overlapping activities create animation inspiration and foster a vital public life. This last criterion of the sustainable city is again very similar in the knowledge city. Diversity is seen as the base of quality of life, but the last one is much broader. Both themes deal with the amenities and facilities in a city. This diversity of activities makes a city attracting. In the project, there have to be different amenities and facilities to have a good quality of life. The aim is to let people meet and relax at these locations. Besides these leisure activities, there should also be diversity in living and working areas.

CONCLUSION
Many similarities can be found in the knowledge city and the sustainable city. The most relevant ones are the easy contact, diversity and creativity. In both cities, these factors are important in the success factor of the city. Besides, there is something of the knowledge city in every criterion of the sustainable city.

There are no big contradictions between the two model cities described in this text. Rather, they complement each other. Designing a sustainable, knowledge city is indeed possible.
2.3 CURRENT CAMPUS SETTINGS

As earlier discussed and stated by den Heijer (2008) do knowledge cities generate employment. Main fundamentals of knowledge cities are based on knowledge is said by Van den Berg et al. (2005) and Yigitcanlar et al. (2008). And Christiaanse (2007) stated that there is a lack in interaction between university campuses, which provide knowledge cities of knowledge.

But what different university campus settings can we distinguish in the present time.

- Greenfield Campus
- City Campus
- Technology Campus

The book 'Campus and the City' of Christiaanse (2007) does discuss three types of campus sides; three university campuses, one corporate campus. The selection is representative according to academic and commercial campus developments. The categorisation into inner-city, greenfield and high-tech campus highlights the different and unrelated aspects of these various campus typologies.

Among inner-city campuses, a major issue seems to be how universities can profit from their urban context and can positively influence surrounding city districts. Many greenfield campuses are currently being upgraded into mixed-use urban science districts. All high-tech campuses naturally aim to generate knowledge and synergies between science and industry. Remarkably, all the high-tech and corporate campuses are set up as closed compounds located on greenfield sites. This in itself is a timely reminder that the origin of the term campus is “open space” and that the roots of the knowledge society are in industry.

These different campuses also have their common trend, to open up. While most campuses still take the form of concentrated compounds or situated in one main location, there seems to be a tendency to rediscover the qualities of the old common model of Cambridge or Oxford; a network of colleges is integrated into the city. Bilgi is organised along similar routes, with campuses spread over the city of Istanbul. UPC, the Cambridge university constitute an even wider-reaching network of specialised clusters that go beyond the city limits in order to stimulate interaction with and the development of the surrounding regions, Catalonia, Silicon Fen, or the Veneto respectively. Campuses are developing on local, regional and world scale.

But what we can say for sure is that the campus is increasing its limits by adding programme, upgrade environments and attract a bigger target group to keep innovated.

“UNIVERSITIES IN KNOWLEDGE CITIES ARE AS COAL MINES IN AN INDUSTRIAL ECONOMY”
Figure 27. Collection of Greenfield campus Zurich
2.3.1 GREENFIELD CAMPUS

LOCATION: With Science City, the ETH Zurich aims to establish itself as a leading university of technology. Science City is not only a physical concept for the reorganization of the ETH complexes - ETH Zentrum and ETH Honggerberg - but even more a concept of how the University’s activities integrate, interact and communicate with the city of Zurich and related institutions elsewhere. Essentially Science City is a networking concept between the ETH, other universities and society at large. In light of this concept, ETH Honggerberg, a 1960s campus on the outskirts of Zurich, is to be transformed from a monofunctional university side into an urban quarter that acts as an interface between academia, industry and the general public. The public and on-campus transport network ensures good access to the city and nearby international airport as well as to the European high-speed rail and highway network.

DEVELOPMENT: As an enclave located on top of Kaferberg and Honggerberg, thereby separated from and looking out over the city, the satellite campus will develop within its borders by enhancing the existing landscape and by condensing teaching, research, spin-off activities, living and amenities into a concentrated environment. The development strategy for Science City is more a transformational project rather than a building project. Hence, the master plan by KCAP is based on a flexible framework, which can develop a relevant set of rules. In this way it is very flexible and constantly can change according to demands of science, economy and society without destroying the coherence of the overall concept for the campus. In this regard the master plan is an instrument that controls the process of transformation. It contains minimal design principles in order to allow planning flexibility.

PROGRAMME: Science City its programme is constantly changing. The existing faculty clusters (Physics, Life Sciences, Architecture, and Civil Engineering) will be retained and complemented by a mixed-use housing district. Additionally, residential accommodation, business start-ups, retail outlets, sports and childcare facilities and other services will be organised around the various quarters. The project also envisions a new conference centre, a library and multifunctional spaces for meetings and exhibitions. All these uses are also open to a wider public and together create an attractive on campus environment for studying, working and living. In order to stimulate the exchange of knowledge and ideas, the master plan allows for a radical mix of uses: publicly accessible zones are located next to highly secure laboratories, offices next to apartment blocks, and conference facilities next to sports centres.

MORPHOLOGY: The urban design strategy of ETH Honggerberg is all about integration and densification. At the same time, a clear structure will be retained, recalling the original plan by Albert Heinrich Steiner. This plan divided the campus into four quarters with the major thoroughfare, Wolfgang Pauli Street, and the new communication axis of the "Congress and Meeting Boulevard" running parallel to it. The basic principle is a spatially interlocking fabric of built volumes and open spaces, internal courtyards and patios, whereby the architecture should be largely flexible, so that it can react to new requirements and different circumstances in the future. The master plan defines building fields whose borders are determined by the most important public spaces and sight lines, in order to allow for a legible and permeable ensemble of buildings. The spaces are not separated from each other but merge into each other to create a network. Within these transitions, spaces of encounter emerge with their own specific character and potential. This intermixing of different spaces and uses is intended to help turn the existing science hub into a thriving, future-oriented global urban district.

THE CITY OF ZURICH: With about 370,000 inhabitants, Zurich is the largest city in Switzerland, occupying an important position in Swiss life. Regarded by many as Switzerland’s undercover capital, it leads the way in education and research, medical science and cultural activities. Zurich is known internationally as a financial hub and a large number of banks are based in the city. With its many scientific institutions, Zurich also aims to position itself as a city of science, with Science City being a major part of this ongoing goal. (Christiaanse, 2007)
INNER-CITY CAMPUS
UPC Barcelona

Figure 28. Collection of Inner-city campus Barcelona
2.3.2 INNER-CITY CAMPUS

LOCATION: The Technical University of Catalonia (UPC) is a regional university consisting of eight separate campuses. Three are located in Barcelona and the others in surrounding cities: Castelldefels, Mataró, Terrassa, Vilanova i la Geltrú and Santa Coloma de Cervelló. This implementation of facilities interacts with the social and economic fabric of Catalonia and contributes to the balanced and sustainable development of the region. On the campuses in Castelldefels and Mataró, the University works closely with private companies and research centres in high-tech parks resulting in economic development and technological innovations. The two main campuses in Barcelona located at the southwestern edge of the city are UPC's North and South Campuses.

DEVELOPMENT: The UPC is a public institution of higher education and research that was founded in 1971. With the incorporation of existing and newly established technical schools and research institutes in Barcelona and surrounding cities, it had an equal expansion. The University is now a leading institution in architecture, science, and technology both at a national and international level. The South Campus was established and mainly built between 1971 and 1976 and the North Campus between 1989 and 1992.

PROGRAMME: Telecommunications, Information Technology, and Civil Engineering bring students, researchers and research centres together on the North Campus which has become a point of reference in the field of technological innovation for Spain and the rest of the world. This campus also houses university services such as a library, sports centre, a 5,000-sqm shopping area, the Student Union with its many student associations, and some student housing. On the North Campus one can also find the Nexus building, which serves as the headquarters of many businesses that maintain close relations with the University, and the UPC Foundation, which is dedicated to lifelong learning and professional retraining. The South Campus accommodates the Schools of Architecture and Industrial Engineering and the Faculties of Mathematics and Statistics, which share space with Barcelona Technology Park, a facility integrating some 20 research groups and enjoying the collaboration of more than 50 companies. It is an area of excellence for research in industrial technologies. Both the North and South Campuses are situated in a residential area of Barcelona and with civic facilities are also open to the general public.

MORPHOLOGY: The South and the North Campuses are located on either side of the Avinguda Diagonal, which provides good public access. The North Campus has a rangy structure that integrates with the surrounding residential district. The South Campus consists of larger buildings and is surrounded by sport facilities. Since both campuses are already surrounded by buildings and the existing infrastructure, redevelopment is only possible within the campus boundaries. Therefore, the expansion of the University mainly takes place at its other satellite campuses where the University will build six more buildings for the Mediterranean Technology Park.

THE CITY OF BARCELONA: Barcelona, the "Southern Gate to Europe; is the capital of Catalonia and the second-largest city in Spain with around 1.6 million inhabitants. The city is a major economic centre and one of Europe's principal Mediterranean ports. The city’s two thousand-year history has left its mark on its architectural, artistic and cultural heritage. It has excellent international communications, Mediterranean climate and cosmopolitan atmosphere. The Barcelona of the twenty-first century was shaped by the 1992 Olympics; it was transformed for and by the need to do justice to that great international event. The effort involved in carrying through this transformation allowed the city to make major advances in its infrastructure, services and physical fabric. Barcelona hosts one of the largest university communities in Europe, made up of seven universities and around 200,000 students. Barcelona is a European capital of astonishing cultural energy with a remarkable, progressive spirit and, despite its many transformations, has always maintained its ties with its proud history.

(Christiaanse, 2007)
Figure 29. Collection of Technology Campus IIT Chicago
2.3.3 TECHNOLOGY CAMPUS

LOCATION: The main campus of the Illinois Institute of Technology (IIT) is located between two main transportation axes. It is a spacious, open campus that comprises around ten city blocks at the heart of Chicago's Bronzeville neighbourhood, once a lively centre of African-American culture. A bus line and two rail connections guarantee rapid connections to the centre of the city, and the campus highway link guarantees quick road connections and direct access to the city's two airports. IIT was formed in 1940 by combining two existing universities; Armour Institute of Technology and Lewis Institute. In 1938, Ludwig Mies van der Rohe, the director of IIT's school of architecture, was commissioned to design a new main campus. By the time of Mies's retirement from IIT in 1958, he had realised much of his plan and many buildings in it, a work often cited as a masterpiece of modern architecture. From the mid-70s onwards, however, the building of numerous social housing projects nearby led to the university's loss in popularity and financial decline. Fortunately, since the mid-90s Chicago's South Side has been working to upgrade the area through a number of social and architectural interventions.

In parallel, in 1996 IIT commissioned Mies' grandson, the architect Dirk Lohan, to design a new master plan to revitalise the historic campus. Two new buildings from this plan have already been completed: The McCormick Tribune Campus Centre by Rem Koolhaas and a new residence hall by Helmut Jahn.

PROGRAMME: The eastern side of the IIT campus accommodates halls of residence, student services and sport facilities, while the western side is home to academic and administrative buildings, a conference centre, library and the University Technology Park (UTP), which is currently being developed to boost IIT's focus on biotechnology and profitable synergies between business and technology. Marking one of the most significant commercial investments in Chicago's South Side in recent history, UTP is to generate approximately 2,500 jobs over the next decade.

MORPHOLOGY: From the beginning, Mies's concept for the campus plan was based on the strict street grid of Chicago, defining the relationship of the faculty buildings to each other by a universal grid based on units of 24 x 24 feet and a height grid measured in units of 12 feet. This grid system not only responded to the urban context and economic and functional conditions, but also ensured the architectural harmony of the campus in the future. This allowed for the planning of large green areas between the buildings, which were set in a rather relaxed spatial arrangement within the orthogonal city blocks. The grid was also expressed in the refined structural steel construction of Mies's buildings and in the detailing of their ultra-thin steel and glass facades, which enclose free-flowing open or "universal" spaces. Today, the campus is bordered by an expressway and divided in half by overhead train tracks, and the campus's major parking lots. The new campus is forming a bridge connecting the two sides and enclosing the overhead railway as it crosses the top of the building, acoustically isolating it and bringing a new dynamic to the heart of the campus. Directly between Mies's masterpiece, S.R. Crown Hall, and IIT Tower, which marks the southern entrance to the IIT campus, the buildings of UTP continue the established grid structure of the campus.

THE CITY OF CHICAGO: Located on Lake Michigan, Chicago - with 2.8 million inhabitants - is the third-largest city in the United States and the financial, business and cultural capital of the Midwest. Founded in 1833 at the site of the portage connecting the navigable waterways of the Mississippi River and the Great Lakes, Chicago soon became an important transportation hub in North America. After a canal was built in 1848, enabling shipping to travel from the Chicago River to New York and the Caribbean, various industries such as the meat packing industry and steel industry quickly grew up. Soon the city became a nodal point for freight and passenger traffic, expanding to air traffic with the establishment of O'Hare International Airport, and it continues to be a major distribution and transportation centre today. (Christiaanse, 2007)
Figure 30. Collection of current campus setting TU Delft
2.3.4 DELFT CAMPUS

The university of Delft can be divided into the greenfield campus setting.

LOCATION: As said before, the city of Delft is named Knowledge City because of the presence of Delft University of Technology (TU Delft), which is the largest and most important technical university in the Netherlands. The ongoing development of the campus is foundation of the campus being one of the 21st- century, concerning not only aspects regarding Delft university, but also economic and social aspect of further segregation of the campus area.

Public transportation connects the campus to the main railway station poorly, therefore most people commute by bicycle, which takes about ten minutes from the historic centre. Rotterdam and The Hague are both about ten minutes away by car, Rotterdam Airport and Amsterdam Schiphol are roughly an hour away.

DEVELOPMENT: TU Delft was founded in the city's historic centre but, since the 1960's the university started moving from the inner city to outside city historical city boundaries, because its need for more space. Today only a few, mainly administrative, functions remain in the city centre. The campus itself consists of three parts: TU Middle, TU South and TU North. TU Middle and South are to be developed into a research and technology park called Technopolis, masterminded by the Delft-based and internationally renowned architecture office Mecanoo. The new name for the campus reflects the intention that it should act as a catalyst for the interaction of research and education in technology.

PROGRAMME: Technopolis integrates the university campus that forms the core of education and science at TU Delft and the 120-hectare Innovation Park that is reserved for research and development companies. It aims to become one of Europe's most important science parks in the near future. The TU North campus will connect Technopolis with the historic centre of Delft. This zone will be developed to become an attractive residential district. In addition, new buildings will house functions, while student dormitories, a hotel, the international student centre and a faculty club will be placed in existing buildings.

MORPHOLOGY: The aim of Mecanoo's 2002 master plan is to enhance connectivity and promote cooperation. It does so by clustering the faculties closer together and by establishing connections and different meeting areas between the faculties. The heart of the university campus will be the Strip, a key-shaped central zone designed as a catalyst for university life and home to all central and collective functions, such as the auditorium, central library, cultural centre and new sports centre.

The Strip itself is only open to slow traffic; the transversal streets accommodate individual motorised traffic, parking and public transport. Two pavilions, called Servers, will house collective faculty spaces such as exhibition areas, computer labs or cafeterias. As the main location for meetings and encounters, their organic architectural language is to be characterised by vaulted roofs and canopies pointing towards the main entrances of the faculty buildings and by transparent facades allowing inside and outside to merge. Lecture halls, meeting spaces and study areas within the Servers are to be designed as recognizable geometric shapes, such as cones, ellipsoids or spheres, protruding through the roof and anchoring the transparent building. Mecanoo's central library, with its iconic cone rising above the hill-like sloping grass roof, has already become a landmark building for TU Delft. By 2008, the main thoroughfare running through the campus will be converted into an esplanade, a large-scale park that can accommodate a variety of day-to-day activities as well as larger university events.

Although the Mekelpark had to become a connecting strip and central point to link all faculties, it neglects expansion areas as technopolis and TNO, which will be individual research and development centres instead of one connected knowledge environment.

THE CITY OF DELFT: Delft is located in the province of South Holland between the larger cities of The Hague and Rotterdam. Delft is nicknamed de Prinsenstad (the Princes'City), because William of Orange, the first in the Dutch royal line, held court in Delft in the 16th century. Delft has a well-preserved historic centre characterized by canals and old merchant houses. The town hall, the Prinsenhof, and the cathedral - the Oude Kerk - are major historic Dutch landmarks. Since around ten percent of its 100,000 inhabitants are students, Delft is a vibrant and lively city. This fact and the presence of TU Delft has attracted a large number of technology-based companies in recent years. (Christiaanse, 2007)

CONCLUSIONS

Advantages of flexible designing can constantly change campus settings according to demands of science,economy and society. Flexible designing means, creating possibilities for areas or buildings to change in future related to campus needs. Example; If there are too many parking lots and to less faculty space. Flexible designing can help to change this according the needs of direct environments.

facilities as residential accommodation, business start-ups, retail outlets, sports and childcare facilities and other services will be organised around the various quarters. Not only students and employees do make use of the campus sides, but the area can also become attractive to city inhabitants.

The fact of large events creating spinn off, is reaffirmed concerning the olympic games which were located in Barcelona. Such as the European Capital of Culture in Cork, caused an enormous city advantage.

Fast and alternative connections are important for interweaving campus
Figure 31. Review of current campus setting in comparison with TU Delft.
Technische Universität Delft (TU)
Motto: Challenge the future
Founded: 1842
Number of employees: 4,433
Number of students: 13,711
Percentage of foreign students: 11%
Ratio male / female students: 80% / 20%
Number of faculties: 8
Largest faculty: Architecture
Annual budget: 470 m EUR [2005]

Delft Technopolis
Founded: 1960s, 2001 redevelopment
Campus area: 910,000 sqm + 700,000 sqm planned
Floor space: 600,000 sqm + 600,000 sqm planned
Number of employees: 4,583 + 15,000 sqm planned
Number of students: 13,711
Number of residents: planned
Number of companies: 50
Number of institutions: 5
Investments: 1,000 m EUR planned

 Eidgenössische Technische Hochschule (ETH) Zurich
Motto: Welcome tomorrow
Founded: 1855
Number of employees: 8,191
Number of students: 12,705
Percentage of foreign students: 23%
Ratio male / female students: 71% / 29%
Number of faculties: 15
Largest faculty: Architecture
Number of Nobel Prizes: 21
Annual budget: 717 m EUR [2005]

ETH Zürich, Science City
Motto: Stadtquartier für Denkkultur
Founded: 1959, 2003 redevelopment
Campus area: 320,062 sqm
Floor space: 203,000 sqm + 145,000 sqm planned
Number of employees: 3,500 + 1,400 sqm planned
Number of students: 5,300 + 1,200 planned
Number of residents: 1,000 planned
Number of companies: 10 planned
Number of Institutions: 5 ETH
Investments: 75 m EUR [2003–06] + 400 m EUR planned

Universitat Politècnica de Catalunya (UPC)
Founded: 1971 [1851 School of Industrial Engineering]
Number of employees: 3,953
Number of students: 43,471
Percentage of foreign students: 3%
Ratio male / female students: 73% / 27%
Number of faculties: 24
Largest faculty: Industrial Engineering
Annual budget: 303 m EUR [2007]

Barcelona North Campus
Founded: 1980
Campus area: 112,000 sqm
Floor space: 160,000 sqm + 17,000 sqm planned
Number of employees: 1,944
Number of students: 7,824
Number of residents: 100
Number of institutions: 29 incl. 3 UPC
Investments: 121 m EUR [1980–2006]

Illinois Institute of Technology (IIT)
Motto: Transforming lives. Inventing the Future.
Founded: 1890 [1803 Armour, 1896 Lewis Institute]
Number of employees: 1,180
Number of students: 6,795
Percentage of foreign students: 30%
Ratio male / female students: 68% / 32%
Number of faculties: 25
Largest faculty: Biology, Chemistry, Physics
Number of Nobel Prizes: 3
Annual budget: 224 m EUR

IIT Main Campus and University Technology Park
Motto: Moving innovation forward
Founded: 1940, 1996 revitalization
Campus area: 425,000 sqm + 61,000 sqm UTP
Floor space: 279,000 sqm + 167,000 sqm planned
Number of employees: 1,280 + 2,500 planned
Number of students: 6,795
Number of residents: 2,500 + 4,000 planned
Number of companies: 100 incl. 16 UTP + 81 planned
Number of institutions: 29 incl. 25 IIT
Investments: 103 m EUR + 45 m EUR UTP [1996–06]
Summarizing work studied so far, several guidelines for campus design can be listed in order to create physical interaction of the campus university and the city. In this way a campus can contribute to economic- and social development of a knowledge city. A lot of these guidelines are based on the contribution of a university campus in a knowledge city. The university campus itself has to be even attractive, knowledge based and economic developing as the knowledge city itself.

- **connectivity (Human scale, pedestrian, public and private transport)**
  To interact on a global, national, regional and local level, it is important to be connected on different levels. According to Van den Berg et al. (2005) accessibility is a key factor for knowledge activities. On global scale, fast access is provided by airports or international train connections. Also lower scale level connections are important for exchange and innovate knowledge. It stimulates continuous interaction between citizens. Baum et al. (2007) stated that different levels of transport have to be close connected, this in order to connect clusters inside knowledge cities. This means that university campuses have to be well connected to their direct environment and city but also on a higher scale level to be successful in national and international networks.

- **open/public ground floors (services, retail, exhibitions)**
  Objective is that not only staff and students can make use of these restricted areas, but also city inhabitants. On the other hand, staff and students are able to make optimal use of the city itself. This generates a better environment to interact, to retain and hand over knowledge. University campuses have to open up and share their services with surrounding neighborhoods to create urban symbiosis. Academic institutions have to be open clusters, because it is easier to exchange knowledge in clustered areas.

- **balanced mix of applications (specialized clusters and diversification)**
  To exchange knowledge it is important to cluster services. To innovate knowledge it is important to have an inspiring environment, also on university campuses. This is stimulated by a diversification as Jacobs (Franke & Hospers, 2009) wrote. She distinguished four criteria which are important for an urban environment being diverse:
  - Mix of uses of primary functions
  - Small building blocks that frequently turn corners
  - Buildings that vary in age and conditions; Mix of old and new buildings
  - Sufficiently dense concentration of people

- **accommodation (housing, boarding, guest, hotel)**
  However, universities feel more and more responsible for accommodating their students and international staff, especially when considering the growing number of international staff, students and guests (speakers, teachers, researchers, etcetera). These groups need short to medium term stay, or hotel facilities for accommodation. Also, mobility of students and staff is changing, because of the increasing university network, which creates links to other (inter)national universities, industry and other related business (Den Heijer, 2008). The aspect of quality of life desires high quality accommodation according to Baum et al., 2005 and Yigitcanlar et al., 2008 confirms this.

- **communication (Meeting places, café-bars, plazas, parks, conference)**
  Den Heijer (2008) cited on page 5, that according to Kenney et al. (2005) “The café-library-lounge might become a popular place (Kenney, Dumont et al. 2005)”. Apparently this is a trend, but not necessarily on campus sites. Important for these meeting places is wireless internet to compete with the campus. This communication aspect is high-rated in the quality of life aspect. Den Heijer (2008) states that Dutch students rather decide on sense of place than quality of educational program. “All the more reason why university and city planners should coordinate their strategies, also to brand their universities and cities.” (Den Heijer, 2008, p. 5)

- **high-quality and permeable public space (accessibility, comfort, leisure)**
  The quality of life aspect is important to attract knowledge workers (Van den Berg et al., 2005) As Florida states that attracting talent is most attracted by, what he calls quality of place (Baum et al., 2007). Cultural
activities and amenities play big attractions for knowledge workers. Relaxing your mind is stimulating innovation and is inspiring for creating new knowledge.

• catalytic conditions (surrounding neighborhoods, business parks)
  Important for university campuses is that they are surrounded by suburbs (Christiaanse, 2007). Adding non-university functions to encourage diversity and social interaction will discourage the risk of further isolated, mono-functional sides. But, when generating a campus, away from the city with a complete range of amenities for living, working, shopping and leisure, it will turn into an autonomous compound with all characteristics of a gated community. In other words, there has to be interaction between university campus and its surroundings to be not isolated.
  Campus universities also attract Research and Development related business and can create services which surrounding neighborhoods can use and which creates jobs for inhabitants of a city.

• urban, culture, economy, landscape (contributing and inspiring factors)
  These aspects are forming characteristics of a city and generate creativity because of its diversity. Christiaanse (2007) believes that campuses need to have identity, influenced by external factors. Using these factors, university campuses are socially, economically and physically connected to the city.
  Diverse areas attract business, city inhabitants and visitors.

• strategic tectonic flexibility (responsiveness to changing needs)
  Perry and Wiewel (2005) wrote that it is important for university campuses related to city development, that they can response to changing needs. Flexibility is an important aspect for immediate reaction on shifts in demands or business.

**LIST OF GUIDELINES:**

1. connectivity (Human scale, pedestrian, public and private transport)
2. open/public ground floors (services, retail, exhibitions)
3. balanced mix of applications (specialized clusters and diversification)
4. accommodation (housing, boarding, guest, hotel)
5. communication (Meeting places, café-bars, plazas, parks, conference)
6. catalytic conditions (surrounding neighborhoods, business parks)
7. urban, culture, economy, landscape (contributing and inspiring factors)
8. strategic tectonic flexibility (responsiveness to changing needs)

[Figure 32. Schematic guideline explanation]
2.5 DUTCH POLICIES

This chapter deals with current policies according to Dutch national, regional and local development for the south wing, Delft and the university campus.

2.5.1 REGIONAL POLICY MODEL; RANDSTAD ITS SOUTH WING

Delft is one of the cities of the ‘Zuidvleugel’, South wing, of the Randstad. Other cities are Rotterdam, The Hague, Dordrecht, Zoetermeer, Leiden and Gouda. These cities are combined in a governmental platform, the South wing. This can also be seen as a network city. This platform wants to stimulate economical progress by intensifying the core qualities of the region. The three core qualities are:

- (inter)national centre of justice and government
- the high-quality knowledge centres
- main harbour and logistics cluster.

The first quality is seated in The Hague and the third in the area west of Rotterdam. Delft is one of the cities with a high-quality knowledge centre. The South wing wants to distinguish on a European and mondial scale with this set of core qualities. Improvements are assigned for different themes, like green, water, living, infrastructure and labour. The last two themes have most influence on Delft as a knowledge city. (Bestuurlijk Platform Zuidvleugel, 2003)

Figure 33. Main infrastructural lines in Randstads South Wing
As mentioned earlier, there are three main themes for the economy, government and justice, knowledge and maritime and logistics. Figure 36 shows the knowledge economy on the map.

There are four assigned knowledge centres:
- Node Leiden-West
- Binckhorst, Trekvliettracé
- Knowledge boulevard A13
- Shipping Valley

These knowledge centres have different themes and have different qualities for the knowledge economy. There are two large supporting areas, the sea harbour and the green housing area in Westland.

These areas have specified knowledge. There are three universities in the South wing:
- University of Leiden (bio sciences)
- Delft University of Technology
- Erasmus university (business)

These universities complement each other and attract different students. There are some integrated studies. Next to the universities there are several colleges. Delft has an assigned knowledge centre, a university and a college. It is the centre for technology in the South wing. This should be one of the key factors in the strategy for Delft. Links can be made with the other cities in the South wing.
2.5.2 STIMULATING KNOWLEDGE IN THE SOUTH WING

The knowledge alliance of Zuid-Holland is founded in 2003. It is a network of innovation and entrepreneurship to connect the four groups of actors (education, research institutes, entrepreneurs and authorities). Their main goal is to stimulate the innovative industries. Main themes are observing and connecting. The strategy of the alliance exists out of three core activities: network organisation, implementation organisation and knowledge organisation. The first activity observes the developments in the province and connects different actors; in order to let the knowledge economy will develop in a more efficient way. The second activity is about starting up projects that will contribute to the innovation and the entrepreneurship in the province. The last activity deals with creating knowledge and expertise.

Besides the city council of Delft, main actors are the province of Zuid-Holland, the city council of Rotterdam and Den Haag, three universities, three higher education institutes, other city councils, the Chamber of Commerce and companies, like Shell, Siemens, TNO etc. The alliance is settled in the centre of Delft. (Kennisalliantie Z-H, n.d.) This knowledge alliance will support the development of knowledge businesses in Delft. The first activity is the most important one, creating a network of knowledge-based businesses and people.

It is important for the knowledge city that there will be networks to share knowledge. However, there should be attention to the different scale levels of knowledge sharing; international - local.

2.5.3 FOUNDATION DELFT KENNISSTAD

In order to become a knowledge city, the city council of Delft started the foundation Delft Kennisstad. Their goal is to attract knowledge-based businesses. These businesses, together with the university, will serve as the engine of the economy of Delft and they will bring it to a higher level. In this collaboration of the foundation, there are four groups of actors: education, research institutes, entrepreneurs and authorities. Main actors are the university, the two higher education institutes, the city council, the Chamber of Commerce and knowledge-based businesses. The foundation is cooperating with the Kennisalliantie Zuid-Holland (knowledge alliance). (Stichting Delft Kennisstad, n.d.) The attention of the city council is focused on the higher level of education and similar businesses. They forget that knowledge is not only for universities, but for everyone.

2.5.4 CITY MARKETING

In order to attract businesses, citizens and tourists to Delft, the city council made a marketing campaign. There are four main themes: technology, history, creativity and innovation. The goal of this marketing campaign is to create a livable and wealthy city.

The city of Delft has set up four main arguments, based on the main themes, to attract businesses and people. The first one is the cultural history of the city. Main attractions for tourists are the delftware, the old churches, the Prinsenhof and the city centre. The second argument is the university. It attracts students and knowledge-based and international businesses. This way, there are many nationalities together, which creates a very diverse society. The last argument is the creative city. Historical figures of Delft were creative inventors, like Anthony van Leeuwenhoek and Johannes Vermeer. Nowadays, Delft is the second creative city in the Netherlands. The last argument is the free minded and informal atmosphere in the city, created by the diverse population of students, international employees and tourists. (Vier unieke troefkaarten, n.d.) The city council of Delft has four main themes, which fit partially in the knowledge city. Technology, creativity and innovation are important themes for this concept. History can fit in, if it is used in an educational way. The marketing campaign needs a good slogan and not only four main themes.

2.5.5 HOUSING VISION

In its vision for housing policies, the city council of Delft formulated three main themes: Knowledge, Quality and Changes. In order to become a knowledge city, special target groups are mentioned who needs extra attention. These are the students, the knowledge workers and starting companies. Another starting point is the creation of the living-learning-working- ladder. More higher education institutes are settling in Delft and more national and international students come to the university. This means more students will come to Delft and want to live there.

Housing for students will be mainly realized on the campus. Temporarily students can live in buildings in redevelopment areas. After finishing the study, many people leave Delft. In a knowledge city, it is important to keep starters, because only with these young knowledge workers the city can develop. For this target group, compact, urban living environments should be created. Combined housing and working should be possible in these areas. Besides, there should be enough recreational amenities. The city council of Delft sees potential in the TU area to create these environments.

