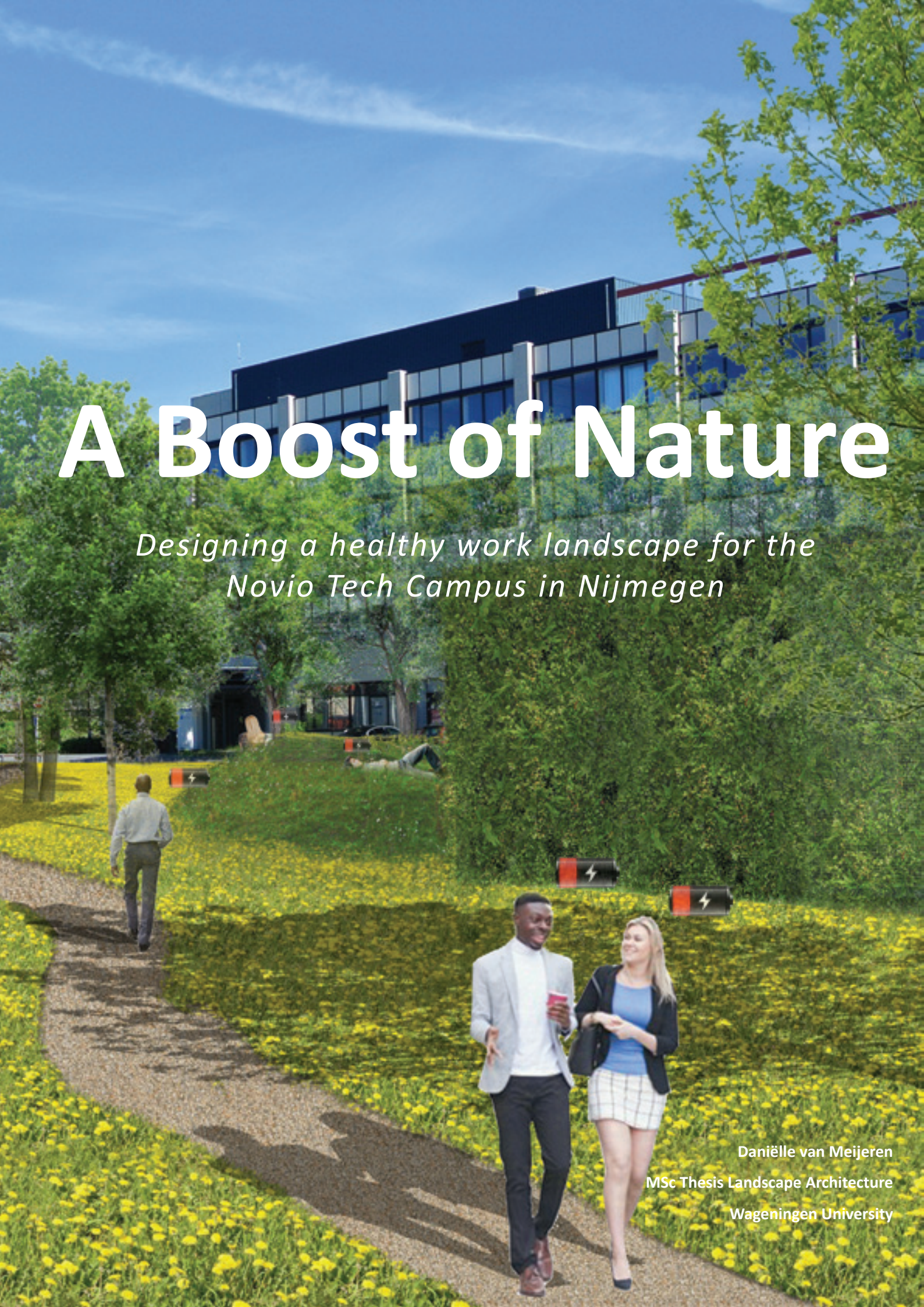

A Boost of Nature

Designing a healthy work landscape for the Novio Tech Campus in Nijmegen

Daniëlle van Meijeren

MSc Thesis Landscape Architecture

Wageningen University

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PREFACE

This thesis is affected by my interest for health and nature. I believe nature and physical environment have a huge impact on humans. Unfortunately, the value of nature is underestimated by many. Furthermore, I am interested in psychology. I have always been fascinated in how humans experience and use space. For example, when people visit a park and occupy the edges first, or prefer to sit under a tree. Where is this coming from? Why do all people behave like this? These interests are all combined in this thesis.

In the 21st century, more and more people experience the burdens of stress, often resulting in burn-outs. Especially the ones from the millennium generation (born between 1986 and 2000), of which I am part of, feel mentally unhealthy and experience stress in the workplace. In addition, in my personal environment I have experienced the consequences of high stress levels. I think this is a relevant and societal issue, where landscape architects can play a prominent role. This thesis shows how we can intervene in the work environment by designing a healthy work landscape, offering the opportunity to recover from stress and restore attention.

I would like to thank my supervisor, Rudi van Etteger, for his help and support. He guided me during my thesis and gave me freedom in the choices I had to make. I would like to thank Joost van der Zanden, urban planner from the municipality of Nijmegen, for his expertise and help. He showed me around the Novio Tech Campus, and provided me with information, documents and maps. Finally, I would like to thank my fellow students for supporting me and giving me the feeling I wasn't going through this process alone. A special thanks to Louise Capelle-Burny, who helped me through the final work, reading through my English and going for supportive walks in the Uiterwaarden of Wageningen.

With this thesis I want to address the importance of this topic, and I hope to inspire many people. Health should be treated as an integral aspect of future landscape architectural design.

ABSTRACT

Burn-outs are an increasing problem worldwide, and the Netherlands is no exception. Burn-outs are a stress-related disease, and especially employees experience high stress levels in the workplace. A few measures are already taken by employers, but none of these have anything to do with the physical work environment. Whereas there is profound evidence that nature and the environment is effecting the mental health state of people. Nature reduces stress, restores people's attention, and should be seen as our most vital health resource. Intervening in the work environment by designing a healthy work landscape, will contribute to the reduction of stress and thus burn-outs.

A lot of knowledge and proof is available regarding the stress reducing and restorative effect of nature. Unfortunately, it is all very theoretical and both practical and spatial implications are lacking. This thesis examined how a healthy work landscape can be designed. The first part of the research was focused on developing design principles, and the second part on the case: Novio Tech Campus. Thereafter, a design is made to turn the existing work environment into a healthy work landscape.

The result is a design for the Novio Tech Campus in Nijmegen, where the design principles are applied. The design principles are divided in three categories: general, private and public, and can be easily combined in the design. Furthermore, other aspects as public facilities, climate and biodiversity can be included in a healthy work landscape as well. As long as the design principles are present, the design will support mental health.

A healthy and attractive design is essential to tackle the issue of burn-outs, but the daily routine of employees should change as well. Employees should become aware of the importance and effectiveness of nature in relation to their mental health. This thesis could be seen as a way to increase the awareness of the relation between nature and health, and to motivate designers to integrate this aspect in future designs and provide employees, but also other people, with a boost of nature.

Key words: Burn-outs, Environment, Health, Landscape architecture, Nature, Stress, Workplace.

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1 INTRODUCTION

1 INTRODUCTION

1.1 INCREASE OF BURN-OUTS

Burn-outs

Burn-outs are an increasing problem worldwide, and the Netherlands is no exception. In 2017, 16% of employees aged 15-to-75 were physically exhausted from work several times a month, in comparison with 13% in 2015 (CBS, 2018). More than half of the Dutch population has stress related complaints (Gezondheidsnet, 2016). Furthermore, burn-outs and stress are the number one work related diseases (AD, 2018) and mental illness is the cause of more than half of the work related diseases- of which almost three quarters of these are related to extreme fatigue and burn-outs (Volkgezondheid, 2017) (see figure 1.1).

Stress related Disease

Burn-outs are a stress-related disease and have become a huge global problem (Grahn and Stigsdotter, 2010). According to the World Health Organization (WHO), mental health disorders, together with cardiovascular diseases, are major contributors to illnesses in all parts of the world (WHO, 2008). Additionally, diseases rooted in physical inactivity and stress are the two major causes of death in the developed world. Leading the WHO to designate obesity and stress-related diseases as a priority in preventative health care. (WHO, 2008).

Stress is caused by too many stimuli or stressors. Good coping skills are needed to deal with these stressors (Volkgezondheid, 2018). Stress is the physiological process in which humans responds to a situation that challenges or threatens their well-being (Ulrich, 1991). These situations can happen anywhere, such as a work environment, at home or even when someone is on holiday. There are different causes for a high stress level, including worrying about children, health, work, financial problems and concerns for loved ones (Gezondheidsnet, 2016). Stress has both physical and mental consequences. Stress can change the eating patterns of people, which in turn could cause obesity and heart and vascular disease. Mentally, stress could cause burn-outs, anxiety, depression and schizophrenia (Nisbet and Zelenski, 2014). Burn-outs are the result of a lack of balance between stressors, such as deadlines, demands and working hours, and positive aspects, such as rewards, recognitions and relaxation. (Observer, 2016). A burn-out gives people the feeling of being emotionally and physically exhausted.

Measures by Employers

Within this thesis the focus will be on the increasing amount of burn-outs among employees. Stress is the number one disease affecting employees; their absence costs the Netherlands 1.8-billion euro a year (NRC, 2017). Employers indicate the importance of tackling this issue. Some of the preventative measures taken by the employers are: personal growth plans, health checks, attention for home-work balance, stress reduction programmes, yoga, or other kind of mental health programmes (RIVM, 2014). But none of these measures have anything to do with the physical work environment. Whereas there is profound evidence that the environment is important for the mental health state of people (Kaplan, 1995; Marcus, 2018; Ulrich, 1991).

Enjoy-work Philosophy

The healthy mental state of employees is not solely important to deal with stress and burn-outs, it effects the productivity, the creativity, and the motivation of employees as well (Kaplan, 1993). Furthermore, the philosophy of 'enjoy-work' is relevant to mention. This philosophy beliefs that supporting and engaging individuals, is the key to productive and engaged employees. Happy people are more committed, more creative and productive. A workplace stimulating and refreshing the employees, encourages them to work harder, stay longer and have better ideas (Enjoy-Work, 2017).

Header: one in seven employees have burn-outs (CBS, 2015).

Header: more psychological fatigue experienced by work (CBS, 2018).

Header: Half of the Netherlands has physical complaints caused by stress (Gezondheidsnet, 2016).

Header: Burn-out? Well, it reigns… (AD, 2018).

Fig. 1.1 Recent newspaper articles related to burn-outs and stress.

1.2 URBANIZATION AND DENSIFICATION

Urbanization and Densification

Urbanization swallows up natural areas and cuts people off from natural surroundings. It reduces the possibility for humans to have contact with nature (Hartig et al., 2014). The further the distance to nature the less frequent the use (Nordh and Østby , 2013). In the last few hundred years, humans have disconnected more and more from their natural environment (C. Maller et al., 2005). Nowadays, two-thirds of the Dutch population lives in an urbanised environment (Nisbet and Zelenski, 2014). This number is still increasing, leading to densification within the city. Densification of the city reduces the opportunities for stress-reducing nature contact as well as an increased exposure to environmental stressors (Hartig et al., 2014) (see figure 1.2).

Nature is really important for one's physical and mental health. Most people think only about forests and nature areas outside a city as effective areas for health. A small pocket park within a city can already have an effect on one's health (Nordh et al., 2009) (see figure 1.3). But now, urban green spaces are under threat as well (Peschardt et al., 2016). Ensuring access to urban green spaces should be seen as a public health priority (Nordh et al., 2009).

1.3 HEALING EFFECT OF NATURE

Nature and Health

Nature has a lot of influence on humans health. Nature improves air quality, reduces stress, restores people's attention, improves people's feelings, stimulates physical activity and facilitates social contact (De Vries, et al., 2009). Natural areas should be seen as one of our most vital health resources (Maller et al., 2006). Nature has both physical and mental effects. This thesis focuses on the mental effects of stress reduction and attention restoration. Of which stress plays an important role in several health problems, such as cardiovascular diseases, anxiety disorders and depression (Grinde and Petil, 2009).

Mental Health

As said above nature has restorative and stress reducing effects on humans. It ensures a shift to a more positive psychological state, including better cognitive functions or performance. These psychological resources play an important role when one has to cope with challenges or stressors (Kaplan 1995; Ulrich, 1991). Moments of restoration are needed throughout the day (Kaplan, 1995). Short durations of nature exposure could have an important function when recovering from stressors, such as daily hassles, and reinforcing one's coping skills. (Ulrich, 1991).

Fig. 1.2 Urbanisation and Densification – Zuidas Amsterdam (NOS, 2017).

Fig. 1.3 Small pocket park – New York, Paley Park (Smartcities, 2017).

1.4 DEFINITION OF NATURE

Nature is often defined by the fact that it is essentially not touched by humans. Which actually means that in the Netherlands there is no real nature anymore. So when using the word 'nature' we actually mean something else; for example the Hoge Veluwe, a large, green environment that looks like a natural area. Keep this in mind, especially when research describes the relation between health and nature and the fact that gazing upon a few trees can already be effective for improving one's health (Kaplan, 1995). A few trees are not officially defined as nature, but still the research emphasizes the effect of nature - in other words the effect of greenery.

Furthermore, there is little research and proof of the distinctive effects of different types of nature. Also, research about different types of greenery compared for their restorative effects is scarce (De Vries et al., 2009). The beneficial effects of nature have been associated with various types of environment, including wilderness, parks, gardens and natural features around residences (Grinde and Patil, 2009). It is important to note that green spaces that look unmanaged decreases the feeling of social safety and are therefore perceived as less positive and are less likely to be restorative (Grinde and Patil, 2009).

Within this study the words nature, natural environment and greenery will be used interchangeable. But all are meant to indicate a green environment or vegetation.

1.5 RELEVANCE

Societal Relevance

Burn-outs are an urgent problem, especially in the workplace. Not only does it cost a lot of money every year, it also influences colleagues and the atmosphere of the workplace. Stress influences the performance of employees, their motivation, their job satisfaction and their general well-being (Kaplan, 1993). One solution to reduce the number of burn-outs is to redesign the outdoor environment around offices. When the outdoor environment contributes to restoration and lowering the stress levels of employees, employees will be able to renew their coping capacity. Even the minor effects of adding plants can help to decrease the health burden on a global scale (Grinde and Patil, 2009).

Scientific Relevance

There is a profound amount of theory and research regarding the relation between nature and health. This study adds practical implications to this body of research. What is lacking are practical implications focused on supporting mental health in a work environment in the form of design principles.

Challenge for Landscape Architects

Landscape architects can play a prominent role in designing better work environments. Work environments are commonly dense, grey areas. They are often viewed as the least attractive areas of a city. If there would be residences in the same place, the environment would be completely different. Therefore the concept of 'work landscapes' was introduced in 2006 by the ministry of Housing, Spatial Planning and the Environment. Also on a lower administrative level the policy is that work places should be considered as part of our living environment (Provincie Gelderland, 2011). According to the ministry, work landscapes should improve the spatial quality of the area - offering a variety of non-work functions, while creating a spatially coherent environment.

This concept of a work landscape is the first step to create better work environments, but the aspect of health is not clearly integrated yet. We should be aware that employees spend one-third of their day in a work environment. Moments of restoration or stress recovery are needed throughout the day, as well as during work. I think the healing effect of nature would be important to experience in the place one works.

1.6 THESIS OUTLINE

This thesis researches the existing knowledge regarding nature and its effect on mental health, and explores different ways to integrate this knowledge in a physical work environment.

Chapter 2 investigates the health models developed by the WHO; followed by the relationship between health and environment, as discussed in the theoretical framework. Afterwards, the research design is laid out in chapter 3. Aspects, such as the problem statement, the research questions and the methods, are explained. In chapter 4 the first research question is answered by setting up design principles. The design principles are extracted from three theories underlying the relation between mental health and environment: the prospect-refuge theory, the stress reduction theory and the attention restoration theory. Chapter 5 is the case study where the Novio Tech Campus in Nijmegen is discussed. Several types of analyses are conducted, including a questionnaire among employees of the Novio Tech Campus and a consultation with the municipality of Nijmegen. The design principles and the case study lead to three different models for a healthy work landscape, which are discussed in chapter 6. The models represent three distinct landscape typologies: the forest, the park and the meadow. One of those is developed further into a design, discussed in chapter 7. Finally, conclusions and recommendations are made in chapter 8.

2 THEORETICAL FRAMEWORK

2 THEORETICAL FRAMEWORK

2.1 MODELS OF HEALTH

Shift from Biomedical to Ecological Model of Health

Different models of health are developed the past years (see figure 2.1). The *Biomedical Model of Health* has been around since the mid-19th century, where the focus is on the physical condition of the individual. The former definition of health given by the World Health Organisation (WHO) as absence of disease or infirmity supports this Biomedical Model of Health. Mid-20th century this definition changed to 'health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity'. In this definition the physical, mental and social domains were included (Huber et al., 2011). The view on health changed further when the Ottawa Charter was developed in the 80's. In this document different starting points were mentioned to support health, including the need for supportive environment (see figure 2.2). Besides, 'the main determinants of health' scheme was developed (see figure 2.3). This model acknowledges the importance of other factors that influences the health status of individuals or a population, such as personal, social, economic and environmental factors (RIVM, 2015). This development fits within the *Ecological Model of Health* that explains how health is linked to environment and not only defined by the physical state of an individual.

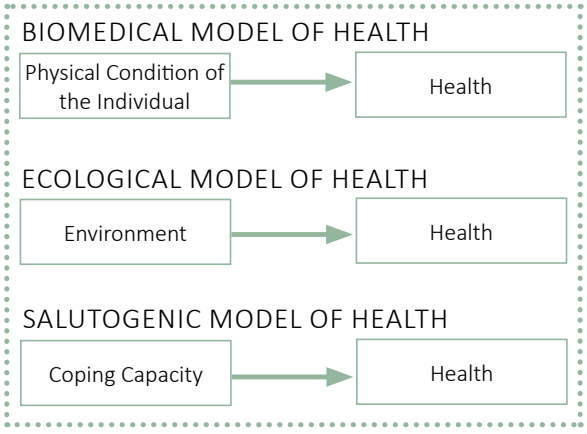


Fig. 2.1 Models of Health

Salutogenic Model of Health

There are some discussions about the current definition of health regarding the word 'complete'. What if someone has diabetes but is perfectly well to cope with this infirmity in his or her life? Or, what if someone experiences stress for a few days? Is that person immediately unhealthy? For this reason, Huber and colleagues propose changing the health definition towards 'the ability to adapt and to self-manage life'. In this definition coping capacities are relevant instead of complete recovery (Huber et al., 2011). *The Salutogenic Model of Health* fits within this definition, that emphasizes how health is a continuum between ease and dis-ease and how coping capacity defines if someone is more on the ease or dis-ease side (see figure 2.4).

The models of health are important to understand the shift that is made last century. Environment is increasingly recognized as an important factor influencing health. Since landscape architects deal with the physical environment of people, the focus of this thesis is on the environmental influence on the health status of humans.

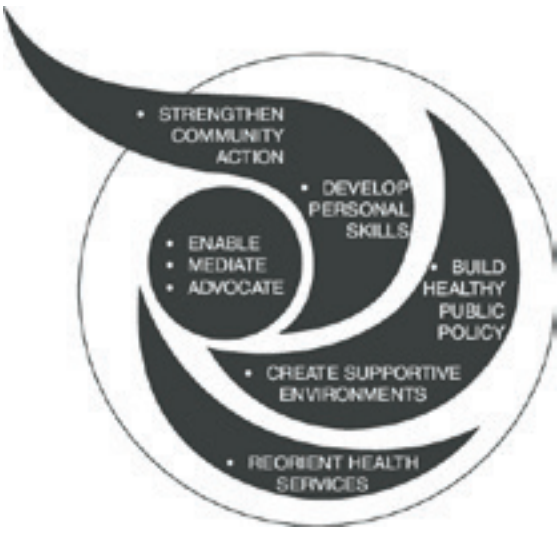


Fig. 2.2 Ottawa Charter for Health Promotion (RIVM, 2015).

Mental Health

Health is a very broad concept and consists of three different domains: the physical, the mental and the social. Within this thesis the focus is on the mental domain of health. This domain is important in relation to cope with stressors and prevent burn-outs. Mental health is defined by the WHO as *'a state of well-being in which the individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community'.* And again, not just an absence of mental illness (Huber et al., 2011). In this definition the coping capacity of humans is mentioned as well. For this thesis I choose to work with both the Ecological Model of Health and the Salutogenic Model of Health.

Fig. 2.3 Main determinants of Health (RIVM, 2015).

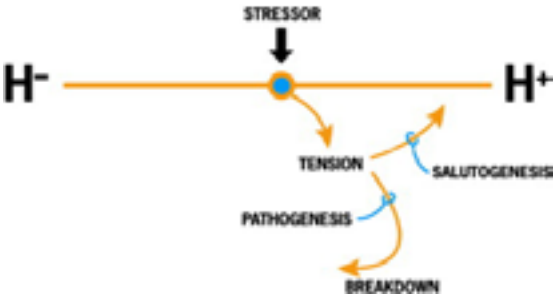


Fig. 2.4 Health ease-disease continuum (ResearchGate, 2018).

2.2 HEALTH AND ENVIRONMENT

Relation between Nature and Humans

Though nature is not always kind to human beings, they have come from nature and can't do without. In many cultures, both present and past, there is an affection for nature. This relationship is called 'Biophilia' by social psychologist Erich Fromm. He defined biophilia as 'the passionate love of life and all that is alive' (Fromm in Marcus, 2018). It is the need of humans to affiliate with life and our affection for plants and other living things (Grinde and Patil, 2009; Kahn, 1999).

Furthermore, humans have lived in a natural environment for thousands of years. This natural environment is seen as our 'Environment of Evolutionary Adaptation' (EEA) describing the qualities of the environment humans are adapted to live in. Plants were crucial as food resource, shelter and indication of water. Therefore we are presumably adapted to live in a natural environment (Grinde and Patil, 2009). Humans have only lived in urban environments, dominated with manmade objects, for a few generations (Maller et al., 2006). The modern societies differ from our EEA. The differences humans experience are referred to as 'mismatches', which can both be positive and negative. A positive mismatch is beneficial and increases our quality of life. For example sleeping on a mattress instead of on the ground. A negative mismatch, in turn, decreases our quality of life. For example the absence of natural elements in daily life, proven by many studies that researched the psychological effects of nature (Grinde and Patil, 2009). It is difficult to describe how nature effects the mind. It influences both the conscious and the subconscious part of the brain. It doesn't matter if the person is focused on or is interested in plants, the present of nature will influence the person anyway (Grinde and Patil, 2009) (see figure 2.5).

Fig. 2.5 Biophilic design in architecture (AD, 2015).

Fig. 2.6 Savanna setting (Turkanabasin, 2011).

Theories underlying the Relation between Nature and Mental Health

Research emphasizes and explains the relation between environment and mental health. The last decades, two theoretical perspectives have been leading for this research: Stress Reduction Theory (SRT) developed by Ulrich and Attention Restoration Theory (ART) developed by Kaplan (Joye and van den Berg, 2018; Marcus, 2018). Another theory, the Prospect-Refuge Theory (PRT), is at the base of almost all landscape designs (Hudson, 1992). This theory explains how humans experience safety in an environment. The theory is developed by Appleton (1975) and attempts to explain the relationship between humans and their habitat, which was originally a natural environment and not an urban environment (Peschardt et al, 2016). The three theories are described shortly in this paragraph and more thorough in the literature study.

The *Prospect-Refuge Theory* explains that how survival instinct influences humans' environmental preferences and experience of safety, influenced by the possibility of prospect and refuge. Humans avoid intuitively environments threatening survival and prefer to have a clear view (prospect) without being seen and protected from potential hazards (refuge). The landscape of a savanna, open grassland with scattered trees, is a universally preferred setting, because of the right division of openness (prospect) and places to hide (refuge) (Marcus, 2018) (see figure 2.6).

The *Stress Reduction Theory* explains the stress reducing effect of nature. Four elements are important to generate this stress reducing effect: sense of control, positive natural distraction, physical movement and social support (Marcus, 2018; Ulrich 1991). Sense of control refers to the ability of people to escape a stressful environment physically or mentally. Positive natural distraction refers to a distraction that blocks stressful thoughts. Physical movement refers to the possibility to exercise in an environment. Social support refers to give someone a sense of belonging to a social group or network (Marcus, 2018).

The *Attention Restoration Theory* explains the restorative effect of nature when people are mental experiencing fatigue. Four elements are important to restore from such fatigue: being away, soft fascination, extent and compatibility (Kaplan, 1995; Marcus, 2018). Being away refers to the sense of being separate from one's usual thoughts and concerns, which can be both a

conceptual and a physical transformation. Soft fascination refers to the attention of an individual being held without requiring any effort or focus. Extent refers to the feeling of being engaged with the environment, where it is important that one feels comfortable and is able to explore. Compatibility refers to the feeling of joy one should have in an environment (Kaplan, 1995; Marcus, 2018; Positive Psychology Program, 2018).

Experiments underlying the Relation between Nature and Mental Health

There is a profound body of research based on the theories described before. Especially experimental research has been done to proof the recovering effect of nature on humans mental health. During the experiments a group of healthy volunteers has been inducted with stress. Afterwards, one part of the group has been exposed to a natural environment and the other part to an urban environment, where the volunteers exposed to the natural environment recovered faster (Joye and van den Berg, 2018).

Many experiments have been done in a hospital environment, to explore the influence of natural environments on the recovery and the health outcomes of patients. Patients with a view on nature from their window: needed less pain medication, recovered faster, were more satisfied and had less postoperative complications (Grinde and Patil, 2009; Maller et al., 2006; Marcus, 2018) (see figure 2.7). Besides, patients in a waiting room of a hospital felt less stressed when viewing nature from a window, or a picture of nature on the wall (Ulrich, 1991) (see figure 2.8).

Experiments have been conducted in a few other environments as well. For example, at a university students who viewed nature scored better on a test than those without a natural view (Maller et al., 2006). Another example, in a work environment employees with a view on trees and flowers found their job less stressful, reported fewer illnesses and headaches, and were more satisfied with their job than employees with a view on a built environment (Maller et al., 2006). Some other experiments have been done in the living environment of a neighbourhood. For example, more greenery in a neighbourhood resulted in a longer life span and less suicides. Another experiment showed that elderly live longer when living close to a park (Nisbet and Zelenski, 2014).

Fig. 2.7 View on greenery from a window (Wikimedia, 2014).

Fig. 2.8 Nature painting in a waiting room (Het Groene Medicijn, 2019).

2.3 KNOWLEDGE GAP

A few knowledge gaps can be identified.
First, there is a lot of knowledge and proof available regarding the stress reducing and restorative effect of nature. It underlies and emphasizes the relation between nature and mental health. This knowledge could be very useful to reduce the amount of burn-outs by preventing high stress levels in a work environment. Unfortunately, it is all very theoretical and both practical and spatial implications are lacking. Besides, the conducted experiments were mainly focused on the view of greenery, since the visual experience of plants has a bigger impact than the scent for example (Grinde and Patil, 2009). Clues how this greenery should be designed on eye-level, when being outside, remains unclear.
Second, the concept of healing environment acknowledges the relation between nature and health. Commonly, healing environments are linked to healthcare facilities. Most researches and experiments have been done in a hospital environment and there is plenty of evidence of the healing qualities of nature in relation to patient recovery. However, there are more environments that need this healing environment concept. As discussed before, work environments are particularly in need of a healing environment which reduces stress and restores the mental state of people throughout the day.
The goal is to combine the key aspects: work environment, nature and mental health. The focus is on the development of practical and spatial design principles for a work environment, and the implementation of the principles in a design in order to create a healthy work landscape (see figure 2.9).

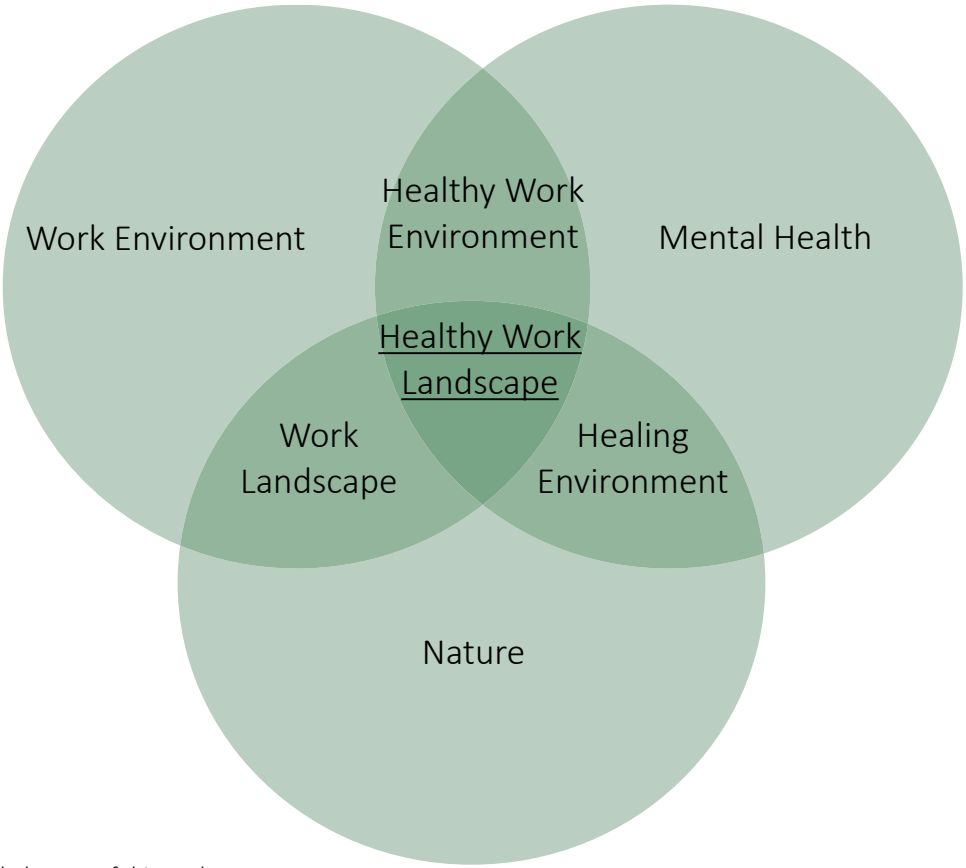


Fig. 2.9 Knowledge gap of this study.

3 RESEARCH DESIGN

3 RESEARCH DESIGN

3.1 PROBLEM STATEMENT

The relation between nature and mental health has been researched thoroughly, but lacks clear operationalisation. Research stays theoretical without offering design tools. Furthermore, the topic is often related to healthcare facilities, whereas other environments need this healing aspect as well. A shift towards other environments, such as the work environment proposed in this study, should increase the awareness of the relationship between nature and mental health, which is not only useful for patients. In this thesis, the focus is on the outdoor environment in workplaces. The environment should contribute to the mental health state of employees by reducing stress and restoring their attention in order to prevent burn-outs.

3.2 RESEARCH OBJECTIVE

Within this study there are two objectives to achieve.

Objectives

1. Expand the knowledge on the healing effects of nature by developing design principles for healthy work landscapes.
2. Propose a design for a work environment with the potential to become a healthy work landscape.

The first objective is a more general one. The design principles should be applicable to every work environment, in order to turn it into a healthy work landscape. In this way, all work environments can profit from this thesis and not only the case study. The case study is purely to give an example how the design principles could be implemented by means of a design, which is included in the second objective. The design serves as inspiration for other work environments. An important note is to make concerning the word 'potential'. After the design is made, it is important to monitor the effect of the design on the employees, through gathering evidence whether the design is supporting mental health.

3.3 RESEARCH AND DESIGN QUESTIONS

The design question for this thesis is related to the second objective. However, the first objective is needed as input.

Design Question

How can the Novio Tech Campus in Nijmegen become a healthy work landscape for employees?

The aim is to find out how the work environment can be developed towards a healthy work landscape.
First, design principles are set up, in order to implement them in the work environment. The design principles are the outcome of research question one and are related to the first objective.
Second, it is important to generate an understanding of the current outdoor work environment at the Novio Tech Campus, regarding physical layout and health considerations. Besides, it is key to gather opinions of the employees of the campus, to discover how they experience their current outdoor work environment. This is covered by research question two.
Eventually, the goal is to decrease the amount of burn-outs by offering a healthy work landscape, where employees can experience stress reduction and attention restoration in everyday (work)life.

Research Questions

1. Which design principles can be developed to support mental health in a work landscape?
2. What is the current situation of the outdoor work environment of the Novio Tech Campus in Nijmegen?

Two sub research questions are formulated in order to answer the first research question.

Sub Research Question

1. Which spatial factors influence mental health?
2. Which outdoor activities and preferences are important for developing a work environment?

Research on the existing information regarding the relation between nature and mental health is needed for the first sub research question. It is key to discover the spatial factors related to this relationship, in order to translate the theory into practice. Besides, research on the employees' wishes is important to make the design principles specific for a work environment. This is covered by sub research question two.

3.4 RESEARCH STRATEGY

Worldview

The research strategy is informed by a certain worldview or paradigm. This research is conducted from a constructivist worldview, meaning that the research is shaped by own interpretation and background of the researcher. Besides, it is important to understand the case thoroughly and gather information personally by visiting the case. Meaning is generated from the data, collected in the field, and collecting participants meaning is key (Creswell, 2014).

Qualitative Case Study

The study is a qualitative research, since the main goal is to understand and explore a problem. The problem is to understand the healing effects of nature and to explore design principles contributing to that effect. An important aspect of a qualitative research is the researchers own interpretation of the analysed data, consisting of text and images (Creswell, 2014).

The study design is a case study, since the goal is to focus on a single concept or phenomenon and to develop an in-depth analysis (Creswell, 2014). The main goal is to design a healthy work landscape for a specific area in Nijmegen. A case study is useful when exploring an area which one wants to understand (Kumar, 2014).

Research Strategy

The research strategy is a combination of 'research for design' and 'research on design'. Research for design is a strategy where knowledge is generated to inform the design (Lenzholzer et al., 2013). In this study, the gained knowledge is translated into design principles and a better understanding of the case. Both are necessary to inform the design. Research on design is a strategy where research is conducted on finished design products and/or the design process (Lenzholzer et al., 2013). In this case the research will be carried out on the models, the design principles, and the final design which will be evaluated and discussed.

3.5 RESEARCH METHODS

Different research methods are used, even as a combination of primary and secondary data. Primary data is collected by the researcher oneself and secondary data is extracted from other researchers or documents (Kumar, 2014).

Literature Study

A literature study on earlier research, secondary data, is conducted to answer the first sub research question. Especially peer-reviewed articles about the theories (prospect-refuge theory, stress reduction theory and attention restoration theory) are used. Besides, articles regarding researches using these theories are included as well. The literature study gives a thorough understanding concerning the different aspects used in the three theories. The information is brought together and is summarised (see paragraph 4.1). Words indicating a spatial implication, or words important to include in a design, are marked. The outcome of the literature study is a table with spatial factors, key to design an environment that reduces stress and restores attention. The table is important input to set up the design principles.