For older knowledge workers, the city council wants to create city-centrelike urban living environments close to infrastructural nodes and green urban living environments. The first environment can be created around the railway stations. The other environment needs more space and can be situated at the borders of the city. Delft almost reached its borders, so other cities need to cooperate with Delft. Delft tries to connect the knowledge institutes with the so called living-learning-working-ladder. Delft wants to stimulate knowledge sharing by mixing functions on different scales. Business should enter the living environments and housing blocks should be combined with offices or education institutes. Internships and courses should be available...
for all inhabitants (Gemeente Delft, 2008b).
The TU campus side can play an important role in this vision. Housing for students, starters and other knowledge workers can be created here, because the features of the area have many possibilities for creating an urban living environment. Mixing functions will be important to create this living-learning-working-ladder.

2.5.6 CLIMATE AND ECOLOGICAL PLAN

The city council wants to decrease the CO2-emissions. However, there are many large developments, which lead to higher CO2-emissions. Delft made a climate plan for lowering the total CO2-emissions of the existing buildings and the new developments. They use the 'trias energetica': diminish the demand for energy, use sustainable energy sources and use energy efficient. Delft uses the knowledge city concept also for the climate plan. Innovative solutions for a different use of energy, such as mobility issues, should come from the knowledge-based companies. New developments can be example projects and can be inspiring for its citizens, which is also important in knowledge city. (Gemeente Delft, 2003)

Another environmental policy is the ecological plan. The two main strategies are to create a high-quality ecological structure and to keep a good balance between nature and the built up area. A good ecological structure has a positive effect on the social, physical and economical environment of the city. The people can enjoy the green areas and recreate in it. The quality of the air and the water will improve. This leads to a better health and more safe environment, which is attractive to people and companies. (Gemeente Delft, 2004)

2.5.7 CURRENT UNIVERSITY CAMPUS PLANS

The city council of Delft sees university campus as a business district. They admit that the area has huge potential qualities like the proximity of the canal, the railway station and the highways A4 and A13. New plans are made to connect the university campus with the rest of Delft city and create a lively and attractive area. Some areas surrounding the campus, like de schie canal banks already respond at the business district Delft is to become; Breeding grounds, studios for graduated students from the university, so they can start up their own business. The existing industrial businesses will move to the Harnaschpolder.

An important node in the area will be the railway station Delft Zuid. This will be upgraded, because it will be part of the 'Stedenbaan'. This new railway concept has more trains in a higher frequency. The new station will be surrounded by housing and offices. (Schieoevers, n.d.)

The municipality, describes the main goals as:

- attract more businesses to the area;
- connect the neighbourhoods Voorhof and Tanthof with the university and Technopolis;
- connect the city to the rural landscapes;
- create ecological zones next to roads and water;

(Gemeente Delft, 2008)

The next chapter discusses the campus vision of 2030, which is created for the TU Delft.
PART 3: SPATIAL ANALYSIS
3.1 INTRODUCTION

After gathering the theoretical background and some ideas, it is important to look back at the aim of the project. In the problem field, definitions of the issues are drawn:

- Spatial problems: campus as a mono-functional enclave
- Social problems: mono-functional, segregated area
- Connectivity problems: High-quality connections are needed
- Lack of ‘quality of life’: This to stay attractive for knowledge workers and keep innovative

The research is focussing on the regional and local role of the university of Delft and university sides in general. Aim is to deal with this regional and local role of Delft its University in this knowledge environment.
To do so, it is important to define where the spatial potentials for development are and in what way they can be used to improve the regional and local role and position of TU Delft its university campus.

**Figure 38. Structure**
3.2 REGIONAL ANALYSIS

This chapter discusses the regional position of the city of Delft. In order to make a clear vision, connected to this regional environment.

3.2.1 HISTORY

On a regional scale, the area consists out of the cities of Rotterdam, The Hague, Delft and Zoetermeer which are connected through infrastructural routes on a higher scale. In the area, there are some smaller villages, who evolved from the historical ribbon developments that came up in the time of cultivation of the land around 1650.

In history, the tide occurred in the finger shaped water inlets (Figure 40), across the area where now Delft and Pijnacker are situated, which causes that these areas are filled up with clay. Outside of the domination of the sea, the creeks and the river developed in the area, in between the locations where nowadays Rotterdam and The Hague are situated. From this peat area, the water escaped and the rivers Rotte, Schie and the Oude Leede developed.

While colonisation in the 12th century, the dikes and drainage systems where built parallel to the rivers and after the land has being cultivated and water was drained out of the peat, agricultural land appeared. Along the rivers, roads appeared where small ribbon villages appeared. At the same time the peat started shrinking and the level of soil became lower than the waterways, which is still visible in the landscape. Around 1750, the top layer of the peat land was dug out just underneath ground water level, to serve household in the cities and villages. The dried peat could be used as fuel for heating and cooking. The digging of the area occurred per allotment, starting off from the ribbon. By doing this, everywhere a connected wet area appeared, almost the whole agricultural area was drowned under water. After this, economic value of the land was lost. Wet areas were cultivated again and dividid into new allotments.

After 1850, a new infrastructure was added in the region, a rail line between Rotterdam - The Hague - Amsterdam was created. Followed up by the next big infrastructural development of the Hofpleinlijn; a rail connection, connecting the surroundings with the cities of Rotterdam and The Hague.

Figure 39. Soil map of Randstad its South Wing and Delft and surroundings (Alterra, 2010)
Around 1985 a rapid growth of the second generation of urbanisation and infrastructure is visible. The airport of Zestienhoven, nowadays Rotterdam - The Hague Airport, is being developed, along with an expansion of the road network. The region is being more interweaved in the national network. The urbanisation of the area is developing including rapid expansions of the cities inside of the South Wing its network. After the development of the second generation of urbanisation, the need is to come up with a vision for the area, to prevent a clutter area. The green space in between the city areas is defined as one of the qualities in the area (Figure 41). The strengthen this, it is important to develop a green network structure that connects and divides the area at the same time. A few nodes in between are defined for development.

From 2010, the fourth generation of urbanisation is going to be developed. Now it is time for urban regeneration and sustainable development, because of high pressure on these green areas because of exploding cities. For further development it is very important to follow a vision or strategy, covering the entire region. If independent municipalities are going to make their own plans, the overall scale vision will get lost.
Figure 42. Main polder directions combined with green network around the project area.
3.2.2 REGIONAL GREEN NETWORK

As said before, there is a lot of pressure on the green area (Midden Delfland, Figure 41) in between Rotterdam and The Hague, from both sides as well as from the Delft and Zoetermeer side. Natural qualities are important considering the ‘quality of life’ aspect, discussed in the theoretical framework. Green environments are places to recreate and relax to keep innovative and creative.

Due the changes of the landscape over time, caused by human action, different landscape directions were created (Figure 43).

The landscape area is, as written before, evolved in different stages throughout history. These different developments are visible in the structure of the landscape which can be divided into the gridstructure of:

- Rijnland
- Schieland
- Delfland

As visible on figure 42, two mayor green areas are connected to the landscape, in the north the Green Heart and in the South there is Midden Delfland as a carrier.

Figure 43 shows the characteristic green network between Rotterdam, The Hague, Delft and Zoetermeer. The grid direction is clearly visible and a green network is present between the Green Heart, starting at the north side of Zoetermeer towards Amsterdam and in between the Hague and Rotterdam, Midden Delfland is situated (Figure 44).

Intensive reclamations took place in the thirteenth century under the pressure of population growth. After a period, not only peat grounds were reclamated, but also rivers clay, which created uncontrolled polder allotments, even in length up to 2 kilometres. As on figure 43 is visible, these uncontrolled reclamations along the rivers, are all directed towards the water.
Figure 45. Regional infrastructure
3.2.3 REGIONAL INFRASTRUCTURE

The area in between Rotterdam and The Hague is surrounded by highways, even as the city of Delft which is enclosed by two highways; A4 and A13, connected through Delft campus via Kruithuisweg, what will be discussed further on in this booklet.

In between this ‘triangle’ of highways, there is a network of regional roads, but some parts of this highway network are lacking in the current situation. That is why in future, highway A4 and A20 will be extended:

- Extend A4 in direction of Rotterdam
- Make a connective highway between A13 and A16, called A20

The project location is well connected to the highway network on the right side, and the railway on the left side. Delft has two railwaystations; Delft CS and Delft Zuid. Both of the stations need a 15 minute walk towards the university campus or a 5 minute busride only available from the main station of Delft.

The railway of Delft is currently being transformed into a railway tunnel underground, with on top a green park and business district with in the middle Delft central station.

The railway station of Delft zuid will in future be part of the ‘Stedenbaan’. This is a project which combines two strategies:
1. Creation of a high-frequency public transport system on the existing national rail network
2. A regionally coordinated urban development programme based around the stations on the rail network

3.2.4 SLOW TRAFFIC ROUTES

There is a large number of slow traffic routes in the area; cycling paths and pedestrian paths, mostly along historical lines, still visible in the landscape and through green structures.

The project area has more potential to connect with the regional slow traffic network. The current situation offers good connections but mostly stops at the borders of the planning area. Potential to hit the heart of the campus is present and needfull because of the high amount of people traveling by bicycle every day to Delft university Campus.

Figure 46. Stedenbaan Concept, which Delft Zuid will be part of

Figure 47. Cities positioned around the Green Heart and Midden Delfland
Regional Connections
Rotterdam-the Hague

Figure 48. Schematic figure of the Regional Public Transport system

HANNES VAN DE VEN
3.2.5 REGIONAL PUBLIC TRANSPORT SYSTEM

As already discussed in the previous chapter, the different cities in this region are connected to a rail network (Figure 45). But also an extensive public transport network in between, is connecting the big cities and smaller villages by a metro network. Public transport lines are very attractive for extend, densify residential or office areas or with a mix of functions, because they give good access to these areas. Focus of this project is to improve accessibility of the project area, because of the future vision to become a very large economic and strategic hub in the south wing of the randstad. The project area has a big potential to deal this connectivity on local, regional, national and even international scale, but the current situation is not using these potentials. According to many, it is important to give good connected places value, by adding quality and activity.

To be able to understand this public transport network, it is important to elaborate more on the different scales of the public transport network, what will be done in the next chapters. Figure 48 shows a schematic figure of the public transport lines in Randstad’s southwing.
Figure 51 - Metropolitan north-south axis (source: TU Delft college van bestuur (2010) TU Delft Campus Visie2030, Delft)

Figure 52 - East-west leisure axis (source: TU Delft college van bestuur (2010) TU Delft Campus Visie2030, Delft)
3.2.6 CONCLUSIONS

TU Delft campus has potential to expand, because of its central location at the Hague - Rotterdam axis with in between the regional park 'Midden-Delfland'. Finishing the A4 highway will enlarge the potential to create an urban axis between the Hague and Rotterdam. The city of Delft has less space for urban expansion, while the university has more potential space. It creates chances to expand in direction of Rotterdam, as said in Campus Vision2030. Delft could be a strategic intersection.

Between the Hague and Rotterdam, amounting the city of Delft, a green leisure axis is crossing the metropolitan line. Delft city is the intersection point of those two lines. That is why Delft has a large potential to become a strategic point in this regional environment.

Regional conclusions that can be stated are:

1 Use one vision

2 Midden Delfland is an historical and characteristic, open polder landscape which has to stay intact

3 Car- and slow- traffic networks are present and can be upgraded to improve accessibility of the project location

4 Delft is only connected directly to The Hague and Rotterdam by a train network system, potential lies in the public transport infrastructural scale in between.
Figure 55. Development of the city of Delft and changing position of the university campus (red)
3.3 LOCAL ANALYSIS

To be able to generate a more detailed plan for the university campus of Delft, it is needful to analyse the local urban fabric of the city to clarify the qualities of the project location located in Delft city.

3.3.1 HISTORY

Delft University of Technology in the city of Delft, the Netherlands, is the nation’s largest technical university, with over 15,000 students, 2,700 scientists (including 200 professors) and 1,800 people in the support and management staff. As said before, University campus of Delft was set up in 1842.

Because of the movements Delft campus lies isolated from the city. The physical perceptible lack between the city centre and TU Delft campus, only attracts target groups (students and employees). The TU Delft Campus is not connected to the rest of Delft city, although it creates the biggest brand aware name of the city. The university is independent and physically, socially and culturally isolated (Knight, 1995).

By creating an isolated campus with a concentration of educational buildings, inhabitants of Delft are avoiding this area. As there is nothing for them to visit, they show a social lack of interest in knowledge institutes and business. Fernández-Maldonado & Romein states that also students and employees are not connected with Delft City and become a commuter flow (Yigitcanlar et al., 2008).

The knowledge-based businesses are close to the university. Some are located at the university grounds, but others are right next to it. The new Technopolis innovation park is planned on the south side of the university campus, close to the highway exit Delft Zuid, on the A13 connecting The Hague and Rotterdam. Research and development businesses are attracted to Technopolis, because of the proximity of the university, the good accessibility and a cooperative local government. The complete Technopolis will be around 120 hectares (Technopolis, 2006). The gap between the university, the knowledge-based businesses and the city centre is also a physical one. People do not go the Campus, except for the students or the employees of the university and Technopolis is even further away from the city centre. The university is independent and physically, socially and culturally isolated. (Knight, 1995)

By centralising the university buildings, knowledge-based businesses, the people of Delft are discouraged to visit this area. There are no amenities for them to visit. This leads to a social gap, because the people of Delft do not feel connected to knowledge institutes and businesses. The problem is the same the other way around: the knowledge workers are not connected to the city centre of Delft, because of this spatial segregation, arise out of historical point of view. The good accessibility of the highway A13 leads to further commuter traffic. (Fernández-Maldonado & Romein, 2008)
3.3.2 LOCAL GREEN NETWORK

The existing green areas in inside Delft city are small, spread areas. The Kruithuisweg is the only striking road, combined with green. Delft is surrounded by polder areas, as discussed in chapter 2.2 of part 3, before. Also has Delft some green parks, which also are spread around Delft city. The area where the TU campus is located in, is the historical Wippolder. Characteristics of this polder area are almost gone, because of the takeover of the University campus. Only the characteristic straight polder lines are in some cases still visible. Because of all these green areas, the municipality wants to add several ecological connections in between of them.

In Delft, most of the recreational functions are in the city centre. For example, more than 70% of the restaurants are at the city centre. Besides, the theatres and clubs are in this area. The connection from the university campus towards the city centre needs to be upgraded to high-quality rapid connections. This way, the new population could profit from the facilities of the centre. There are not many parks in Delft. The Delftse Hout is the only large green area in the city. On the Schie canal banks, there should be a park, also for the surrounding neighbourhoods. The other parks are not close to the project location, so the surrounding population should be able to profit from this park. The green and urban facilities should be in balance. These facilities should be connected by slow traffic routes, to facilitate the neighbourhood.

Facilities that should be added are restaurants, bars, terraces, a supermarket, a park, playgrounds etc. For large recreational facilities, there should be rapid, high-quality connections to the city centre. Along the Schie, some places are combined with the green structure. But lots of lacks towards the city are visible. The municipality wants to add more surface water, to restore the historical value of the area.

The Schie canal is mostly used by boat traffic, but not for recreational functions along it, although it is a very busy waterway. Many inland vessels use this route. Besides it is used for recreational transport. There are two rowing clubs located along the Schie. There are two harbours, one for large boats and one for the households surrounding it. Other boats lie at the quays next to the canal. The municipality wants to add more harbour places combined with functions.
3.3.3 LOCAL INFRASTRUCTURE

The existing road structure around Delft has three levels; Highway, main roads, secondary road.
The existing structure is unbalanced, because it developed through the years almost only in north - south direction. The only strict east-west connection is between A4 and A13: kruithuisweg. A13 and Kruihuisweg are in current situation open for Hazardous Substances.
The campus side had one main road; Mekelweg, which is transformed into Mekelpark and only can be reached by foot and bicycle. In future there also will be a tramline, discussed in the next chapter.

The cities in the South wing need to cooperate, so the connections between the cities are essential. The connections are already good, but as said before, two main interventions are needed. Highway A4 should be continued from Delft to Rotterdam. Nowadays, the A13 is the only fast connection between the cities, but it has also many traffic jams. The A4 can partly solve this problem and has a better connection to the south of Rotterdam. The Kruihuisweg, main road between those two highways plays an important role in this setting.
The travel time to from Delft Technology campus to Rotterdam airport is short for cars, but takes more time (approximately 55 minutes) by public transport.
There should be a better connection to the airport from Delft. On the scale of the city, the mobility nodes to the higher network are very important.
In Delft, the stations and the highway exists are the major nodes. It is important to connect these nodes with each other and the rest of the city. The connection from Delft South Railway station should be improved. The connection of the campus and its area is pretty good, coming from the highway.
The slow traffic connections to the railway stations are very important. This slow traffic network should also connect other parts of Delft to the the campus environment.
There are two railway stations in Delft. They both facilitate the project area. Delft zuid and Kruthuisweg do cross over each other. Delft Zuid station is almost invisible, but could be a big supplier of the TU Delft campus.

The central station of Delft is currently under construction. The railway will be undertunneld and a new business district will exist around this central spot of Delft. But this area is hard to reach by car, compared to the campus area which potential to have good accessibility by car and public transport.

The connections to the mobility nodes should be improved. The route to the exit Delft Zuid of the A13 is very long. There is a long detour and this should be improved. The slow traffic connections to the railway stations are very important. This slow traffic network should also connect other parts of Delft.

Connectivity of the level in between (metro, lightrail) is low. Delft is only accessible by train and local connections, with starting point main station of Delft. Slow, low quality busconnections travel towards Rotterdam and the Hague.

High comfort, rapid public transport connections are missing in the City of Delft and its region.
3.3.4 LOCAL PUBLIC TRANSPORT SYSTEM

Public transport inside Delft city, consists mostly out of buslines, which connect parts of Delft and Delft in a regional context with the Hague and Rotterdam. Delft has two tramlines: 1, Tanthof and 19 in future towards Technopolis.

Tramline 19 is a future tramline, which connects Technopolis, Tu Delft the railway station of Delft central with the Hague, using an eleven kilometre long track. Delft CS is providing several bus connections in direction of Rotterdam and The Hague. Three buslines are using the same route towards TU Delft campus as the tramline does. These lines do split up at the entrance of TU Delft main axis (Mekelweg). A former busline 69 with endstop Technical University (TU-wijk) is cancelled. Further analysis of this tramline (19) can be found in the Appendix.

Figure 60. Tramline 19 and tramline 1 positioned in Delft

Figure 61. Tramline 19 in direction of TU Delft Campus, connected to several buslines
Figure 62. Sequence of tables regarding demographic data of people living in Delft City (Buurtmonitor, 2009)
3.3.5 DEMOGRAPHIC DATA OF DELFT

This chapter discusses population of Delft. All neighbourhoods are compared (Gemeente Delft, 2009).

PEOPLE DENSITY
Nowadays, Delft has more than 95,000 inhabitants. Most inhabitants live in hof van Delft, but the highest density is in Voorhof, caused by the high buildings in that area. Wippolder has a low density, caused by the mono-functional division of the area; low amount of housing, high amount of business.

GREEN AREAS AND AMENITIES
Research is done according to appreciation of green areas. Clearly visible is that people, living in Wippolder are not enthusiastic about the green areas, located here. Contrasting the green and open space, Wippolder has, is it, according inhabitants not of high quality. Also amenities/facilities are lowest appriciated in Wippolder.

OVERALL APPRECIATION
This is again in Wippolder the lowest. The biggest percentage of people here is planning to move because of a lack of attractiveness.

UNEMPLOYMENT
Unemployment is highest in Voorhof and Buitenhof. Delft city centre en Hof van Delft has the lowest rate of unemployment.

KNOWLEDGE-BASED ACTIVITY
Logic, is the high rate of knowledge-based activity in the Wippolder. This knowledge environment attracts small, medium and large companies.

AGE OF DELFT
Compared to the rest of the Netherlands, Delft accommodates a lot of young people, because of the many students studying at the university. People who studied in Delft, move away after they graduate.

CONCLUSIONS
The project area, located in the Wippolder, is mono-functional and focussed at knowledge based activity. This environment creates a lot of jobs. Research states that people do not want to live here, also because of a lack of functions not related to the university.

3.3.6 ADDITIONAL AREA
At the north part of Delft, green housing is located. Also just outside Delft, green housing is placed in the landscape. These areas are potential expansion areas. The project area covers a cemetery which is located in the middle of the TU Delft campus and has, as visible at the historical maps an historical value.
Figure 64. Google maps picture of Delft City

Figure 65. Strict north-south orientation prevents east-west developments

Figure 66. Adding strengths & weaknesses of campus area

Figure 67. Poor co-operation between TU-management and Delft municipality
3.3.7 CONCLUSIONS

Barriers
In a local context, the university campus is isolated from the city. Three barriers are preventing connections between city and campus: Industrial zone along Schie canal, railway and A13. Especially connections with the west side of TU Delft campus are poorly. Public transport connections with the city of Delft are excellent. On the other, accessibility of Delft university campus by public transport is undersized. (Figure 65)

Enclosed by city
Over the years, the campus is enclosed by urban expansion. Nowadays, the campus experiences urbanization. TU Delft north, is developing dwellings while the south part is expanding with science-park Technopolis. Living environment at the TNO-area will be generated and also the industrial Schieoevers will be transformed into creative urban area. These urban transformation and expansion will create new chances for better facilities and a high quality environment in and around the campus area. This Technical University is an important link for balanced development in the city of Delft. (Figure 68)

Diversity of environments
The planning area has a diversity of environments, especially in east-west direction which is a strength. Diversity contributes to wider attractiveness of people and broader support of facilities. (Figure 66)

Bad accessibility by Public Transport
A disadvantage of the TU Delft campus is the poor accessibility by Public Transport. In future, a tramline will cross the Mekelpark. Because a lack in co-operation between the management of TU Delft and the city municipality, the campus area is isolated. Important is to collaborate and link urban space on the campus area with surroundings. (Figure 67 and 69)

Conclusions according to the local analysis, which can be used for a design, are:

1. Improve slow traffic connections; Railway and campus
2. Create quality of life around the campus area; Save attractive environments that is good accessible by private and public transport. Current situation to less but needed for innovation and meeting places and connect them with slow traffic routes
3. Add facilities to these green areas to make it attractive not only for students and employees
4. These meeting points should be at nodes of different routes. Different people will visit the area for different reasons, housing working or leisure. People will use different routes, so the meeting point will be at nodes, in order to connect the people
5. Use monumental buildings to create attractivity
6. For pedestrians and cyclist, there are many entrances, assigned on the map on the former page. These routes are not very nice to ride for recreational purposes now. There is great potential to make better routes for slow traffic
7. There is a lack of high quality public space, where people could recreate. There should be a good balance between green and urban areas
8. Create urban diversity for attracting a broader target group.
Figure 68. Google maps picture of Delft Campus.
This chapter shows the vision for the campus area of TU Delft, followed by the specific design location. This chapter analyses the current campus vision 2030 and discusses which principles are used in the design of the project location.

4.1.1 CAMPUS VISION 2030

After the loss of the building of bouwkunde, a new campus vision 2030 is in development. Based on a contest (prijsvraag) for the location of new bouwkunde building and a ‘Denktank’ (think tank) was organized for future developments of the university. The municipality of Delft put the question to upgrade the relation between TU Campus, city and region; research on a higher scale and generate an urban vision for Delft south east.

The complete CampusVision2030 Research can be found in the Appendix

The campus vision 2030 describes the strong and weak points of Delft’s university campus. This chapter describes the opportunities and threats set up according to useful aspects of the campus area based on CampusVision2030 strong and weak points.

These opportunities and threats constitute the design principles for further elaboration of the project.

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**Figure 72.** Strengths & Weaknesses of campus area according to Campus Vision 2030

**Figure 73.** Opportunities and Threats

**Figure 74 - New Masterplan for University campus area, by Campus Vision 2030**
4.1.2 VISION
This chapter describes what principles, related to the written campus vision 2030 are to be used for further elaboration of a detailed campus plan.

1. REGIONAL VISION
The regional concept of the campus vision 2030 focusses on a one way orientied metropolitan axis between the Hague and Rottedam. Important is to not only focus on one way development as happened on Delft’s local scale. Future scenarios describe a large co-operation between different universities, science parks, airports and research and development areas on local, regional, national and international scale (network university).

Principle is to link university campus Delft on different scales; focus is on local and regional scale.

Important in campus vision 2030 are two lines (green and metropolitan) which cross each other. East-west oriented development is needful to keep the green leisure axis open by stimulating east-west orientation, also from an historical point of view. Connect this urban line on regional scale.

TU Delft wants to be profiled as network university, therefore it is important to be connected on different scales.

2. LOCAL CITY VISION
At the strategic intersection of the metropolitan- (red) and leisure (green) axis, Delft knowledge city is located. Campus vision 2030 describes that, better co-operation between municipality and TU Delft management is a requirement for integrating campus structure in its surrounding urban fabric.

The recent contrasting city center and university campus is created by an unattractive and monotonous university campus, bad interweaved infrastructural networks and difference in densities.

URBAN DIVERSITY
Creating an attractive university campus by adding program (Offices, dwellings, commercial, horeca, sports and parks) will attract a wider target group. It will also upgrade interaction between campus and city center.

Mental barriers will disappear by attractiveness of facilities at the university campus.
INTERWEAVED URBAN FABRIC
By extending potential east-west oriented routes (Bicycle and car) within the campus area towards the surrounding urban fabric, a better interweaving will improve accessibility and removes the strict borders (Schie Canal, Schoemakerstraat). The campus ringroad and ongoing east-west oriented links will upgrade accessibility on local and regional level even more.

By focussing on east-west oriented development, the characteristic north-south development of the university campus will turn into east-west direction.

A green network from Midden-Delfland towards Delft’s city center will enter through the university campus (Mekelpark) as a leisure axis.

DENSIFICATION
Analyzing Delft’s university campus concludes a contrast in densities between Delft city center and campus. High densities in the city center versus low density at university campus.

Delft city has limited space to expand their boundaries. Developments of the city can take place at the campus area by densifying it. Contrasts in urban fabric will decrease and will be better interweaved.
Delft University wants to profile itself in the future as a network university. Therefore it is not only important to be connected on local, national and international scale, but also on the scale in between; Regional Scale.

The university is connected good for private transport, but accessibility by public transport is underdeveloped while students are one of the larger user groups of the public transport system.

Focus on further development of this project will be based on this regional scale level connections by public transport. Tramline 19, which is already under construction does connect the university with the central railway station of Delft and the Hague in a north-south oriented direction. The new connection (tramline 37), east-west oriented, is planned to connect the university campus with railway station Delft Zuid and the regional RandstadRail network.

4.1.3 DESIGN PRINCIPLES
A high quality (rapid, comfortable) public transport connection has potential to give future - expansion, direction. The north south oriented development of Delft, threatens to densify the regional green leisure axis. By turning the expansion orientation, the green axis will stay unaffected and city of Delft can develop along the new PT line in east-west direction.

An important public transport intersection will appear at TU Delft's campus.
With this new line as backbone, the university campus can be densified by adding programm. By better co-operation between the municipality of Delft and management of Delft university, urban fabric can be interweaved.
LANDSCAPE AS A BACKBONE

Figure 84. Randstad Vision

HANNES VAN DE VEN
4.1.4 RANDSTAD VISION

After doing the analysis of the current Campus Vision2030 and discusses what to agree or disagree, a vision at randstad level is presented in this chapter.

RANDSTAD VISION
The randstad consists out of several cities in the west part of the Netherlands. The city of Delft is part of a network of important business carriers in this Randstad. Especially in the south wing of the Randstad, TU Delft has a strategic position. Natural landscape in between these cities has high quality in national policies. This ‘groene hart’ (green heart) and Midden Delfland, are areas that are preserved to stay open. This backbone landscape area, is functioning as a carrier, with business surrounding it. These cities are all connected, by railway and highway networks. Some regional metro networks are connecting cities on a lower scale level (Figure 48 and 49).

SOUTH WING VISION
The area between Rotterdam and The Hague accommodates a metropolitan axis, crossed by a characteristic green network of nature, grass areas and recreational routes. Old east-west polder lines needs to be strengthened and natural qualities should be strengthened. The green Midden-Delfland area have to stay open. Therefore urban development have to be redirected into east-west direction instead of north-south direction. Future development should not densify the open, Midden-Delfland area. Connections between The Hague and Rotterdam are still needed, but have to stay minimal and bundled.

Private transport connections between cities are pretty good, but regional public transport connections are limited especially with Delft.

Figure 85. Southwing Vision
Regional Connections
Rotterdam-the Hague

Figure 86. Upgrade regional public transport connections
4.1.5 PUBLIC TRANSPORT VISION

To improve the regional oriented connections, previous analyzed connections (p. 66) are being extended. New in figure 86 is the blue line; Railway station Delft Zuid - RandstadRail station Pijnacker centrum. Public transport lines are strict lines in the landscape and are important for user supply and even can create a development direction.

This Delft line connects TU Delft campus to a regional network scale, in between. Related areas linked at the line (in black frames) are faster reachable or have diverse alternatives to be accessed; national railway network or regional public transport connections.

Municipality of Delft has problems finding locations to expand and generate more housing facilities. This is caused by strict north-south lines (A13, railway, Schie canal, etcetera.) Delft is enclosed in. Need is to cross these lines and enlarge expansion possibilities for Delft municipality. This is made possible by turning current north-south oriented direction, towards an east-west oriented direction, along the new public transport line, which creates good accessibility potentials.

Next to this regional connections that is added in the first phase, recommendations will be done to strengthen strategic TU Delft location even more. The dotted blue and green line can be extended in a second phase.

A high number of people that work as employee at Delft university campus are living in Zoetermeer. Potential is to extend the line even further towards Zoetermeer.

Municipality of Rotterdam is already planning to finish the public transport ring (green), which links Rotterdam-the Hague Airport with the regional connections, which can even strengthen the position of TU Delft even more, also in international ways.

The same can be done with the blue line, which will be extended towards The Hague and creates a public transport ring around the city of The Hague.

By creating this regional network, TU Delft, Technopolis and other related business can strengthen its position in Randstad, Randstads south wing and can be interesting, even at international scale level, because of fast connections towards Rotterdam-The Hague Airport.

Phase 1: Delft Zuid - Pijnacker Centrum

Phase 2: Zoetermeer - Pijnacker Centrum
Loosduinen - Delft Zuid
Binnenhof - Schiedam

Different reasons to create a metropolitan public transport system at this Rotterdam - The Hague region are:

_ Public transport will be more important in future as an alternative for car use. Related to densifying policies, more functions will be positioned along these networks and important nodes, causing an attractive travel alternative.