Questionnaire

A questionnaire is set up to obtain primary data. The questionnaire is e-mailed to the employees working on the Novio Tech Campus in Nijmegen. Advantages of a questionnaire are the accessibility to a large population and the anonymity. Disadvantages are the need for clear questions understandable to all respondents and the low response rate which reduces the

sample size (Kumar, 2014). Since 70 companies and 3400 employees are involved with and/or established on the Novio Tech Campus, I chose a questionnaire to gather as many opinions as possible. The main goal of the questionnaire was to gather descriptive and explorative data about the opinions of the employees, regarding their outdoor work environment. The questionnaire consisted of open-ended and closed questions. Polytomous variables were used for the closed-ended questions, rather than dichotomous, in order to gain explorative data (Kumar, 2014). Data obtained from the questionnaire is analysed in a descriptive way. The rest of the procedure and the content of the questionnaire is discussed in paragraphs 4.2 and 5.7. The full questionnaire is included in the appendix.

Consultation Nijmegen Municipality
The municipality of Nijmegen is making a strategic vision for the Novio Tech Campus. I had contacts with the urban planner of the municipality, Joost van der Zanden. The first meeting was at the campus, where he showed me around and told a lot about the history and the development of the campus. The second meeting was at the municipality in the centre of Nijmegen. We discussed the developed models. The consultation with Joost van der Zanden is primary data and was useful to obtain more inside information and to understand the current state of the plans for the campus.

Different studies and analyses are conducted to gain a thorough understanding of the case, which are essential before continuing with the design question.

Landscape Study and Analysis
In the landscape study and analysis the main data source are maps. These maps are studied on different themes as the green structure and the infrastructure. Besides, the direct and larger context of the area has been included in the study as well. The results are several themed maps with accompanying text, helping to understand the case.

Document Study and Analysis
In the document study and analysis, different documents are studied. The documents contained information concerning the site itself, the development of the site as work landscape and the future plans. Some documents were provided by the municipality of Nijmegen. The document study resulted in a written text with some images.

Field Visit and Photo-analysis
Several fields visits have been done. On one of them I walked a route and took photo's along the way. This route with photo's is analysed to gain a good understanding of the area and the context. The result is a photo series with accompanying text, a map of the walked route, and a map of the observations made along the route.

SWOT-analysis
A SWOT-analysis (Strengths, Weaknesses, Opportunities and Threats) is made as a more concluded part of research question two. In the SWOT-analysis all the previous methods, regarding the second research question, and their results are taken into account. A SWOT-analysis helps to give direction to the design.

Design
All the methods described before are used to answer the research questions, in order to answer the design question. An important part of the design phase is the development of models. The models are purely focused on the design principles and show the different possibilities within these principles. After the models are developed, they are evaluated on several aspects. Consequently, one model is chosen to develop further and to show how it can be developed towards a healthy work landscape.

The research strategy including the research methods are shown in figure 3.1.

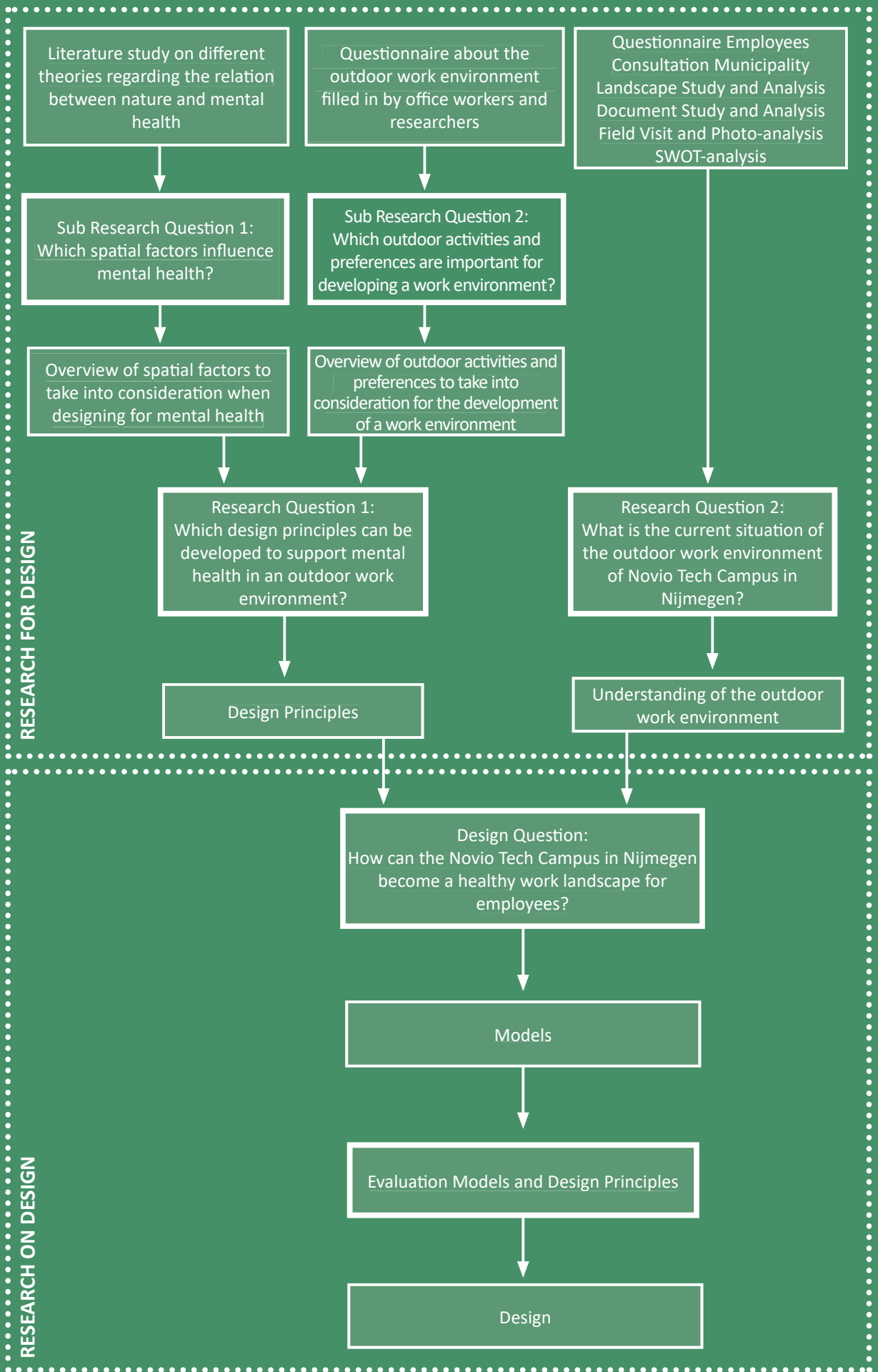


Fig. 3.1 Scheme of the research strategy and methods.

3.6 VALIDITY AND RELIABILITY

The validity and reliability are different for the research and design questions in this study.
Validity is the accuracy that is applied to a research process (Kumar, 2014). It refers to the plausibility and credibility of the results (Creswell, 2014). Whereas reliability is about giving the same results at another occasion (Kumar, 2014). It refers to the consistency of the research (Creswell, 2014).

The first research question, regarding the design principles, is meant to be applicable for other work environments. For this reason the reliability should be high. The principles should give the same result in other work environments. Since the principles are mainly based on literature study, the information is consistent and stable, increasing the reliability. The aspect that could lower the reliability is the input of the questionnaire that is filled in by employees working at the Novio Tech Campus. Assuming that employees of a work environment often have the same interest, the reliability is still high enough to make the design principles general applicable.
The same applies to the validity of the first research question. In the literature study triangulation is used, meaning that research is confirmed from different sources (Creswell, 2014). In this case different authors are consulted. Additionally, different theoretical perspectives are used to examine the subject. The more evidence, the higher the validity (Kumar, 2014). The validity of the questionnaire is ok, although it could be higher when more employees had responded.

The second research question and the design question are both related to the Novio Tech Campus. Because this part of the study is focused on one single case the reliability is poor. However, the case helps to understand the theory and the design principles. It is meant to show the possibilities of implementing these principles. Although, it is possible to repeat the steps for other work environment, because the procedure is carefully documented in this report.
The validity, however, will be high. Triangulation of methods and data sources is used, since the goal is to generate a broad understanding of the case. The results are credible, nevertheless it should be noted that the process is influenced by own interpretation and creativity as well.

4 DESIGN PRINCIPLES

4 DESIGN PRINCIPLES

4.1 SPATIAL FACTORS INFLUENCING MENTAL HEALTH

Introduction

Research emphasizes and explains the relation between environment and mental health. The last decades, two theoretical perspectives have been leading: Stress Reduction Theory (SRT) developed by Ulrich and Attention Restoration Theory (ART) developed by Kaplan (Joye and van den Berg, 2018; Marcus, 2018). Another theory, the Prospect-Refuge Theory (PRT), is at the base of almost all landscape designs (Hudson, 1992). This theory, developed by Appleton (1975), attempts to explain the relationship between humans and their habitat, that was originally a natural environment and not an urban environment (Peschardt et al, 2016).

All three theories are important to answer the first sub research question *'Which spatial factors influence mental health?'*. First, the theories and their components are explained. The marked words in the text indicate a spatial implication important for design. Second, the relationship between the theories is elaborated. Finally, the design implications regarding the theories are discussed, by creating a table that connects spatial factors with the components. This table is an important step for developing the design principles.

Prospect-Refuge Theory

Appleton (1975) explains that humans' survival instincts influences the environmental preferences and the experience of safety. This experience is influenced by the possibility of refuge and prospect (see figure 4.1).

Refuge

Humans prefer to have the possibility of refuge, **to shelter** from the hazards. The hazards have changed over the years. Where it used to be more animate hazards, such as wild animals, it has shifted more to inanimate hazards, such as

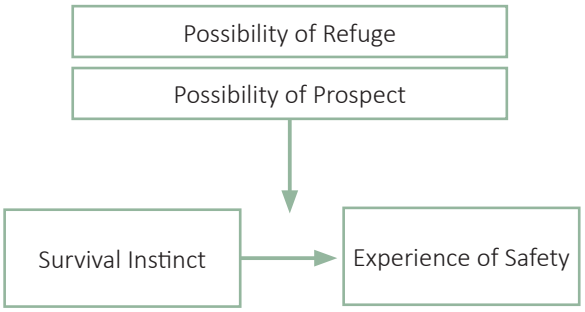


Fig. 4.1 Scheme of the prospect-refuge theory.

the **weather** or **noisy surroundings** (Hudson, 1992). Likewise, the **amount of people** can be a hazard as well. Too many people can make a place feel crowded, whereas too few people can make a place feel unsafe (Nordh and Østby, 2013). Regarding weather hazards: a **greenhouse**, a **gazebo** or a **pavilion**, are good opportunities for shelter when being outside. Because when one is cold or wet the ability to relax, and thus to recover, is low (Pálsdóttir et al., 2018). The opportunity to **distance oneself** from a noisy and disturbing surroundings contributes to recover from mental fatigue (Peschardt et al, 2016). Taking distance could be done by adding **screening** or **barriers blocking the view.**

Prospect

Besides the opportunity of shelter, the opportunity of prospect is important. Humans need **visual control** over the environment to detect dangers (Grahn and Stigsdotter, 2010). Furthermore, vision is the most important of all human senses. Almost 90% of the information stored in our brain is derived through sight (Hudson, 1992). Therefore, we prefer **vista's**, **clear views**, and **open and plane areas** with a view (Grahn and Stigsdotter, 2010).

The possibility of refuge and prospect are closely related. For example, humans prefer an **enclosed environment** where they can watch others

without being seen (Grahn and Stigsdotter, 2010). The possibility to see others without being seen or disturbed, affects people's ability to relax and influences restoration positively (Appleton, 1975; Nordh and Østby, 2013). Humans avoid intuitively environments threatening survival. This phenomenon could be explained by the aspects of refuge and prospect which are key to PRT. In short, humans prefer to have a clear view (prospect), without being seen (refuge) and without potential danger (hazard) (Marcus, 2018).

"The ability to see without being seen is conducive to the exploitation of environmental conditions favorable to biological survival and is therefore a source of pleasure" (Appleton, 1975, p. 270)

Stress Reduction Theory

Ulrich explains the stress reducing effect of nature. Stress recovery ensures a positive change in psychological state, behaviour and performance (Ulrich et al., 1991). Stress is not an illness per se, because stress reactions are natural and necessary. Stress triggers the fight-or-flight reflexes and sharpens the senses (Grahn and Stigsdotter, 2010). Stress is a physiological process in which a human responds to a situation challenging or threatening well-being (Ulrich, 1991). If these situations cumulate it can cause mental and physical unease.

The theory provides four components, important in the environment to experience this stress reducing effect: sense of control, positive natural distraction, physical movement and social support (Marcus, 2018; Ulrich et al., 1991) (see figure 4.2).

Sense of Control

Sense of control contains two main aspects. First, it refers to the possibility to **escape** a stressful environment **physically** and/or **mentally**. In addition, the escape can be passive (looking out a **window**) or active (going outside for a **walk**). In case of going outside the feeling of escape is increased by **greenery** that **closes off** the disturbing surroundings and **distracts** from worrisome thoughts. Sometimes, even the **awareness** of a garden, the possibility to escape, can be enough to relieve stress (Ulrich et al., 1991; Marcus, 2018). Second, sense of control refers to the **possibility of choice** increasing the

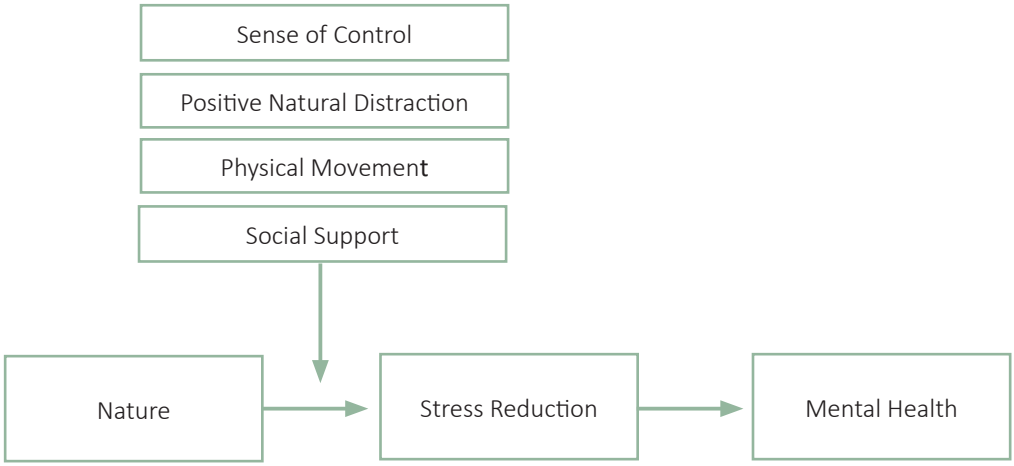


Fig. 4.2 Scheme of the stress reduction theory.

attractiveness of a place (Pálsdóttir et al., 2018). People like to be able to choose. For example, the possibility to **wander** (more mysterious or challenging pathway) or the possibility to follow a **clear pathway** leading to a clear destination (proper way-finding). Besides, choices regarding: **sun vs. shadow, open vs. enclosed, sitting private vs. social gathering, different things to look at, various opportunities for enjoyment,** all facilitate to a sense of control.

Positive Natural Distraction
Positive natural distraction refers to a distraction that blocks stressful or worrisome thoughts and is effortless (Ulrich et al., 1991). Senses, such as **sight**, **smell** and **sound**, are important to address (Marcus, 2018). Because they are linked more to emotional than cognitive appreciation. This component has a lot in common with the **component 'soft fascination'** as part of the ART, discussed a little further.

Physical Movement
Physical movement refers to the **possibility to exercise** in an environment. The exercise can be **intense**, however **mild** movement can be enough to reduce stress as well (Ulrich et al., 1991). An attractive environment, providing opportunities to exercise, such as **walking loops**, a **ball court** or a place where **yoga** or other mental health programs can be given, can motivate people to go out.

Social Support
Social support refers to giving someone a sense of belonging to a social group or network (Marcus, 2018; Ulrich et al., 1991). Features **promoting gathering**, such as **tables**, **benches**, and a **cafe**, can stimulate this component of social support in an environment (Peschardt and Stigsdotter, 2014). Furthermore, the configuration of seating is of influence as well. Seats facing each other or moveable seats allow two or three people to talk (Marcus, 2018). Besides **small-scale seating places**, larger spaces are important for **group gatherings** or **group activities**. It is important that the environment offers suitable and enough places to sit which are **easily accessible**, where people can meet and find each other, **amuse themselves** and **watch others** (Grahn and Stigsdotter, 2010).

Attention Restoration Theory
Kaplan explains that humans get mentally fatigue during the day and restoration from this fatigue is offered by natural environments (Kaplan, 1995). It requires effort for humans to concentrate. Doing so, they use the psychological mechanism 'directed attention'. Moments of restoration are needed throughout the day and are important to be able to cope with distractions, challenges and stressors. Prolonged periods of directed attention without restoration can lead to an increase of irritability, impatience and unhappiness. Furthermore, mental fatigue can lower an individual's judgement and ability to concentrate (Marcus, 2018).

The theory provides four components important in the environment to experience this restorative effect: being away, soft fascination, extent and compatibility (Kaplan, 1995) (see figure 4.3).

Being Away
Being away refers to the feeling of being separate from one's usual thoughts and concerns. It can involve both a **conceptual** transformation and a **physical** transformation (Kaplan, 1995; Marcus, 2018; Positive Psychology Program, 2018). This is in line with the first part of the component 'sense of control' of SRT. Key is the creation of psychological distance from the demands and routines where the directed attention capacity is used (Nordh et al, 2009). **Stepping outside** for a deep breath of fresh air can already be helpful, and the opportunity to **wander** even more (Marcus, 2018). Creating this feeling is strongly influenced by **grass, bushes and trees** (Nordh et al, 2009).

Trees and bushes can offer some **enclosure** and distraction, creating the opportunity to feel away, physically as well as psychologically, and entering a whole other world (Kaplan, 1995; Nordh and Østby, 2013). Additionally, it can **block** the connection to the surroundings that influences the feeling of being somewhere else negatively. Likewise, an **entrance** or a **gate** can create the feeling of entering another world and strengthen the feeling of being away (Pálsdóttir et al., 2018).

Soft Fascination

Soft fascination refers to the attention of an individual being held without requiring any effort or focus (Kaplan, 1995; Marcus, 2018; Positive Psychology Program, 2018). Elements, such as **flora and fauna**, are very suitable to capture the attention effortless (Kaplan, 1995; Nordh et al, 2009). The underlying thought is that humans have an intuitive attraction to living things that is described as 'biophilia' (Grahn and Stigsdotter, 2010; Marcus, 2018). The **ability to explore** is one way to experience these environmental elements capturing the mind (Nordh et al, 2009). Another way is the opportunity to **sit** in an **enclosed space** gazing upon the **natural elements** or gazing upon the elements through a beautiful **view**. Besides, **sensory engagement** is important for distraction as well. For example: active engagement with soil and other natural materials as in an **allotment garden** (to feel, to taste and to smell), **motion of the leaves** or **birds songs** (to hear), the **play of light**, **clouds** and **sunset** (to see) or the **scent of nature** after a rainy day (to smell) (Marcus, 2018). Two examples containing several element of soft fascination are given by a study of Pálsdóttir et al. (2018). First, a **large pond** is perceived as a calm and tranquil place, to hear the sound of water running, to see the fishes in the pond and to see the sky reflecting in the water, the possibility to dip one's feet in the water and to feel its freshness. Second, a **forest garden**, to smell grass, taste the berries, hear the wind and bird twitter and see the tracks from animals. Besides elements that provide soft fascination, there are elements needed which do not distract people from soft fascination. In this **natural screening** for example can be helpful to **protect** from the **noisy** and **disturbing surroundings**. Sounds from and view of traffic or construction activities could be very unpleasant and distract people in a negative way (Peschardt et al, 2016). A solution to reduce noise could be to mask negative sounds by adding **positive sounds** as distraction, such as the sound of water from a **fountain** (Marcus, 2018; Nordh and Østby, 2013).

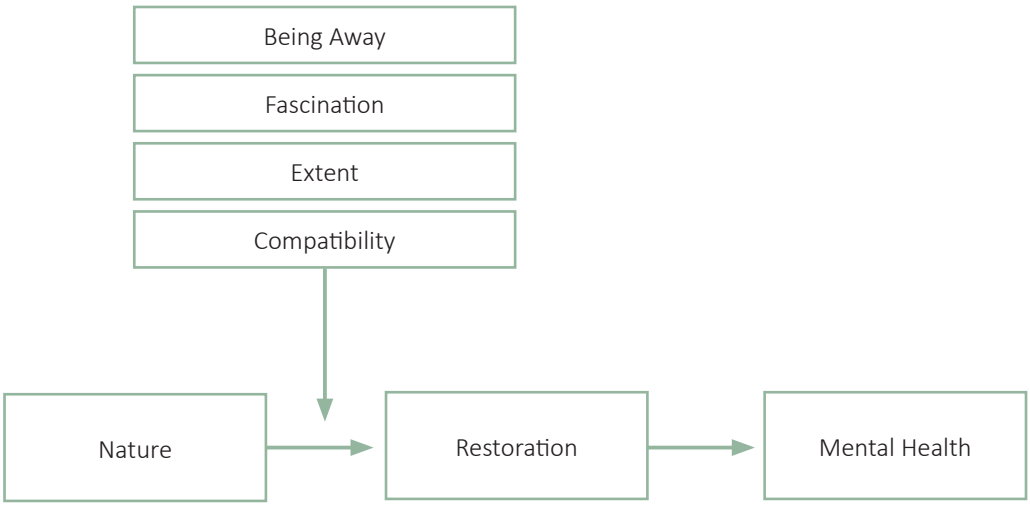


Fig. 4.3 Scheme of the attention restoration theory.

Extent

Extent refers to the feeling of being engaged or immersed with the environment. Important is that one feels **comfortable** and is able to **explore** (Kaplan, 1995; Marcus, 2018; Positive Psychology Program, 2018). Besides, a certain degree of **coherence** is important (Nordh et al., 2009). A place is coherent when it is **orderly** and **organized** into clear areas, where people are able to make sense of a place (Kaplan, 1995; Marcus, 2018). This aspect is closely related to the second part of sense of control from SRT where 'proper way-finding' is mentioned. Thus a **clear layout** is needed, however it should be **complex** as well: **rich in plants**, places to **sit** and **paths to wander** (Marcus, 2018). **Legibility** can help people to **make sense of a place**. Memorable components, or icons, can help people to remember and to navigate through a place (Marcus, 2018). However, as said before, the ability to explore is important as well. To achieve this a certain **'mystery'** could be added, such as **curving pathways**, **not being able to see what is coming next**, and a glimpse of an object that attracts the visitor (Marcus, 2018). When an area is small, pathways can be designed in such way that a small area seems much larger (Kaplan, 1995). The possibility to explore and take a **walk** can motivate people to go out. Furthermore, applying both legibility and mystery give humans a **choice**. This component has a lot in common with the second part of the component 'sense of control' of SRT.

Compatibility

Compatibility refers to the feeling of joy one should have in an environment. It is important that the individual **chooses to be out** in a particular environment (Kaplan, 1995; Marcus, 2018; Positive Psychology Program, 2018) and that there is a **match** between the desired activities of a person and the activities offered by the place (Kaplan, 1995; Nordh et al., 2009). For this component it is important to know the desired activities of the employees in their work environment. This is covered by sub research question 2 *'Which activities are important for developing an outdoor work environment?'.* When users of a place can experience something compatible with their **preferences**, the feeling of **place attachment** will be higher (Peschardt and Stigsdotter, 2014). Place attachment refers to the bonding between a physical environment and the user and influences the experience of the environment. A study by Lottrup et al. (2012) has indicated some work related outdoor activities. Within this study 'having lunch' was the most commonly reported activity. This is not surprising since it is the longest and most formalized break during a workday for most office workers.

Relationship between the Theories

The three theories are related to each other (see figure 4.4). The PRT describes what is needed to experience safety in an environment. As already mentioned in the explanation of PRT, the feeling of safety is important in relation to restoration and stress reduction. Therefore this theory is included in this research. When people feel safe and at ease, they are more relaxed and thus more likely to restore.

The components of SRT and ART have some commonalities, although the starting point of both theories is different. SRT is focused on stress and ART is focused on mental fatigue. Both are important in relation to burn-outs, and thus important for this research. The difference is that mental fatigue doesn't need a stressor or a challenge. Getting mental fatigue will happen anyway, because focus and directed attention are used during a regular workday, for example of an office worker or a researcher (Kaplan, 1993). Stress is the consequence of the experience of stressors and challenges, which can happen during the workday. The amount of stress can differ every day. The overlap is that mental fatigue can lead to be stressed sooner (Kaplan, 1993) and both can be the cause of a burn-out.

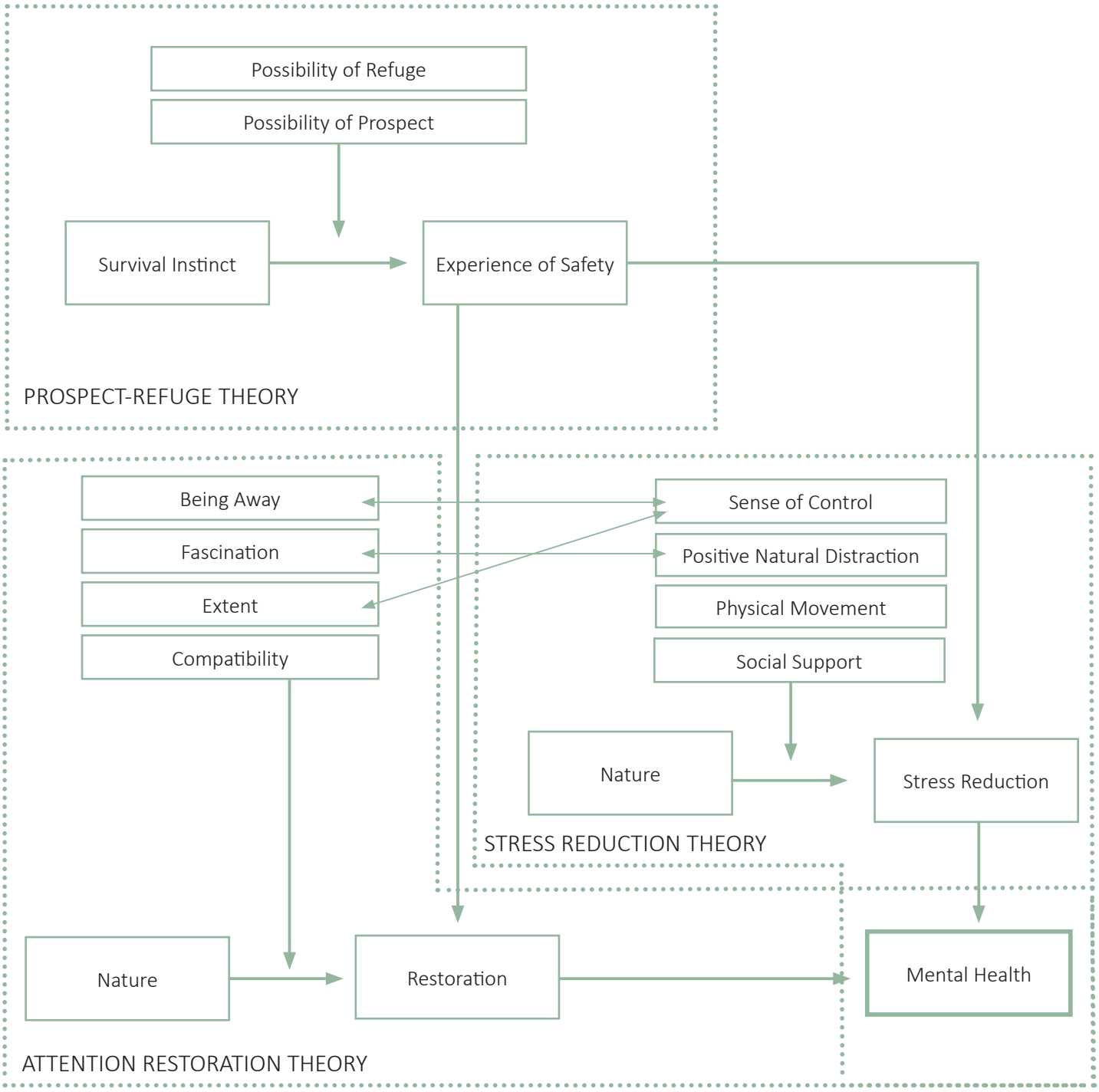


Fig. 4.4 Relationship between the theories.

Design Implications

The components of the theories have their own design implications. To make this clear, different spatial factors are distinguished based on the text above where every component is explained. This is brought together in one table (see figure 4.5).

From this table necessary spatial factors to achieve a certain component can be extracted. In addition, one spatial factor addresses two or more components of the theories. Because the components have some commonalities. For example, the components 'positive natural distraction' and 'soft fascination' need the same spatial factors to achieve their effect of effortless attention. Same applies for 'sense of control (1)' and 'being away', as already indicated in the text before. The components 'sense of control (2)' and 'extent' refer both to the ability of choice and addresses therefore all spatial factors.

It also works the other way around, for example the spatial factor 'enclosed space' applies to a number of components. Enclosed space is needed to protect people from disturbing surroundings (refuge), to give them the feeling of being somewhere else (sense of control (1) and being away) and to distract someone's attention (positive natural distraction and soft fascination).

The spatial factors essential to achieve compatibility differ per type of environment, because there should be a match between the user and the place. For this research the spatial factors are derived from the questionnaire, discussed in the next paragraph. This questionnaire is filled in by the employees working at the Novio Tech Campus, since they are the main users of the space.

There are some conflicts between the components. Some components need 'enclosed space' and others 'open space'. Or some components need 'clear routes' and others 'exploring routes'. This doesn't mean they can't coexist. Just different spaces, and thus choices, are needed. Matching the component 'sense of control (2)' and 'extent' where the ability of choice is emphasized. In addition, there is variability between people and their preferences at a certain moment, emphasizing the need for different spaces as well. These contradictions are important to keep in mind when setting up the design principles.

	Spatial Factors									
	space		sight		routing		program			
Components	enclosed	open	blocked	view	clear	exploring	furniture	greenery	possibility to be active	possibility to walk
Refuge	■		■							
Prospect		■		■						
Sense of Control (1)*	■		■			■		■		■
Sense of Control (2)**	■	■	■	■	■	■	■	■	■	■
Positive Natural Distraction	■		■	■		■	■	■		■
Physical Movement									■	■
Social Support		■			■		■		■	
Being Away	■		■			■		■		■
Soft Fascination	■		■	■		■	■	■		■
Extent	■	■	■	■	■	■	■	■	■	■
Compatibility										

* refers to the ability to escape

** refers to the ability of choice

Fig. 4.5 Table of the theoretical components in relation to the spatial factors.

4.2 OUTDOOR ACTIVITIES IN A WORK ENVIRONMENT

Introduction

In the previous paragraph several components are explained, which are needed to experience stress reduction and restoration in an environment. One of these components 'compatibility' needs some further research, since this component is dependent on the type of environment and the users. A questionnaire is send to employees working at the Novio Tech Campus (NTC). The goal of the questionnaire was to find out the employees' thoughts regarding: their current work environment, how they use the place, what they want in the environment and the desired activities. All in order to answer the second sub research question *'Which activities and preferences are important for developing an outdoor work environment?'* and complete the scheme.

Questionnaire

The questionnaire contained of 12 questions, both multiple choice and open (see appendix). A few questions were based on a study done by Lottrup (2012), researching how the outdoor work environment is used by office workers. The questions in the questionnaire addresses the use of the outdoor environment, the outdoor activities, the obstacles for going outdoors and the characteristics of the outdoor environment. Besides addressing the current outdoor environment, preferences and wishes were asked as well. The latter one is the most important for this part. The opinions of the current outdoor environment are discussed more thoroughly in chapter 5 as part of the case study.

Procedure

The questionnaire was send by e-mail to reach all employees as much as possible. First, around 50 companies established at NTC were contacted. I explained to them my research and asked whether it was okay to send them the questionnaire. 18 Companies responded, of which 11 responded positively. Those companies received a second e-mail including the digital link to the questionnaire. They forwarded the e-mail internal to all employees. The digital link to the questionnaire made it easy for participants to respond, and for me to keep track how many already had responded. E-mail surveys increase the speed of collecting data, however makes it easy to delete the e-mail when it is not convenient. Furthermore, the questions should be short and clear, otherwise people won't make any effort (Kumar, 2014).

Respondents

After two weeks 30 employees responded to the questionnaire. Because the e-mail was forwarded internal, I wasn't able to indicate the total of eligible respondents and to conclude on the response rate. A low response rate weakens the ability to generalize to the population (Kumar, 2014). 30 Respondents aren't many, but sufficient enough when gathering opinions and more explorative and descriptive data.

Results

The questionnaire indicates that all respondents had an opinion about the importance of nature for one's mental health (question 1). No one answered 'neutral' and 90% find nature important or very important. This is an interesting starting point, since most of them are probably aware of the mental health effects of nature. More than half indicate the need for several moments of rest during a workday (question 3), showing again the importance of this study.

A few activities are preferred the most: have lunch, drink coffee or similar, relax, go for a stroll, and enjoy sunshine, flowers, birdsongs or similar (question 6). These activities could considered compatible with the spatial factors: furniture, ability to walk, and greenery.

The question *'What would you want in the outdoor environment at your workplace?'* is asked twice. Once as closed-ended question (question 7) and once as open question (question 12). In both cases seating places and greenery are most desired. In the closed-ended question the possibility to take a walk is most desired as well. In these answers the wish for furniture and the possibility to walk is mentioned again. In the open question 'greenery' is mentioned by many different words: plants, flowers, trees, grass, nature, bushes, and small parks. This underlines the spatial factor greenery. Other answers are agreed or mentioned by less respondents and therefore less significant for the component 'compatibility'. Nonetheless, they can be kept in mind, but they won't be included in the table.

What I found remarkable is the not excessive wish of working outside. The opinions are divided in 30% would like to work outside, 40% is neutral, and 30% doesn't want to work outside (question 6). Furthermore, only one respondent mentioned the wish of power outlets (question 12). An explanation could be that the content of the work doesn't allow to work outside, or that employees want to be outside when not working and use the outdoor environment as a non-work zone. Nonetheless, I think offering the possibility is still a good idea, however there is no need for designing many outside work stations.

Concluding, the spatial factors 'furniture', 'greenery' and 'ability to walk' are included in the table for the component compatibility (see figure 4.6). The table is finalized and can be used as input for the design principles in the next paragraph.