_ A metropolitan public transport system covers the ambition of the Rotterdam - The Hague region, to use scale advantages, which are seen as potential in a three million people region.

_ Because of increasing interaction between different parts of Randstads south wing, a coherent, high-quality, regional public transport system is needed. Current situation is, except RandstadRail, almost only focussing at individual agglomerations.

_ A public transport system, that can meet the transport demand, can also give new impulses according to spatial-economical development and social renewal.

_ A metropolitan public transport system in coherence with good slow traffic infrastructure can facilitate mobility demand in a sustainable way; High quality living environment and energy (CO2-emission).
Figure 88. Changes in travel alternatives and faster connections

Figure 89. Changes in catching travel time

Figure 90. Alternative travel routes
TRAVEL IMPROVEMENTS
What happens when constructing these connections?
The left page shows travel trajectories in current situation and in future situation
when generating the recommended connections.

Creating these missed links, creates a stronger position of University’s campus
side, but also increases better cooperation between Delft university, related
business and universities in the region, Randstad and even international.

Comparing these different travel routes, does not mean that all travel routes
are faster, but will give more alternatives to travel and because of the high stop
frequency of this regional public transport network, a larger reach area will be
covered.

For example, people living in Zoetermeer and working at Delft University, can in
future use a rapid, high-quality public transport connections. This will save a lot
of time.
Another example is a group of students, studying at Delft university. The coorporate
with Erasmus University in Rotterdam. Because of a rapid, high comfort, regional
connection, it is made possible to use a public door to door connection.
It also gives alternative routes. After technical failure at railway connection, it
is possible to use other high-quality routes to get at destination. Facilitate inter-
route transfer possibilities (A-B-C, B-C-A, C-B-A) (figure 92).

Creating more, faster and better travel possibilities and constructing public
transport transition for fluent direction change. People are more attracted to use
public transport.

The vision for future campus scenario is highly related to good connections, because
of broader cooperations all over the world. Therefore, physical connections are
indispensable and playing an important role of TU Delft’s future development.
4.2 DESIGN LOCATION

Figure 93. Campus Vision 2030

Figure 94. Reference Project; Lyon

Figure 95. Adding program means, attracting a wider target group
LOCATION INFO

- APPROXIMATELY 100 HECTARE
- CENTRAL AREA OF UNIVERSITY, TNO/TECHPARK AND TECHNOPOLIS
- ACCOMMODATES TWO PUBLIC TRANSPORT LINES
- RAILWAY ENTRANCE DELFT ZUID

4.2.1 DESIGN LOCATION

The final project location that will be designed is the area around the Kruithuisweg (100 ha.). This main road, focused at local but also on regional connections, is an important entrance of the city and TU Delft campus. Because of the future growth of technopolis, this Kruithuisweg will be located as a central road inside this TU, TNO, Technopolis area. This main road is not only well connected to the highway, but also crosses Delft Zuid railway station which can function as a good supply of users towards TU Delft on a higher scale level.

Reference is a project in Lyon. Tramline T1 was extended, because of a low user rate. On the east side of the city, tramline T1 used to turn at the technopark. Because it only was attractive for students and employees, the end part was only used by this target group. By upgrading and extending a neighbourhood (Saint-Priest; Figure 94) beyond the technopark, the target group of users became broader and the line was used more intensively (Figure 95).

Idea is to use the same vision in the TU Delft model. Make an interesting area for both high intensive users of the area and inhabitants of Delft.

Instead of one tramline in the Lyon model, the project area in Delft is planning to accommodate two tramlines. Tramline 19, which is already under construction (north-south) direction. The other line is tramline 37, which will connect TU Delft campus in east-west direction.

Tramline 37 can play an important role in the project location, because it has potential to function as a public transport supply from Delft Zuid towards TU Delft Campus. Whether it is a tramline, lightrail, metro or a busline.
Figure 96. Aerial of the Project location, Kruithuisweg (Google maps, 2010)

Figure 97. Bird’s eye of the Project location, Kruithuisweg (Bing maps, 2010)

Kruithuisweg (N470), provincial road, speed limit 100 km/h, Route for hazardous substances

Monumental Building, Kruithuis

Delft Zuid Railway station
Schieoevers

Delftechpark

Cultural Pavilion
TU Delft

Urban Expansion Area
Delfgauw

Reserved Tram Tunnel

Highway A13

Sport Facilities

Total length Delft Zuid - Highway exit A13: 1700 meters

URBAN SYMBIOSIS
4.2.2 CITY STRUCTURE
The city of Delft and its environment is divided into several monofunctional parts, especially TU Delft campus. The knowledge city should have a mixed structure; housing, working and leisure should be combined. This is possible, because of the polluting industries leave the city and people can live closer to working areas. To create more diversity, functions should be added in this area, like housing, recreational facilities and shopping facilities.

The east side of Delft city accommodates a small area of green houses. This area is under pressure because of cities growing towards each other. Lots of green house facilities moved in direction of Hoek van Holland.

The project location is in current situation covering sport fields, industrial Schie canal banks and TU Delft related buildings.

4.2.3 CHARACTERISTICS OF THE DESIGN LOCATION
The project location is surrounded by educational related program. At the north side, TU Delft is located, the east side accommodates TNO and Delft Techpark and in future, the south side will be developed as Technopolis Innovation Park into one of the most important knowledge areas of Europe. This business area is focusing on the research and development companies. The location of Technopolis is close to the university of technology, so there should be a collaboration between the university and the businesses. The business area will be developed in the next 20 years. At the end, it will be around 86 hectares. The first company is already settles, the Dutch Measurements Institutes (NMI). (Technopolis, n.d.) The location of Technopolis is also close to the exit of the highway A13. However, there is a big barrier in between Technopolis and the university (Kruithuisweg), so the advantage of proximity is limited.

Along the Schie Canal, several monumental buildings are located. Kruithuis is the only building positioned inside the project location. Nowadays it accommodates a scouting club. In history it was used to store the powder for battle. This monumental building is almost not visible, but needs to be preserved.

Other monumental building outside the design location is the Porceleyne Fles. It is famous for its delft-ware, its blue porcelain. Nowadays, tourists visit the Porceleyne Fles, the old factory of the ceramics.

Glue and gelatine area is the former lime and gelatin factory is situated in the middle of the Schie canal banks. The city council wants to turn this factory into the centre of the art and knowledge city. This new centre Lijm & Cultuur (Glue and culture) will be a place where cultural creativity and innovation will inspire the people of Delft.
In order to prevent graduated students leaving the city of Delft, in the Schie hall, new space will be available for small starting businesses. Graduated students can hire studios. There is a lot of space and flexibility. The function of the Schie-factory is very important in the knowledge economy. In a building like this, there is a lot of sharing of knowledge. At the other hand, it is sustainable to use an existing building and re-use it in another way, because you do not have to demolish and build a new building.

The Schie is an historical water-line and accommodates several historical buildings, which are used for re-use in order to help the knowledge economy.

Except the project location, the rest of Delft Campus is good accessible by Public transport. The two stations, and lots of busstops are covering almost the whole campus side. Tramline 19 is taken into account. A research of tramline 19 is discussed in the appendix part of this report.

The Highway, railway and Kruihuisweg are producing a lot of noise in the area. Kruihuisweg has a speed limit of 100 km/h and the highway of 120 km/h. Kruihuisweg is route for hazardous substances.
MEKELPARK
Mekelpark is a green axis which is surrounded by TU Delft its University buildings. The tramline nineteen will, in future, pass this green axis and will be part of the Mekelpark to transport students and staff. Mekelpark will cover the area between Aula and the sports fields and has an almost 90 meter width, with three tram stops along the line. Motorized traffic (cars and busses) abandoned from the park. The 3D image shows on left side a seven storage high building line (civil engineering) and on the other side the first floors of the 90 meter high building of electrical engineering along the main axes.
This spatial profile surrounding tramline 19 is caused by the formal mekelweg and possibilities to park the car in front of each faculty. Nowadays it Mekelweg made place for Mekelpark, a green axes through the heart of the TU Delft campus. This environment provides the traveler and the urban space itself with high quality landscape features, but also has a huge impact on the width of the profile.

TECHNOPOLIS
As said before Technopolis Innovation Park is being developed in the immediate vicinity of the Delft University of Technology. The business park focuses on research and development (R&D) projects, such as techno start-ups, the leading international R&D centres, and European branches of R&D-intensive companies. Knowledge, expertise and research facilities are all at hand. Within 20 years, this business campus should be fully occupied with knowledge-intensive companies that expand the boundaries of new applications. Technopolis is becoming one of THE most import knowledge centres in Europe. The design plays with the south sided Midden-Delfland area. Polder shaped buildings are placed into this new developed area.

The appendix shows a more extended research of future tramline nineteen and Mekelpark.
Figure 109. Section A-A'. scale 1.500. Kruithuisweg crossing Schie Canal

Figure 110. Section B-B'. scale 1.500. General Kruithuisweg setting

Figure 111. Section C-C'. scale 1.500. Station Delft Zuid

Figure 112. Section D-D'. scale 1.1000. Height difference of Kruithuisweg
SECTIONS CURRENT SITUATION

A strict barrier in the project area is the six meter high Kruithuisweg. This road cuts through the landscape and is a barrier between TU Delft campus and, in future, largest research and development area of Europe; Technopolis. But Technopolis is related to TU Delft and TU Delft to Technopolis. Important is to cooperate related to business, but also in a physical way.

Right now the area is divided into pieces by barriers of infrastructure, canal, railroad and Kruithuisweg are all positioned on different levels. Current situation gives five possibilities to under cross Kruithuisweg (figure 97). The current situation is attractive for pedestrians nor cyclists. The area is only used for crossing it, but not spending time here.

Kruithuisweg is only accessible for motorized traffic. To interweave this strict line into the city’s urban fabric, more interaction between levels is needed.
4.3 Concept

1. Greenfield Campus
   - Rural: Low FSI, Low GSI
2. City Campus
   - Highly Urban: High FSI, High GSI
3. Regional Campus Node

Figure 115. Three design variants

Regional Campus Node

- Local/Regional Oriented
- Private- and Public Transport System / Grid Structure
- Situation of Spreading
- Public Transport System
- Development
- Program
- Spatial Interaction
- University
- Housing
- Commercial
- Offices
- Leisure Facilities
- Parking Facilities
- Sports Facilities
- Hotels
- Hybrid Light Rail

Figure 116. Foundation Stones
CONCEPT
Concept of the design location is based on several foundation stones. Three design variants are created with each different stones related to three different campus settings, discussed on page 39 - 49. One of these concepts is used to design a final design plan, other two concepts can be found in the appendix.

Concept of the project location is to focus at the importance of Kruithuisweg in this area. Kruithuisweg is, as analyzed in previous chapters, an important entrance for private transport towards the city of Delft. It also has potential to become a public transport supply route, towards the university campus and Delft city. This regional campus node accommodates a diversity of facilities; university, housing, commercial, offices leisure, etcetera.

This concept represents a highly urban area, positioned along an important route which is local- and regional oriented, because of Delft its high potential, strategic location in Randstad its south wing.

Good connections, both public and private network possibilities are creating high accessibility.

Along this important Kruithuisweg - axis, a high FSI rate (2.7) should be created, which is comparable with Zuidkade's density, Rotterdam (Figure 118). An explanation of the FSI (spacemate-method) can be found in part 4, the appendix.

Concept for further design (figure 85) shows the important Kruithuisweg line, crossed in north-south direction by three different identity-lines; Waterline, Polderline, Tree lane-line. Strict lines as A13 and Railway do not have to influence current urban expansion direction. Waterline is related to the Schie Canal entering the city of Delft. Polderline is based on south located Midden-Delfland entering the city as a green carpet, through the center of university (Mekelpark) and Tree Lane line is private transport road towards the city center.

This set up of university related areas, have to be used and interweaved as a jig saw in the overall urban fabric of the city. Current situation has several individual jig saws (TNO, Delfttechpark, Technopolis and University). By adding one central jig saw, which connects all of the individual jig saws, an interweaved area is generated. Page 94-95 shows the Lyon model, which references to adding an attractive area, beyond a monofunctional area can create more liveliness. The same is here, adding an attractive jig saw, makes tramline 19 more attractive for a broader target group.

This jig saw is supplies users by a public transport node (Railway station Delft Zuid), a private transport node (Highway exit A13) and Kruithuisweg accessibility. This concept requires the design location to function as an entrance of the city because of good public transport connections towards the city centre.

Important location is the green area, located at the junction of these lines as a central spot, where different lines meet each other. This central location is to be designed, according to the campus trends discussed in review paper and case study about different campus set up possibilities and surrounding influences characterized in figure 117.
Figure 119. Connecting public transport line at regional scale
This chapter discusses the design part. How is previous research used to create a fitting plan.

PUBLIC TRANSPORT AS A BACKBONE

We all know that students are very dependent of public transport systems for long distance travel and bicycle or foot dependent on shorter distances. High-quality public transport connections are therefor important. Proposal is to create a high-quality lightrail connection, which links RandstadRail’s network with the existing tramlines in Delft (Blue line in figure 119). The line uses existing lines in the landscape setting. Last part of the line, is a current buslane, which can be used to improve public transport.

Public transport connections can, as said before, give direction to urban expansion, which in this case will be west-east. They also can attract living-, working- and leisure facilities and give form to new urban development.

Important is to not only have regional connections, but link this regional network also to local urban fabric. Along the new connection between Delft’s local tramline and regional oriented RandstadRail, two interesting potential urban development areas are located. First phase area is the design location, which covers the crossing of the two future tramlines. This area represents the central spot of different TU related areas and has good accessibility by private- and public transport. It has potential to act as an important area for the TU Delft campus related to nowadays campus trends, researched in the literature review. This new development can function as acupuncture, attracting new expansion.

Related to this acupunctural expansion, the new line can connect new developed areas and also should function as a backbone at regional scale. Phase two of future development can transform current green housing area, between RandstadRail and Highway A13, which can solve the urban expansion problems of the Delft city. Because Delft is enclosed by strict, infrastructural lines, there is no space left to expand the city to meet the current housing demand, besides north-south direction which have to stay open. The current green house area can move to outside the city, towards Hoek van Holland side. A good public transport connected area can be constructed.

Case study research (emperical research) to exploitability of public transport lightrail lines, gave information how to process the construction of a public transport system and what is needed to have a high user-rate on the line. The case study of public transport systems can be found in the appendix.

A PT SYSTEM WHICH MEETS THE MOBILITY DEMANDS OF IT’S POTENTIAL USERS

> User and stakeholder involvement which enables people to relate to the tram line (or public transport system in general) and to see that the system suits the demands of the actual users (desired potential reach, travel patterns). A well suited and appreciated PT system is likely to increase the percentage of people that will use the PT system. (Boelens, 2006)

The car is an individual mode of transport, and the network on which it can be used is infinite, but also has a very detailed grain, almost every house has an excite from a street or garage facility. This is not the case with public transport modes. These public transport modes are often rigid and linear and the people travelling cannot choose whether to go left or right when they want to. Only by combining the different public transport modes, a coherent and covering network can be established, which can compete with the network of the automobile. It is by no means goal to erase the car from the city, the car should be a partner in the network structure as well.

A network will only function as a network if the different modes and links in the network work together. Competition between them is disastrous for the efficiency of the transport network system.

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Figure 120. Public transport as backbone. Important, connectivity according to literature review
Car-, slow-traffic feeder routes as network partners
Figure 106. Position of light rail systems in design location.
DESIGN OVERVIEW, MAIN STRUCTURE

The left page shows the design proposal for the area. Kruithuisweg is used as a backbone, crossed by tree different identity lines to create a variety of landscapes, infrastructural interventions, sightlines and urban environments along the tramline. It decreases the perceptual travel distance and creates an attractive travel experience.

This green area is a place to meet and exchange experiences and knowledge in a quiet environment. It is based on historical polder grids and it is called the ‘Polder Park’.
Figure 125. Detailed design
This detailed design, is a part of the design on higher scale level. The design gives a reality view of the project area.
5.2 INFRASTRUCTURE
INFRAPUTRUCTURAL LAYER

It is important to give city centers and new urban extensions a central, environmental friendly axis, Kruithuisweg. This is only possible when there is an intense relation between traffic planning/plans and urban planning/plans. In the urban pattern, early and continuous spatial profiles should be realized and reserved for public transport, with stops in the nodal areas. This transport line will function as a backbone from an urbanism point-of-view and as corridor-thinking.

If this urbanism backbone thinking is applied in the allotment and corridor network thinking, exploitable public transport can be realized. Within the functional reach of the limited amount of stops (possible in the case of a fast riding tram), all users have an improved connectivity with public transport than in traditional public transport lines. Outside those catchment areas people always have a cross-over/transfer, or they can go by bicycle. But this transferring is already the case with most public transport journeys. Only people that go from a living function to another living function have to transfer twice. But this is quite a small group and they do not have the strict time limitations that some other (work-related) travels have.

5.2.1 KRUITHUISWEG AS A BACKBONE

Kruithuisweg will be an urban axis, with good access, oriented at private- and public transport. To generate a perfect section, four other cases are experienced; IJburglaan, Avenue Ceramique, Laan op Zuid and Weena. Function of first two sections are different, because they function as boulevards in an urban fabric. Weena and Laan op Zuid do have physical attraction and have the same function as Kruithuisweg has in the design. Broad boulevards, with high buildings do frame the section. Diverse transport possibilities are bundled here.

Researching different public transport lines in other cases (IJburg, Amsterdam and Ypenburg, The Hague in the appendix), made visible that it is important to create high density along a transport line, to make it exploitable.

<table>
<thead>
<tr>
<th>76-85 Won/ha</th>
<th>66-75 Won/ha</th>
<th>56-65 Won/ha</th>
<th>46-55 Won/ha</th>
<th>36-45 Won/ha</th>
<th>26-35 Won/ha</th>
<th>&lt;25 Won/ha</th>
</tr>
</thead>
</table>

Figure 126. High density along tramline.

Figure 127. Reference Cases.
Kruithuis weg is going an interweaved boulevard connected to regional and local scale networks (slow traffic and motorized traffic).

Figure 108 shows the designed main section of Kruithuisweg. The original width of current Kruithuisweg is used to build this profile. The sloop steeps are filled up and can be used to dig in tubes for cables and pipelines. Height of Kruithuisweg remains six meters, the current carcass of the road is used to enclose its new environment. On ground level along the road, possibilities for parking lots are created. These spaces are not catching any sunlight and can finely be used for private parking motorized traffic or store stocks. Wide boulevards generate enough walking space for pedestrians and a separate lane is available for bikers. In the middle of the profile, space is reserved for the public transport lane. High buildings on both sides frame in the boulevard.

Current Kruithuisweg allows dangerous substances and has a 100 km/h speed limit. This will decreased to 50 km/h and dangerous substances are not allowed, because of the urban development directly along Kruithuisweg. Dangerous substances can be transported through other routes. Even more reason to complete A4 highway at the west side of Delft city for alternative routes.
It is important to give city centers and new urban extensions a central, environmental friendly axis, Kruithuisweg. This is only possible when there is an intense relation between traffic planning/plans and urban planning/plans. In the urban pattern, early and continuous spatial profiles should be realized and reserved for public transport, with stops in the nodal areas. This transport line will function as a backbone from an urbanism point-of-view and as corridor-thinking. If this urbanism backbone thinking is applied in the allotment and corridor network thinking, exploitable public transport can be realized. Within the functional reach of the limited amount of stops (possible in the case of a fast riding tram), all users have an improved connectivity with public transport than in traditional public transport lines. Outside those catchment areas people always have a cross-over/transfer, or they can go by bicycle. But this transferring is already the case with most public transport journeys. Only people that go from a living function to another living function have to transfer twice. But this is quite a small group and they do not have the strict time limitations that some other (work-related) travels have.

5.2.2 MOTORIZED PRIVATE TRANSPORT (ROAD NETWORK)

The area with its backbone road is the main feeder of the area, but it also have to be feeded. Feeder routes are at regional scale, A13 highway and on local scale the Schoemakersstraat. This is the only private transport connection with a six meter high Kruithuisweg, with a rate of increase, 4.4% (stijgingspercentage 4.4%) (Section Figure 134, D-D'). Nearby the lightrail stops, ‘mobility towers’ are planned. This are parking lots, which are close connected to the use of public transport. Creating a lot of parking space and comfortable transits of car use to lightrail use will stimulate public transport when entering Delft campus and even the city. This environmentally friendly way of traveling contributes to a sustainable knowledge city.

The case study research shows the importance of different transit possibilities. In the area, it is important that you will not be forced to use a specific transport possibility, but you can choose to use a bicycle, public transport or get to your destination by foot (figure 132).

Figure 106 shows differences in motorized- and slow traffic accessibility. To displace use of motorized traffic as much as possible, large areas are not allowed for motorized traffic.
Figure 133. Location of sections

Figure 134. Sections

Rate of increase; 4,4% (stijgingspercentage)
TRANSPORT TO AND FROM STOPS
A shift from individual traffic towards more collective traffic can only occur when the transport to and from the stops served by public transport is efficient and comfortable. This means that the urban designer has to design efficient, sheltered and safe bicycle/pedestrian routes to and from stops.
The weakest link defines the overall quality of the transport chain. Transferring spots with long waiting times, public unfriendly crossings and above all scary and untidy boring crossings and transfer points will breach each attempt to lure potential users towards Light Rail.

LIGHT RAIL STOPS AND PARKING GARAGES AS ‘CITY GATES’
Due to the increased spreading of the spatial character of cities people do not walk or cycle towards a city center. When they come by car, they want to park it as close as possible to their primary destination. Parking garages functions as city gates for the city.
The positioning of these city gates is very important for the performance of this center. The increased rent prices for a crowded pedestrian street are a proof for this effect (Dabinett, 2006).

‘MOBILITY TOWERS’
To create a fluent link between private transport and public transport to stimulate the use if it as a new entrance towards the campus and even towards the city centre of Delft, these mobility towers are proposed. Parking your car through kruithuisweg exits, going underground so they will not interrupt the pedestrian and bicycle boulevard, will give access to a very good connected slow traffic network.
This mobility tower is directly connected with other buildings, by glass tubes ‘flying’ over Kruithuisweg (Reference, figure 155, page 128). These buildings are striking in material and colour use, along the Kruithuisweg route. They have to be recognizable along the way, as city gates. Fast connections to public transport stops by tunnels under Kruithuisweg and even for wheel chairs, there is an elevator in the facade that gives opportunity for less mobile people to deal with lots of differences in ground levels.

These Public mobility towers give room for approximately 2400 parking places.
Parking along Kruithuisweg under buildings, outside these public mobility towers is private. Also these are accessible by traffic lanes, dissapearing underground.

Figure 135. ‘mobility tower’ locations
Figure 136. ‘mobility tower’ / ‘City gate’
Figure 137. Street View
**CALAMITY ROUTES**

Figure 138 shows the calamity routes for police, fire department and ambulance usage. Main entrance point of Kruithuisweg is through the ‘tree lane’ line (Schoenmakersstraat), but also is Kruithuisweg accessible through the west side of the railroad track.

Boulevard area, only allowed for slow traffic, can be used by local traffic (bestemmingsverkeer) in emergency situations.

Along the Kruithuisweg housing is accommodated. This means that parking to pick somebody up is a requirement. Besides the to driving lanes, there is a parking lane available. This lane also can be used to put garbage along the road.

Distribution of goods using light-rail:
The light rail or tram track could also partly be used to provide the served area with goods. Especially in the so called ‘daluren’ there is the possibility to use the tracks for provision of shops by personal that is at the moment not driving trams. Containers could be located close to stops, so that shops can dispose their garbage etc. and new products can be provided.

Stock the pavilions in the polder area can be done through the boulevards, outside peak hours. Stocking is only possible in the morning or evening but can also been done by using the lightrail in ‘dal uren’.

Figure 138 shows a section of the only connection between ground floor level and six meter high Kruithuisweg. Location of the section is visible in figure 133.
**PUBLIC TRANSPORT INFO NEW LINE:**

- **LIGHTRAIL CONNECTION**
- **LENGTH:** 9 km
- **TRAVEL TIME:** APPROXIMATELY 20 MINUTES
- **10 STOPS**
- **DOUBLE TRACK**

**LIGHTRAIL SPECIFICATIONS:**

- **90 - 110 SEATS, 150 STANDING PLACES**
- **LENGTH:** 37.5 METERS
- **WIDTH:** 2.65 METERS
- **HEIGHT:** 3.80 METERS
- **MAXIMUM SPEED:** 80 km/h
- **DURABILITY:** 30 YEARS, 100,000 km/y
- **TWO DIRECTIONAL**

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### Tramways and metro

<table>
<thead>
<tr>
<th></th>
<th>bus</th>
<th>tram</th>
<th>fast tram</th>
<th>Lightrail &amp; (semi)metro</th>
<th>NS-sprinter</th>
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<td>333</td>
<td>524</td>
<td>1768</td>
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</tbody>
</table>

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**Figure 140.** Comparable scheme of public transport possibilities (Bach, 2006)

**Figure 141.** A schematic figure a lightrail and metro reach and position (Bach, 2006)

**Figure 142.** Lightrail Lyon
5.2.3 PUBLIC TRANSPORT (LIGHTRAIL NETWORK)

Comparing different public transport systems, gives an overview of advantages and disadvantages. Lightrail connections are high-quality comfort connections, which is a demand for knowledge environments to have rapid, high-quality connections. Current bus connection is low quality and lightrail can transport much higher user percentage at a double frequency (figure 143).

Trams are for local connections and uses much shorter average track length. Lightrail can adjust on different system uses, as a system in between. Low speed at high dense area, higher speed at low dense area, called time-size-rank rule (figure 144).

Although potential reach concerns the amount and type of functions which can be reached within a given travel-time budget. (Lynch, 1990) Based on Hägerstrands action-space theory, Zahavi (Zahavi et al., 1981) states that people do not save time by gains in travel speed, instead they make more and further trips. People do not minimize travel time & costs to achieve a given set of activities, instead they maximize activities or opportunities that can be reached within their travel time and budget. So according to this action-space theory, a public transport line which enables people to reach a high amount and diversity of functions within their daily travel time-budget, is more likely to develop a high level of ridership.

OPTIMAL INTEGRATION OF THE PUBLIC TRANSPORT SYSTEM WITHIN THE URBAN FABRIC:

Collaborative design involving both urban planning and transport design is necessary to create sufficient transport demand for the public transport system (density, functional mix, service area) and an optimal integration of the public transport system within the urban fabric.

> Facilitate inter-modal transfer possibilities (Train, metro, bus, tram, car, bicycle, pedestrian) Like connection with Railroad; Delft Zuid

> Facilitate inter-network transfer possibilities (International, national, regional, local);

Car and Bus networks fill up the gap of other Public Transport Systems, this already happens with feeder busses. If these systems are combined with the car and with pedestrian and cyclist traffic, total coverage and flexible and diverse coverage can be realized. However one must take into regard that the different modes will compete with each other. In order to truly function like a coherent system, there must be no competition but partnership -> the transport system should be a MONOPOLY, preferably owned by a government or another sort of non-profit organization.

Comparing fig. 119 with fig 102. increased accessibility, future situation covers whole red accentuated area.

Why lightrail? Light Rail contributes to the urban ambience and high-quality when they service:
- at a high frequency
- A large amount of stops
- serve crowded pedestrian areas
- bring passengers deeper inside the urban center
- stay above the ground.

A light rail contributes less to the urban quality when:
- the service frequency is lower
- the amount of stops is low
- when the tracks serve as a barrier

A light rail that contributes to urban quality is comfortable, rapid way of transport.

Figure 143. Lightrail has higher capacity

Figure 144. Time-size-rank-rule speed: more stops in zones with a high transport value and lower speeds for safety matter, higher speeds in low transport-value zones
Compared to France and Germany it is hard to set up a Light Rail system in the Netherlands. This is mainly caused by the absence of clear and influential ‘transport authorities’. The role of that provinces play is often vague and are overshadowed by local, short-term interest and do not correlate with the movement/travel-patterns of the municipalities and provinces involved. These problems are worsened the retracting government (privatisering).

By using one transport-authority aimed to exploit (hybrid) material provides possibilities to make an affordable and rapid increase of quality in public transport. Most important is that organizing and executing organs meet the demands of daily traffic streams.

The problem with the Light Rail network in the SouthWing (RandstadRail) is that each transport company wants to continue using their own tracks (NS, RET, RandstadRail, HTM).

The larger amount of traffic jams is being caused by trips covering distances between 10 and 18 km. In the last 10 years, Germany and France have been covering a part of 10 to 18 km trips by the introduction of Light Rail, decreasing a part of the traffic pressure on the roads, such as Kruithuisweg.

Within Netherlands a lot of investments have been made in free bus lanes like in Tanthof. However these busses have less appealing qualities on luring car users and are less capable of increasing the loyalty of current public transport users when compared to Light Rail Transit. For example, German experiments with Park and Ride facilities around Karlsruhe learned that people do not want to trade their car for a slightly larger car. In other words, they do not want to transfer to a slightly different mode of transport. The German experiment showed that automobile drivers are willing to transfer to another type of vehicle when it is available in the vicinity of his/her house which can bring him/her deep into the urban and close to their final destination without transferring. So it is not only important to create lightrail networks, but also to make them important to use.

From a historic point of view the urban grid is the most durable product of urbanism. This makes the urban grid very useful for urban planners on a local level. The urban grid gives us a clear insight in the missed opportunities in recent Light Rail implementations.

Karlsruhe is a good example where the light rail line runs through the center. This generated so much more turnover for local shops that they protested when the transport company suggested to place certain parts of the track underground.

Societal advantages of the STAM & FEEDER concept:
- The attracting/appealing aspect which can attract people ‘from the traffic jams’
- More people will be moved in an environmental friendly way
- In city centers: more parking space will be vacant for people travelling longer distances, these users on average spend more money.
5.2.4 SLOW TRAFFIC NETWORK

The public transport stops need to be positioned at principal infrastructural lines to create liveliness and to optimize stop/station connectivity and accessibility (Figure 147).

The city grid shows the pattern of roads and routes leading to a stop. In a more grid-like pattern, the distance to a stop gets bigger on a virtual diagonal line. If at least a part of the pedestrian and cycling routes towards a stop is radial, the usability and reach of a stop will grow bigger. Urban instruments to increase the user likeliness of a stop:

1) Increase density (FSI: Floor-Space-Index)
2) Create radial routes or radial part of routes
3) Create a concentric high FSI around and close to stops
4) Create a high concentric mix and density of functions around and close to stops.

It seems a paradox, but a grid is the pattern that can easily be adopted to create car-free areas in or nearby station or a pedestrian area. Traffic can easily be guided around these zones at certain times.