	Spatial Factors									
	space		sight		routing		program			
Components	enclosed	open	blocked	view	clear	exploring	furniture	greenery	possibility to be active	possibility to walk
Refuge	■		■							
Prospect		■		■						
Sense of Control (1)*	■		■			■		■		■
Sense of Control (2)**	■	■	■	■	■	■	■	■	■	■
Positive Natural Distraction	■		■	■		■	■	■		■
Physical Movement									■	■
Social Support		■			■		■		■	
Being Away	■		■			■		■		■
Soft Fascination	■		■	■		■	■	■		■
Extent	■	■	■	■	■	■	■	■	■	■
Compatibility							■	■		■

* refers to the ability to escape
** refers to the ability of choice

Fig. 4.6 Final table of the theoretical components in relation to the spatial factors.

4.3 DESIGN PRINCIPLES SUPPORTING MENTAL HEALTH

Introduction

In the previous paragraphs a table is set up, explaining the components of the theories and the corresponding spatial factors. It is important to understand the spatial factors to be able to use them as a designer. Therefore definitions, spatial characteristics and examples are discussed for each factor, in order to set up the design principles and answer the first research question *'Which design principles can be developed to support mental health in an outdoor work environment?'.*

Spatial Factors

Space

A space is defined by an area unit and a three-dimensional boundary (Loidl and Bernard, 2003). It is a place where people stand or move (Vroom and Ettema, 2005) (see figure 4.7).

Fig. 4.7 Area unit + three dimensional boundary = a space

Both an area unit and a boundary are not always needed. Three sides of boundaries produce a very clear spatial situation even without an area unit (see figure 4.8). The area unit can strengthen this even more, although it is not necessary to define a space (see figure 4.9). When closing the space with four sides of boundaries, an area unit is not needed anymore, whereas it no longer needs to distinct from the surroundings (see figure 4.10).

Fig. 4.8 Three boundaries without area unit, experiences as a space.

Fig. 4.9 Three boundaries with area unit, strengthens the space.

Fig. 4.10 Four boundaries, closes the space.

An area unit doesn't always need boundaries to be experienced as a space. It is important that the area unit differs enough from the surroundings. The higher the contrast, the more an area is seen as coherent. This contrast can be achieved by difference in material or height for example (see figure 4.11 and 4.12).

Fig. 4.11 Area unit distinguished by material.

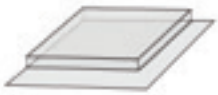


Fig. 4.12 Area unit distinguished by height.

The experience of a space, as enclosed or open, is determined by the amount, the height and the distance of the boundaries. For an enclosed space at least three out of five sides should have a boundary (Loidl and Bernard, 2003; Vroom and Ettema, 2005). These boundaries can all three be vertical, but also two vertical and one horizontal that blocks the sky (see figure 4.13 and 4.14). For example, walking through a tree lane with big, closed crowns, or sitting under a tree grid with a closed roof.

Fig. 4.13 Three vertical boundaries.

Fig. 4.14 Two vertical boundaries and one horizontal boundary.

The spatial effect of the boundary depends on the distance of the viewer to the boundary and the height of the boundary itself. The distance and height determines the ratio of boundary and sky (see figure 4.15-4.17). The greater the distance to the boundary, the more strongly the sky dominates the landscape. When the sky is dominant, the space is experienced more as an open space. When the boundary is dominant,

and the sky is not or less visible, the space is experienced as an enclosed space (Loidl and Bernard, 2003).

Fig. 4.15 Ratio boundary-sky, 1:1

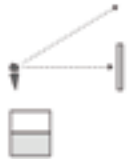


Fig. 4.16 Ratio boundary-sky, 2:1

Fig. 4.17 Ratio boundary-sky, 4:1

Besides, the height of a boundary in relation to eye-level is important. A height of 100-120 cm ensures a strong division for children and people who are sitting, however it is not totally isolated from the surroundings (see figure 4.18). A height over 150 cm gradually shifts the effect to isolation and privacy and creates a strong sense of spatial separation (Loidl and Bernard, 2003) (see figure 4.19).

Fig. 4.18 Boundary 100 cm high

Fig. 4.19 Boundary 150 cm high

Enclosed space

An enclosed space is a space with limited openings for entry and exit. The goal is to separate from the surroundings. An enclosed space can protect from a disturbing surroundings, it can give the feeling of being in a different place and it can help to distract of everything that happens outside the enclosed space. Spatial boundaries can be uniform and solid, such as walls, fences and hedges. But also more complex, created by arranging different elements along a boundary line, such as trees and shrubs or plant borders (Loidl and Bernard, 2003). A few examples are shown in figure 4.20-4.23.

Fig. 4.20 Three complex vertical boundaries, trees and shrubs.

Fig. 4.21 Four solid and uniform vertical boundaries, hedges.

Fig. 4.22 Two vertical and one horizontal boundary, tree lane.

Fig. 4.23 Two vertical and one horizontal boundary, pergola.

Open space

An open space is a space distinctive, but connected with the surroundings. An open space gives overview and makes sure people can control the place visually. Open spaces are good places to gather with other people and play activities. An open space can consist of only an area unit, one or two higher boundaries, or one to four lower boundaries. A few examples are shown in figure 4.24-4.27.

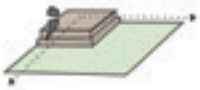


Fig. 4.24 Area unit with no boundaries, distinguished by height, a plateau.

Fig. 4.25 Area unit with low boundaries, grass field with some bushes around.

Fig. 4.26 Area unit with no boundaries, distinguished by material, a pond.

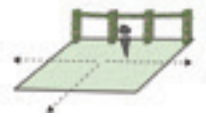


Fig. 4.27 Area unit with one high boundary, a pergola.

Sight

Sight is the ability to see and it means that one can look away (Vroom and Ettema, 2005). It gives the feeling of freedom. With an open sight there can be a nice view over the surroundings (see figure 4.28). Sight can be blocked when there is a boundary (see figure 4.29). The spatial characteristics of the boundaries, such as height and distance, are the same as the spatial characteristics of the boundaries that define space. However, in the case of 'sight' only vertical boundaries are included, whereas horizontal boundaries are not blocking one's view. In addition, 'space' is more focused on the place itself and sight is more focused on the relation with the surroundings (Loidl and Bernard, 2003).

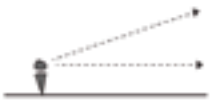


Fig. 4.28 Open sight by a view.

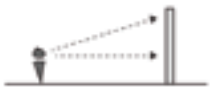


Fig. 4.29 Blocked sight by a boundary.

Blocked sight

When a sight is blocked by a boundary it creates a closed edge. A closed edge protects people from a disturbing surroundings, it closes people off and gives the feeling of being in a different place. Additionally, the edges are attractive places for people to walk and sit. Edges are always occupied first when people sit down in a park (Vroom and Ettema, 2005). Boundaries blocking a sight can be solid, but also more transparent (Loidl and Bernard, 2003). The height should be above eye-level, or in case of seating places a boundary of one meter can be enough for blocking sight and giving protection in the back. A few examples are shown in figure 4.30-4.33.

Fig. 4.30 Solid boundary, hedge.

Fig. 4.31 Solid boundary, shrubs and trees.

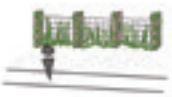


Fig. 4.32 Transparent boundary, fence with climbing plants.

Fig. 4.33 Transparent boundary, espalier.

View

When there is no boundary there is a sight, a view, over and a connection with the surroundings. A view gives people visual control over the environment. It makes people feel safe. Besides, a beautiful view distracts people from their ongoing thoughts. A view can just be a prospect over the surroundings. Further, a view can be framed or guided, then it is a vista. Vista's provide a view to a distant point along a line, through two lines or through an opening. Connecting a view to a distant point without framing it, is called a sight line. Vista's and sight lines help to anchor a place in its environment and thereby promote spatial cohesion. They help to control the space (Vroom

and Ettema, 2005). Furthermore, it can be helpful to add higher places to overcome boundaries or to achieve even a further view (Zwart, 2004). A few examples are shown in figure 4.34-4.37.

Fig. 4.34 Vista, framed view, a gate.

Fig. 4.35 Vista, guided view, a tree row.

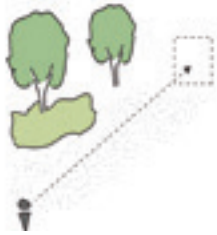


Fig. 4.36 Sight line, not framed or guided, open field with some greenery.

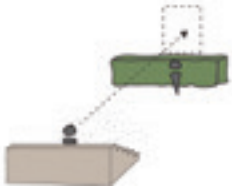


Fig. 4.37 View achieved by a higher space, a stand.

Routing

The routing in an area is the way an area is reached, entered and crossed. A route makes the place accessible and experiencable. People are always looking for a route to achieve their goal. This goal can be several things, such as a building, a bench or a view (Vroom and Ettema, 2005). People instinctively take the most direct route to their goal (see figure 4.38). For example, office workers walking to their building when arriving. However, when strolling it is not the aim to go to a goal directly. For example, taking a stroll during lunch break. In this case, intermediate goals become important and the final goal has less priority (see figure 4.39). It is more focused on the activity itself then moving directly to a final goal.

Fig. 4.38 Direct route to goal.

Fig. 4.39 Indirect route to goal, guided by intermediate goals.

Scenic control is really important when taking a stroll. A curved pathway only works when curves are motivated by visual links and sight restrictions (see figure 4.40). In addition, movement restriction can help as well, since it possible to cut off a path by crossing a grass field (see figure 4.41), but not when there is a pond (see figure 4.42) (Loidl and Bernard, 2003).

Fig. 4.40 Scenic control by visual links and sight restrictions.

Fig. 4.41 No scenic control or movement restrictions.

Fig. 4.42 Only movement restrictions.

People are always looking for orientation and connections, like prospect in PRT, whether one wants to move to a goal directly or taking a stroll. When there is no orientation possible then chaos rules and insecurity or fear can arise. Orientation can be promoted by adding: visual links, focus

points or landmarks, good guidance of pathways, and path material and profile (Vroom and Ettema, 2005).

Visual links help to motivate forward movement and could serve as intermediate goals (Loidl and Bernard, 2003) (see figure 4.43). A focus point or landmark marks the place, announces a destination, attracts attention and is a sign of welcome. For example gates are important moments on a route and in experience of space. They mark a transition from one place to another (Vroom and Ettema, 2005) (see figure 4.44). Guidance of pathways can be reinforced by a row of trees or a hedge for example (see figure 4.45). This creates a strong sense of path movement direction (Loidl and Bernard, 2003). Path material and profile can ensure coherence and security when it stays the same (see figure 4.46). It reassures users that they are moving in the right direction, so that they can relax. Changing one of the characteristics of the path draws attention back to the path and probably means a change of orientation (Loidl and Bernard, 2003).

Fig. 4.43 Orientation by visual link, sight line.

Fig. 4.44 Orientation by focus point, a gate.

Fig. 4.45 Orientation by guidance, a hedge.

Fig. 4.46 Orientation by path material and profile.

Clear

A clear route is needed when it is a directly goal-oriented route. It is often a main route: straight, guided, open, and the final goal is visible or indicated (see figure 4.47 and 4.48). A clear route is important for gaining a sense of control and making sense of the environment. Besides, clear routes are often connected to spaces with a more public scene and with a high communication level (see figure 4.49). They ensure easy accessibility (Loidl and Bernard, 2003).

Fig. 4.47 Straight and guided path.

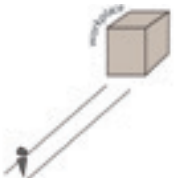


Fig. 4.48 Goal is visible and easy to reach.

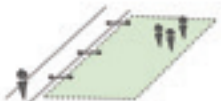


Fig. 4.49 Providing clear accessibility to a public space.

Exploring

An exploring route is preferred when it is an indirectly goal-oriented route. It is often a side route: curved, alternately open and closed and with intermediate goals (see figure 4.50 and 4.51). An exploring route is important for the feeling of being somewhere else and being distracted by the surroundings or intermediate goals. Exploring routes are often connected to smaller spaces with a degree of privacy (see figure 4.52). Accessibly through a path off the main route (Loidl and Bernard, 2003).

Fig. 4.50 Curved, alternately open and closed, path.

Fig. 4.51 Path with intermediate goals such as views, a pond and a bench.

Fig. 4.52 Providing access to more private space.

Program

The program of a place defines how a place is used and the type of visitors. A few different programs are needed to achieve stress reduction or attention restoration. In the environment there should be furniture, greenery, and possibilities to be active and to take a walk.

Furniture

Furniture along a route offers a clear invitation to stop and rest. The type of furniture determines the possibility to sit alone or with colleagues. Therefore it is important that a place provides different types of furniture to have the possibility to sit alone, with two people, or with a group. A few example are given in figure 4.53-4.55.

Fig. 4.53 Individual place to sit, a chair.

Fig. 4.54 Place to sit with two, a bench.

Fig. 4.55 Place to sit with a group, a picnic bench.

A quiet surrounding, something special to look at and a protected back is important when one wants to be able to rest (see figure 4.56).

Fig. 4.56 Private place with protected back and a view in an enclosed space with one entry.

This will add to the experience of 'positive natural distraction' and 'soft fascination'. A quiet place can be achieved in several ways. For example small 'havens' along a path, greater niches, or an independent space secluded of the path with a little path as own access (Loidl and Bernard, 2003) (see figure 4.57-4.59).

Fig. 4.57 Haven along a path.

Fig. 4.58 Niche along a path.

Fig. 4.59 Independent space secluded of a path.

When sitting in a group it is important that the place is easy to reach for all people and that there is enough space. This will add to the aspect of 'social support'. Accessibility and openness play an important role (see figure 4.60).

Fig. 4.60 Public space in an open space with more entries and easy to access.

When arranging the position of furniture it is important to consider 'social distance'. Social distance is 1 to 5 meter between the position of individuals (see figure 4.61). If the distance is less than social distance there will be tension, aggression or unease (Loidl and Bernard, 2003). Maintaining 'public distance', 5 to 7 meter, is a clear sign of resistance to communication (see figure 4.62). This can help when arranging spots where people want to sit quiet and alone.

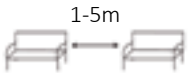


Fig. 4.61 Social distance

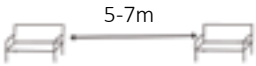


Fig. 4.62 Public distance

Greenery

Greenery is important for creating the feeling of being somewhere else, distracting from worrisome thoughts and is desired greatly by employees. Sensory engagement is a good instrument to distract people (Marcus, 2018). Let them see, feel, hear, taste and smell. Adding greenery, but also water elements are good ways of achieving this sensory engagement. Motion of the leaves, smell of the flowers, and to hear water is very restful (Zwart, 2004). Therefore water elements will be included as well in this spatial factor. A few examples are given in figure 4.63 and 4.64.

Fig. 4.63 Greenery, such as trees and flowers.

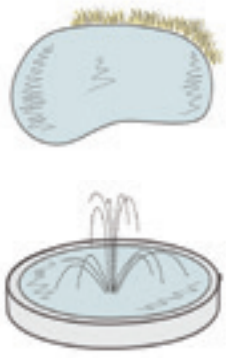


Fig. 4.64 Water elements, such as a pond and a fountain.

Possibility to be active

The possibility to be physical active is important in order to reduce stress. Furthermore, doing an activity together stimulates social support. Spatially, it is important to create an open space where activity is possible without bothering other people. For example, a big grass field for doing yoga or a ball sport (see figure 4.65 and 4.66). Other facilities for specific sports, such as a tennis court, are not suitable for a work environment. A space for multifunctional use fits better as it is not a sports field.

Fig. 4.65 Doing yoga on an open grass field.

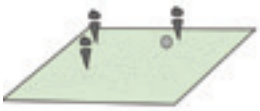


Fig. 4.66 Doing a ball sport on an open grass field.

Possibility to take a walk

The possibility to take a walk is very important to reassure restoration. Walking or strolling can be helpful to create the feeling of being somewhere else, to distract from worrisome thoughts and to the opportunity to move. Walking is a mild activity performed on a low intensity level and leisurely. In a work environment walking is a suitable activity during the break. A nice walk could be made when there is an exploring route and some furniture to have the possibility to rest (see figure 4.67).

Fig. 4.67 Nice walk with places to rest.

Design Principles

The elaborated description of the spatial factors is important to set up the design principles supporting mental health in a work environment. Design principles are a kind of rules that are general applicable for a certain type of design. In this case the design principles are applicable for the outdoor design of work environments. Principles contain both vision and concept and are based on theory (Vroom and Ettema, 2005).

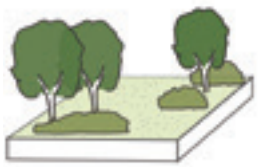
During the literature study, setting up the table linking theoretical components to spatial factors and describing the spatial factors, it became clear that there are several contradictions needed to support mental health in a work environment. Contradictions between open and enclosed spaces, blocked sights and views, exploring and clear routes, individual and groups furniture, and the possibility to do group activities and go for a stroll. The only factor that is not in contradict is 'greenery'. Greenery, including water elements, are needed anyway.

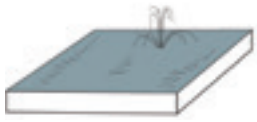
Therefore the first two design principles are general ones: add greenery for sensory engagement and add water elements for sensory engagement. These general design principles could be seen as the material that should be applied the most in a work environment.
The other principles can be divided in two main groups. One group supporting the need for private spaces and the other group supporting the need for public spaces in the outdoor work environment (see figure 4.68). To make this contradiction even more clear two scenes are shown in figure 4.69 and 4.70 One scene shows an example of the design principles important to create a private space. The other scene shows an example of the design principles important to create a public space. The challenge is to design the two opposite groups in an integrated way.

1. GENERAL

a. Add greenery for sensory engagement.

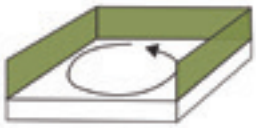
b. Add water elements for sensory engagement.



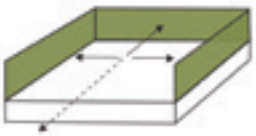


2. PRIVATE

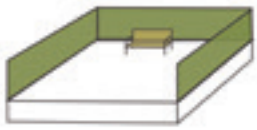
a. Create enclosed spaces to sit privately and to be able to rest.



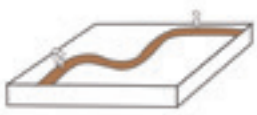
b. Create blocked sights to close of the surroundings and to give protection, alternated with views that distracts.



c. Place furniture for individuals or small groups in the enclosed spaces.



d. Create the possibility to take a walk, alone or in a small group.



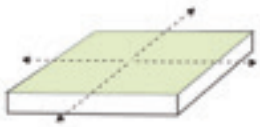
e. Design exploring routes to wander, with intermediate goals and alternately open and closed along the route.

f. Place the enclosed spaces along the exploring route for more seclusion.

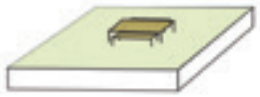
3. PUBLIC

a. Create open spaces for group gathering and activities.

b. Create views to orientate and overlook the area.



c. Place furniture for groups in the open spaces.



d. Create the possibility to do group activities.

e. Design clear routes to move quickly to main goals, guided and with clear orientation.

f. Place the open spaces along the clear route for direct and easy access.

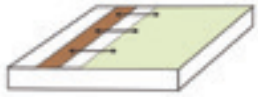


Fig. 4.68 Design principles divided into three categories.

PRIVATE SCENE

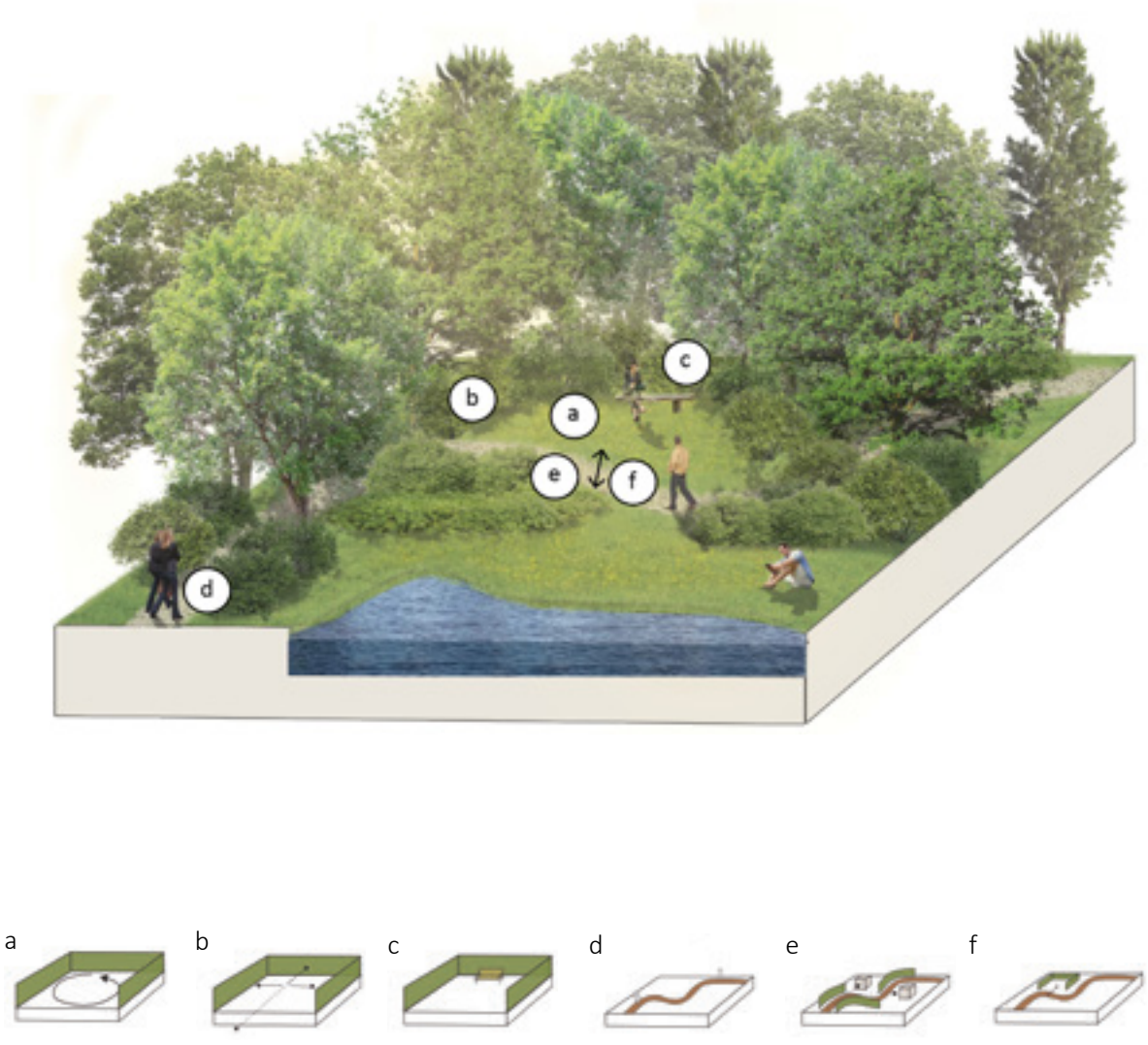


Fig. 4.69 Example integration design principles: private scene.

PUBLIC SCENE

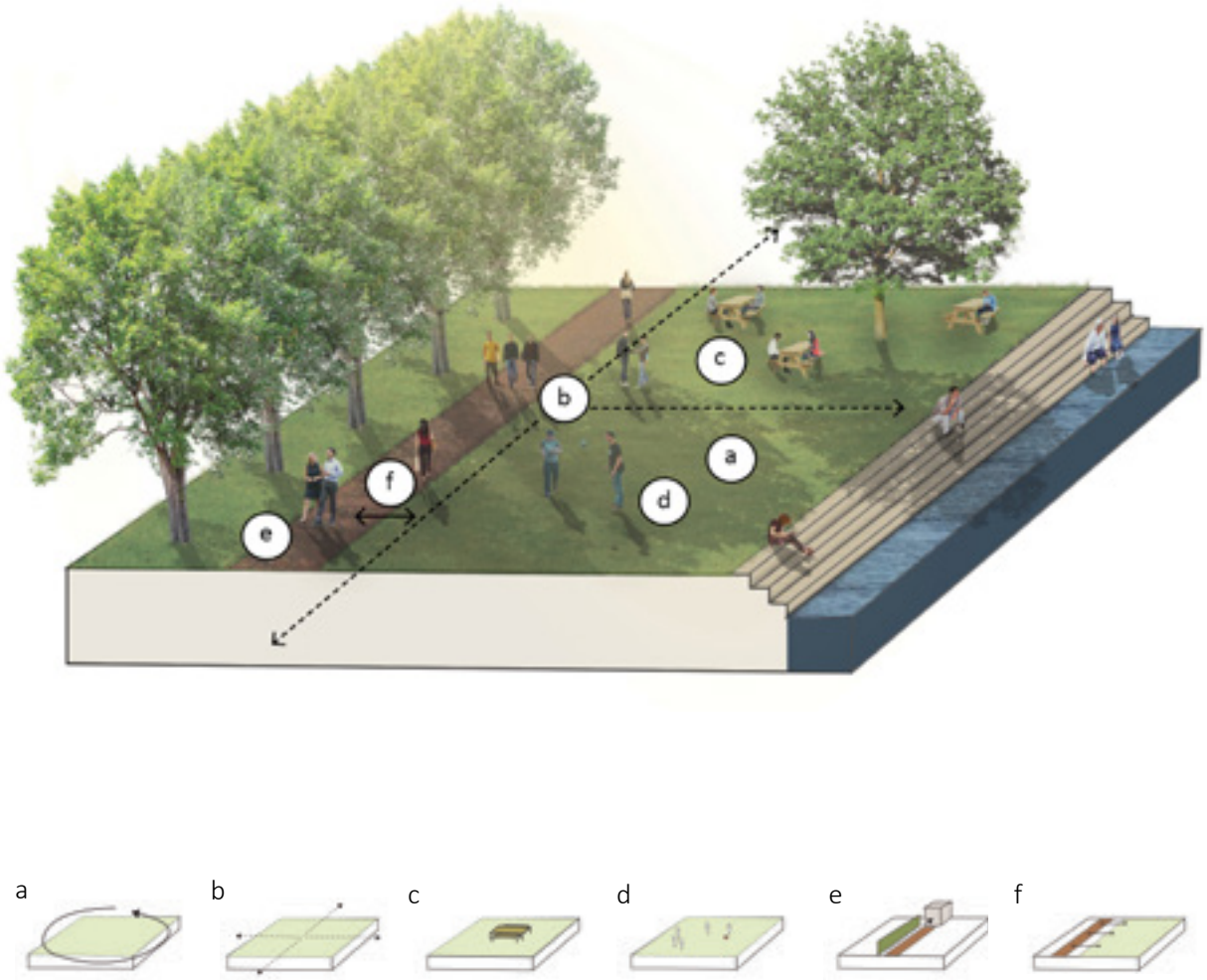


Fig. 4.70 Example integration design principles: public scene.

CASE STUDY
NOVIO TECH CAMPUS

5 CASE STUDY NOVIO TECH CAMPUS

5.1 NOVIO TECH CAMPUS

Nijmegen

The Novio Tech Campus (NTC) is located in Nijmegen, a city in the Dutch province Gelderland. The province of Gelderland has three important grow sectors: Wageningen, Arnhem and Nijmegen (see figure 5.1). Wageningen is focused on food, Arnhem is focused on energy and Nijmegen is focused on health and high tech (Briskr, 2019; Omroep Gelderland, 2016). Nijmegen wants a collaboration between different companies, institutions and research centres to create a strong 'Health and High Tech' ecosystem. Part of this ecosystem are Radboud UMC, Radboud University, HAN University of Applied Science, Mercator Technology & Science park and the Novio Tech Campus (Briskr, 2019). Nijmegen is profiling itself with the health theme and wishes to create a healthy environment in the city. Their goal is to promote health by making the healthy choice the easy choice, a slogan made earlier by the World Health Organisation. Besides, the municipality acknowledges the need for 'health in all policies', emphasizing the collaboration between different domains. The health vision for the city is explained in the document 'Samen Gezond in Nijmegen 2017-2020' (together healthy in Nijmegen 2017-2020). With this thesis I would like to make a valuable addition to the health goal of the city.

Location NTC

NTC is located in the south-west part of Nijmegen near the Winkelsteeg, a large industry area, and the Goffertpark (see figure 5.2). From the centre NTC is easy to reach by train, due to the new railway station the Goffert. In figure 5.3 the near surrounding is more clear. On the right side the Goffertpark and some health care facilities are located in the forest – and on the left side the Maas-Waalkanaal as border between the Winkelsteeg and a residential area. The closeness of NXP, Goffertpark and Maas-Waalkanaal are made clear on the aerial pictures in figure 5.4 and 5.5 as well. Further details are discussed in the landscape study and analysis (see paragraphs 5.2).

Fig. 5.1 Grow sectors Gelderland (image adjusted from Broekman, 2019).

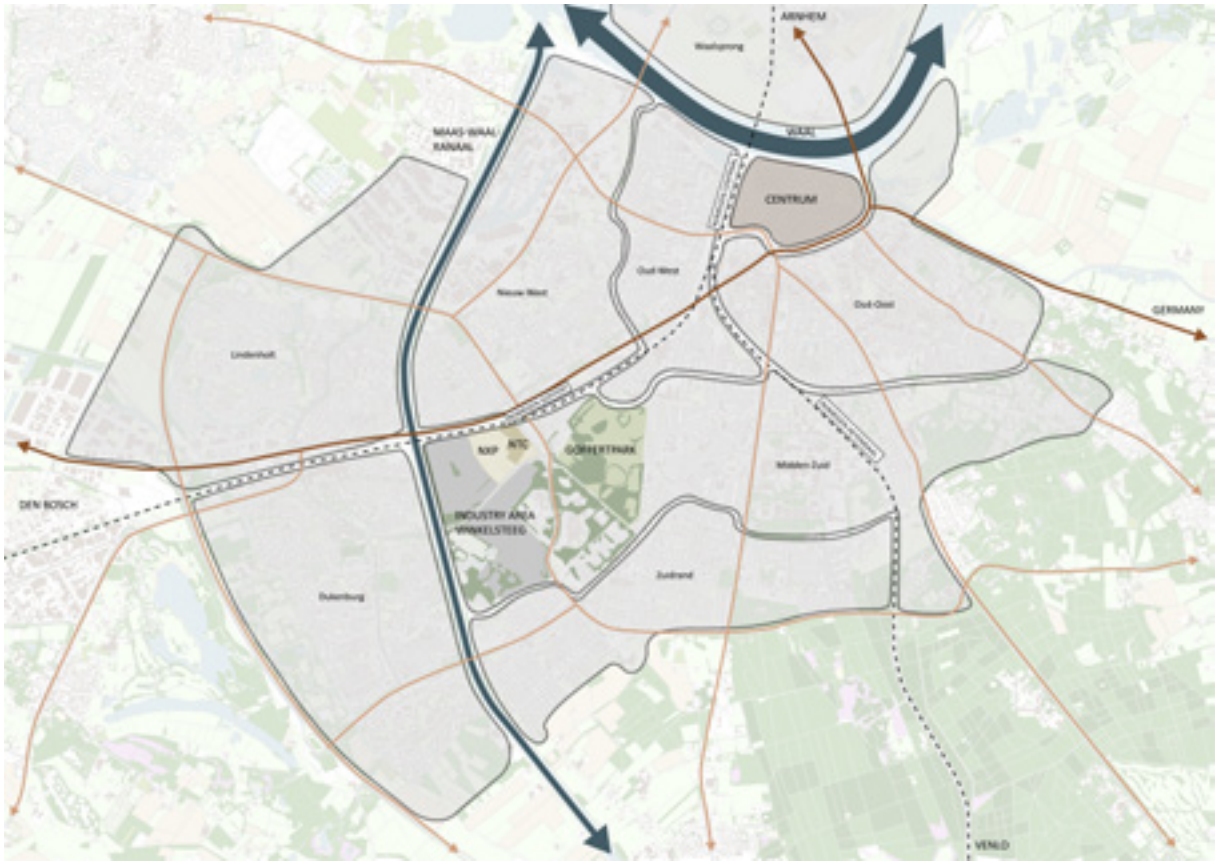


Fig. 5.2 Location NTC in the city Nijmegen.

Fig. 5.3 NTC and surroundings.

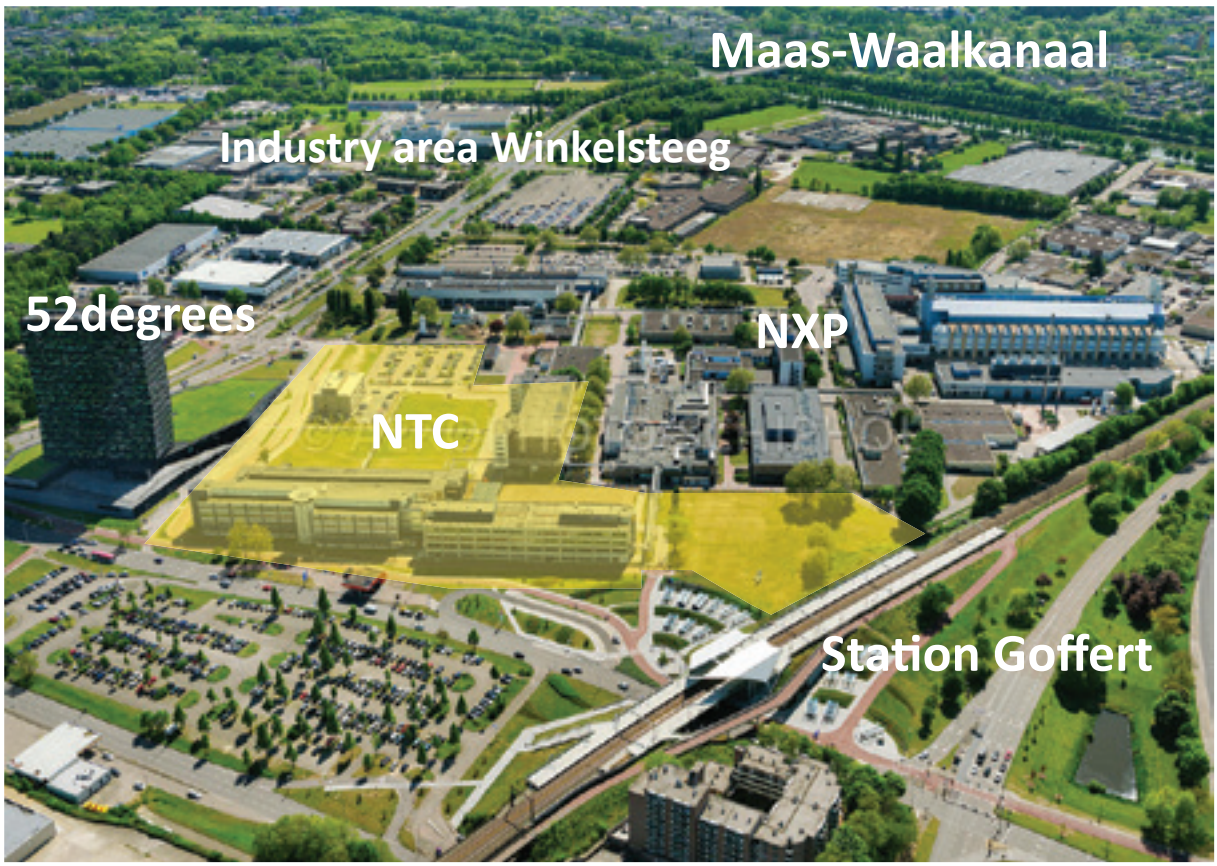


Fig. 5.4 Aerial picture NTC from north-east direction (image adjusted from Aerophotostock, 2017).