The quality of the direct environment of ‘human pumps/ city gates’ such as Light Rail, shops and stations crucial, therefore the first 300 m should be reserved on both sides for cycle and pedestrian routes. This space could be designed as a city axis or carfree boulevard. P+R & parking facilities along this line; ‘mobility towers’

Figure 148 shows main bicycle routes trough the area. At the station, a facility to rent bikes is available (reference, Hoge Veluwe). Not only the lightrail stops are connected to the slow traffic network, also a grid in the polder area is creating a good inside network. Good positioned lightrail stops create good slow traffic (bicycle and pedestrian) routes towards them, which enlarge the reach. These slow traffic routes do also connect on higher scale, regional networks towards Rotterdam, The Hague, Zoetermeer and city center of Delft along the Schie canal. For example, a former reserved tram tunnel under A13 is used as slow traffic connection instead, to provide rapid bike routes towards and away of the campus side. Besides all buildings having lots of space to park bikes, focus is on slow traffic routes towards lightrail stops. Enough parking space is realized here to enlarge the catchment area of the lightrail system. The area has a strict water barrier, which has to be crossed. Slow traffic has two possibilities to cross this, and motorized traffic can only use Kruiithuisweg because of ships passing Schie canal and Kruiithuisweg can not bear with traffic jams.
STOP ACCESSIBILITY

To create accessible lightrail stops, case study research is done. High public transport stop/station accessibility due to safe feeder routes and crossing to stops is needed for a high user rate (figure 152 - 153). People want to have easy access of the public transport line. Creating mobility for people with disabilities using this area is also very important, because of the accessibility of different floor levels. Therefore stops have slopes towards the platforms, possibilities to enter the platforms by using escalators and elevators.

Increase amount of bicycle storage at public transport stops to enlarge catchment area, by creating high amount of bicycle parking space around the lightrail stops (figure 153). Reserving bicycle storage on lightrail vehicles can enlarge the movement area of people using slow traffic.

Legible public transport stop position by clear and logical stop hierarchy also enlarge the catchment area. Directly connected routes on the public transport line, create fluent interaction.

Figure 152. Slow traffic platform accessibility

Figure 153. Slow traffic automatic accessibility methods

Figure 154. Bicycle storage on vehicles

Figure 155. Connecting tube in Eindhoven, Parking Garage (left building) with Shopping area (right building)
AN ACCESSIBLE KRUITHUISWEG

Slow traffic accessibility
To create an interweaved Kruihuisweg, it is important that it also can be entered at many different places all along Kruihuisweg. Creating a transparant road will take away the current barrier experience. If there will be many possibilities to access the six meter higher level road and cross it, the barrier experience will be replaced for an interweaved experience (Figure 156 - 157). Again is shown, that the road only is accessible by motorized traffic at one elevator point.

Also visible at figure 158, is availability to cross water barriers. Continuous lines of slow traffic routes are in this way not being interrupted.
Figure 159. Insight model of height differences at railway station Delft Zuid

Figure 160. Realistic design overview of Railway station Delft Zuid

Figure 161. Elevator point at railway station square

Figure 162. Section of Station Delft Zuid with Square on six meter higher level
Railway station Delft Zuid

Railway station Delft Zuid has a great supply potential for the area and contributes to an interweaved and highly urban Kruithuisweg. Through this public transport node, lots of students and employees travel towards the university campus. This transit node needs to be interweaved in the area and fluent transit possibilities enlarge attractiveness of public transport. In current situation, railway station Delft Zuid is hidden under Kruithuisweg. Idea in the design is to create a recognizable station area, positioned at the head of a six meter high square, were new offices can be developed. This landmark is the public transport supply route of the campus area, which brings visitors and users from outside the region into this area. The station has interaction with on one side Kruithuisweg its height level and on the other side ground level for slow traffic accessibility linked to the boulevard. (figure 159 -165).

Figure 133 on page 120 gives the location of the section on the left page.
Figure 166. Tramline 19 and light rail crossing each other

Figure 167. Rapid transit possibilities

Figure 168. Section of tramline crossing
Crossing of tramline 19 and lightrail

Figure 166 - 168 show an overview and section of the crossing point of the two public transport lines in the designing area. Also here, rapid transit possibilities are generated (direct connected staircases and escalators). The sections shows the high amount of parking spaces that are available around this node. The node can function as a central point were shops, bars and offices can develop. Figure 133 at page 120 shows the location of the section in the plan area.

Optimize Public Transport Integration

Realtime travel information, makes travelling easier. People do not like waiting and want to be prepared at how long waiting times are. Therefore it is important that stops are provided by digital signs, displaying information.

Noise Pollution

To be able to build along Kruithuisweg, the maximum of decibels may not be overran. As analyzed before at page 99, current situation around Kruithuisweg, produces over 75 decibels. A maximum of 55 decibel around housing areas is allowed. To reduce noise pollution, several measures can be taken (Bach, 2006):

1. Reduce speed limit to 50 km/h which produces still 60 decibel.
2. Use very porous asphalt type (ZOAB asphalt). This can reduce noise pollution to a maximum of three decibel.
3. Do not allow heavy transport, which changes traffic combination and can reduce noise pollution up to 2 decibel.
4. Catching up traffic by offering enough parking space, fluent transit points and comfortable, rapid public transport can reduce traffic intensity. Decibel can be reduced up to 1 decibel. Making use of collective transport, decreases intensity of traffic. One lightrail vehicle every 5 minutes makes less noise than 500 cars during 5 minutes.

These different adjustments can reduce noise pollution to an acceptable sound limit, which makes it possible to build along the current noise polluted Kruithuisweg.
This chapter discusses the positioning, types and program related to the urban layer. According to the guidelines, researched in the literature review, it is important to facilitate mixed functions. Mono-functional campuses are enclaves outside city centers. Interweaving campus sides in city’s urban fabric can be stimulated by adding program not only related to university environment. Attractiveness of target groups will be wider, city inhabitants profit of it and knowledge cities stay innovative. One of the concept requirements is, reaching a final FSI of 2.7 according to spacetime model. Besides the requirement of reaching this goal, it also stimulates public transport usage.

5.3.1 URBAN DESIGN

The next chapter discusses the green in and around the area. The building positioning is related to it. It frames the green ‘PolderPark’ area in the middle of the project location.

As visible at the left page and schematic drawn in figure 173, building blocks located at the north side of the Kruithuisweg are polder like building blocks, which create sightlines from Kruithuisweg towards the lower level polder park. This creates a higher attractiveness of the area.

Inside this frame, a set of transparant pavilions is positioned related to the polder grid. Two of these pavilions are existing ones; monumental kruithuis and cultural center along the Mekelpark axis.

Figure 171 shows in the back, white building, the existing cultural center. Spread all over the ‘PolderPark’ are the pavilions positioned along the grid polder, each with other leisure facilities in it.

Along highway A13 (figure 175) TNO and Delft Techpark are being extended towards the highway. Office buildings along the highway give an urban, high dense area identity in comparison with current situation, which is no view towards TU Delft campus at all. Extending this area, identity of Delft university can be added and TU Delft will be recognized along the highway (figure 176). This area consist out of polder grid buildings, which represent the polder get back in the city, from a historical point of view.
1. Current Kruithuis situation

2. Using one-sized blocks
   - 5.40 meters
   - 27 meters
   - 16 meters

3. Taking sun into account

4. Creating diversity in heights

5. Creating diversity in block direction (turning blocks)

6. Creating alleys (slow traffic routes)
4. Creating diversity in heights

5. Creating diversity in block direction (turning blocks)

6. Creating alleys (slow traffic routes)

7. Turning facades to accentuate important lines

8. Create elevation points

9. Add program

10. Add material usage and street furniture

Figure 177. Series of model development taking several aspects into account
URBAN DESIGN

As said before, high density along the public transport line and design urban environment in human scale, stimulate the use of public transport.

Previous page showed development of the current Kruithuisweg into a new urban area.

Used are, blocks with same size; 5 x 5,40 length (bay widt/Beukmaat) and 16 meters width and 3 meters high. This method was also used at Java-eiland by Sjoerd Soeters. This size covers 432 square meters and one block can park approximately 40 cars.

Pile up these blocks, construct buildings along Kruithuisweg. These buildings, function at the same time as walls to cover the difference in height between polder-ground level and six meter high Kruithuisweg level.

Because of constructing high FSI along the road, high buildings are being built. Buildings need to catch day- and sunlight to be attractive as living accommodations. Blocks that do not catch any light or a minimum of daylight can be used as parking- or storage space.

Figure 3 and 4 on previous page are sun models. Left blocks are piled up higher. Optimal positioning of building blocks according to sun is taken into account.

Sun model 4 plays with different building heights. By doing this, more sunlight can slip trough gaps.

Model 5 and 6 creates more diversity along the road. Turning blocks creates more gaps for alleys towards the higher level Kruithuisweg. The gaps also generates space for slow traffic routes, through the building blocks. From closed private blocks, open integrated public blocks will appear.

Figure 179. Opening blocks (private to public)

Model 7 shows how these one sized blocks can be edited by adding facades to accentuate important structural lines. By doing this, again more diversity will be created to these one sized building blocks. The blocks are shaped related to their direct environment and environmental aspects.

Figure 180. Adding facades to accentuate lines
Between these building blocks, where alleys appear which create interaction between Kruithuisweg and ground level, elevation points are placed. Also possibilities to cross Kruithuisweg by tunnels are constructed. Through these tunnels, lightrail platforms can be reached with escalators. For 'usage-quality' and 'public safety' outside office hours it is crucial to design high-quality urban plints. A high-quality urban plint should contain a broad urban functional mix. For reasons of attractivity and public safety outside office hours it is crucial to have access to the above-housing around every 40 meters in the urban plint. Equally important is to created sheltered routes (against sun/wind/rain ... elements). Routes along high-rise structures should be protected from falling wind by porches (luifels) and/or arcades.

The program that is divided into the building blocks is inherent with sun- and sound influences. Housing needs to catch sun instead of shops. That is why shops are placed at non-daylight catching areas and housing and offices at places which do catch daylight. Parking can be placed under Kruithuisweg, where no sunlight is reaching at all. Not only sunlight is determines the program placing, also noise is an important aspect taking into account.

As discussed before in this thesis, designing a new urban boulevard with an FSI of 2.7 along it and diversity of program to have a 24 hour usage of the area will create a new noise source; tramline and motorized traffic using the two lane road. Some adjustments in asphalt material, reduce speed limits can prevent noise pollution. But placing program outside noise catchment areas can also prevent this.

Figure 183 shows the importance of building blocks not having one orientation. Buildings along Kruithuisweg have two orientations, related to their environments. Facades along Kruithuisweg are oriented on commercial environments (shops), facades along the PolderPark boulevard are oriented at the green, quiet environment (bars, terraces).

Finally the building positioning has taken shape and material use for facades can even enlarge diversity in the area; glass-, brick- or metal facades. Diverse usage of high quality materials and Diverse and high quality architecture contribute to a high exploitability of public transport networks, according to case study research.
5.3.2 Program

According to Den Heijer (2007), nowadays campus trend is to add mixed function to campus sides. Interweaving different target groups is interweaving urban network directions. Mixed functions creates liveliness (part of high quality living) and an area, which will be used all over the day instead of current situation, which is TU Delft being a mono-functional enclave. Creating a 24 hour area usage, means a high social security (eyes-on-street, figure 185). Case study research showed that public transport systems also can contribute to usage of mixed program.

Light Rail Gates and Their Surrounding Program

The ‘City gate’ functioning of a Light Rail is fundamentally different than that of a parking garage. Halfway their walk within the city they have to walk back to their car. Therefore a shopping circle can be suggested or shopping malls. However smaller cities do not have the capacity to facilitate a double length urban program, while malls do not contribute to the liveliness and interaction of an urban environment and it’s public transport system.

A collective transport system can be a solution. High quality stops need to be developed at both end of the shopping canal. It is important that these stops have a large accessibility with transferring. Light rail can facilitate ‘window shopping’ throughout the length of a shopping street. Another aspect of what to situate within the reach of public transport nodes-stops. Light rail is above all exploitable when a functional mix of urban program is situated within the reach of the systems stops/nodes. No large travelling peaks should occur. It is important to fill in the low-peak hours with passengers from nearby schools, dwellings and daily facilities (like counter-function-offices). This will generate transport users outside the typical daily working.

Figure 185. Program on campus sides according to den Heijer (2007)
Spread daily transport demand, by accommodating functions which attract public transport users during the entire day, and not merely at peak hours. But how can this be realized?

High amount of mixed functions and facilities within walking distance of public transport stops. By creating functions along a line, different users will use the line.
Program in the project area is based on the needs, according to new campus trends nowadays.

Because this area will function as a central point for TU Delft, TNO, Techpark and technopolis, supplied by two routes, railway and highway, many parking space is divided along Kruithuisweg. The area can be used as new city gate, but this parking places also can contribute when events will take place inside the Polder Park. Because of offering enough parking space around the Polder Park and creating good accessibility in the area, it can be used as an event area pretty good. Besides these temporary events, the area offers leisure facilities. The theme of this area is, meeting and relaxing. Therefor, facilities are related to it; bars, restaurants, swimming pool, museum, fitness, theatre, etcetera. To create a 24 hour usage of the area, availability to live here is also offered. Different housing types will be realized to get mixed living environment.

The area is ofcourse university related, this means that between nine o clock a.m. and five o clock p.m., the area also is being used by spinn of business. The area can even be used for faculties, now located in the Technopolis area, but in future located along the Kruithuisweg. TU Delft university will be more compact and the area around Technopolis can offer more space for housing.

The railway station area is off course very attractive for national oriented business. Around a six meter high, located square, different a business area is located. Advantage here is the good accessibility through public transport.

A new center area is being created, this is around the crossing of two tramlines on ground level. Hotel, bars and restaurants can be placed here, oriented on the Polder Park.

First floor program is almost equal to ground floor level, some parking places are changed into living facilities.
Second Floor Program

The second floor program of the area has the same height as Kruithuisweg. Because the buildings function as retaining wall (keer muur), one side of the building is six meters high and the other side can be used to place ground floor level facilities (Figure 182). Figure 190 shows the second floor level program. Clearly visible are the ‘mobility towers’ coloured in blue. Along Kruithuisweg, the green area is accommodating commercial facilities: supermarket, bookshop, etcetera.

Third Floor Program

Third floor level is on both sides of the buildings of Kruithuisweg not being contiguous to ground floor levels. Some of the commercial area, at southside of Kruithuisweg, have two layers, positioned here because of these blocks not catching any sunlight, which commercial areas do not need. The other side of Kruithuisweg facilitates related university business and housing facilities.
**Fourth Floor and higher Program**

Fourth floor and higher program only accommodates housing, parking and business program. Again, the 'mobility towers' are recognizable. Along highway A13, only office program is placed, because of too high decibels according to housing norms and because A13 is a route of dangerous substances, which makes it impossible to create housing in this area.

**Different types of housing**

Housing in the area is important to create a 24-hour usage of the area. Creating different types of housing will attract different types of users. This stimulates the interweaving of this area in the city of Delft.

According to den Heijer (2007) universities are cooperating more than ever is this knowledge economy. Therefore they are feeling responsible for accommodating their international staff and students. This is why housing program for students in this area is important. But to not create another segregated enclave, it is also important to introduce other housing types for starters or other household types.

Staff or tourists of Delft can choose to spend time in hotels located near public transport system to be very moveable. Students or staff staying for limited periods; half a year, can make use of short stay facilities. Other areas are available for permanent living.
Housing types

Figure 194, shows the spread of housing types based on:

45% | 60m² | small: 1515 stuks = 9.45 ha.
40% | 100m² | middle: 830 stuks = 8.4 ha.
15% | 150m² | large: 205 stuks = 3.15 ha.

Small housing types will be used for social housing and student housing. Middle housing types are going to be used for starters and students. And large housing types gain possibilities for larger apartments, living along quiet green routes; Schie and Bicycle connections.

Different types of University related business

Because this area is the centre of different disciplines of TU Delft, TNO, Techpark and Technopolis a wide scale related business types can be placed here. Related business along Kruthuisweg for good accessibility, breeding places in and around the campus area for starting companies to be innovative and get assistance from University. Incubators do help the university by using and manage their knowledge. Also this related business need close physical relation with university. Kruthuisweg functions as a new central spot where all sorts of business and innovation come together.
Commercial and Leisure program

For staying innovative, these businesses need to have leisure. Therefore, the PolderPark is developed. PolderPark accommodates several forms of leisure and facilities; temporary and permanent located in pavilions (figure 198). A museum along the Schie Canal, can cooperate with the 'Porcelain fles' museum; exhibitions. The monumental Kruihuis building can also function as a museum and being the area its attractor. The Kruihuis, who in current situation accommodates a scouting, can be replaced by a pavilion. At the other side of the Schie, more relaxing and sporting functions can be placed. The rowing club, in current situation located under the Kruihuisweg along the Schie canal can get its own Pavilion along the water. A swimming pool, fitness and wellness club can be placed in the Polder park. In evening hours, to create liveliness, bar can be placed inside a pavilion and along the PolderPark oriented along the liveliness green area. Delfts policy was searching for a new theatre location, also this can be placed in one of the pavilions. And daycare is important for staff working at TU Delft, also possibility to create space for this in a pavilion.

Along the Kruihuisweg a new central spot is created where more commercial things are located. These facilities are more related to an urban boulevard and covers a super market, clothing shops, book stores, etcetera.

This area can perfectly contribute to Delft its problem, which is related to an increasing amount of students and staff but not having enough living space. Even the international amount of students is growing, so housing and facilities for it in directly environment related to the campus side is important. Prognosis predict even a further growth of the student and staff population.

By creating new housing and facilities for it in contributing the interweaving of the campus side in Delft, part of the problem can be solved.

The facility program in this thesis, is not permanent because of still changing needs in these areas. Example; If more breeding places are needed and not all office area is in use those to facilities can contribute to fulfill all changing needs. Same is for housing, which is needed. Flexible inside building architecture makes it possible to change office buildings into housing.
5.3.3 PROGRAM AMOUNT

Overall Design: 100 hectare.

HOUSING:
45% | 60m2 | small: 1515 dwellings = 90.4500 m2
40% | 100m2 | middle: 830 dwellings = 80.4000 m2
15% | 150m2 | Large: 205 dwellings = 30.1500 m2
------------------------------------------------------------+
2600 dwellings

OFFICES AND RETAIL:
190,000 m2 offices
50,000 m2 retail

PARKING SPACE:
10,000 parking places

The detailed design is included in the overall design calculations, but are represented below:

HOUSING:
550 dwellings of 60 m2
320 dwellings of 100 m2
------------------------------------------------------------+
870 dwellings

OFFICES: 40,000 m2
RETAIL: 10,000 m2

PARKING: 1862 parking places
5.4 GREEN AND BLUE
GREEN AND BLUE

This chapter discusses the natural and water layer combined. Because this design is based on the historical polder grid, that once covered this area. Three identity lines are crossing the area. First is the Waterline which includes the Schie canal. This canal has historical value because of monumental buildings along the route are re-used; Kruithuis. Besides this, bicycle routes can be bundled along this water axis to enter the city through a high-quality green environment. Second axis is the main axis of the area. At the south side of Delft, Midden Delfland is located as shown in figure 56, page 72, before. Through this polder axis, the green central PolderPark, is connected with Midden Delfland its nature and functions the axis as a slow traffic route and public transport route towards the inner-city of Delft. Third line is the tree lane, which is the private transport route from Kruithuisweg, in direction of the city center of Delft. These carpets, do interweave this area into the city’s environment. They also are different identities along the lightrail route, which stimulates the usage.
5.4.1 EnvironmentaL Green

Besides the meeting potential of the central green PolderPark node, lots of natural life can exist. Because of the identity lines, especially the Schie canal and Polder line that connects the PolderPark with Midden Delftland can bring polder's nature into the city environment. This enlarges attractiveness of the PolderPark. But what nature target types (natuurdoeltypen) are able to live in this environment? (Bal et al., 2002)

1. Marsh marigold grassland (Dotterbloem grasland)

This type appears on nutrient-poor, moderately acidic to alkaline soils. During winter, the water level have to be at least around ground level. (0-20 cm. less 35 ground level) In summer only superficially dry. This type of grassland knows some characteristic species: blonde zegge, vlozegge, sterzegge, twee- zuizige zegge, knotszegge, blauwe zegge, waterdrieblad, draadrus, melkviooltje.

Management intensity is low, once a year this type has to be mowed. The mowed grass is being removed.


2. Flowery grassland (Bloemrijk grasland)

These areas appeared after cultivation of swamps. This type occurs in areas that every year are flooded by surface water (eg along the rivers). This type will develop on peat soil with an average water level of 20-30 cm. below ground level, with water level in summer only short periods lower. Some characteristic species are: butterflies, meadow birds, kemphaan, watersnip, zomertaling, paapje, donker pimpelblaauwtje, rode vuurvlinder, moerasprinkhaan, zompsprinkhaan, harlekijn, weidekervel, trostravik, wilde kievitsbloem, brede orchis, fijnstelige, kale, geplooid, slanke en spitslabbige vrouwenmantel, waterkruiskruid, zwartblauwe rapunzel, bosbies and adderwortel.

Same as marsh marigold type, the managing type is to mowe once a year and the mowed grass is being removed.

No fertilizer applied, with the exception of rough manure (up to 20 tons per hectare per year) or liming.

3. Wet litter bush (Natte strooiselruigte)

![Example of wet litter bush](image)

Remarkable flowering of tall-herb vegetation, reeds along the water lines. Brushwood washed up on these belts occur along water dredging which has continued to fall after the cleaning of ditches. Sometimes they develop from reed that sedimentation and not be mowed annually. The flower has many riches attract insects. Other species are beaver and otter, frogs and fish in the reeds. Insects such as butterflies and dragonflies.

Intensity of management is low. For a long time doing nothing is enough, extensive grazing by cattle or sheep takes place.

4. Moderately nutrient-rich wet grassland (Nat matig voedselrijk grasland)

![Example of moderately nutrient-rich wet grassland](image)

This type is found mainly in closed estuaries, and peatlands. It is being developed in areas that are regularly flooded which is caused by surface water flooding. In summer the water level drops quickly, then most will flood occasionally. This type is a transition zone between water and dry grasslands.

The usual form of management is two times pear year mowing. In winter, these grasslands is important for geese and swans.
Trees play important roles according to public spaces. But what are characteristics of the used trees? and how can they contribute to the environment. The Populus Italica Nigra, even as the Salix Alba are only used in areas outside dense urban environments (only in PolderPark). This means that they have all freedom to fully develop. The Platanus Acerifolia on the other hand, is used along infrastructural routes. This tree is used because of the low requirements that they need to develop in limited grow opportunities.

Aspects to deal with in urban profiles are, cables and pipes so their roots can develop fully and width of the crown.

Besides esthetical value of trees, they also contribute to ecological value. The tree lanes used in this design, are accentuating the wide boulevards. Because of the wide boulevards, trees have enough light and space to develop. Platanus Acerifolia is resistant to salt in winter.

The ritmical placing of the trees in figure 214, prevent a chaotical view in designing the public space.

The ritmical placing of Salix alba and Populas Italica Nigra in figure 216 is characteristic for strict polder landscapes to accentuate the polder grid. Populus Italica Nigra is accentuating the frame around polderpark.
Figure 217. Waterline accentuating view on monumental Kruithuis
5.4.2 BLUE WATERLINES

Water in the design is related to the characteristic polder grid from historical point of view.
Two waterlines that are very characteristic in the area, Schie Canal which is intensively used by boat traffic. and the waterline, which accentuates the Kruithuis (Figure 217).
Because of the low water level in the area, the species discussed in the previous chapter can develop. Offcourse not all sightlines are accentuated by waterlines. Figure 218 shows all sightlines in the design area. Notable are all views from Kruithuisweg towards PolderPark. This green environment has an enormous attractiveness and can be stimulated by creating these sight lines.

Figure 218. Sightlines in the area

5.5 LEISURE

The area can be perfectly used for organizing large events, because lots of space, parking places nearby and good accessibility in the area.
Besides the permanent leisure facilities inside the area, temporary events can be held here.

Figure 219 shows some pavilions, related to potential events in the project area. The museum pavilion can exhibit outdoor, bar in the middle of the area can organize summer festivals, Theatre can do outdoor plays or movies. The area can even facilitate a temporary leisure park (kermis) or a circus.
As researched in the theoretical part, knowledge cities need special events to become famous, like in the city of Aveiro, Portugal or Cork in Ireland (page 36). These events can help attracting a wider user group.

Figure 219. Temporary events in the area
5.5.1 ORGANIZED LEISURE

Different forms of organized leisure can be held in the PolderPark

Figure 220. Organized temporary leisure facilities

Outdoor exhibition

Temporary leisure park (kermis)

Circus

Music festival
5.5.2 NON ORGANIZED LEISURE

Besides these organized leisure events, the Polder Park, but also Kruithuisweg have lots of other facilities and potentials related to leisure.

Figure 221. Permanent leisure facilities
5.6 PHASING

- 1-5 years
- 6-15 years
- 16-25 years
- 26-35 years
PHASING

Time of implementation of the PT line.
It is crucial to have the public transport system up and running in the startup phase of the neighborhood, as occurred in case of IJburg. People will involve the tram system in their daily travel patterns and will consider travelling by tram sooner than they would in cases where the public transport system is implemented later on. During case study research, found out was that the tram in Ypenburg was constructed and functioning after most inhabitants were already settled and used to travel by car. People used to car are less likely to switch their modal-shift behavior towards public transport

Collaborative design involving both urban planning and transport design is necessary to create sufficient transport demand for the public system (density, functional mix, service area) and an optimal integration of the PT system within the urban fabric. This is why after finishing the public transport line, it is needed to create destinations along the line. Public transport lines are very attractive for business. If once some business started up, more will follow.

It is hard to guarantee the economic push that light-rail provides to mid-sized regional cores. Positive effects are found, yet they are moderate and often not optimal due to various boundaries.
- The entire track needs to be completed before vehicles can run, it is therefore impossible to 'get stuck' with a half-finished product;
- Investors know that a lot of money has been invested to realize a stop, and as money to this out of the money-makes-money principle;
- Investors are assured that a stop is a long-term investment. A bus-stop can easily be replaced to another location.

With bottom-up design nor the vehicle, nor the system nor the network form the design basis. Bottom-up design start with the wishes and needs of the user. Stops are designed where people want to be, or developments are taking (or are most likely) to take place. The stop design is nice, safe, sheltered, is provided with theft-proof bicycle sheds and is positioned on a place with a high public safety.

Phasing of the design is all independant off the public transport line. First phase is important to create good accessibility by constructing parking towers along the line, it is not expensive to built them and the are most needed in current situation. Second phase is to start up business along this high quality and accessible urban axis; a first business district around the lightrail crossing can function as accupuncture point. Also realizing the theatre and beginning PolderPark at the old Bouwkunde area, can be a first step to attract more leisure oriented development in next phases.

Besides constructing the lightrail line in the second phase, it is important to realize housing in a short term, to catch up the increasing student amount. Creating a central area, creates more pressure on the further phasing of the design area; Delft Railway Station and along the highway.

By realizing small districts of business along the line in first phase, attractiveness of this area (good accessibility, central high knowledge point) will stimulate densifying the urban axis over the years. Current Delft Techpark is finished in 1995 being the newest development in the area. This can still function for a couple of years and in last phase transform it, according to the design plan.
Figure 225. Connecting slow traffic route under highway

Figure 226. Bird eye view at water front, in winter ice skating potential

Figure 227. Highway exit

Figure 228. Bird eye view at higher level railway station square
Figure 229. Overview PolderPark

Figure 230. Railwaystation view, two boulevards

Figure 231. Waterline

Figure 232. High dense urban axis
Figure 233. View through alley, under Kruithuisweg

Figure 234. Difference in height

Figure 235. Walk overs

Figure 236. ‘Backside’ Kruithuisweg, functioning as front sides
PART CONCLUSIONS
Figure 237. Overview high dense urban area

Figure 239. Different material use

Figure 238. Through alley

Figure 240. Design on top
When starting this thesis, focus was on the university campus side of Delft. Guidelines where listed, to create a better interacting campus with its environment. After doing research, it became clear that several methods to create a more interweaved campus side are possible. Research on future plans and environment characteristics changed orientation to a project area beyond the campus side. Creating an attractive area here, and link it to its direct environment but also with the region, stimulated the use of the hole area. (See Lyon Model). Guidelines that where listed earlier, are still used. These principles are interesting to attract a broader target group on campus sides in knowledge environments, which is created.

Guidelines which are researched in the literature review are contributing to a better interaction of the campus and the city, but are more focussing on the campus side itself. This thesis changed focus after doing research. First impression was to upgrade connection from campus side point of view, towards the inner-city of Delft (upgrade St. Sebastiaan Bridge). Lyon’s public transport system as reference, changed focus southwards around Kruithuisweg. Creating an attractive area, based on the researched guidelines, beyond the campus side, contributes to a more used TU Delft campus side.

Figure 241. Essential Design directions in the thesis proposal. The three local oriented, identity lines, crossed by the Kruithuisweg with its regional focus, provides the user supply of the area (Railway station, Highway exit). Along the Kruithuisweg, the parking towers offer parking space and serves as a new public transport, entrance of the city. The PolderPark has a lot of leisure, which is also attractive for Delft’s inhabitants and is good for relaxing which stimulates innovation of knowledge. The slow traffic boulevards are linking all program.

The next page discusses the integration of the guidelines that are important in nowadays campus design, based on the literature research.
1. connectivity
Most important guideline of this list is connectivity. Areas have to be supplied for usage in different ways. Connectivity in different scales is therefore important, local, regional, national and international. By better cooperation of municipality and TU Delft it is possible to interweave the campus better in urban fabric. Conclusion of this guideline implemented in the design location is a better and more logical entrance of the area, also for non-university people. The Lyon model is a good reference in this guideline. By adding a new centre area, connected by several transport methods, it is more logical for outsiders to use it.

2. open/public ground floors
Current situation of the TU Delft campus side, has a mono-functional character. It is only attractive for TU Delft students and employees. By opening up the campus, make it attractive for outsiders a broader target group of users will be attracted. Conclusion is that not only spatial interaction is needed. This can lead to social interweaving of different areas.

3. balanced mix of applications
This guideline focusses on the attractiveness of the area. By creating attractive retail for inhabitants of Delft, students and employees, the user group of the area will be larger. This creates social interaction and a more lively environment, because of 24-7 usage of the area.

4. accommodation
Important is accommodation for students, employees and inhabitants of Delft. Again, this generates a broader user group of the area. Attracting knowledge workers needs high quality living possibilities. International focus of TU Delft requires different types of living, short stay-, hotel-, and normal facilities. Also living space for starters and regular families is important to create diversity.

5. communication
The Polder Park with its facilities is a good example for these meeting places. A short walk to exchange knowledge, going to a bar for relaxing or use the sport facilities to refresh your mind are things that are contributing the high quality living environment which is important for attracting knowledge workers. It also attracts inhabitants of Delft.

6. catalytic conditions
These are necessary and available in the TU Delft campus issue. This offers the possibility to interweave with direct environments. The catalytic conditions can benefit from each other, it creates urban symbiosis, it offers more jobs, leisure and retail.

7. urban, culture, economy and landscape
Using this factors give the specific location identity. In this thesis, Midden-Delfland plays an important role. This green, polder identity, meets the campus side. The current economy stays the same, but is expanded. All these factors together give a strong identity to the project area.

8. strategic flexibility
Important in TU Delft area, is the flexibility of architecture along Kruithuisweg. The building inside is easily adaptable to current requirements. This sustainable way of building science contributes to a high quality environment.

As said before, the guidelines which contribute to current campus design trends are generic and be applied in other situations as well. Other campus sides can be designed with the same guidelines. The design of the Kruithuisweg is focussing on different scale levels. It is not a design for a fragment of the urban environment, it covers different layers and influences. By doing this it is important to enhance not only the quality of the location, but also use the potentials of this location for this area.

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**LIST OF GUIDELINES:**

1. connectivity (Human scale, pedestrian, public and private transport)
2. open/public ground floors (services, retail, exhibitions)
3. balanced mix of applications (specialized clusters and diversification)
4. accommodation (housing, boarding, guest, hotel)
5. communication (Meeting places, café-bars, plazas, parks, conference)
6. catalytic conditions (surrounding neighborhoods, business parks)
7. urban, culture, economy, landscape (contributing and inspiring factors)
8. strategic tectonic flexibility (responsiveness to changing needs)

**Figure 242. Guideline checklist**
Focus of the project was on different scale levels. It is important for the future development of Delft university that it interweaves in these different scale levels. It has to contribute to local Delft’s city and being competitive on a regional, national and international level to attract knowledge workers. On the first hand, this thesis was focussing on the campus side itself. Creating more diversity was the original project. After doing research, it became more clear to use a border area to integrate the area better in its environment, based on the Lyon Model (Figure 243). Orientation was changed, from centre of the campus side to centre of the whole knowledge area, where focus is on connectivity. The project area includes two national oriented supply routes: Railway station and highway exit.

This thesis is written regarding municipality and Delft university, for stimulating their cooperation. What we see now is bad social interaction of municipality and TU Delft causing bad physical interaction of spatial areas. After development through several years, campus problems occur, this forces us, urban designers to use existing problems and space in and around the locations to solve the problems and recognise the potentials of the locations. The focus of different municipalities or management is often only within the borders of the specific design area, while often the potential is just on or over the border to interact with its environment. Cooperation or guidance between them is necessary to use the potentials of the location.

The guidelines according to campus design trends, were very helpful in getting grip on the situation, in the end this method was even a test for the design. These guidelines are clear principles for campus sides in knowledge cities to develop and being competitive. This generic method for stating what is important for campus sides and knowledge cities to develop, was helpful to frame the research and design.

Using different qualities as landscape designer and urban designer, these flexible guidelines were shaped into the specific design location. Different other networks or more abstract approaches could be taken into account to deal with other problems at the location.

This thesis describes an urban project. Different qualities; landscape design, urban design and architecture are playing important roles on different scales. Designing through several scales and creating better environments for inhabitants and users of the area are part of urban regeneration. Physical changes can stimulate user value and economical value of an area. By developing high quality environment, it is attractive to be used.

This graduation project offered me a small insight in the world of urban design. It was very interesting and informative. Also learning different ways of research and approach were important parts of the thesis. I am aware of the fact that I am entering the world of urban design and that there is still a lot to learn in this practice.


BACH, B., 2006, Urban design and traffic- a selection from Bach’s toolbox, CROW, Ede 2006


CHRISTIAANSE, K., HOEGER, K., 2007, Campus and the City: Urban Design for the Knowledge Society. GTA Publishers, Zurich


DELFt MUNICIPALITY, 2009, Ontmoetingen met Delft 2030, ruimtelijke strucuurvisie. Delft


FLORIDA, R., 2002, The rise of the creative class and how it is transforming work, leisure, community and every-day life. Perseus books group, New York

FRANKE, S., HOSPERS, G., 2009, De levende stad: Over de hedendaagse betekenis van Jane Jacobs. Uitgevrij SUN, Amsterdam


HEIJER, DEN, A., 2008, Managing the University Campus in an Urban Perspective: Theory, Challenges and Lessons from Dutch Practice. Published PhD Thesis Delft University of Technology, Delft


HEIJER, DEN, A., 2008, Managing the University Campus in an Urban Perspective: Theory, Challenges and Lessons from Dutch Practice. Published PhD Thesis Delft University of Technology, Delft


LYNCH, K., 1990, City Sense and City Design: Writings and Projects of


MINISTRY OF HOUSING, SPATIAL PLANNING AND THE ENVIRONMENT, 2008, Structuurvisie Randstad 2040. The Hague


ROOIJ, R.M., 2005, The Mobile City. The Planning and Design of the Network City from a Mobility Point of View. T2005/1, TRAIL thesis Series, The Netherlands


TECHNOPOLIS, 2006, Technopolis innovation park [Internet], Den Haag, The Netherlands


WIT, DE, S., 2009, Dutch Lowlands: Morphogenisis of a cultural landscape, SUN, Amsterdam

YIGITCANLAR, T., VELIBEYOGLU, K., BAUM, S., 2008, Knowledge-based development: Planning and Applications in the information Era. IGI Global, London

APPENDIX

1 LITERATURE REVIEW
2 CASE STUDY: PUBLIC TRANSPORT
3 CAMPUS VISION 2030 ANALYSIS
4 CONCEPT VARIANTS
5 FSI RESEARCH
Abstract – The relation between concentrated university campuses and the city is often very complex and conflicting. This paper is written, based on an academic literature study to find an answer to the following question: *What are main guidelines for designing university campuses in knowledge cities related to economic-, social- and physical development?*

By answering this question, an academic review will be written according to the fundamentals of a knowledge city and the physical contribution of university campuses in it. It creates better understanding of campus planning and their socio-economic effects in knowledge cities in order to generate better interaction between cities and university campuses.

Academic literature treated in this paper will cover the fundamentals that are needed for knowledge cities to be attractive and innovative; what role university campuses play in knowledge cities based on economic-, social- and physical development; and which physical urban planning elements are mainly needed to affect the contribution of university campuses.

Summarizing studied literature has generated a list of guidelines in order to redesign a university campus, which increases social-, economic- and physical interaction with the knowledge city.

Key words – Knowledge City fundamentals; Campus design guidelines; City development; Campus design trends

Introduction

Yigitcanlar et al. (2008) cited Sassen who said that a revolutionary shift in knowledge, is caused by the innovation of electronics which made ‘the digital world a reality’. This is confirmed by Knight (1995) who states that there was a shift in the last decades of the twentieth century, from the industrial to a post-industrial economy: ‘knowledge based’ and service economy. This has been made possible by innovating information and communication technology, which increased the mobility of people and simplified worldwide communication (Knight, 1995).
It is a statement that it is essential to educate, attract and retain ‘knowledge workers’ in our present ‘knowledge-economy’ to keep countries competitive. Therefore, the importance of universities has become high-rated in order to keep this economy running. According to Ergazakis et al. (2004) the knowledge city aims at knowledge-based development by encouraging the continuous creation, sharing, evaluation, renewal, and update of knowledge. To achieve this, continuous interaction between homeland citizens and foreign citizens is needed.

Often, these knowledge intensive activities are enclaves, away from the city centre. (Knight, 1995 ; Markusen, 1996). According to Bender (1988), there is almost no interaction between these concentrated university campuses and the city, which is not providing economic-, social- and physical development. Enriching academic life with urban life can stimulate interaction between different social layers which improves knowledge-based development (Hoeger, 2007). Hoeger (2007) explains it as an attempt to create a sustainable and lively sense of urban community. Opening and interacting a university campus is regarded as potential for institutions to integrate in urban surroundings. It will bring structural and infrastructural changes in advance of long term economic growth.

This paper will deal with guidelines that meet today’s trend in university campus design, which is opening up to generate interaction with its surroundings. By doing a literature study on fundamentals and the effects of a knowledge city, demands of it are defined. Besides this, the paper will discuss the contribution of university campuses in these knowledge cities, related to economic-, social- and physical development (Roberts & Sykes, 2006). This will result in a list of guidelines in order to redesign a university campus, which increases social-, economic- and physical interaction.

2 A Knowledge City

To generate a successful knowledge city, it has to attract and retain knowledge workers. The fundamentals of a Knowledge City explains how they contribute in creating a successful environment and what effects it has.

2.1 Definition of a Knowledge City

Because of the development on the level of ICT, the internet technologies make people less dependent on time and place (Rooij, 2005). This causes a more global economy, with cities trying to compete. These cities that are being innovative by generating new knowledge will be economically more successful.

Instead of industrial matters, knowledge is now seen as ‘strategic tool’ to keep economy running. Governments often develop strategies which are knowledge based. According to Knight this can turn knowledge resources into local development (Knight, 1995). These ‘knowledge cities’ are described by Alraouf as “cities that possess an economy driven by high value-added exports created through research, technology; and brainpower. Technological innovations have shaped and are still shaping the economic-, social- and physical development of cities all over the world.”(Alraouf, 2006, cited in Yigitcanlar et al., 2008, p. 240).

“Cities are, above all, business nodes where knowledge exchanging takes place.” (Jacobs, 2000, cited in Franke and Hospers, 2009, p. 59). Also van den Berg et al. (2005) regards cities as places where knowledge is produced, innovated, exchanged and marketed. This is often encouraged by networks of academic institutes that cities have. These networks create well educated citizens.

2.2 Fundamentals of a Knowledge City

Van den Berg et al. (2005) distinguished seven fundamentals representing economic, social and environmental values. The same aspects are confirmed by Yigitcanlar (2008) as important to build up a successful knowledge environment.
As shown in figures 01 and 02 the first fundamental stone is, a city that is knowledge based. Creation of knowledge mainly appears in cities and according to van den Berg et al (2005, p. 15) are “quality, quantity and diversity of universities, other education institutes and Research & Development activities determined to a large extent of the starting position of a knowledge city.” Florida (2002) says that it is also important for cities being innovative. To innovate, cities try to attract ‘knowledge-workers’. Florida (2002) states that these ‘creative’ thinkers are the backbone of the economy with their knowledge, innovation and creativity. As important is to transfer, share and use this knowledge, also for creating success in other sectors and increasing the job-amount for different social-layers (Roberts & Sykes, 2006). From this point of view it opens opportunities for local-level business to interact with international corporations. This represents the second fundamental stone: the economic spin off (Wiewel & Knaap, 2005) Attracting knowledge workers can contribute to economic patterns, which encourages the economic growth in cities even more. Key factor to attract them is mainly quality of life in cities, the third fundamental stone (Castells, 2000, cited in Van den Berg et al., 2005; Florida, 2002). In other words, cities try to create this high quality living level by developing an attractive and inspiring environment where topics as liveliness, local culture, vitality, uniqueness, diversity and tolerance play important roles. By upgrading cities intellectual fame, more and more knowledge workers can be attracted (Castells, 2000, cited in Van den Berg et al.; Florida, 2002; Luijten, 2005). By creating good accessibility like an international and national network, knowledge-workers from all over the world can be attracted. This stimulates global connections but also promotes face to face contacts generated by fast and efficient infrastructural networks, representing the fourth fundamental element. Jacobs (1969) describes this ‘diverse city’ as a dynamic, enterprising city, which is built in an intricate structure of different actors. This introduces the fifth fundamental stone; Urban Diversity. It brings inspiration and promotes creativity, which is according to Jacobs (1969) and Florida (2002) the key factor to a socio – economic successful and attractive knowledge environment.

Van der Voordt translated Maslov’s model to spatial aims in a learning and working environment, figure 03. This environment has to support the working processes of students and staff. Van der Voordt (2003) also states that a learning and working environment has to be inspiring and attractive. This is confirmed in the creativity-chain of figure 04 by Saris and Brouwer (2005). It shows that inspiration, interaction and transaction are key factors for cities keeping competitive retaining knowledge, attracting knowledge workers and economic development. More opportunities are provided when interaction between creative sectors and other actors in a network can be stimulated.

As shown in Figures 01 and 02, urban scale is important for attracting knowledge workers. The bigger a city, the more variety of jobs to choose and for business the more suitable staff to find. According to Van den Berg et al. (2005) also agglomerations of smaller cities can benefit from each other. With good infrastructural connections, they can work together and operate even on global level. Last fundamental of a knowledge city to develop is based on social equity. Inhabitants and visitors want feel safe and healthy, also confirmed by Van der Voordt’s model, visible in figure 03. To grow and be attractive as a city, there should be no tension between cultures because of missing needs. Economic development is closely connected to cities where people are not feeling save.

By being able to offer these seven fundamentals (Van den Berg et al., 2005; Yigitcanlar et al., 2008) it is possible for cities to be knowledge-based and attract economic development. According to the scheme in figures 01 and 02, these fundamentals can apply to knowledge, attract knowledge-workers, create knowledge and develop growth clusters. According to Van den Berg et al. (2005), these growth clusters, like universities, have to interact with their knowledge-based environment and need to contain all seven fundamentals to be even as successful as its surroundings.
2.3 Importance of physical interaction

The fundamentals of the knowledge city are untouchable elements, which are effects of physical elements in a city. The coherence of them is creating an environment where people are willing to live and are attracting more and more knowledge workers in an economic stabilized city. But why is physical interaction necessary if the ICT communication networks are increasing and what can be physical elements of a knowledge city?

Ergazakis et al. (2004), but also in the scheme of figure 04 of Saris & Brouwer (2005) it is stated that interaction between people is necessary to produce, evaluate and exchange knowledge. Physical interaction between people generates knowledge. Also physical experience of the environment is needful to innovate and which is lacking when using ICT communication. As in figure 04 is mentioned that the sense of feeling the environment is inspiring for innovation. This is promoted by diversity in urban landscape. Besides it is not possible to do al interaction via ICT communication. Van den Berg et al. (2005) introduced two kinds of knowledge. Explicit knowledge, which is new information which is explicitly exchanged between people to gain knowledge. Second is tacit knowledge and is learned and experienced through practice which is exchanged via physical interaction.

Contrary to the increasing ICT communication, places to interact remains important for exchanging knowledge. Ergazakis et al. (2004) and Yigitcanlar et al. (2008) believe that knowledge environments need to be designed regarding to several guidelines.

3 The University Campus

Universities are important engines in Knowledge Cities. What are contributions of them according to the seven fundamentals and related to the urban regeneration process? The important themes of influencing an urban regeneration process (see figure 05) are discussed in order to generate a list of guidelines at the end of this paper, concerning the contribution of university campuses in knowledge cities.

3.1 University Campuses in Cities

University campuses are important ‘engines’ in knowledge cities, where interaction between citizens takes place. Their means are: education of the knowledge workers of the future; collaboration with industry; subsidizing innovative research and creating economic clusters that generate employment. (Heijer, 2008). Often, these knowledge intensive activities are concentrated or clustered in limited spatial areas (Knight, 1995; Markusen, 1996). According to Bender (1988, p.190) “there certainly is no symbiosis, between city and university.” In other words, the relation between concentrated university campuses and the city is often very complex and conflicting. Their former mentality was to settle away from the chaos of the city and free from distractions of modern civilization. This is the reason why university campuses nowadays profile themselves as mono-functional, unattractive enclaves, while the trend is the opposite: ‘The future campus as a meeting place’ related to the city (Ekkelboom, 2008).

If we look back to the fundamentals of a knowledge city, Van den Berg et al. (2005) and Yigitcanlar et al. (2008) state that the main fundamental stone is based on knowledge which is an effect of the presence of universities, education institutes and Research and Development activities. According to Castells and Hall (1994), cited in Yigitcanlar et al. (2008), universities in knowledge cities are as coal mines in an industrial economy. Yigitcanlar et al. (2008) also cited Ergazakis (2004) who believes that building a knowledge-based development can be stimulated and attracted by setting up knowledge and research related activities like universities and technology parks.

Often, there is a lack in interaction between university campuses and city. This is caused by the traditional thought of campuses located away from the city chaos so not being distracted during the creation and exchange of new knowledge. Perry and Wiewel (2005) cited Shills (1988) who wrote that it is impossible for Universities to be self-contained. This means that they have to interact with their environment to be successful.

Over the years, the campus university has had many contextual urban forms in relation with its environment. Currently there remain three of these models in Western Europe (Heijer, 2008; Christiaanse & Hoeger, 2007):

- The campus as a separate city (outside city borders)
- The campus as a ‘gated community’ in the city (independent area).
- The campus integrated within the city (Connected to its environment).

These campuses are often set up as mono-functional entities on isolated locations beyond the city limits (Christiaanse, 2007). The university buildings are directly used for educational and research purposes: lecture halls, classrooms, laboratories, libraries, and etcetera. As said before, the new trend of campus design is focused on integrating them and opening up, which can stimulate economic development and interaction with the city.

3.2 A Framework of an Urban Regeneration Process

The key to an urban regeneration process are, according to Roberts and Sykes (2006) model, the many factors that are supporting the conditions in a city. However, they are close to what many academic institutions are currently attempting to do; integrate themselves into the urban environment from an ideological (economic and social) and physical point of view, resulting in mixed use and economic developments with local and public functions as discussed by Hoeger, cited in Christiaanse (2007, p19).
Urban regeneration is a comprehensive and integrated vision and action which leads to the resolution of urban problems and which seeks to bring about a lasting change in the economic, physical, social and environmental condition of an area that has been subject to change. (Roberts & Sykes, 2006, p.34). These aspects are important for cities being successful in a regional, national and international way. To frame the review, the economic-, social- and environmental aspects (inputs) of an urban regeneration process are taken to find relevant information on this topic. They are relevant researchable topics to generate change in an urban environment (Outputs in figure 05).

All guidelines of designing a University campus are based on the needs of a successful knowledge city and the contribution of the campus.

3.3 Contribution of a university campus to a Knowledge City

Based on the urban regeneration process, the economic-, social- and environmental contribution of university campuses in knowledge cities will be discussed to explain the value of these important ‘engines’.

3.3.1 Economic contribution of a university campus to a Knowledge City

Like the seven fundamentals of Van den Berg et al. (2005) and Yigitcanlar et al. (2008), a knowledge- and economic base is needed for cities to profile themselves as ‘knowledge city’. As discussed before, academic related activities, like universities, are attracting economic business and stimulates knowledge based development. Therefore it is important that good interaction between university and business sector is possible (Winden et al., 2007, cited in Van den Berg, 2005).

Campus design is not only related to academic activity. It attracts technology parks and business related economy to settle close to university grounds, so they can profit from scientific research and resources (Christiaanse & Hoeger, 2007). This leads to even further development and innovation, which keeps cities competitive.

Besides creating links with business, it is important for universities to interact with city inhabitants to exchange, retain, innovate and use knowledge. Perry and Wiewel (2005) described universities as urban developers. They can have positive spillovers for the neighbors, attracting business and creating jobs.

3.3.2 Social contribution of a university campus to a Knowledge City

Christiaanse (2007) sees the ideal university campus, as “an interconnected deconcentration” of specialized clusters, which together constitute a network of knowledge and individually function as catalysts for their immediate surroundings”. He believes that this creates symbiosis in environment and everyday life. It promotes social activity because of diverse building architecture and lots of public activities.

Social conditions are being generated and affected by physical and economic elements. Social elements are results of a high-quality living-environment which is created by high-quality environmental elements and opportunities in economic development.

Attracting knowledge workers, means attracting knowledge based development. Baum et al. (2007) created a list of demands of different types of knowledge workers and their demands to be attracted. (figure 06).
Perry & Wiewel (2005) wrote that regenerating and expanding existing university campuses can have a significant effect on surrounding neighbourhoods. These campuses are providing housing, social activities and support services continues to grow. Effects in these surrounding neighbourhoods are mainly the improving of appearance, safety and socio-economic status.

3.3.3 Social contribution of a university campus to a Knowledge City

Figure 05 shows a model, generated by Den Heijer (2006) which shows an environmental translation of fundamental stones of Van den Berg et al. (2005) and Yigitcanlar et al. (2008). Den Heijer pointed out the physical elements which are needed to affect knowledge-development and economic development; Apply knowledge, attracting knowledge workers, create knowledge and develop growth clusters, figure 01 and 02.

Attracting knowledge workers for stimulating knowledge development is creating a good quality of life. According to Florida quality of life should be replaced by ‘quality of space’. It gives a better physical sense of feeling, what this quality contains in an urban setting. He listed three dimensions (Baum et al., 2007):

What’s there: the combination of the built environment and the natural environment

-- a proper setting for the living of creative lives;

Who’s there: diverse kinds of people, interacting and providing cues that anyone will accept and can make a life in the community(s);
What’s going on: the vibrancy of street life, café culture, arts, music and people engaging in outdoor activities.

Figure 08 shows a scheme where physical elements represent quality of place.

To keep universities competitive, there is a shift in objectives. Coping with ‘the future campus’, they suddenly need to offer a wider range of facilities to become attractive for both national and international matters. In other words, these former education-focused areas can support city development in order to have more economic value.

Figure 08: Dimensions of Urban Quality derived from Llewelyn Davies Yeang, 2006; Clark 2003; Florida 2002 (Baum et al., 2007)

4 Conclusions

Objective of the paper was to generate a list of guidelines in order to redesign a university campus in a knowledge city to increase economic-, social- and physical interaction with it. As read before, fundamentals for a successful knowledge city and its effects on the environment are discussed. Furthermore, the contribution of university campuses to economic-, social- and physical development in knowledge cities is studied. Guidelines and how they are applicable to redesign university campuses are created and explained.

Summarizing this paper will conclude that knowledge workers have to be attracted to innovate, create, retain and exchange knowledge. To attract knowledge workers, quality of life is provided. Attracting knowledge workers, means attracting business, which generates economic development.

Universities campuses are important engines in knowledge cities, but are very isolated mono-functional enclaves. Today’s trend is to open up these campus sides stimulating knowledge-based development, which is also good for local economy and surrounding neighborhoods. This can be realized by enriching academic environments with urban everyday life. Physical elements affect social and economic development related to city. Knowledge cities have to be designed and from that point of view will have a social- and economic spin over on its surroundings.

The listed guidelines can be used for redesigning university campuses to interact with the knowledge city related to economic-, social- and physical development.

5 Recommendations

Summarizing work studied so far, several guidelines for campus design can be listed in order to create physical interaction of the campus university and the city. In this way a campus can contribute to economic- and social development of a knowledge city. A lot of these guidelines are based on the urban regeneration process shown in figure 05 and the contribution of a university campus in a knowledge city. The university campus itself has to be even attractive, knowledge based and economic developing as the knowledge city itself.

University campus design guidelines

• open/public ground floors (services, retail, exhibitions)

Objective is that not only staff and students can make use of these restricted areas, but also city inhabitants. On the other hand, staff and students are able to make optimal use of the city itself. This generates a better environment to interact, to retain and hand over knowledge. University campuses have to open up and share their services with surrounding neighborhoods to create urban symbiosis. Academic institutions have to be open clusters, because it is easier to exchange knowledge in clustered areas.

• connectivity (Human scale, pedestrian, public and private transport)

To interact on a global, national, regional and local level, it is important to be connected on different levels. According to Van den Berg et al. (2005) accessibility is a key factor for knowledge activities. On global scale, fast access is provided by airports or international train connections. Also lower scale level connections are important for exchange and innovate knowledge. It stimulates continuous interaction between citizens. Baum et al. (2007) stated that different levels of transport have to be close connected, this in order to connect clusters inside knowledge cities. This means that university campuses have to be well connected to their direct environment and city but also on a higher scale level to be successful in national and international networks.
• balanced mix of applications (specialized clusters and diversification)

To exchange knowledge it is important to cluster services. To innovate knowledge it is important to have an inspiring environment, also on university campuses. This is stimulated by a diversification as Jacobs (Franke & Hospers, 2009) wrote. She distinguished four criteria which are important for an urban environment being diverse:

Mix of uses of primary functions

Small building blocks that frequently turn corners

Buildings that vary in age and conditions; Mix of old and new buildings

Sufficiently dense concentration of people

• accommodation (housing, boarding, guest, hotel)

However, universities feel more and more responsible for accommodating their students and staff, especially when considering the growing number of international staff, students and guests (speakers, teachers, researchers, etcetera). These groups need short to medium term stay, or hotel facilities for accommodation. Also, mobility of students and staff is changing, because of the increasing university network, which creates links to other (inter)national universities, industry and other related business (Den Heijer, 2008). The aspect of quality of life desires high quality accommodation according to Baum et al., 2005 and Yigitcanlar et al., 2008 confirms this.

• communication (Meeting places, café-bars, plazas, parks, conference)

Den Heijer (2008) cited on page 5, that according to Kenney et al. (2005) “The café-library-lounge might become a popular place (Kenney, Dumont et al. 2005)”. Apparently this is a trend, but not necessarily on campus sites. Important for these meeting places is wireless internet to compete with the campus. This communication aspect is high-rated in the quality of life aspect. Den Heijer (2008) states that Dutch students rather decide on sense of place than quality of educational program. “All the more reason why university and city planners should coordinate their strategies, also to brand their universities and cities.”(Den Heijer, 2008, p. 5)

• high-quality and permeable public space (accessibility, comfort, leisure)

The quality of life aspect is important to attract knowledge workers (Van den Berg et al., 2005) As Florida states that attracting talent is most attracted by, what he calls quality of place (Baum et al., 2007). Cultural activities and amenities play big attractions for knowledge workers, as shown in figure 06. Relaxing your mind is stimulating innovation and is inspiring for creating new knowledge.

• catalytic conditions (surrounding neighborhoods, business parks)

Important for university campuses is that they are surrounded by suburbs (Christiaanse, 2007). Adding non-university functions to encourage diversity and social interaction will discourage the risk of further isolated, mono-functional sides. But, when generating a campus, away from the city with a complete range of amenities for living, working, shopping and leisure, it will turn into an autonomous compound with all characteristics of a gated community. In other words, there has to be interaction between university campus and its surroundings to be not isolated.

Campus universities also attract Research and Development related business and can create services which surrounding neighborhoods can use and which creates jobs for inhabitants of a city.

• urban, culture, economy, landscape (contributing and inspiring factors)

These aspects are forming characteristics of a city and generate creativity because of its diversity. Christiaanse (2007) believes that campuses need to have identity, influenced by external factors. Using these factors, university campuses are socially, economically and physically connected to the city. Diverse areas attract business, city inhabitants and visitors.

• strategic tectonic flexibility (responsiveness to changing needs)

Perry and Wiewel (2005) wrote that it is important for university campuses related to city development, that they can response to changing needs. Flexibility is an important aspect for immediate reaction on shifts in demands or business.
Bibliography


CHRISTIAANSE, K., HOEGER, K., 2007, Campus and the City: Urban Design for the Knowledge Society. GTA Publishers, Zurich


FLORIDA, R., 2002, The rise of the creative class and how it is transforming work, leisure, community and every-day life. Perseus books group, New York

FRANKE, S., HOSPERS, G., 2009, De levende stad: Over de hedendaagse betekenis van Jane Jacobs. Uitgevrij SUN, Amsterdam


HEIJER, DEN, A., 2008, Managing the University Campus in an Urban Perspective: Theory, Challenges and Lessons from Dutch Practice. Published PhD Thesis Delft University of Technology, Delft


ROOIJ, R.M., 2005, The Mobile City. The Planning and Design of the Network City from a Mobility Point of View. T2005/1, TRAIL thesis Series, The Netherlands


Case study criteria IJburg

Issues which should be analyzed in the different case studies

- PT network design
- Urban design
- PT system functioning (usage)
- Urban planning & Policy

Figure 1 - Traject of Ultram 26
Figure 2 - Traject of IJtram 26
IJburg resident info

IJburg is a neighborhood in the eastern part of Amsterdam and is currently being constructed. The neighborhood is being realized on artificial islands in the IJmeer. In the first phase 3 islands have been constructed: Steigereiland; Haveneiland-West and the Rieteilanden. When completed IJburg will consist of 7 islands. The most important street is IJburglaan, which connects the different islands, the Ultram (tram line 26) runs along this street and its bridges. In the original plans a metro connection was planned, however the costs were too high and the population size too low. At the moment IJburg has a population of 13,000, when all islands are constructed the population will count around 45,000.

<table>
<thead>
<tr>
<th>AGE (years)</th>
<th>IJburg(%)</th>
<th>Amsterdam(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-19</td>
<td>36,1</td>
<td>21,0</td>
</tr>
<tr>
<td>20-64</td>
<td>61,4</td>
<td>67,9</td>
</tr>
<tr>
<td>65 and older</td>
<td>2,6</td>
<td>11,2</td>
</tr>
</tbody>
</table>

*Figure 3 - Age Table IJburg and Amsterdam*

Ethnicity

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>IJburg(%)</th>
<th>Amsterdam(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dutch</td>
<td>53,0</td>
<td>51,5</td>
</tr>
<tr>
<td>Turkish</td>
<td>3,6</td>
<td>5,2</td>
</tr>
<tr>
<td>Moroccan</td>
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<td>8,8</td>
</tr>
<tr>
<td>Surinamese</td>
<td>11,8</td>
<td>9,4</td>
</tr>
<tr>
<td>Antillian&amp;</td>
<td>1,7</td>
<td>1,5</td>
</tr>
<tr>
<td>Aruba</td>
<td></td>
<td></td>
</tr>
<tr>
<td>South European</td>
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<td>14,1</td>
</tr>
<tr>
<td>Other nationalities</td>
<td>9,6</td>
<td>9,5</td>
</tr>
</tbody>
</table>

*Figure 4 - Ethnicity Table IJburg and Amsterdam*

Household Types

<table>
<thead>
<tr>
<th>Types</th>
<th>IJburg(%)</th>
<th>Amsterdam(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td>33,7</td>
<td>55,0</td>
</tr>
<tr>
<td>2-persons</td>
<td>17,3</td>
<td>20,0</td>
</tr>
<tr>
<td>Fam. with children</td>
<td>35,8</td>
<td>15,0</td>
</tr>
<tr>
<td>Single parent</td>
<td>13,2</td>
<td>10,0</td>
</tr>
</tbody>
</table>

*Figure 5 - Household types in IJburg and Amsterdam*

The tables on the left showing that many youth is living in IJburg. Ethnicity in IJburg is on the same hand as Amsterdam and most of the residents are families with children. Educational level is higher then avarage in IJburg.

PT network design

1. Position of the city within the urban network

IJburg is located outside the border of Amsterdam’s A10 periphery where the A1 highway meets the A10. IJburg is an urban expansion of Amsterdam and has an intense relation with this city. The public transport connection (tram 26 server by GVB) is a straight connection between Amsterdam CS and IJburg.