Fig. 5.5 Aerial picture NTC from north-west direction (image adjusted from Aerophotostock, 2017).

Start of NTC

NTC is the Health and High Tech hotspot of Gelderland (The Economic Board, 2018). Sometimes even called the Silicon Valley of Europe (Omroep Gelderland, 2016). In the 50's Philips Semiconductors established at the site. In 2006, Philips Semiconductors privatized and became Next eXPerience (NXP). NXP is a billion dollar business worldwide and the largest factory of NXP is established near NTC. It is the most important place in the world regarding the development of semiconductors and computer parts (Briskr, 2019). In 2013, part of the site became vacant due to reorganisations and redistribution plans from NXP, the starting signal for the development of NTC (see figure 5.6). The development started with building M, followed by building A in 2016. Where they started with 4 companies in 2013, are now 74 companies and more than 3400 employees (Novio Tech Campus, 2019).

"Knowledge, business and innovation come together on Novio Tech Campus. Open innovation between researchers and entrepreneurs in Health and High Tech leads to growth, making the campus an innovative hotspot for products and services of a better, healthier world. From a preventive malaria-drug, to a new generation of chips. It's happening on Novio Tech Campus: Where Innovation Works"
(Novio Tech Campus, 2019)

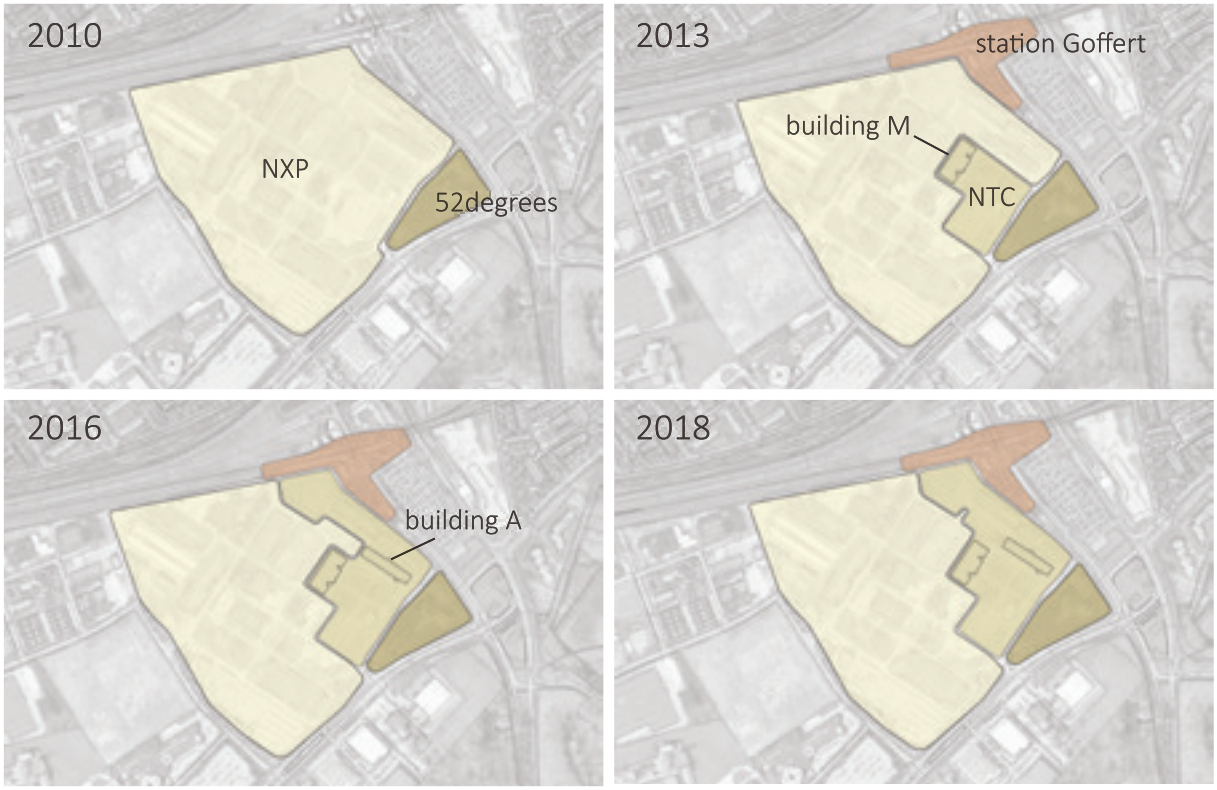


Fig. 5.6 Development NTC (image adjusted from Nijmegen, 2014).

Work Branches at NTC

Tech, IT and health related companies are established at NTC. The campus offers shared facilities, such as flex labs, clean rooms and an equipment pool (see figure 5.7). The shared facilities are part of the philosophy of NTC 'Sharing knowledge for growth' (Novio Tech Campus, 2019). Many employees are working behind the desk and inside (see figure 5.8). The work performed requires focus and during the day this focus will get fatigue, meaning that restoration is needed. Besides, in one building young start-ups can rent their own place. These start-ups are under a lot of pressure, concerning to succeed their own company. A restorative and stress reductive environment is important for them as well.

Fig. 5.7 Shared flex lab (Kadans 2019a).

Fig. 5.8 Working inside and behind the desk (Kadans 2019b).

Development NTC

The Novio Tech Campus is quite a new campus and is still under development. At first sight it looks quite green, however, it doesn't have the campus look and the area is not very appealing (see figure 5.9 and 5.10). Furthermore, the green and open spaces are under pressure because of the development of new buildings (see figure 5.11). The municipality is working on a strategy to develop the campus. This thesis could be a valuable addition for addressing the health topic and for providing some theoretical background.

Fig. 5.9 Green space at NTC, solely grass.

Fig. 5.10 Not an attractive place to sit at the picnic bench.

Fig. 5.11 Construction of a new building.

5.2 LANDSCAPE STUDY AND ANALYSIS

Context

Novio Tech Campus is located near the Winkelsteeg, an industry area in the south-west of Nijmegen (see figure 5.12). The surrounding environment is not very appealing, mainly consisting of offices and businesses. However, there are two places which could be exploited more, the Goffertpark on the right and the Maas-Waalkanaal on the left. These two are beautiful places and should be better connected to the campus. The Goffertpark is a city park located on a mound slope with a forest and a few ponds (see figure 5.13). The park has a stadium, an open air theatre and a field were concerts can take place. The Maas-Waalkanaal is a canal that used to be the border of Nijmegen. In 1970, Nijmegen expanded to the west side of the canal, turning the canal into a waterway through Nijmegen instead of a border (see figure 5.14). It is used for shipping and connects the river Meuse with the river Waal.

Public facilities are not around, except for a fitness centre and a sports hall with restaurant. Still, there is a large road to cross. Public facilities, such as a supermarket, a pub, a day-care, a gym, a shared meeting location and recreational facilities could be valuable to the campus and in the development towards a work landscape.

Currently, NTC is kind of isolated. In the north the campus is closed off by a railway, in the east by a large road, in the south by the building '52 degrees' and in the west by NXP. Clear entrances and connections with the surroundings could develop NTC towards a more open and hospitable work environment.

Fig. 5.12 Surrounding areas of NTC.

Fig. 5.13 Goffertpark

Fig. 5.14 Maas-Waalkanaal

Green Structure

On the site there is little green, commonly for many industry areas unfortunately (see figure 5.15). However, both on the right and left are beautiful green spots. On the right, the forest of the Goffert is coming into the area and on the left, old tree lanes are located along the Maas-Waalkanaal. Additionally, the railway is covered partly by thickets. For the rest, there is a lot of scattered greenery without any structure. The only structure at the site itself, is the axes cross of trees (see figure 5.16). However, the trees are still very young and not a robust structure yet. Developing the site to a more healthy environment, that reduces stress and restores attention, requires definitely more green.

Fig. 5.16 Young trees in an axis.

Fig. 5.15 Green structure on and around NTC.

Infrastructure

The infrastructure around the site is quite good (see figure 5.17). The provincial road N326 ensures the place is easy to reach by car, including the different parking spots. The only obstacle is the 'Jonkerbosplein', a busy crossing. For bikers and pedestrians this is an obstacle as well, since one has to wait for the traffic light two or three times (see figure 5.18.). After the construction of the new railway station Goffert in 2014, the place is very easy to reach by public transport. There were already a few bus stops, yet a train is often faster and more comfortable. This new railway station makes it more attractive to come by public transport and avoid the busy roads. For bikers there is a fast bike route 'Batavierenpad Zuid'. This route connects Beuningen with RadboudUMC and crosses Goffertpark. Employees could use this fast bike route to reach NTC, although there is still 'Jonkerbosplein' to cross.

Fig. 5.18 Crossing Jonkerbosplein

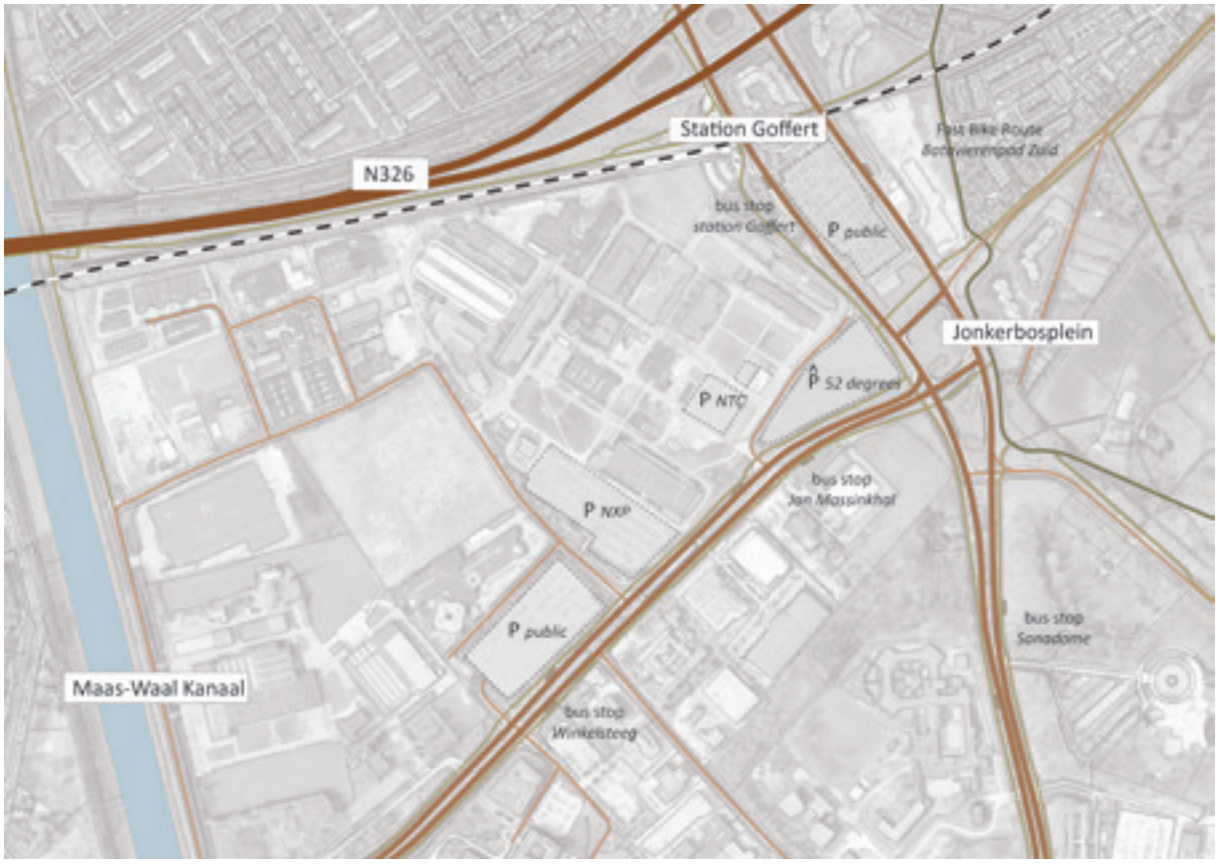


Fig. 5.17 Infrastructure around NTC.

5.3 DOCUMENT STUDY AND ANALYSIS

Work Landscapes

Novio Tech Campus is a pilot project for the development of work landscapes (Provincie Gelderland, 2011). Work landscapes are a reaction on the often heard complaint that industry and business areas are perceived ugly, by both employees and local residents. In addition, with the concept of work landscapes the province tries to present the work environments more as a living environments. Work landscapes can differ strongly, although they have a few things in common. A definition of a work landscape is given by the province of Gelderland (2011):

Work landscapes:
- The function 'work' is key
- The function 'work' is mingled with other functions, causing added value for the company and the employees.
- Meet quantitative and qualitative needs of entrepreneurs and other users of the location.
- Show spatial cohesion with the surroundings.
- Take into account the aspects of spatial quality.
- Have a scale that is comparable with the scale of an industry area.
- Offer work locations with an own identity that provides a supplement to the existing range.

The definition is very broad. Other, less vague, aspects that come from the document, and are important to take into account are: accessibility, connection with the surrounding, mix of facilities, own identity, flexibility or expansion options, ecology, diversity, attractiveness, parking facilities and recognisability. In addition, key is that a work environment should be considered on the same level as a living environment.

NTC is still under development, however a few aspects of a work landscape are already established quite well. NTC has a strong identity by accommodating only high tech companies, offering shared facilities that stimulates contact with other companies, and the collaboration with other research institutes, such as RadboudUMC. Besides, NTC is easy to reach by car and public transport. A few other important aspects are not there yet: the mix of facilities, the connection with the surroundings, and the place is not attractive.

One goal of NTC is to attract (international) top talent, since there is a shortage among IT people. Therefore it is also important to develop NTC as an attractive work landscape (see figure 5.19).

Fig. 5.19a Example Work Landscape Chiswick Park in London (Chiswick Park, 2018).

Fig. 5.19b Example Work Landscape Chiswick Park in London (Chiswick Park, 2018).

Vision of the Municipality

The vision of the municipality of Nijmegen regarding NTC, is written in the document 'Bouwsteen ruimtelijke kwaliteit' (Building block spatial quality) (Gemeente Nijmegen, 2019). In this document they emphasize the wish to develop NTC towards an open innovation campus. To achieve this, an open relation between companies collaborating and sharing information, is key. Besides, it is important to stimulate informal meetings between employees. These meetings could be facilitated by facilities, such as a coffee corner, a restaurant, a shared parking, and recreational and sport facilities. All placed in a shared, informal, outdoor environment.

A successful campus offers facilities aimed at relaxing and meeting, creates a lively atmosphere with an outdoor space focused on staying, and has a logical routing and recognizable pathways. Furthermore, it is important that the campus becomes more a living environment than a working environment.

All aspects mentioned, could help to attract new employees in the 'battle for talent', since there is a shortage of IT staff (Gemeente Nijmegen, 2019).

5.4 CONSULTATION NIJMEGEN MUNICIPALITY

To explore the current development of NTC, NXP and the Winkelsteeg the municipality of Nijmegen has been consulted. Joost van der Zanden, urban planner of the municipality and involved with the plans for NTC, has told the current state of the plans (see figure 5.20 and 5.21). NXP will reorganise again and is open to become a part of NTC by removing the fences. The fence around the main building will stay though. One building of NXP will be taken over by NTC and another building will be demolished because of the bad condition. The municipality is planning to buy the wasteland. The parking place on the west side is already owned by them and will become part of NTC as well. The time span of this is unknown.

Joost van der Zanden indicated the importance to design a strong spatial concept with flexibility for development, because new buildings will be constructed. Existing buildings M and A are almost filled and new buildings are definitely needed. Besides, there should be a more prominent vision on the spatial quality and the development of the green spaces, because it is too focused on the development of buildings. In addition, the vision is still to develop NTC as a campus or work landscape, a more living environment instead of solely a work environment. Therefore the spatial quality is important as well. Besides, the connection with the surroundings plays an important role. Better connections will increase the accessibility and will also attract other people than employees.

Fig. 5.20 Current situation , NTC is 5,5 ha.

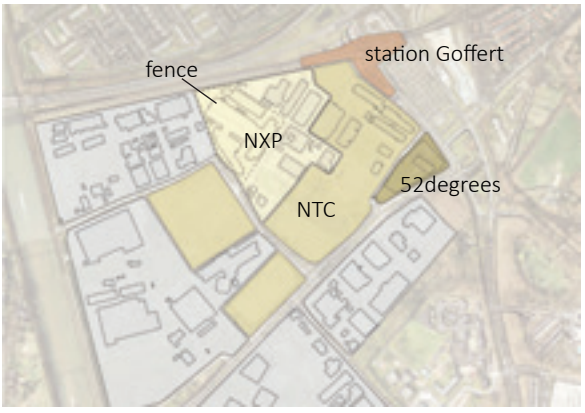


Fig. 5.21 Future situation, NTC is 20 ha.