*Figure 6 - IJburg’s position outside Amsterdam’s A10 periphery road.*

2. Tram 26 line characteristics

Line 26 runs from Amsterdam central station to the Haveneiland-West. It has 9 stops and stops at important facilities such as NEMO, the Muziekgebouw aan ‘t IJ, Passagier Terminal Amsterdam. It uses the 1.9 km long Piet Hein tunnel and crosses various bridges which connect the various islands of IJburg. An interesting aspect of the trams is that they allow travellers to take their bicycles with the.

- Total line length: 8.5 km
- Amount of tracks: 2
- Amount of stops: 9
- Average speed: 27 km/h
- Traject travel time: 19 minutes
- Date of construction: 2000-2005
- Operational since: 28-05-2005
- Design: Dienst Infrastructuur, Verkeer en Vervoer (DIVV) Amsterdam
- Exploiter: GVB
- Maximum speed reached inside Piet Hein tunnel: 70 km/h
- Bicycles are allowed on board
- Frequency: every 6 minutes
- Travelers: 10,000 travelers a day
- Users of tram per dwelling: 0.9

3. Flexible transport system: room for future expansions

Within the development plans of IJburg possibilities for future public transport connections, concerning different transport modes, are left open. Mentionable modes are the Zuidtangent and a Light Rail connection. In a few years the Utram will be extended to Strand Island and Buiten Island. This depends on the pace of development of IJburg.

Bus Rapid Transit (Zuidtangent Oost)
Zuidtangent is a Bus Rapid Transit connection between Haarlem (central station), Schiphol airport and Amsterdam Zuidoost (NS station Bijlmer ArenA). This bus connection will possibly be extended towards IJburg in 2013. In the long run, busses from and to Almere, Muiden and Diemen will run through IJburg.

Lightrail
Within the IJburg plans space is reserved for a future light rail connection. Decisions about this line are to be taken in the future. The planned route will run from NS station Diemen-Zuid to the Middeneiland of IJburg. A possibilities are left open to create a connection towards Almere. In earlier plans this light rail connections was meant to be a subway connection to Diemen-South (Volkskrant, 21 november 1995).

4. Network characteristics

Line 26 has one main function, and that is to connect IJburg and the developments along the Piet Heinkade with Amsterdam Central Station. It is the most important line to the IJburg area and along this line are several transfer possibilities to station Bijlmer ArenA, Java island and the southern parts of Amsterdam.

![Figure 7 - Transfer possibilities along tram line 26.](image-url)
Urban design

1. Identity around PT lines and nodes
2. Stop connectivity
3. Urban design around the nodes and the transport line
4. Urban program around the nodes and the transport line
5. Car network characteristics
6. Stop design
7. Safety
8. Boundaries

1. Identity around PT lines and nodes

Tram line 26 to IJburg has a diverse range of identities, in functional aspect, environmental aspect and on the field of urban design and architecture. The main functional zones that can be distinguished are the hectic transport node of Amsterdam Central Station; the formal business area along the Piet Heinkade; the industrial Zeeburg island and the urban living environments of the two IJburg islands. Each of these functional zones have different styles of urban design and architecture, enforcing the identity and character of these zones. These zones are separated by water, they are all different islands, and are connected by bridges and tunnels. These tunnels, bridges and broad blue/green vista’s in between the islands provide the tram traveler with a wide range of views, making them conscious of the island experience.

A - Amsterdam central station
Busy transport node and the functional and monumental gate to the city of Amsterdam.

B - Piet Heinkade business area
Modern business area where large company headquarters are situated as well as offices for medium-sized businesses. The offices are primarily situated on the north-side of tram line 26 due to the barrier opposed by the train tracks on the south-side.
C - Zeeburgeiland
Formal industrial and largely derelict area, currently undergoing development. In future plans, this industrial area will make place for 5,500 dwellings.

D - Steigereiland
Small island belonging to IJburg and positioned in between the business and industrial zone west of IJburg and the urban expansion of IJburg in the east. Steigereiland is currently undergoing development, but it’s current character is less urban then Haveneiland-West due to the very broad profile (lacking human scale) and the low density of housing and functions, especially on the north side of the tram line.

E - Haveneiland-West
Haveneiland-West is the most developed island of IJburg and is designed as a neighborhood with belonging neighborhood facilities. The tram line has a smaller profile here, especially when compared to Steigereiland and the Piet Heinkade, but it is still quite broad. However due to the functions along the line, the medium-rise brick building aligning the streets and the ‘soft’ green hedge rows separating the tram line from other traffic streams Haveneiland-West has a more urban and human feel.

The spaces in between the islands
These tunnels, bridges and broad blue/green vista’s in between the islands provide the tram traveler with a wide range of views.

Figure 11 - Enneüs Heermabrug and a broad view in between Haveneiland-West and Steigereiland.
Sections
The map shows the last island of IJburg. The sections of the tramline shows the arrangement of private and public transport. Also the street measurements are drawn, which are interesting to recover the human scale.

Section A-A’
The picture below (Section A-A’) is showing the cross section of the IJtram between the stops.

Figure 15 - Positioning of the sections.

Figure 16 - Section A-A’.

Section A-A’ (3D)
The Section of the tramline in IJburg will show the seperation of Public- and private transport. The section at the right is showing the four storage high buildings along the main axes. The street profile has a symmetrical build up; sidewalk, bycicle path, parking line, roadway and in the middle a double track for IJtram. The main axes is emphasized by a tree row for an urban identity. Along the track of IJtram a hedge is placed because of safety reasons, but decreases the accessibility of the track, which is very isolated.

Figure 17 - Section A-A’ (3D).
**Section B-B’**
The picture on the right shows a cross section of the light rail around the stop of Vennepluimstraat.

**Section B-B’ (3D)**
The 3D image shows on one side a three storage high building line, along the main axes which are dwellings. The other side is a five floor high building with mixed commercial functions on the ground floor. To create a more open space around the stops, the buildings on the mixed function side are retracted from the street. On both sides of the section, walking sides and bycycle paths are created. Roadways are seperated by the tramline; two lane road in direction of the IJburg and one lane road in direction of Amsterdam city. The tramline is isolated which influences the accessibility of the stops caused by the roadways on both sides forming barriers.
2. Stop connectivity

2.1 Positioned at principal/structural lines
The tram stops are positioned at structural nodes/crossings in the infrastructural network. They are positioned at the corners of blocks where structural roads cross each other, as well as cycling lanes and pedestrian routes.

2.2 Tram platform separated from cycling and pedestrian lanes
There is a strong segregation between the tram line and it’s direct environment on each point of the line. The tram line is the central line within the IJburg’s main transport axis, the IJburglaan, and is situated in between a car and bicycle lanes on both sides. A hedge row separated the tram line from the car traffic road, alongside the stop platforms fencing is applied.

2.3 Axial feeder routes
The tram stops are situated at structural crossings in IJburg’s road network. There are no (or limited) distinct pedestrian or bicycle feeder routes leading from the stops, as the road network is practically the same as the pedestrian and bicycle routing.

2.4 Blocks opened up
On some parts the facade aligning the main street are opened up, so that

2.5 Limited bicycle storage facilities
The tram stops have very few bicycle storage facilities, however each house or function within IJburg (as it has been build so far) is situated within walking distance of a tram stop (see the catchment area of 500 meters map figure 27). In other words, it is not likely that, if bicycle storage had been available, bicycle usage towards tram stops would increase. Never in direct relation with pedestrian routes, same profile at each stop = tram-car-bike-pedestrian-building. Every tram has room for two bicycles to take for travel. Outside these 500 meter borders, pedestrian use is decreasing. Increased accessibility of the tram stops can be reached by bicycle use and opportunities to store them around the stops.

2.6 Safety measures
To reach the tram platforms, a busy traffic lane and a bicycle need to be crossed. These crossings are equipped with traffic lights. The tram line and the stops are separated from other traffic streams by fencing or hedge rows.
3. Urban design around nodes

3.1 Eyes-on-the-street
All four stops on Haveneiland-West are ‘guarded’ by apartment blocks on both sides of the street and has quite a small profile. The Steigereiland stop has a different character. It has a broader profile and only apartment blocks are only situated at one side of the tram line.

3.2 Functional mix and (dwelling) density
The dwelling density is high (around 80 dw/ha) alongside the tram line on Haveneiland-West and a bit lower on Steigereiland (around 70 dw/ha) as figure 25 clearly shows. These density figures are a lot higher then in Carnisselande (Rotterdam) and Ypenburg (both around 40 dw/ha). Higher densities, especially close to the stops, increase the profitabilily of a transport line.

The functional density and diversity is clearly higher close to the stops. Around these stops the plints are reserved for a diversity of functions (commercial, office, other facilities) while the plints in between the stops
3.3 Medium-rise buildings aligning the streets (see figures previous page)
The tram line corridor is aligned by medium-rise buildings, mostly 5 to 6 building layers. The dwelling density and building height on the north side of the tram line is quite similar to the blocks aligning the IJburglaan, however space is reserved for parks and courtyards. The dwelling density and building height south of the IJburglaan is a lot lower, this part of IJburg has a low urban character with a large amount of ground-bound housing.

3.4 Transition public/private
All stops have a hard segregation between the ‘transport-space’ and the surrounding public-private space. No transitions have been implemented in the design of the tram line in relation to its public space.

3.5 Natural resources
The urban space is quite hard, apart from some trees and hedge rows. IJburg is however surrounded by water, and nice and broad vista's are to be seen when travelling with the tram.

4. Urban program around nodes and the transport line
When considering the overall tram line 26 alignment, the distinction between the functions is rather clear. The Piet Heinkade business area has a lot of office buildings, several important cultural functions (like the Muziekgebouw aan ‘t IJ) and hotels, while IJburg’s functional program mainly consists from housing and neighborhood shops, facilities and small office spaces.
The IJburglaan has an urban plint with mixed functions. The ground-floors closest to the tram platforms (and thus the structural crossings of the road network) contain a large variety of functions (commercial, social, educational, medical) whereas the plint in between the tram stops is mostly used for housing. The largest density and variety of functions are situated within a radius of 250 meters from the tram stops (see figure 25) alongside the IJburglaan.

Figure 27 - Functional densities on the IJburg islands.

The urban space around the Venneplumstraat-stop, the stop on Haveneiland-West closest to Amsterdam, contains the highest density and variety of (mostly commercial) functions. This ‘village-center’ functionality is also translated in the architecture and urban design of this area: the block is shaped with village-like features such as sloped roofs (instead of the flat rooftops in the rest of the neighborhood) and is built up from lighter bricks. A square is created to create the intimacy of a town center (see figure 28 and 29).
Figure 28 - Architecture marking the commercial center

Figure 29 - Commercial town square created in front of the Vennepluimstaat. Parking garage entrance located at the center of the square.
5. Car network characteristics

IJburg’s car network has a clear hierarchy and a grid-like structure. IJburg has one clear transport corridor: the IJburglaan. The IJburglaan is build up from the tram line, bicycle lanes and IJburg’s main traffic road. This main road connects IJburg to the A10 highway in the west and the A1 highway in the east. Secondary roads perpendicular to IJburglaan divide IJburg in different blocks, these blocks are served by tertiary roads, completing the car network’s grid structure. The tram stops are positioned on the crossings of the main road and the secondary roads. On-street parking is accommodated alongside each road.

Figure 30 - Main road: IJburglaan

Figure 31 - Secondary road

Figure 32 - The grid structure of primary, secondary and tertiary roads on Haveneiland-West.

Figure 33 - Tertiary road
6. Stop design

The tram stops on IJburg are all similar. They have similar facilities: digital information sign, garbage bins, benches and fencing, the platform width and height is identical as well. No distinction is made within the stops hierarchy (for example the commercial center stop of Vennepluimstraat shows no difference compared to the Ruisrietzstraat stop).

7. Safety measures

Similar safety measures are implemented alongside the tram tracks. Crossing points at the stops are controlled by traffic lights. The tram lines are separated from other traffic streams by fencing and hedge rows. Different traffic streams (car, tram, bicycle) share the same transport corridor, providing the urban space with continuous social surveillance (especially outside office hours), together with the buildings facing the street. This social surveillance would be less if for instance cars would not be able to move along the tram stops.

Figure 34 - Basic lay-out a tram stop on IJburg.

Figure 35 - Traffic light controlled crossings.

Figure 36 - Fencing separates the stops from the street.

Figure 37 - System of shared streets.

Figure 38 - Profile of the IJburglaan with separated traffic lanes. Hedge rows separate the tram lanes from the road.
8. Boundaries

The tram line connects different islands, which are large natural boundaries. Bridges and tunnels are constructed to overcome this boundary. So far these bridges are quite limited, especially for motorized road traffic. Furthermore the island of IJburg are cornered by the IJ lake and the A1 and A10 highway.

![Figure 39 - IJburg’s position in between the A1 and A10 highway and the surrounding water of the IJmeer.](image)

PT system functioning

Usage and users

Tram 26 is a very successful line considering ridership numbers: at the beginning of 2009 ridership numbers have doubled since 2005, from 5,000 to 10,000 travellers per day (Het Parool, 6 januari, 2009). The frequency during peak hours has been raised to 6 minutes, extra places for bicycles and baby carriages are planned to be expanded. These extra places are necessary due to the large amount of young families with children living on IJburg.
Urban Planning & Policy

1. Different levels of governance and their influence and responsibilities

Research workgroup (responsible for the financing research concerning the public transport connection to IJburg)
> The municipalities of Amsterdam and Diemen
> Projectbureau IJburg
> ministerie van Verkeer en Waterstaat
> toekomstige stadsprovincie (ROA)

Amsterdam community council

2. Decision process

The public transport connection with IJburg was a large bottleneck in the plan of expanding Amsterdam into the water. Problems on the field of financing this public transport connection was the main reason for the municipal border’s go or no-go verdict (Volkskrant, 21 November 1995). The initial plan was to a metro line between Amsterdam CS and IJburg, but the construction costs of such a line exceeded the budget.

Several alternative PT systems were developed, the two most commonly accepted variants were:
- the IJ-Rail model (subway connection between Amsterdam CS and IJburg)
- the Combination model

The IJ-Rail model concerns a rapid construction of the IJ-rail, while busses connect IJburg with Diemen and Amsterdam-SouthEast.
The Combination model connects IJburg to Diemen by subway, where this new subway line is connected to the existing subway system. In this variant a regular tram will run between Amsterdam CS and IJburg.

General agreement was found for the Combination model because it had several advantages. The U-rail would only be exploitable in 2007, when 12.000 of the 18.000 planned dwellings were build while a tram connection would be exploitable in 2002, when only 4.000 dwellings have been delivered.

Travel times for both models were calculated from IJburg-central and were 18 minutes (IJburg - Amsterdam-central by tram), 16 minutes (IJburg - Amsterdam-South-WTC by metro) and 26 minutes (IJburg - Sloterdijk by metro).

The development costs of the combined option (which would be similar for both cases) could be spread over a longer period of time. Due to the tram connection to Amsterdam CS and temporary bus connections to Dieman and Amsterdam South-East, the subway between Diemen and IJburg can be constructed much later. The construction costs of the IJ-tram were estimated at 330 million guilders, the subway to Diemen (Diemertak) at 580 million guilders.

Because of high costs and not reach the planned number of residents, the IJtram was constructed instead of a subway. Also planned was a subway connection with Diemen-Zuid. The planned subway was replaced by a possible future light rail connection, probably because of the same reasons as in IJburg.
3. Design approach (phasing)

The tramline in IJburg is functioning as a ‘backbone’ of the islands. This bottom up total design of IJburg is adjusted to the connecting tramline. Figure 40 (below) shows the order of design; starting with the tramline, urban environment and at the end public space. The IJburg design is adjusted to the IJtram, to get the best accessibility and best use of the tramline in order to reduce the car use en realize a good connection with the city center of Amsterdam. By designing in this order (tramline First) the municipality tried to create the most optimal use of the IJtram.

Figure 40 - Bottom up approach
Case study criteria Ypenburg

Issues which should be analyzed in the different case studies

- PT network design
- Urban design
- PT system functioning (usage)
- Policy and decision model environment
Figure 41 - Trajectory of tramline 15
Figure 42 - Trajectory of tramline 15
**Ypenburg resident info**

Ypenburg is a Vinex-neighborhood south-west of the Hague and is realized on the previous Ypenburg Airport location. Since 1997 the VINEX-neighborhood is being developed which when finished has a population of 30.000. Residents of Ypenburg are according to the Hague, young, Dutch and high educated.

<table>
<thead>
<tr>
<th>AGE (years)</th>
<th>Ypenburg(%)</th>
<th>The Hague(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-19</td>
<td>34,0</td>
<td>23,1</td>
</tr>
<tr>
<td>20-64</td>
<td>62,8</td>
<td>63,6</td>
</tr>
<tr>
<td>65 and older</td>
<td>3,1</td>
<td>13,4</td>
</tr>
</tbody>
</table>

*Figure 43 - Age Table Ypenburg and The Hague*

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Ypenburg(%)</th>
<th>The Hague(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dutch</td>
<td>66,5</td>
<td>52,9</td>
</tr>
<tr>
<td>Turkish</td>
<td>2,7</td>
<td>7,2</td>
</tr>
<tr>
<td>Moroccan</td>
<td>1,3</td>
<td>5,4</td>
</tr>
<tr>
<td>Surinamese</td>
<td>10,4</td>
<td>9,7</td>
</tr>
<tr>
<td>Antillian&amp;</td>
<td>1,8</td>
<td>2,4</td>
</tr>
<tr>
<td>Aruba</td>
<td></td>
<td></td>
</tr>
<tr>
<td>South European</td>
<td>1,6</td>
<td>1,7</td>
</tr>
<tr>
<td>Other nationalities</td>
<td>15,7</td>
<td>20,8</td>
</tr>
</tbody>
</table>

*Figure 44 - Ethnicity Table Ypenburg and The Hague*

<table>
<thead>
<tr>
<th>Educational Level</th>
<th>Ypenburg(%)</th>
<th>The Hague(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>16,0</td>
<td>34,0</td>
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<tr>
<td>Average</td>
<td>32,0</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>84,0</td>
<td>34,0</td>
</tr>
</tbody>
</table>

*Figure 45 - Educational level Table Ypenburg and The Hague*


**PT network design**

1. **Position of the city within the urban network**

Ypenburg is located south-west of the Hague in between 3 highways: the A13, the A4 and the A12. The A13 and the A4 are connected on the west-side of the neighborhood at the Ypenburg-crossing, the A4 and A12 meet on the northside at the Prins Clausplein-crossing.

The neighborhood has a public transport connection to the Hague Central Station (tram line 15), in 2010 tram line 19 will connect Ypenburg to Leidschendam and Delft.

Since 2005 the neighborhood has it’s own train station: the Hague Ypenburg, which lies on the Gouda-the Hague rail line.
2. Tram 15 line characteristics

Line 15 runs from The Hague central station to Nootdorp centre. It has 18 stops and passes the city centre of the Hague, NS station The Hague HS and several parliament buildings. The total track of tramline 15 covers a distance of 9,5 km. In the year 2002, the fifth version of tramline 15 was finished, which took over busline 15. The tramline realized a fast, public transport connection between the city centre of the Hague and VINEX neighborhood Ypenburg.

- Total line length: 9,5 km
- Amount of stops: 18
- Average speed: 31 km/h
- Traject travel time: 18 minutes
- Date of construction: 1999-2001
- Operational since: 02-01-2002
- Design: Municipality of the Hague
- Exploiter: HTM
- Maximum speed reached: 50 km/h
- Bicycles are NOT allowed on board
- Frequency: every 10 minutes
- Travelers: 2,500 travelers a day
- Users of tram per dwelling: 0,22

3. Transfer possibilities on line 15

Ypenburg VINEX is still developing and so are public transport connections towards the area. The first part of tramline 15 in the city centre of the Hague, offers lots of bus and tram connections. Ypenburg neighborhood is less connected.

Bus Connections
As viewable at the figure, lots of bus connections in the centre of the Hague are crossing tramline 15. Ypenburg neighborhood has 3 buslines (60 Delft-Leidschenveen; 62 Delft-Nootdorp; 33 Rijswijk-Leidschenveen). In Ypenburg, they cover almost the same area as tramline 15, but are only direct connected on the borders of the VINEX neighborhood.

Lighttrail
Tramline 15 is connected with the Randstadrail at the Hague central station. In Ypenburg it is split up in another track (19) towards NS station Ypenburg and Randstadrail station Leidschenveen, which is not yet in use (Delft Technopolis – Randstadrail station Leidschenveen). The track in Delft is already finished and will be in full use around 2012.

Railway Stations
The line is connected to central railway station of the Hague and the Hague HS. Tramline 19, which is split up in Ypenburg is connected to NS Ypenburg.

4. Network characteristics

Main function of tramline 15 is to connect the VINEX neighborhood Ypenburg to the Hague city centre. The line uses existing tracks and is expanded towards the area. This is the most important public transport line towards Ypenburg but because of bad implementation, it is not used that much (0,22 user per dwelling).

Figure 74 - Transfer possibilities along tram line 15.
Urban design

1. Identity around PT lines and nodes
2. Stop connectivity
3. Urban design around the nodes and the transport line
4. Urban program around the nodes and the transport line
5. Car network characteristics
6. Stop design
7. Safety
8. Boundaries

1. Varied identity around PT lines and nodes

Tram line 15 covers a large variety of identities, in terms of functional aspect, urban design and architecture. Furthermore the line runs through a variety of urban zones belonging to different municipalities, these zones being: the city of the Hague; the adjoining municipality Rijswijk; the VINEX-neighborhood Ypenburg and Nootdorp.

A - The Hague CS and center
Busy transport node and the functional gate to the center of the Hague. The area around the central station has a strong formal identity, due to the ministeries and other governmental buildings surrounding it.

B - Pre-war urban neighborhoods
The tram covers a long strip of pre-war urban neighborhoods in the Hague and Rijswijk.

C - Transition zone (A4, Schie, green zone, business zone)
A zone that contains large infrastructural barriers (A4 highway, Schie canal) with business parks and large green areas. This zone has a very broad and open profile and is positioned in between the urban environment of the Hague and that of Ypenburg/Nootdorp.

D - Ypenburg entrance
Entrance to the Ypenburg neighborhood. The street and tram profile
is still wide, but it is more narrow than the A4/Schiezone’s profile and ‘introduces’ the neighborhood center.

**E - Ypenburg commercial center**
Commercial center of Ypenburg, which is marked by high-rise apartment buildings and a large functional mix. It contains most commercial functions of Ypenburg and is designed as a network of shopping streets which are connected to a large square.

**F - Ypenburg neighborhood and canal zone**
The most quiet part of the neighborhood, where the tram line is merely surrounded by dwellings and park functions. In this area the neighborhood is bordered by a canal with a large green park profile on both sides of the canal. The tram line runs through this park profile, alongside the canal and a bicycle/pedestrian lanes and is separated from the road system.

**G - Nootdorp neighborhood**
Newly build neighborhood where the tram runs on a green separated lane alongside a traffic road.

**H - Nootdorp commercial center**
Commercial center and end stop of the tram line. This final station is located at the edge of a commercial center which is also accommodated by an underground parking garage.
Sections
The map shows the VINEX neighborhood Ypenburg. The sections of the tramline shows the arrangement of private and public transport. Also the street measurements are drawn, which are to recover the human scale.

Section A-A’
The platforms are safe to reach, traffic on the adjoining one-way-traffic roads is only allowed to move slowly, on the other side of the line the platforms are integrated with the canal park. This park is designed for slow traffic only by pedestrian and cycling lanes. The broad green profile with particularly good bicycle and pedestrian accessibility seems to suit the

Figure 51 - Positioning of the sections.

Figure 52 - Section A-A’.

Figure 53 - Section A-A’ (3D).

Section A-A’ (3D)
The picture on the right shows a cross section of the tram line around the Nootdorpse Landingsbaan. What is very distinctive about the spatial profile surrounding tram line 15 here is the broad canal-park along which the tram line is running. This large green/blue structure provides the traveler and the urban space itself with high quality landscape features, but also has a huge impact on the width of the profile. As a result the average distance from the tram platforms at the Nootdorpse

Landingsbaan (Schoolekstersingel and Gruttosingel) to the built environment is high. Bridges are realized over the canal, however it still functions as a barrier, negatively influencing the service reach of the tram line.
The tram line is always separated from other traffic streams, mainly by hedges, which allow the tram to travel at high velocity in a non hazardous way.
Section B-B’ (3D)
The tram line at around the Plesmanlaan stop is aligned in the middle of Ypenburg its mixed-use center, and is surrounded by 4 storey buildings which are partly heightened by 7 storey apartment towers. The building façade on the south side of the tram platform is relatively proximate to the tram platform, whereas the distance of the northern façade is much larger: almost 50 meters. The large space between the tram stop and the northern façade is largely occupied with parking facilities.
Roads are positioned on both sides of the stop, however these roads are equipped with traffic calming techniques such as speed bumps and only allow traffic to move at a 30 km/h velocity, making the stops relatively safe to access. However due to the large distances, in particular towards the northern façade, the Plesmanlaan stop does not particularly blend in with it’s environment, but remains a bit isolated from the lively streets and sidewalks of the mixed use center.

Section B-B’
The picture below shows a cross section of the tram around the Plesmanlaan.
2. Stop connectivity

2.1 Diverse characters of stop accessibility

What is striking about the design of tram 15 is its diversity in character and functionality and the clear differences in stop accessibility linked to this character and functionality. Different urban design and safety measures are applied for the neighborhood-center stops; the neighborhood/canal stops and tram stops outside the neighborhood.

Neighborhood-stop connectivity

The neighborhood stops are meant to serve the inhabitants of Ypenburg, mostly young families with children. The urban design and traffic routes near these stops are aimed to accommodate this ‘vulnerable’ user group. The stops are very well reachable by foot and by bike. Bicycle paths and foot paths are designed around the stops, as well as bicycle and foot bridges crossing the canal. Single-direction roads run along the tram line, the traffic on these roads is slowed down by speed bumps, and cars are allowed to park on both sides of the road.

Neighborhood-center connectivity

Within the built environment of Ypenburg and Nootdorp two clear commercial centers can be distinguished: respectively Plesmanlaan and Parade/Center. These stops have a lot of parking space (parking square at Plesmanlaan and a free underground parking garage at Parade/Center) and more bicycle storage facilities. There are bicycle and pedestrian crossings to the platforms.

Stops outside the neighborhood

The platforms outside the built environment, in between the Hague and Ypenburg, are cut-off by fast traffic lanes, giving them an isolated character. These tram stops are facilitated with bus stops. There are special pedestrian and bicycle crossings to these stops, which are guarded by traffic lights.
2.2 Safety measures
The line 15 traject design lays a large emphasis on safety. The line is always separated from other infrastructure and public space by either fencing, difference in height, hedge rows or broad. The level of segregation between tram line and other spaces is higher near busy roads with fast driving traffic. Due to the tamed traffic (maximum speed 30 km/h) no dangerous streets need to be crossed to reach the platforms. Tram platforms at the more busy streets are equipped with traffic lights and clearly marked pedestrian crossings, tram stops positioned at calm neighborhood streets do not have these safety measures.

The tram stops within the neighborhood have a relatively large amount of social security as they are being ‘watched over’ by building fronts. Stops outside the built environment lack this social security. Social security is highest at tram stops near the neighborhood centers. The mixed functions and facilities of these centers generate lifeliness and activity around the nearby tram stops during the day.

2.3 Stops positioned at structural lines of the neighborhood
The tram stops are positioned at (or near) crossings of principal infrastructural lines within the neighborhood. Some facades have been opened up to create pedestrian routes within the neighborhood, however the relation of these pedestrian routes to the tram stops is not very strong.

2.4 Large distance to stops
The tram alignment does not cut through the neighborhood, but is positioned at the border. As a cause the average distance from a house in Ypenburg to a tram stop is high, which has a negative impact on the general neighborhood connectivity of the tram line. This could be an important cause for the relatively low amount of tram users per dwelling: 0,22.
3. Urban design around nodes within Ypenburg & Noordorp

3.1 Functional mix and dwelling density
The overall dwelling density of Ypenburg and Nootdorp is low (around 35 dw/ha) and is slightly higher around tram line 15 (40 dw/ha) with an exception at the Plesmanlaan (figure 65).

This dwelling density is clearly higher near the Plesmaanlaan stop (around 60 dw/ha) which marked by high rise apartment towers and mixed use functions on the ground floor of the buildings. This relatively high dwelling and mixed-use density create liveliness and increase the amount of potential tram system users.

The other stops in the neighborhood have a low dwelling density (around 40 dw/ha) and very few mixed-use functions within their service area. For a large part the tram runs alongside a canal which has a negative effect on the average dwelling density along that part of the line.

3.2 Built environment along the tram line
Along the tramline a diverse scala of building typologies is used. The centre is marked by high towers.

3.3 Natural resources along the tram line: the canal park
A distinctive feature of the tram 15 trajectory within Ypenburg en Nootdorp is its close relation to the canal and the park surrounding this canal. The ‘canal park’ has a huge influence on the identity of the public transport line, providing it with a high quality open landscape character. However, the canal also functions as a barrier between the different parts of the neighborhood. The large open areas in between Rijswijk and Ypenburg do not have a positive influence on the line. These green zones lack functional and recreational use possibilities and are fragmented by large infrastructure elements and uninspiring industrial and commercial buildings.
3.4 Transport islands & integrated park platforms

Most tram platforms are separated from the urban environment and do not directly engage with the urban space and functions surrounding them. In other words, the tram stops serve the urban areas with connectivity and accessibility, but do not physically interact with this urban space: they act like transport islands (figure 72).

A positive exception to these transport islands are the stops along the canal park (Scholekstersingel and Gruttosingel) which do have a spatial relation with the environment surrounding it (figure 65). The platform and adjoining bicycle storage facilities are integrated with the pebble-stone surface and the green canal dike of the park and are only reachable by bike and on foot. This slow traffic accessibility strengthens the park-like identity of the tram stop and thus the cohesion with its surrounding environment.

4. Urban program around tram stops and the tram line

Ypenburg line 15 has two clear center stops where a high density of mixed-use functions are situated: Plesmanlaan and Parade. The functional variety and density at other stops in the neighborhood is very low, and the functions (like schools) do not seem to have a direct relation to the nearby tram system.

The tram stop at Plesmanlaan is situated in the middle of the commercial center, whereas the stop at Parade is positioned at the edge of an area with a high density of shops and facilities.
Figure 75 - Density map of Ypenburg
5. Car network characteristics

The car network inside the neighborhood is designed for slow driving traffic (30 km/h), fast traffic is guided around the neighborhood. The road network and the tram line are sometimes bundled within the same profile, whereas on other points both infrastructural networks are completely separated from each other.

Ypenburg’s principal road network consist of several structural long lines, which are ‘marked’ by broad grass verges and canals and a broad profile. The trams stops are positioned on or nearby crossings of these structural roads.

Figure 76 - Fast traffic roads guide traffic around the neighborhood. The entire neighborhood is a 30 km/h

Figure 77 - Neighborhood street road.

Figure 78 - Structural neighborhood roads, with a broad profile alongside a canal.

Figure 79 - The grid structure of primary, secondary and tertiary roads on Haveneiland-West.

Figure 80 - Neighborhood road alongside the tram line and the canal park.
6. Stop design

The facilities, design and materials used at the different tram stops are quite similar, however nuances are applied in their design and equipment.

Each stop is equipped with garbage bins, benches, lighting, one tram shelter and the boarding height is the same for every stop. The entries of the tram platforms are designed in a wheelchair friendly way and are equipped with ramps of sufficient length. These platforms are sheltered poorly, due to the relatively small roofed surface provided by the small tram shelters and the large distance in between the platform and the surrounding buildings.

Small differences in design and equipment are made according to the expected amount of users. Not every stop is equipped with electronic information signs. The stops serving the mixed-use centers and stops outside the built environment do have these electronic signs, whereas this is not the case in the ‘neighborhood’ oriented stops. Furthermore, the stop at the mixed-use center at Plesmanlaan has a wider platform to be able to deal with a larger stream of passengers. Trees are planted on this broad platform as well, which is not the case with the other platforms.

Other difference in stop design and equipment have more to do with security measures (See paragraph 2.2). Stops situated along busy traffic roads are equipped with firm security measures such as traffic lights, crosswalks and fencing along the entire length of the platform. These safety measures are more mild, such as difference in pavement, around calmer neighborhood roads.

Figure 81 - Broad platform with trees and electronic information sign at the Plesmanlaan stop.

Figure 82 - Narrow tram platform with less facilities at the Scholekstersingel stop.

Figure 83 - Tram stop outside the neighborhood.
PT system functioning

Usage and users

Tram 15 is not a very successful line considering ridership numbers. The tram line is realized after the biggest part of Ypenburg was already build. Car ownership increased before finishing the tram line because of bad PT possibilities. Figure 84 (below) shows the stagnating amount of users, while the dwelling amount is still increasing. This means a decreasing usage per dwelling.

![Figure 84 - Average line occupancy (towards the Hague center)](source: stadsgewest Haaglanden)

<table>
<thead>
<tr>
<th>Year</th>
<th>Towards the Hague center</th>
<th>Towards Ypenburg/Nootdorp</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>8.4%</td>
<td>7.8%</td>
</tr>
<tr>
<td>2003</td>
<td>11.3%</td>
<td>8.5%</td>
</tr>
<tr>
<td>2004</td>
<td>15.1%</td>
<td>12.7%</td>
</tr>
<tr>
<td>2005</td>
<td>16.8%</td>
<td>14.1%</td>
</tr>
</tbody>
</table>

Figure 85 - Seat occupancy between the Hague and Ypenburg (source: stadsgewest Haaglanden)

Figure 85 (above) shows the seat occupancy in both directions; The Hague center and Center Ypenburg/Nootdorp. Average occupancy of city- and regional public transport varies between 20% and 40%. Tramline 15 its occupancy is still increasing because of an increasing dwelling amount, but concluding from figure 84 (left top), the usage amount is stagnating.
Urban Planning & Policy

1. Decision Process

After developing different scenarios for the expansion area Ypenburg in 1992, a preferred model was chosen in 1993 which functioned as underlayer for plan ‘buitenplaats’. This plan is a preface of the zoning plan for VINEX Ypenburg. This first urban plan of Ypenburg focusses on the positioning of Ypenburg in the Randstad Network. The strong connection to the highway network is extended with accessibility of a public transport network by generating a new NS trainstation towards Utrecht and tramlines towards Rijswijk, Delft and Noordorp. High office buildings at the borders are functioning as eye catchers. The structures of the original purpose of this area (Airport) are used in the design (runway), but also creates contrast with the camouflage woods, linear polders and the ribbon village Nootdorp. The new urban centre is located on the node of Nootdorp, original runway and the polders. This independent element is connected with the NS railway station and the viaduct to Delft. The new centre contains also the crossing of two public transport lines, along the main structures of the urban plan. The old runway is the backbone of the urban plan. Connecting ribbons are relating the old ribbon village of Nootdorp and the new designed VINEX neighborhood. The long linear lines are refering to the original purpose of this area; the Airport.

This main design is almost stayed the same for the expansion area Ypenburg. Also the number of 11.000 dwellings that was planned is not changed from the first urban plan.

Design: Urban Atelier Ypenburg under supervision of Frits Palmboom in order of the cooperation Ypenburg (municipality The Hague, Noordorp, Rijswijk and Pijnacker)
Total dwelling capacity: 11,000
Dwelling density: 30 per hectare

Figure 86 - Urban plan ‘Buitenplaats Ypenburg’
2. Design Approach

Ypenburg is designed by a top down approach. First phases were based on realizing an urban environment and public space. Generating the tramline was divided in the last phase. This way of approaching forces inhabitants to use private transport, because of no other opportunities. Figure 87 (below) shows the way of approach in Ypenburg.
Case study SWOT & CONCLUSIONS

What conclusions can be drawn after doing these case studies
- SWOT analysis
- List of Guidelines

Figure 88 - Traject of Utram 26 (same scale as next page)
Figure 89 - Trajct of tramline 15 Ypenburg (same scale as previous page)
Strengths

**PT NETWORK DESIGN**
- High transport value due to high densities (around 80 dw/ha)
- Fast public transport connection between the city and IJburg
- Tram alignment and profile designed for speed and safety
- Good tram service coverage (urban space and island size adapted to service catchment area)
- Tram positioned at principal infrastructural lines
- Clear end of the tram line

**URBAN DESIGN**
- Provision and good accessibility of natural resources
- Urban design and architecture marking the tram stops
- High social security due to eyes-on-the-streets by front facing apartment blocks and mixed functions on the ground floor near stops
- Varied identity of the different islands
- Transition of urban and functional identities between IJburg and the city
- Differentiation in speed and speed experience (tram drives fast where possible)
- Large variety of views and sightlines (nearby/far, open/closed, urban/landscape)
- Save and predictable tram line due to strict separation of other traffic streams in a continuous profile.
- Mixed functions and facilities near and around tram stops
- Bridges provide a clear entrance to the different islands

**PT SYSTEM FUNCTIONING (USAGE & SERVICE QUALITY)**
- Good tram service coverage
- Bicycles allowed on board of the trams (however merely 2 per tram)
- High service frequency (every 6 minutes)
- HOV = High quality vehicles in terms of comfort, design and boarding height
- Clear information provisions at stops

**URBAN PLANNING AND POLICY**
- Tram line and neighborhood constructed simultaneously
- Possibilities and spatial profiles reserved for future network expansion
- Fased design of PT system which enables spread of financial investment pressure

Weaknesses

**PT NETWORK DESIGN**
- Low network flexibility due to linear character of the PT system

**URBAN DESIGN**
- Weak physical interaction between tram nodes and urban environment (transport islands)
- Limited accessibility of tram platforms (transport islands)
- Low diversity in urban design and identity on the scale of the islands

**PT SYSTEM FUNCTIONING (USAGE & SERVICE QUALITY)**
- The tram line alone is unable to accommodate the multidirectional mobility patterns of IJburg’s inhabitants with public transport
- In case of service breakdown the functioning of IJburg’s entire PT system is affected.
- Road congestions due to too large traffic pressure of the main transport axis.
- Limited bicycle storage facilities
- Merely two on-board bicycle spaces per tram

Opportunities

**PT NETWORK DESIGN**
- Fast connection, means less stops, separated lanes, high speed tram

**URBAN DESIGN**
- Good accessibility of natural resources, means less social control
- Eyes-on-the-streets means less privacy
- Save tram means, separated lane, bad accessible
- Mixed functions around stops, creates busy intersection, unsafe
- Similar use of material makes line monotone

**PT SYSTEM FUNCTIONING (USAGE & SERVICE QUALITY)**
- Bicycles on board means less space for passengers
- High frequency can provide less occupancy

Threats

**URBAN DESIGN**
- Increase interaction of tram stops with environment
- Increase accessibility of tram platforms
- Stronger hierarchy of tram stops by diverse urban design

**PT SYSTEM FUNCTIONING (USAGE & SERVICE QUALITY)**
- While failure occurs, prevent total PT-breakdown by creating different PT possibilities
- Preventing traffic jams by creating high user amount of tramline analyze the need for a tramline and direction of tramline.
- Increase bicycle facilities, wider reachability
- Create more on-board bicycle spaces per tram
### Strengths

**PT NETWORK DESIGN**
- Tramline is diverse. Stops with different functions; centre stop, pedestrian stops
- Hierarchy of stops is expressed in design
- Similar use of materials and design, univocal tramline and stops

**URBAN DESIGN**
- High quality of urban space (high aesthetical value)
- Tramline along green alley
- Accessibility of stops is adapted to functions of urban space
- Interaction with surroundings in green areas

**PT SYSTEM FUNCTIONING (USAGE & SERVICE QUALITY)**
- Relative fast connection between city and Ypenburg
- Different transfer possibilities
- Bicycle parking possibilities to enlarge accessibility

### Opportunities

**PT NETWORK DESIGN**
- Legable tram stops (Clear and logical positioning of tram stop elements such as digital information signs)
- Create diversity in identity, design and functionality along tramline
- Tram alignment through build environment
- Decrease average distance to stops by covering most parts of the served area
- Stops and community centers must be served by principal streets
- Create gates, marking the different zones along the tramline
- Create better sheltered platforms

**URBAN DESIGN**
- Increase integration of urban environment and tram stops
- Decrease distance of build environment and tramline
- Increase dwelling density around stops, to increase PT ridership

**PT SYSTEM FUNCTIONING (USAGE & SERVICE QUALITY)**
- More tram stops near busy spots, less in between (Time-rank-size-rule)
- On-grade vehicle entrance to improve bicycle and wheelchair accessibility

**URBAN PLANNING & POLICY**
- Urban planning interventions to increase the barrier effect, between the Hague and Ypenburg
- Tramline should be operational as soon as people are living in the neighborhood

### Weaknesses

**PT NETWORK DESIGN**
- Digital information signs are available, are positioned poorly
- Identity of tramline on a high scale is monotone
- Some stops are placed at the border of the neighborhood which is influencing the use of the tramline in a negative way
- Average distance between stops is high
- Stops are not situated along main roads
- Tramline as an island in centre area, no interaction
- Unclear entrance of and end stop in Ypenburg
- Poorly sheltered tram platforms, merely one tram shelter per platform

**URBAN DESIGN**
- Average distance of tramline towards buildings inside 500 meter circle is high
- Social eyes-on-street is low because of wide profiles
- Low dwelling density around stops, negative effect on PT ridership

**PT SYSTEM FUNCTIONING (USAGE & SERVICE QUALITY)**
- No variety in speed, which influences the time experience (relatively slow, according to IJburg)
- Vehicle entrance is higher then platform height, making it hard to take bicycles inside

**URBAN PLANNING & POLICY**
- Ypenburg is an isolated area, away from the Hague
- Improper phasing, tram is implemented in last phase

### Threats

**PT NETWORK DESIGN**
- Similar use of material makes line monotone

**URBAN DESIGN**
- Interaction with surroundings influences safety
- Tramline along green alley causes poor accessibility

**PT SYSTEM FUNCTIONING (USAGE & SERVICE QUALITY)**
- Fast connection means high speed tramline, less stops
Conclusions
These case studies, focussed on IJburg and Ypenburg give a clear view of two tramline examples in the Netherlands. Both of the lines are connecting isolated areas outside city boundaries.

Urban expansion characteristics which influences PT use in a negative way

<table>
<thead>
<tr>
<th>DEMAND</th>
<th>SUPPLY</th>
</tr>
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<tbody>
<tr>
<td>&gt; High car ownership per household</td>
<td>&gt; Close to highways</td>
</tr>
<tr>
<td>&gt; Large amount of young families which car</td>
<td>&gt; Car has much more transfer possibilities</td>
</tr>
<tr>
<td>is more user friendly;</td>
<td>&gt; Relative long distance towards city center</td>
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<tr>
<td>- safe transport of young children</td>
<td>&gt; High quality bicycle routes</td>
</tr>
<tr>
<td>&gt; Simply combining different routes</td>
<td>&gt; Lower frequency according to city center</td>
</tr>
<tr>
<td>&gt; Relatively less high-school youth, students and people over 65</td>
<td>&gt; Less PT in first expansion phase causes high second-car ownership</td>
</tr>
<tr>
<td>&gt; Lower dwelling density according to city center</td>
<td></td>
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<tr>
<td>&gt; Lower function density according to city center</td>
<td></td>
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<tr>
<td>&gt; Less mix of functions according to city center, causing one way traffic</td>
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</tbody>
</table>

Figure 90 - Negative influences on PT use

Comparing the cases: Ypenburg & IJburg
An important difference between the examined cases of Ypenburg and IJburg is their difference in PT line usage: tram line 26 serving IJburg has a much higher level of ridership then tram line 15 which provides Ypenburg with PT service.

Several causes can be designated to this inequality, the most important being:

* Dwelling density
The average dwelling density and the dwelling density with the tram system’s catchment area is much higher in the case of IJburg. A large amount of inhabitants living near PT stops means a high potential ridership. Another issue is to seduce these inhabitants to actually use the given PT system. The average number of PT users per dwelling in IJburg is significantly higher (0.92 users per dwelling) then in Ypenburg (0.22 users per dwelling).

* Average distance to stops
The percentage of inhabitants actually using a PT line largely depends on the accessibility of the PT stations and stops and the connectivity and position of those stops within the built environment. Where tram 26 runs through the spatial center of IJburg’s built environment, tram 15 runs at the borders of Ypenburg its built environment. As a result large parts of Ypenburg its built environment are relatively far from the tram line’s access points, decreasing their likeliness to use the PT system and ‘forcing’ them to use other transport means like the car.

Furthermore, the distances between the tram steps in Ypenburg is larger than the distances on IJburg, increasing the average (dwelling and facilities) distance to those tram stops.

* Car accessibility
The outward car network of IJburg (connecting it to areas outside the neighborhood) has a much lower level of diversity and flexibility than the car network of Ypenburg. IJburg’s car network is composed out of one central, mono-directional transport axis which connects the islands the highways positioned east and west of the islands. Due to the heavy pressure of this transport axis traffic jams are a daily phenomenon. Ypenburg car network consist out of several roads connecting the neighborhood to multiple directions and surrounding urban cores.

Due to the more diverse and flexible car accessibility, inhabitants of Ypenburg are more likely to travel by car than the people living in IJburg. In other words, the PT system in IJburg has less competition from the car.

* Time of implementation of the PT line
It is crucial to have the PT system up and running in the startup phase of the neighborhood, as occurred in case of IJburg. People will involve the tram system in their daily travel patterns and will consider travelling by tram sooner than they would in cases where the PT system is implemented later on. The tram in Ypenburg was constructed and functioning after most inhabitants were already settled and used to travel by car. People used to car are less likely to switch their modal-shift behavior towards PT.

* Proximity to urban core
IJburg’s tram 15 directs IJburg quick and directly to the city center of Amsterdam, being a huge attractor for IJburg’s inhabitants. The proximity to a large urban center is less strong in the case of Ypenburg, despite the fact that the distance Ypenburg-Den Haag is similar to the IJburg-Amsterdam distance, the same can be said for the travelling time. The experienced distance between IJburg and Amsterdam is much smaller than the experienced distance between Ypenburg-Den Haag, due to the high diversity of urban zones, landscape, sightlines and the diversity in speed (time-rank-size-rule: the tram reaches high speeds in between the functions zones).
* Potential reach
Potential reach concerns the amount and type of functions which can be reached within a given travel-time budget. (Lynch, 1990) Based on Hägerstrands action-space theory, Zahavi (Zahavi et al., 1981) states that people do not save time by gains in travel speed, instead they make more and further trips. People do not minimize travel time & costs to achieve a given set of activities, instead they maximize activities or opportunities that can be reached within their travel time and budget. So according to this action-space theory, a PT line which enables people to reach a high amount and diversity of functions within their daily travel time-budget, is more likely to develop a high level of ridership.

As we can see in the figures below, more functions can be reached (within the same travel-time-budget) in the case of IJburg then in the case of Ypenburg (even though the PT accessibility to functions within 30 minutes is not very high for both cases). Tram line 15 in Ypenburg seems to add little value to the connectivity of the neighborhood in terms of potential reach, which is likely to have a negative impact on the tram line’s ridership.

**Factors which might have an influence on PT ridership**

* Orientation towards functional transfer hub
Tram 26 provides the islands of IJburg with a logical, fast and clear line towards Amsterdam Central Station, a huge transport hub from which many locations can be reached. The liveliness, attractiveness and high transport hub value of Amsterdam CS and the tram line’s clear and direct orientation towards this hub is likely to have a positive influence on ridership levels. This effect however needs to be verified with further research.

* Acceptance to live in a high density Vinex-neighborhood
It seems like a reasonable assumption that people are more willing to live in high density (Vinex)neighborhoods outside the city center when this living environment has a certain added value (this could be an appealing identity, availability of natural resources for example). The living environments of IJburg are situated on islands with the IJ-lake, providing these living environments with a spectacular and directly accessible natural environment. This ‘added value’ is less strong in the living environments of Ypenburg.
**Goals and Demands for an exploitable PT line**

1. **PT NETWORK DESIGN**
   - The PT system has to be competitive to the car in terms of:
     - Speed;
     - Efficiency;
     - Comfort;
     - Flexibility;
     - Potential reach;
     - Experience.

2. **URBAN DESIGN**
   - Optimize PT usage by:
     - Sufficient amount potential users;
     - Social security and safety;
     - High PT accessibility;
     - High quality urban environment.

3. **PT SYSTEM FUNCTIONING (USAGE & SERVICE QUALITY)**
   - high PT service quality;
     - On-time performance;
     - Diverse and efficient inter-modal and inter-route connections;
     - Realtime travel information;
     - Accommodate cycling as a feeder mode.

4. **URBAN PLANNING & POLICY**
   - Influence model-split behaviour towards PT usage by:
     - Early availability of a high quality PT system;
     - Optimal integration of the PT system within the urban fabric;
     - A PT system which meets the mobility demands of its potential users.
   - Spread daily transport demand by:
     - Accommodating functions which attract PT users during the entire day.

**Guidelines with a positive influence on PT usage**

1. **PT NETWORK DESIGN**
   - Provide a diversity of experiences:
     - Provide diverse speed patterns along the line;
     - Provide diverse environments along the line;
     - Express transport line hierarchy in PT stop design;
     - Generate entrance/gateway at transition area.
   - Good PT system connectivity and accessibility:
     - The PT stops need to be positioned at principal infrastructural lines to create liveliness and to optimize stop/station connectivity and accessibility;
     - Low average distance to stops: positioning of stops/stations and alignment of PT lines has to be configured in such a way that optimal coverage of the urbanized area is achieved;
     - Sufficient and efficient inter-modal and inter-route transfer possibilities, to create a flexible and diverse transport system.
   - Provide high quality PT:
     - The PT system has to be comfortable, clean, fast, efficient and of a high design quality to create a positive image and provide a high service quality;
     - Safe integration of the PT system within the urban environment;
     - Provide well sheltered PT stations and platforms.

2. **URBAN DESIGN**
   - Sufficient amount potential users:
     - High amount of mixed functions and facilities within walking distance of PT stops;
     - High dwelling density, in particular within the catchment area of PT stops;
     - Attractors spread along the entire length of the line;
     - Spread daily transport demand, by accommodating functions which attract PT users during the entire day, and not merely at peak hours.
   - Social security and safety:
     - ‘Eyes-on-the-street’ and liveliness to create social security at and around PT stops.
> High PT accessibility:
  > High quality slow traffic routes to PT stops;
  > High PT stop/station accessibility due to safe feeder routes and crossing to stops;
  > Increase amount of bicycle storage at PT stops to enlarge catchment area;
  > Legible PT stop position by clear and logical stop hierarchy.

> High quality urban environment:
  > Diverse usage of high quality materials;
  > Diverse and high quality architecture;
  > Human scale to provide a safe and pleasant environment;
  > Physical interaction between PT stops and their environment.

3. PT SYSTEM FUNCTIONING (USAGE & SERVICE QUALITY)
> On-time performance:
  > High PT service frequency;
  > High speeds at places with a low transport value, low speeds at high transport value places;
  > Reach high speeds where its safe.

> Diverse and efficient inter-modal and inter-route connections:
  > Facilitate inter-modal transfer possibilities (Train, metro, bus, tram, car, bicycle, pedestrian);
  > Facilitate inter-network transfer possibilities (International, national, regional, local);
  > Facilitate inter-route transfer possibilities (A-B-C, B-C-A, C-B-A).

> Realtime travel information:
  > Digital information signs;
  > Optimal ICT integration.

> Accommodate cycling as a feeder mode:
  > Inner-vehicle bicycle facilities and bicycle storage facilities at PT stops.

4. URBAN PLANNING & POLICY
> Early availability of a high quality PT system;
> Optimal integration of the PT system within the urban fabric;
  > Collaborative design involving both urban planning and transport design; is necessary to create sufficient transport demand for the PT system (density, functional mix within service area) and an optimal integration of the PT system within the urban fabric.

> A PT system which meets the mobility demands of its potential users;
  > User and stakeholder involvement which enables people to relate to the tram line (or PT system in general) and to see that the system suits the demands of the actual users (desired potential reach, travel patterns). A well suited and appreciated PT system is likely to increase the percentage of people that will use the PT system.
1. PT NETWORK DESIGN
PROVIDE A DIVERSITY OF EXPERIENCES
Provide diverse speed patterns along the line

Figure 93 - Lower speeds in areas where the tram meets other traffic streams, especially slow traffic due to the large difference in mass.

Figure 94 - Reach higher speeds in zones between urban areas (tunnels/bridges) and separate tram lanes from other traffic to allow higher speeds.

Figure 95 - Time-size-rank-rule speed: more stops in zones with a high transport value and lower speeds for safety matter, higher speeds in low-transport-value zones.

Figure 95 - A variety of landscapes, infrastructural interventions, sightlines and urban environments along tram line 26’s alignment decrease the perceptual distance between the Vinex-neighborhood of IJburg and the central station of Amsterdam.
Express transport line hierarchy in PT stop design

Figure 96 - The Homme-de-Fer square tram stop (Strasbourg) is clearly marked as an ‘entrance’ to a center filled with activity and liveliness.

Figure 97 - A tram stop from the same tram line in Strasbourg, the tram line has a more modest character which suits the less crowded urban environment serviced by the tram line.

Legible PT stop position by clear and logical stop hierarchy.

Networks of shared streets (Thwaites, 2007)  
Steeds of the ‘connected city’ must be designed to be shared by ‘strong’ and ‘vulnerable’ users of the street. Traffic calming techniques should be used to maintain a positive balance between the different types of users.

A grid-like structure  
Paradoxically to the preferred radial feeder lines, a grid can easily be adapted to create car-free areas nearby stations or pedestrian areas. The accessibility of these car-free areas from the grid can be opened and closed at certain times.

Community centers must be served by main streets, traffic should be tamed but not forbidden (Thwaites, 2007)  
Service and commercial activities only flourish on streets that, in functional and structural terms, are principal. These streets carry a lot of traffic, so traffic techniques are necessary for good and functional cycling and pedestrian conditions.  
Along mixed use areas and centers, vehicles assist to create a sense of liveliness at streets in after hours.

Figure 98 - Tram stops should be located at
GOOD PT SYSTEM CONNECTIVITY AND ACCESSIBILITY
The PT stops need to be positioned at principal infrastructural lines to create liveliness and to optimize stop/station connectivity and accessibility.

Sufficient and efficient inter-modal and inter-route transfer possibilities, to create a flexible and diverse transport system.

Generate entrance/gateway at transition area.

Low average distance to stops: positioning of stops/stations and alignment of PT lines has to be configured in such a way that optimal coverage of the urbanized area is achieved;

Figure 99 - The transition areas between the different functional/physical are marked by ‘gates’, which could be infrastructural works like bridges, but also architecture or landscape landmarks.

Figure 100 - PT system characteristics (Bach, 2006)
2. URBAN DESIGN

SUFFICIENT AMOUNT POTENTIAL USERS:
High amount of mixed functions and facilities within walking distance of PT stops

Attractors spread along the entire length of the line

Figure 101 - Mixed functions around stops

High dwelling density, in particular within the catchment area of PT stops

Spread daily transport demand, by accommodating functions which attract PT users during the entire day, and not merely at peak hours

Figure 103 - NOT concentrated at start/end stop

Figure 104 - Functions spread along line

Figure 105 - Prevent one-way-traffic in peak hours
SOCIAL SECURITY AND SAFETY:
‘Eyes-on-the-street’ and liveliness to create social security at and around PT stops

High PT stop/station accessibility due to safe feeder routes and crossing to stops

Figure 106 - Social security, eyes-on-street

HIGH PT ACCESSIBILITY:
High quality slow traffic routes to PT stops

Figure 107 - High quality slow traffic routes

Figure 108 - Slow traffic routes in Ypenburg (left) and IJburg (right)

Increase amount of bicycle storage at PT stops to enlarge catchment area

Figure 109 - Station accessibility

Figure 110 - Increase amount of bicycle storage
High quality urban environment:
- Diverse usage of high quality materials
- Diverse and high quality architecture

Figure 111 - Station hierarchy in Ypenburg

Figure 112 - Diverse architecture in IJburg

Figure 113 - Diverse usage of materials in IJburg

Figure 114 - Open squares around stops (left) and built in stop (right)

Figure 115 - Human scale in Straatsburg

Figure 116 - Human scale in Amsterdam

Legible PT stop position by clear and logical stop hierarchy
3. PT SYSTEM FUNCTIONING

ON-TIME PERFORMANCE:

High PT service frequency

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</table>

Figure 3.17 - High frequency

High speeds at places with a low transport value, low speeds at high transport value places

Figure 3.18 - Variety in speed patterns

Figure 3.18 - Variety in speed patterns

DIVERSE AND EFFICIENT INTER-MODAL AND INTER-ROUTE CONNECTIONS:

> Facilitate inter-modal transfer possibilities (Train, metro, bus, tram, car, bicycle, pedestrian)
> Facilitate inter-network transfer possibilities (International, national, regional, local);

(And Car and Bus networks to fill up the gap of other Public Transport Systems)

This already happens with feeder busses etc. If these systems are combined with the car AND with pedestrian and cyclist traffic, TOTAL COVERAGE and FLEXIBLE and DIVERSE coverage can be realized. However one must take into regard that the different modes will compete with each other. In order to truly function like a coherent system, there must be no competition but partnership -> the transport system should be a MONOPOLY, preferably owned by a GOVERNMENT or another sort of NON-PROFIT organization.
Facilitate inter-route transfer possibilities (A-B-C, B-C-A, C-B-A)

Optimal ICT integration

REALTIME TRAVEL INFORMATION:
Digital information signs

Figure 121 - Inter-route transfer possibilities

Figure 122 - Digital information signs in IJburg

Figure 123 - Integration of the PT network in different ICT applications

Figure 124 - Bicycle storage on PT vehicle

ACCOMMODATE CYCLING AS A FEEDER MODE:
Inner-vehicle bicycle facilities and bicycle storage facilities at PT stops
4. URBAN PLANNING & POLICY
A PT SYSTEMS WHICH MEETS THE MOBILITY DEMANDS OF IT’S POTENTIAL USERS
> User and stakeholder involvement which enables people to relate to the tram line (or PT system in general) and to see that the system suits the demands of the actual users (desired potential reach, travel patterns). A well suited and appreciated PT system is likely to increase the percentage of people that will use the PT system.
(Luuk Boelens, 2006)

The car is an individual mode of transport, and the network on which it can be used is extremely large (you can say infinite) but also has a very detailed grain (almost every house has an excuse from a street or garage facility). This is not the case with public transport modes. These public transport modes are often rigid and linear and the user (the people travelling) cannot choose whether to go left or right when they want to. Only by combining the different public transport modes, a coherent and covering network can be established, which can compete with the network of the automobile. It is by no means my goal to erase the car from the city, the car should be a partner in the network structure as well. A network will only function as a network if the different modes and links in the network work together. Competition between them is disastrous for the efficiency of the transport network system.

OPTIMAL INTEGRATION OF THE PT SYSTEM WITHIN THE URBAN FABRIC:
Collaborative design involving both urban planning and transport design is necessary to create sufficient transport demand for the PT system (density, functional mix, service area) and an optimal integration of the PT system within the urban fabric.

Figure 125 - Inter-route transfer possibilities
Figure 126 - Digital information signs in IJburg
Study Futurecase Tramline 19 Delft
(Delft Technopolis - The Hague)
Issues which should be analyzed in the future case regarding tramline 19
• PT network design
• Urban design
• PT system functioning (usage)
• Urban planning & Policy
Figure 128 - Traject of The Hague - Delft Tramline 19
Figure 129 - Traject of Tramline 19 in Delft
Delft University of Technology in the city of Delft, the Netherlands, is the nation’s largest technical university, with over 15,000 students, 2,700 scientists (including 200 professors) and 1,800 people in the support and management staff.

The University of Delft was set up in 1842 in only one building inside the city centre. In 1901, the University expanded and several faculties were occupied in the city centre. Because of an exploding growth and because of limited space, the University was forced to expand outside the city centre, Wippolder. Not all faculties moved outside the city centre. However, at the beginning of the twentieth century some technical faculties chose to cross the river Schie.

In the beginning of the 1950s, the university planned to realize a campus in an area with educational buildings along the ‘Mekelweg’ (main road). In 1997, the central library of TU Delft was delivered on the campus. TU Delft left the last building they occupied within the city centre of Delft. Some old buildings on the campus were demolished and some were transformed into student accommodation (Mácel et al., 1994). Recently, the main road (Mekelweg) was transformed into a central park for pedestrians and bicycles. On or around the campus itself some knowledge based businesses is located. As it is close to the highway exit this is an interesting location. Technopolis is very attractive for the research and development businesses.

Because of the movements Delft campus lies isolated from the city. The physical perceptible lack between the city centre and TU Delft campus, only attracts target groups (students and employees). The TU Delft Campus is not connected to the rest of Delft city, although it creates the biggest brand aware name of the city. The university is independent and physically, socially and culturally isolated (Knight, 1995).

By creating an isolated campus with a concentration of educational buildings, inhabitants of Delft are avoiding this area. As there is nothing for them to visit, they show a social lack of interest in knowledge institutes and business. Fernández-Maldonado & Romein states that also students and employees are not connected with Delft City and become a commuter flow (Yigitcanlar et al., 2008).

**Figure 130 - Population of TU Delft University campus**

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<td>9</td>
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<td>9</td>
</tr>
</tbody>
</table>
TU Delft Campus user info

Last years, the student population of TU Delft is booming. Prognosis are showing a stagnating growth. There is also an expansion of international students studying at the technical university of Delft.

Figure 131 - TU Delft student population

Figure 132 - Prognosis of TU Delft student population
PT network design

1. Position of the city within the urban network

Delft is located in the middle of the Randstad, a network of cities. Public transport and highways do function as backbone for attracting and developing business and accommodation, with accessibility as a main goal. Because of this central position in the South Wing, all larger cities (Rotterdam and The Hague) can be reached within half an hour by car and within 15 minutes by Public transport. International connections are available via Rotterdam Airport and Schiphol Airport.

![Figure 133 - TU Delft’s position according to the city center of Delft.](image)
2. **Tram 19 line characteristics**

Line 19 runs from Leidschendam (the Hague) to the Technical University of Delft (Delft). It is planned to have 25 stops of which 11 in Delft and 5 on university campus. The begin/end stops are at Technopolis in Delft and hospital Antoniushoeve in Leidschendam. The tramline crosses VInEX neighborhood Ypenburg and Forepark at the Hague.

- Total line length: 15 km
- Amount of tracks: 2
- Amount of stops: 25
- Average speed: High average speed (around 35 km/h)
- Speed around TUD Campus: 30 km/h
- Date of construction: 2007-2012
- Operational from: expected 2012
- Design Station Delft - TUD zuid: Arcadis infra BV, het Stadsgewest Haaglanden and Delft municipality
- Exploiter: HTM
- Bicycles are NOT allowed on board
- Frequency: every 10 minutes
- Travelers expected: 18.000 travelers a day

3. **Public Transport transfer possibilities**

This line uses 4 km of existing railway and 11 km is added to generate a tramconnection between TU Delft Technopolis and Leidschendam medical centre. The part between Railway station Delft CS and TU Delft Technopolis is discussed in this research.

**Bus Connections**

Tramline 19 is connected to Railway station Delft CS, which is providing several bus connections in direction of Rotterdam and The Hague. Three buslines are using the same route towards TU Delft campus as the tramline does. These lines do split up at the entrance of TU Delft main axis (Mekelweg). A former busline 69 with endstop Technical University (TU-wijk) is cancelled.

**Railway**

Because TU Delft being the largest Technical University of the Netherlands, it is important to be well connected on national scale. The tramline is passing railway station Delft CS, which offers two directions: Rotterdam - The Hague. Students and employees of TU Delft from both directions, traveling by PT, meet at Delft central station, where they change over to bus or tramline.

*Figure 134 - Transfer possibilities along tram line 19.*
Urban design

1. Identity around PT lines and nodes
2. Stop connectivity
3. Urban design around the nodes and the transport line
4. Urban program around the nodes and the transport line
5. Car network characteristics
6. Stop design
7. Safety
8. Boundaries

1. Identity around PT lines and nodes

Tram line 19 to Technical University Delft has different identities in functional aspect. In environmental aspect and on the field of urban design and architecture the tram line can be split up in two areas; border of the city center and the university. The main functional zones that can be distinguished are the Delft Central Station transport hub; an urban neighborhood along the Schie; the Technical University of Delft which covers the sports field and Technopolis. The tram line is not crossing the unique, historical center of Delft, but is driving around it and stops at Zuidpoort. This causes less experience of Delft its historical city. The two zones of city center and university are separated by water and are connected by the St. Sebastiaansbrug (bridge). The tramline is created as a fast connection from Delft Central Station and the University, but is rather monotonous.

A - Delft CS
Busy transport and business node of Delft. This hub covers a train-, tram- and bus station.

B - Zuidpoort
Tramline 19 does not cross the historical city center of Delft. Zuidpoort is one of the gates towards it, although it does not have the character of a gate towards a shopping district. This because of the stop and the shopping area seperated by high building blocks and invisible for visitors.
C - Michiel de Ruyterweg
The future situation of the Michiel de Ruyterweg will be experienced as a urban lane with dwellings. A separate tramline along the road will also make place for busses.

D - Mekelpark
Mekelpark is a green axis which is surrounded by University buildings. The tramline will pass this green axis and will be part of the Mekelpark to transport students and staff. Mekelpark will cover the area between Aula and the sports fields and has an almost 90 meter width, with three tram stops along the line. Motorized traffic (cars and busses) abandoned from the park.

E - Technopolis
Technopolis Innovation Park is being developed in the immediate vicinity of the Delft University of Technology. The business park focuses on research and development (R&D) projects, such as techno start-ups, the leading international R&D centres, and European branches of R&D-intensive companies. Knowledge, expertise and research facilities are all at hand. Within 20 years, this business campus should be fully occupied with knowledge-intensive companies that expand the boundaries of new applications. Technopolis is becoming one of THE most import knowledge centres in Europe. (www.delft.nl)
Serial Vision (Photo reportage)

Architect and urban designer Gordon Cullen belongs to the group stressing the importance of the physical setting. In his book *The Concise Townscape (Cullen, 1961)* Cullen shows in a series of photographs and sketches how amongst others design styles, ornamentation, gateways, vistas, landmarks and the way buildings open out into spaces contribute to the quality of public space. This chapter is used to use Cullens way of analysing public space quality, to give an impression of the route from Delft Central Station towards Technopolis.

1. Delft CS
2. Zuidwal (landmark: electrical engeneering)
3. Zuidwal
4. Zuidwal
5. Zuidpoort
6. Zuidpoort
7. Zuidpoort stop (future tramline 19)
16. Sports Fields

17. In beyond, the viaduct of N470

18. Entrance of Technopolis

19. Turning point of tramline 19 at Technopolis

Figure 142 - Tramline 19 series
**Sections**
The map shows the tram line passing the Mekelpark. The section of the tramline shows the arrangement of private and public transport. It shows the experience of scale around the tramline.

**Section A-A’ (3D)**
The 3D image shows on left side a seven storage high building line (civil engineering) and on the other side the first floors of the 90 meter high building of electrical engineering along the main axes.

This spatial profile surrounding tramline 19 is caused by the formal mekelweg and possibilities to park the car in front of each faculty. Nowadays it Mekelweg made place for Mekelpark, a green axes through the heart of the TU Delft campus. This environment provides the traveler and the urban space itself with high quality landscape features, but also has a huge impact on the width of the profile.
2. Stop connectivity

2.1 Positioned at principal/structural lines
The tram stops are positioned at structural nodes/crossings in the infrastructural network. They are positioned at the corners of blocks where structural roads cross each other, as well as cycling lanes and pedestrian routes.

2.2 Tram platform separated from cycling and pedestrian lanes
There is a strong segregation between the tram line and its direct environment on each point of the line. The tram line is the central line within the IJburg’s main transport axis, the IJburglaan, and is situated in between a car and bicycle lanes on both sides. A hedge row separated the tram line from the car traffic road, alongside the stop platforms fencing is applied.

2.3 Axial feeder routes
The tram stops are situated at structural crossings in IJburg’s road network. There are no (or limited) distinct pedestrian or bicycle feeder routes leading from the stops, as the road network is practically the same as the pedestrian and bicycle routing.

2.4 Blocks opened up
On some parts the facade aligning the main street are opened up, so that

Figure 146 - The tram stops are positioned at structural lines within the neighborhood where different modes of transport meet.

Figure 147 - Opening in the facades along the IJburglaan
Analysis TU Delft Campus Vision 2030

Issues which are analyzed in according to the Campus Vision 2030

- Methods
- Regional and local context
- Urban plan
  - Diversity
  - Upgrade Connections
  - Public Transport

This chapter is an analysis of the Campus Vision 2030. This research will insight the design directions according to the TU Delft campus of the future.

INTRODUCTION

After the loss of the building of bouwkunde, a new campus vision 2030 is in development. Based on a contest (prijsvraag) for the location of new bouwkunde building and a ‘Denktank’ (think tank) was organized for future developments of the university. The municipality of Delft put the question to upgrade the relation between TU Campus, city and region; research on a higher scale and generate an urban vision for Delft south east.

1. Four Concepts
Four concepts were created for a new campus set up.

These four concepts are showing different compositions of the campus on different scale.

**MEKEl SQUARE**
This high dense concept is focussed on local connections within its environment. A human scale square, surrounded by faculties does not connect an international campus with the city, but is focussed on a local scale.

**MEKEl PARK**
This concept (already realized) focusses, the same as Mekel square on a local scale. A lower dense area with buildings surrounding a green central axis. A grid infrastructural network, connects the different faculties surrounding the park and commercial facilities inside it.

**MEKEl lINE**
Mekel line focusses on a more regional level, with Mekel park and Mekel square as one of the clusters linked to the line. Main transport mode is a tramline which connects these different functions and clusters through a region.

**MEKEl WORLD**
This high scale concept focusses on ICT future. Physical connections are limited here, but this virtual campus is connected through the internet. This world scale provides an internet campus where physical interaction is almost disappeared.

Four concepts are placed in a scheme in figure 149 on the right. TU Delft has the largest international technical education level in the Netherlands. Therefore it is important to operate on local - regional and global level. The Mekel world concept is covering this aim, but misses the physical interaction as on a campus setting. This is the main aim for staying innovative.
2. Parties & Method
The campus vision2030 focusses on goals which are set up through different phases: ‘Building for Bouwkunde’ contest (prijsvraag), the strategic ‘think tank’ (denktank) called ‘Envisioning the future faculty’ and several plans which were created by Facility Management & Real Estate (FMVG).

Four different stakeholders are concerned during the planning:

- The university as a user and inhabitants of the campus.
- Neighbours, city and region.
- The university who is financing infrastructure and real estate
- Manager of the campus (FMVG)

3. Planning Area
The team of developers concerning the campus vision2030 researched the goals of TU Delft and the municipality of Delft by enlarging the plan area beyond campus borders, but within the municipality. The campus vision2030 is focussing on the area between railway, highway (A13), South border of the city center of Delft and Midden-Delfland.

The map in figure 152 shows the different identities at the borders of the planning area. Two ‘strict’ lines (railway & highway) at the east and west side are causing the north - south development direction of the planning area.

Because of these strict lines and the northern Schie canal, clear entrances are not located towards this area.
2. ANALYSIS

The team of developers concerning the campus vision2030, analyzed the location of TU Delft university in a regional and city context.

1. Regional Context
TU Delft campus has potential to expand, because of its central location at the Hague - Rotterdam axis with in between the regional park ‘Midden-Delfland’. Finishing the A4 highway will enlarge the potential to create a urban axis between the Hague and Rotterdam. The city of Delft has less space for urban expansion, while the university has more potential space. It creates chances to expand in direction of Rotterdam, as said in campus vision2030. Delft could be a strategic intersection.

Between the Hague and Rotterdam, amounting the city of Delft, a green leisure axis is crossing the metropolitan line. Delft city is the intersection point of those two lines. That is why Delft has a large potential to become a strategic point in this regional environment.

Figure 154 - Metropolitan north-south axis (source: TU Delft college van bestuur (2010) TU Delft Campus Visie2030, Delft)

Figure 155 - East-west leisure axis (source: TU Delft college van bestuur (2010) TU Delft Campus Visie2030, Delft)

Figure 156 - Schematic figure of strategic position of Delft city
Figure 157 - Combined maps of both axes; north-south and east-west (source: TU Delft college van bestuur (2010) TU Delft Campus Visie2030, Delft)
2. LOCAL CONTEXT

The local analysis are needful to create a better interaction between campus and city of Delft. This is where Delft municipality asked for a team of developers concerning campus vision 2030.

Barriers
In a local context, the university campus is isolated from the city. Three barriers are preventing connections between city and campus: Industrial zone along Schie canal, railway and A13. Especially connections with the west side of TU Delft campus are poorly. Public transport connections with the city of Delft are excellent. On the other, accessibility of Delft university campus by public transport is undersized.

Enclosed by city
Over the years, the campus is enclosed by urban expansion. Nowadays, the campus experiences urbanization. TU Delft north, is developing dwellings while the south part is expanding with science-park Technopolis. Living environment at the TNO-area will be generated and also the industrial Schieoevers will be transformed into creative urban area. These urban transformation and expansion will create new chances for better facilities and a high quality environment in and around the campus area. This Technical University is an important link for balanced development in the city of Delft.
**Strengths & Weaknesses**

This analysis focuses on strengths and weaknesses concerning the TU Delft campus on local and regional level.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
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</thead>
<tbody>
<tr>
<td><strong>Location</strong></td>
<td>Location</td>
</tr>
<tr>
<td>+ part of Randstad network</td>
<td>- isolated campus and bad connected on local level</td>
</tr>
<tr>
<td>+ close to Rotterdam and the Hague</td>
<td></td>
</tr>
<tr>
<td><strong>TU North</strong></td>
<td>TU Centre</td>
</tr>
<tr>
<td>+ monumental characteristic buildings</td>
<td>- lack of maintenance</td>
</tr>
<tr>
<td><strong>TU Centre</strong></td>
<td>- low occupancy of buildings</td>
</tr>
<tr>
<td>+ flexible and large office-like floors</td>
<td>- many 60's and 70's buildings</td>
</tr>
<tr>
<td>+ /f_lexible and large office-like /f_loors</td>
<td>- distance between buildings</td>
</tr>
<tr>
<td><strong>Technopolis</strong></td>
<td>General</td>
</tr>
<tr>
<td>+ attractive location along A13</td>
<td>- limited investment opportunities</td>
</tr>
</tbody>
</table>

*Figure 161 - Strengths & Weaknesses of campus area*  

The team of developers of the campus vision2030 quotes that spatial qualities of the campus are undersized. Especially international students and researchers are related to ‘their’ university campus, because they live there and it is their ‘window to the world’. The campus has a large scale set up and public space is unattractive. Mekelpark is finished and has a beautiful appearance, but is large scale with less (8) entrances directed towards it. This influences liveliness and social security. The large scale set up of Mekelpark is contrasting the smaller scale set up of Delft city center. The campus of TU Delft is located at a strong Randstad position and close to A13 highway. But there is a lack on public transport accessibility.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Public space</strong></td>
<td>Public transport</td>
</tr>
<tr>
<td>+ diversity of environments</td>
<td>- bad accessibility by Public transport on local and regional level</td>
</tr>
</tbody>
</table>

*Figure 162 - Adding strengths & weaknesses of campus area*  

The planning area has a diversity of environments, especially in east-west direction which is a strength. Diversity contributes to wider attractiveness of people and broader support of facilities.

**Bad accessibility by Public Transport**

A disadvantage of the TU Delft campus is the poor accessibility by Public Transport. In future, a tramline will cross the Mekelpark.

Because a lack in co-operation between the management of TU Delft and the city municipality, the campus area is isolated. Important is to collaborate and link urban space on the campus area with surroundings.

*Figure 163 - Adding strengths & weaknesses of campus area*

*Figure 164 - Poor co-operation between TU-management and Delft municipality*
3. CAMPUS VISION

1. Network university
TU Delft wants to be a network university: creating, innovating and exchanging knowledge. The campus is becoming part of the city where shared use of facilities can take place. Creating an inspiring work- and study environment and space where entrepreneurs can establish themselves, is part of TU Delft its strategy.

2. Knowledge city
TU Delft wants to contribute the nowadays knowledge economie, therefore it is important to have educational institutes and a economic foundation. To attract this environment, it is necessary to create high quality living environment, facilities and urban diversity.
Developing the region of Delft into knowledge city an intensive co-operation between local authorities and knowledge institutions is needful. High quality knowledge environment is needed to fight international’s best recommendation. However, accessibility and high quality living environment leave poor behind. This vision focusses at physical conditions to contribute to a high quality knowledge city.

3. Urban Diversity
The Delft university wants to contribute to future developments of physical infrastructure of the knowledge city; high quality environment, rich accessibility, city scale and urban diversity. Upgrading spatial quality should create usage, spread all over day and week.
This vision describes a fit of more urban program. As said before, the TU campus is contrasting the city center of Delft. By upgrading urban program, opportunities to create a higher level of liveliness will appear. Urban program could be dwellings, a hotel and supermarket, swimming pool and horeca facilities.
4. Fixing Links

This vision introduces an imaginary ladder, which improves accessibility of campus and city. It consists of a ringroad; Schoemakersstraat and Rotterdamseweg as foundation piles. The horizontal connections are the steps in this ladder. These extended horizontal routes are crossing the Schie canal and railway on one side and A13 highway on the other.

This approach improves east-west orientation and connections with the surrounding city. Making these links generates cohesion between surrounding expansion areas; Railway zone, TU North, TNO, Schieoevers and Technopolis.

Creating this ladder set up, improves accessibility and orientation in the south of the city of Delft.
5. Creating Streets

To equalize the current, low building density around Mekelpark and the high dense city center of Delft, it is necessary to implement program. This will fight the contrast between university campus and city center. Establishing a finely-meshed network, will direct the implementation of building blocks to create a higher density. It will create a better balance between Delft’s city center and TU Delft its university campus.

Streets, squares and a central park where buildings and building blocks, define public space. Important is to generate an attractive and human (small) scale environment in between large scale faculty buildings. Extending city center its urban fabric towards university campus will create a more balanced interaction.

By creating ongoing links from east to west side of TU Delft campus, an urban axis can develop in a contrary direction as in the current situation. Breaking the original north - south oriented development is introduced in the campus vision of 2030. A green axis will penetrate into the city center with Mekelpark as part of it. This concept is based on the larger scale leisure axis crossed by the metropolitan axis (the Hague - Rotterdam).
6. Finely-meshed and green network

Bicycle routes and hiking paths will be created which will connect Mekelpark with new living environments on east and west side of the university campus. The Schoemakerstraat will be transformed from anonymous route into a recognizable main entrance of the city. Mekelpark is a north-south orientated recreative city axis which connects Delft city center with Midden-Delfland.

Figure 175 - Different networks
7. Public transport

To increase accessibility, not only by private transport, it is important to create a high quality Public Transport system. Especially for students and in knowledge cities, it is important to offer high quality environment. In future, two tramlines will connect TU Delft campus with its environment. Tramline 19 is currently under construction and expected to be finished in 2011.

Another tramline will be available in future. Tramlines can be seen as backbones of developments. The campus vision 2030, focusses a lot on east-west oriented development, which can be stimulated by a east-west oriented tramline.

The university of Delft is doing research on the possibilities to generate a solar shuttle between Technopolis - Rotterdam Airport - Station Delft Zuid. It could be used as a ‘showcase’ for sustainable- and innovative development.

Figure 176 - Public Transport Network
4. OPPORTUNITIES & THREATS

The campus vision 2030 describes the strong and weak points of Delft’s university campus. This chapter describes the opportunities and threats of the campus area based on the strong and weak points. These opportunities and threats constitute the design principles for further elaboration of the project.

**Opportunities**

- TU Delft is positioned at a strategic location in Randstad’s southwing. Opportunity is to be connected on different scale levels; upgrade TU Delft’s accessibility by link it to a local and regional public transport system.

- Flexible buildings are sustainable. Establish to functionality.

- Interweave campus structure with surrounding urban fabric to break the isolation barriers.

- Adding program will create human scale. Walking distances will decrease.

- Investment opportunities are limited. Opportunities are: Intensify the campus area by adding program or development in other directions.

**Threats**

- Delft is located in the middle of a metropolitan axis. A threat is the densification of the green leisure axis in future.

- Attractive location along A13, but prevent the development of an industrial area.

**Strengths**

| Location | + part of Randstad network  
| TU North | + close to Rotterdam and the Hague  
| TU Centre | + monumental characteristic buildings  
| Technopolis | + flexible and large office-like floors  
| Public space | + attractive location along A13  

**Weaknesses**

| Location | - isolated campus and bad connected on local level  
| TU Centre | - lack of maintenance  
| General | - low occupancy of buildings  
| Public transport | - limited investment opportunities  
| Public space | - many 60’s and 70’s buildings  
| Public transport | - distance between buildings  
| Public transport | - bad accessibility by Public transport on local and regional level  

5. CONCLUSIONS & DESIGN PRINCIPLES

This chapter describes what principles, related to the written campus vision 2030 are to be used for further elaboration of a detailed campus plan.

1. Regional Concept
The regional concept of the campus vision 2030 focusses on a one way orientated metropolitan axis between the Hague and Rotterdam. Important is to not only focus on one way development as happened on Delft’s local scale. Future scenarios describe a large co-operation between different universities, science parks, airports and research and development areas on local, regional, national and international scale (network university).

Principle is to link university campus Delft on different scales; focus is on local and regional scale. Important in campus vision 2030 are two lines (green and metropolitan) which cross each other. East-west oriented development is needful to keep the green leisure axis open and connect this urban line on regional scale.

TU Delft wants to be profiled as network university, therefore it is important to be connected in different scales.

2. Local City Concept
At the strategic intersection of the metropolitan- (red) and leisure (green) axis, Delft knowledge city is located. Campus vision 2030 describes that, better co-operation between municipality and TU Delft management is a requirement for integrating campus structure in its surrounding urban fabric.

The recent contrasting city center and university campus is created by an unattractive and monotonous university campus, bad interweaved infrastructural networks and difference in densities.

**URBAN DIVERSITY**
Creating an attractive university campus by adding program, will attract a wider target group. It will also upgrade interaction between campus and city center.
Mental barriers will disappear by attractiveness of facilities at the university campus.

![Figure 177 - East-west orientation on regional scale](#)
![Figure 178 - Adding program](#)
INTERWEAVED URBAN FABRIC
By extending potential east-west oriented routes (Bycicle and car) within the campus area towards the surrounding urban fabric, a better interweaving will improve accessibility and removes the strict borders (Schie Canal, Schoemakerstraat). The campus ringroad and ongoing east-west oriented links will upgrade accessibility on local and regional level even more.

By focussing on east-west oriented development, the characteristic north-south development of the university campus will turn into east-west direction.

A green network from Midden-Delfland towards Delft’s city center will enter through the university campus (Mekelpark) as a leisure axis.

DENSIFICATION
Analyzing Delft’s university campus concludes a contrast in densities between Delft city center and campus. High densities in the city center versus low density at university campus. Delft city has limited space to expand their boundaries. Developments of the city can take place at the campus area by densifying it. Contrasts in urban fabric will decrease and will be better interweaved.

Figure 179 - East-west orientation on local scale

Figure 180 - Densification of university campus
3. Public Transport
Delft University wants to profile itself in future, as a network university. Therefore it is not only important to be connected on local, national and international scale, but also on the scale in between; Regional Scale.

The university is connected good for private transport, but accessibility by public transport is underdeveloped while students are one of the larger user groups of the public transport system.

Focus on further development of this project will be based on this regional scale level connections by public transport. Tramline 19, which is already under construction does connect the university with the central railway station of Delft and the Hague in a north-south oriented direction. The new connection (tramline 37), east-west oriented, is planned to connect the university campus with railway station Delft Zuid and the regional Randstadrail network.

4. Conclusions
A high quality PT connection has potential to give future expansion, direction. The north south oriented development of Delft, threatens to densify the regional green leisure axis. By turning the expansion orientation, the green axis will stay unaffected and city of Delft can develop along the new PT line in east-west direction.

An important public transport intersection will appear at TU Delft’s campus. With this new line as backbone, the university campus can be densified by adding programs. By better co-operation between the municipality of Delft and management of Delft university, urban fabric can be interweaved.

Figure 181 - Increase PT accessibility of the university campus

Figure 182 - Local scale interweaving with urban fabric
3 abstract design approaches

- Greenfield Campus
- City Campus
- Regional Campus Node (TOD)

TU Delft campus can be designed in different design directions. To take different orientations into account, three concepts based on different principles are described in this chapter.
INTRODUCTION

Three concepts are created for a new campus set up. TU Delft campus can be developed into several directions. It is important that these development directions are clear and based on firm visions and goals. This chapter describes three possible maximal directions, to create discussion and to able to exploit the development potential of current campus and it’s public transport system.

As stated, TU Delft campus and it’s Public Transport system can be developed into several directions. Some of these directions are relatively easy to fit into the contemporary situation, where other directions are harder to apply; technically or economically impossible. The different developments have different effects on the functioning of the university campus and it’s public transport system, some negative, some positive or neutral, some interventions strengthen each other where others conflict.

These strengths and weaknesses, possibilities and impossibilities are explored in the following chapter, where each concept is reflected on the current situation, and each reflection combined with each other.

1. Playfield of different ambitions

Some of the concepts have regional ambitions, others have a more modest appeal. Some aim to create a high urbanity city-like environment, where others aim at a more spread rural environment. These different ambitions are visualized in the scheme for spatial logic of urban density (SpaceMate) (figure 84).

1.1 What is Space Mate?

As stated by Space Mate are, “Recent changes in urban design and planning practice (e.g., large scale projects, very long time spans, privatization, an unpredictable future, and increasingly complex programs) require strategies that enable planners, politicians and the public to regain influence on relevant aspects of the quality of the urban environment” (SpaceMate, 2001). These complex strategies must leave designers flexible to be creative. Spacemate can be used in such a strategy as an expressed density concept method.

This method makes it possible to describe an urban environment by using a set of density variables (FSI, GSI, OSR and L). These quantitative aspects can be used both to describe and characterize, as well as prescribe different urban environments. Spacemate thus enables different actors in the design and planning process to relate different programmatic demands to different spatial solutions.
FSI) Floor Space Index: The FSI expresses the built intensity of an area.
GSI) Ground Space Index: The GSI expresses the compactness of an area.
OSR) Open Space Ratio: The OSR expresses the openness of an area and the pressure on the non-built space.
L) Layers: L expresses the average number of floors in an area.

The Spacemate diagram allows the four variables to be assessed simultaneously. The FSI on the y-axis gives an indication of the built intensity of an area and the GSI on the x-axis reflects its compactness. The OSR and L are gradients that fan out across the diagram. Combining these four variables gives every project a unique ‘spatial fingerprint’.

1.2 Using Space Mate
Urbanization is determined to a large extent by the pressure on non-built space, the OSR. Accordingly, new clusters can be distinguished in the diagram, ranging in degree of urbanization from rural to highly urbanized. (Figure 186)

Using the land development typologies and the degree of urbanization, the diagram can reflect differences in non-built space. In this case we are concerned with the non-built space that is directly related to the buildings. (Figure 187)

2. Three design directions
A grass-land
B country house grounds
C farmyard
D public parkland
E park-like gardens
F private gardens
G city parks
H inner courts
I patios
J roof parks
K labyrinthic courts
L partly built up inner courts
M roof gardens
Based on the Spacemate method, different identities are displayed on the horizontal axis: from a ‘rural’ low dense, quiet and green character till a highly dynamic profile. The different design directions can be placed within this axes system. Each concept deals with a different point of view and more qualities are taken into account. These directions will be explored in the following chapters.

The three directions of development are the Greenfield Campus(1), the City Campus(2), the Regional Campus Node(3). None of these extreme concepts will be reality, however they are an enlargement of the intrinsic qualities of the area subject to change. Exploring these concepts will help to find which of these qualities can and can not be used to improve the current situation of TU Delft campus and it’s public transport system.

The final concept choice and/or selection of interventions will be based on three weighing factors:
A) Applicability
B) Public transport exploitability
C) Quality of environment (urban and rural) (flexibility, ease of applicability, sustainability, exploitability)

2.1 DESIRABLE / UNDESIRABLE
Analysis already framed design directions to work with. After doing research on campus design, nine recommendations are listed.

1] REGIONAL ORIENTED CONNECTIVITY (public- and private transport)
2] OPEN/PUBLIC GROUND FLOORS (services, retail, exhibitions)
3] BALANCED MIX OF APPLICATIONS (specialized clusters and diversification)
4] ACCOMMODATION (housing, boarding, guest, hotel)
5] COMMUNICATION (Meeting places, café-bars, plazas, parks, conference)
6] HIGH-QUALITY AND PERMEABLE PUBLIC SPACE (accessibility, comfort, leisure)
7] CATALYTIC CONDITIONS (surrounding neighborhoods, business parks)
8] URBAN, CULTURE, ECONOMY, LANDSCAPE (contributing and inspiring factors)
9] STRATEGIC TECTONIC FLEXIBILITY (responsiveness to changing needs)

Other desirable design directions are based on the Campus Vision 2030.

UNDESIRABLE
Further isolating campus area in future.
1. GREENFIELD CAMPUS

Figure 190 - Pictograms: Abstract Foundation Stones Greenfield Campus Concept
CONCEPT

Idea in this concept is to position several faculty buildings and facilities in a green area. This green area is to generate meeting places, important in these knowledge environment.
2. CITY CAMPUS

Figure 191 - Pictograms: Abstract Foundation Stones City Campus Concept
Vision of this concept is to interweave the campus side in the city structure. Urban blocks can be the faculties, within these blocks, other program based on facilities for knowledge environments.
3. REGIONAL CAMPUS NODE

Figure 192 - Pictograms: Abstract Foundation Stones City Campus Concept
CONCEPT

This concept shows an important accessibility line, which is used to increase accessibility of the campus area. This public transport line is used as a backbone, along with it, high FSI buildings will be placed.
4. MAQUETTE

CURRENT

TU     BVO     45ha.
Technopolis  BVO    60ha.
TNO     BVO     17ha.
Sporten  11.4ha.

Dwellings

- FSI < 0.5
- FSI 0.5 - 1
- FSI 1 - 1.5
- FSI 1.5 - 2.5
- FSI > 2.5

Offices

- Hockey
- Voetbal
- Honkbal
- Tennis 3x
- Rugby
- Zaal

Commercial

- 76-85 won/ha.
- 56-65 won/ha.
- 36-45 won/ha.
- 26-35 won/ha.
- 16-25 won/ha.

Sports

- Voetbal Honkbal Tennis 3x
- Rugby
- Zaal
MAQUETTE
After this spacemate playfield, a maquette was made for fitting these concepts in the current location. Pieces of 0.5 - 1 - 4 hectares were made to puzzle the project locations program and size.
Plot surface in m²
Build surface in m²
Number of floors
Floor Space Index
Ground Space Index
Open Space Ratio
Appartments per 10.000 m²

Name and location of reference project
Amount of appartments
Amount of rooms, appartment surface

De Hoge Heren, Rotterdam
285 luxurious appartments
3/4 rooms, 108 - 220+ m²

De Hofdame, Rotterdam
231 appartments
3-5 rooms, 70 - 125 m²

DWL Tower, Rotterdam
124 appartments (each)
3 rooms, 85 - 100 m²

Block in Blijdorp, Rotterdam
180 appartments
2-3 rooms, 45 - 95 m³

Lombardijen, Rotterdam
48 appartments
3 rooms, 70 - 75 m³

Figure 196 - General Building settings
FSI RESEARCH

This FSI research is done to deal with different densification forms, related to the spacemate model used to create different concepts.