5.5 FIELD VISIT AND PHOTO-ANALYSIS

Field Visit

On May 15th I went on a field visit to the site. I prepared a walk from the station to NTC, the Maas-Waalkanaal and the Goffertpark. I wanted to achieve a few goals. First, discovering how the outdoor space at NTC is used during lunch break. Therefore I went to the site around noon and also had lunch there myself. Second, walking to the Maas-Waalkanaal to experience how long the walk would take and if the route was engaging enough. Finally, walking to the Goffertpark to discover which route would be most convenient from NTC and if this route would be attractive.

The route walked is shown in figure 5.22, guided with my findings and thoughts. In figure 5.23, the spots and the directions of the made photos are indicated. The series of photos with guided subscription are shown in figure 5.24.

Fig. 5.22 The route walked during the field visit including findings.

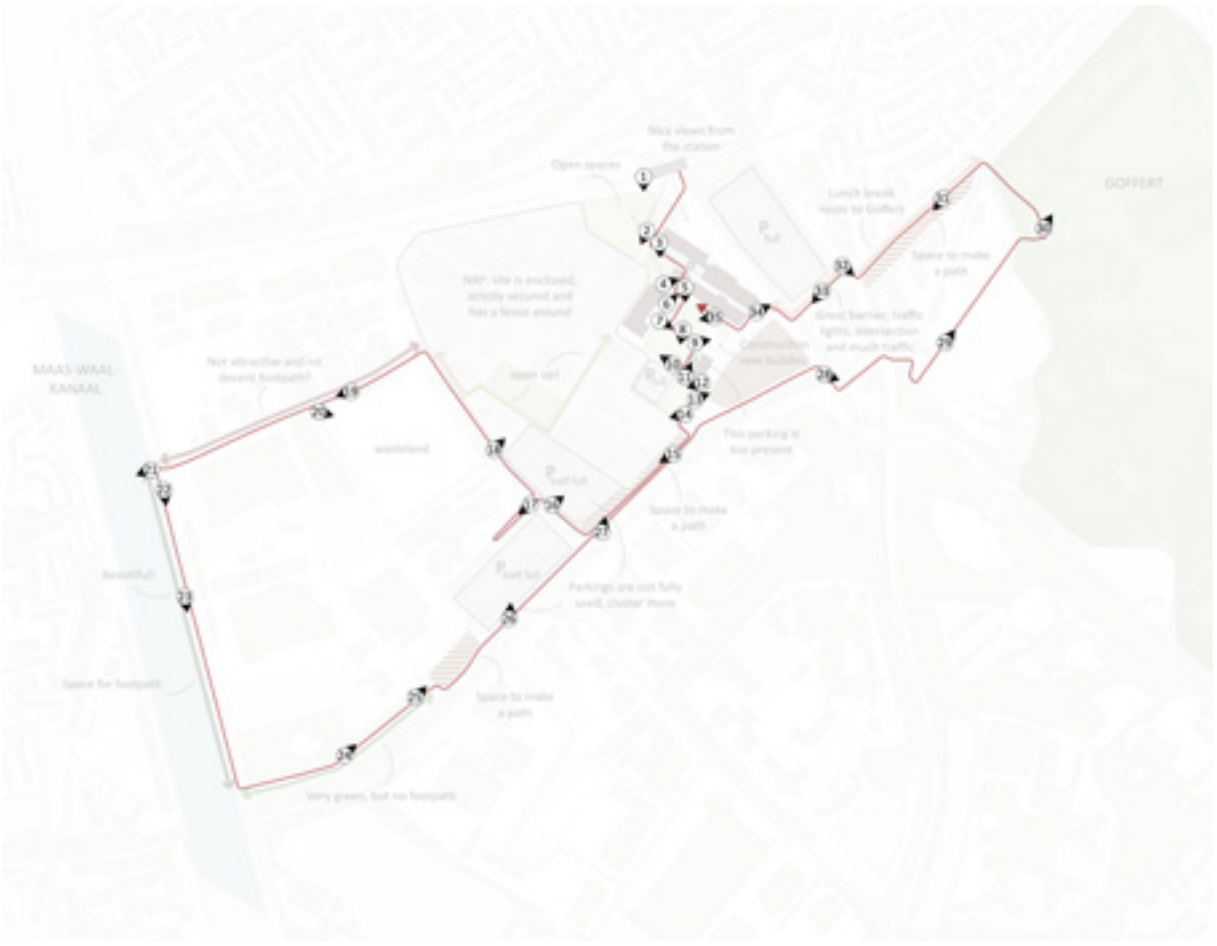


Fig. 5.23 Spots and directions of the made photos.

1. From the station there is a nice view to the inner side of NTC. It connects several open spaces.

2. When entering the site there is a confronting fence that closes off NXP.

3. A small open space with a view to the main space. It looks quite green, but it is just grass. The space doesn't feel comfortable, because it is too open.

4. A strange, not clear, entrance to the main space of NTC. It looks dark and feels narrow. One is forced to go underneath, because on the left is just grass.

5. The main open space is enclosed by hedges and is divided by an axis of trees. There are picnic tables open in the field with no protection from wind or sun.

6. On the site there are some old constructions which are not in use anymore. Maybe a nice opportunity for climbing plants and greening the place.

7. The axes of trees divides the open space and makes a clear entrance and route to building M and A.

8. From the open space the parked cars a quite visible and present.

9. A construction of a new building has started. This building will enclose the space, which can be an opportunity to create a more comfortable place.

10. There are no hedges on this side. The bench is strange positioned with a view on a parking space. Fence of NXP closes the space, which makes walking to the Maas-Waalkanaal more difficult.

11. The parking place belonging to this building is too present. It is positioned more in the open space instead of next to it.

12. Another open space at the other entrance and side of NTC. This space is very close to the busy road.

Fig. 5.24a Photo series 1/3

13. Building 'fifty two degrees' is officially not a part of NTC. But it is a recognizable point from the road.

14. NXP is strictly secured with a fence and entry gates. This can feel uncomfortable when walking around NTC.

15. Behind the fence is green space. If the fence could be removed, or replaced, then there is space to make a nice footpath instead of one next to the busy road.

16. It seems that the parking space of NXP is almost not used. But because of shift works at NXP it is full when the teams change.

17. Cars are randomly parked, while the parking place next to it still has a lot of free spots. Especially on the left the cars take a lot of green space.

18. Green and open space on NXP site. It would be nice to make a connection or passageway to NTC.

19. The road to the Maas-Waalkanaal is not attractive and has no decent footpath.

20. There is a big surface of wasteland near NTC and NXP.

21. Maas-Waalkanaal is a shipping route connecting the Maas and the Waal.

22. Beautiful tree lane along the Maas-Waalkanaal. One asphalt road with no separate footpath.

23. Potential space to create an exploring route along the water.

24. Road is very green on both sides, but no separate footpath. There is potential space on the right to create an exploring route.

Fig. 5.24b Photo series 2/3

25. The road bends to the main road. A path could be created straight ahead through the bushes for a clearer connection.

26. The public parking space is half used most of the day.

27. Again, potential space to create a path on the left when the fences would be removed.

28. In the direction of Goffertpark a big intersection has to be crossed.

29. The route to the Goffertpark was not clear. It lead me to this narrow path that didn't feel comfortable or safe.

30. Goffertpark, a good place to sit, relax, walk, and have lunch. Great place for 'being away' from work.

31. Walking back to NTC a few office workers were walking this pathway to Goffertpark. There is potential space on the left to make a much nicer and more exploring route.

32. Crossings and traffic make it not easy to walk to the park. A zebra could already be helpful to make it easier and more attractive.

33. Again, crossings, traffic lights and much traffic make it not easy to cross.

34. Groups of office workers going for a lunch walk to Goffertpark.

35. Office workers having lunch outside. Small groups were seated at the picnic tables. Individuals or two persons were seated on the benches on the side.

Fig. 5.24c Photo series 3/3

Main findings
The main findings of the field visit and photo series are the following:

• There is quite some (green) open space. However, these spaces are very open and don't protect from wind, sun and surrounding. They don't feel very comfortable now, but have great potential.

• The axis of trees is the only green structure at the site, yet, not a robust one.

• Industrial background of the site could be exploited more to generate more identity.

• The highly secured site of NXP is closing NTC of on one side. This blocks the opportunity to walk in the direction of the Maas-Waalkanaal. Additionally, the fence around NXP is not pleasant when staying in the outside of NTC.

• The parking places in and around the site are not fully used the whole day. This could be designed in a more sufficient way and could leave place for more greenery or other new developments.

• A wasteland near NTC has potential to expand the campus when opening NXP.

• The route from NTC to the Maas-Waalkanaal could be a nice lunch walk. There is a lot of potential and the tree lane along the canal is already very beautiful. By creating and designing this route employees will be seduced to go to the water.

• There is already a path to the Goffertpark taken by some office workers during lunch break. Still, this path is not clear, unattractive and has some barriers to overcome. By designing this in a better way more employees will consider to take a walk and go the park during lunch.

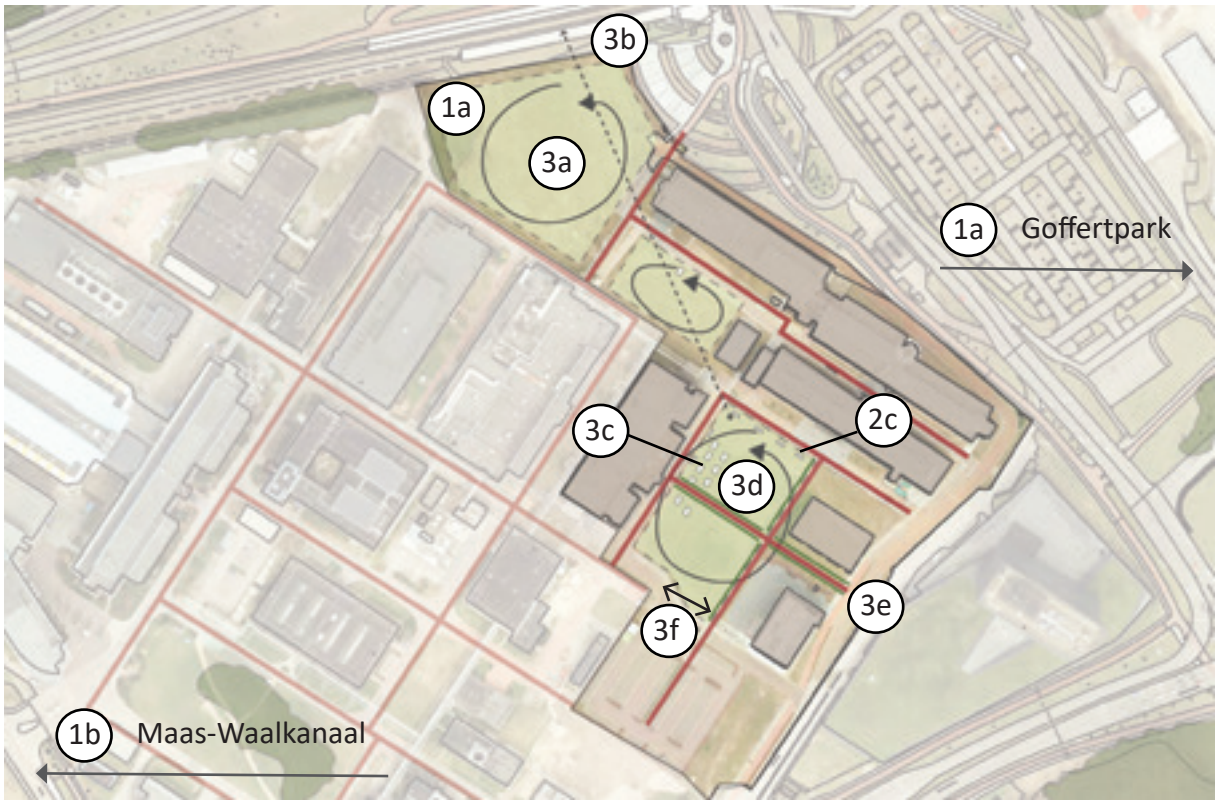
5.6 DESIGN PRINCIPLES CURRENT SITUATION

The photo series in the previous paragraph, gives a good overview of the current situation of the Novio Tech Campus. For the present situation the design principles are indicated. Just one principle (3f) is exactly present, others are not, or partly present (see figure 5.25). Especially principles from the 'private' category are lacking.

General Design Principles
Greenery is mainly present through grass in the open spaces. However, this doesn't do much for the sensory engagement. For experiencing the sensory engagement of greenery one has to walk to the Goffertpark. There are no water elements at the campus as well. The nearest waterbody is the Maas-Waalkanaal, although this is on quite a distance and there is no route.

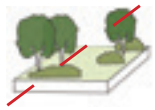
Private Design Principles
The six principles of the 'private' category are hardly present. There are no enclosed spaces or walking routes for restoration. On the edge of one space there are benches, furniture for individuals or small groups, however these are not placed in an enclosed space.

Public Design Principles
The six principles of the 'public' category are more present than the 'private' category. There are three main spaces, although they are not appealing for group gatherings or activities. One view, through these three spaces, gives a little bit of an overview of the campus. In one space there are a few picnic benches, however in a limited amount. In addition, the picnic benches are all the same and don't offer a variety in groups furniture. Axes on the site provide a clear route structure from parking place to the buildings and from the station to the buildings. However, the axes are not guided and thus less clear. Except for the axes in the middle, which are guided by trees. Although, these trees are still very young and not a robust structure yet. All principles lack something, except for principle 3f. The open spaces are easy accessible from the axes, the clear route.

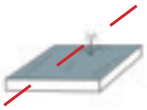


Design Principles

1. General



a. Add greenery for sensory engagement.

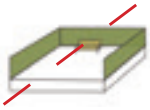


b. Add water elements for sensory engagement.

2. Private

a. Create enclosed spaces to sit privately and to be able to rest.

b. Create blocked sights to close of the surroundings and to give protection, alternated with views that distracts.



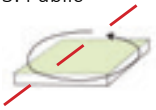
c. Place furniture for individuals or small groups in the enclosed spaces.

d. Create the possibility to take a walk, alone or in a small group.

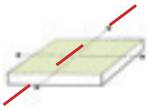
e. Design exploring routes to wander, with intermediate goals and alternately open and closed along the route

f. Place the enclosed spaces along the exploring route for more seclusion.

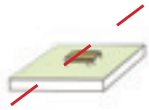
3. Public



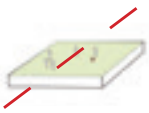
a. Create open spaces for group gathering and activities.



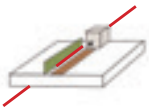
b. Create views to orientate and overlook the area.



c. Place furniture for groups in the open spaces.



d. Create the possibility to do group activities.



e. Design clear routes to move quickly to main goals, guided and with clear orientation.

f. Place the open spaces along the clear route for direct and easy access.

Fig. 5.25 Design principles in the current situation.

5.7 QUESTIONNAIRE EMPLOYEES

As mentioned earlier in this report, a questionnaire is held among employees of NTC. The questionnaire is shown in the appendix. The goal of the questionnaire was to gather the opinions of the employees (see figure 5.27). From this questionnaire I concluded on a few main findings, important to take into account when designing.

First, more than half of the employees spend between 0 and 30 minutes outside during working hours and go outdoors a few times a week or a month. Only 13 percent goes outside on a daily basis. However, more than half indicates the need for several moments of rest during work and no less than 90 percent agrees with the importance of nature for mental health. Would be great if this could be linked to going outdoors a few times a day during work. The 'distance from the workstation to the outside', or 'colleagues or employers consider it not appropriate to go outdoors' are no reasons to stay inside. However the 'workload' and 'there is no attractive place to go to' are indicated by more than half.

Second, the preferences of the employees are quite clear as already discussed in paragraph 4.2. Greenery, possibility to take a walk and sitting with colleagues, including the need for enough furniture to have lunch or drink a coffee, are important for most of the employees. Besides, the opinions of the current outdoor space are underlying this. The respondents mention regarding furniture: 'limited tables', 'not enough seats', and 'could have more and different places to sit'. And in the category greenery: 'too little nature', 'could be more trees and plants', and 'not enough green and flowers'. In addition, the words 'boring', 'minimal', and 'basic' are mentioned underlying the need for a new design. Some respondents worry about the upcoming development of new buildings, reducing the amount of green space.

Third, the connection with Goffertpark and Maas-Waalkanaal is something what could be improved. Almost half of the respondents indicated that Goffertpark is too far to walk and more than half of the respondents indicated that Maas-Waalkanaal is too far to walk. Besides, the way to go there is not attractive, indicated by some employees. Creating a nice route could change the perception or the feeling that it is too far. In addition, nobody finds the places themselves not attractive.

Finally, one remarkable thing is that more than half of the respondents travel to work by car, despite the new station. Only 10 percent indicates to travel by public transport. Therefore it is important to place the parking strategically and to promote and facilitate use of public transport.

Fig. 5.27 Opinions of the employees.

5.8 SWOT-ANALYSIS

As conclusion a SWOT-analysis is used. In the SWOT-analysis the strengths, weaknesses, opportunities and threats derived from the previous analyses are indicated (see figure 5.28).

The SWOT-analysis provides an overview of the potential of the site and important aspects to take into consideration. It is key to increase the spatial quality and to give it a strong identity, besides the identity of the companies located at NTC. The spatial quality should be increased by treating the place as a living environment, instead as a work environment. Boost the liveability by adding public facilities and creating connections with the surroundings would be helpful. There is quite some space at the campus to develop the place towards a work landscape, however, flexibility is needed to be able to construct new buildings and expanding the campus.

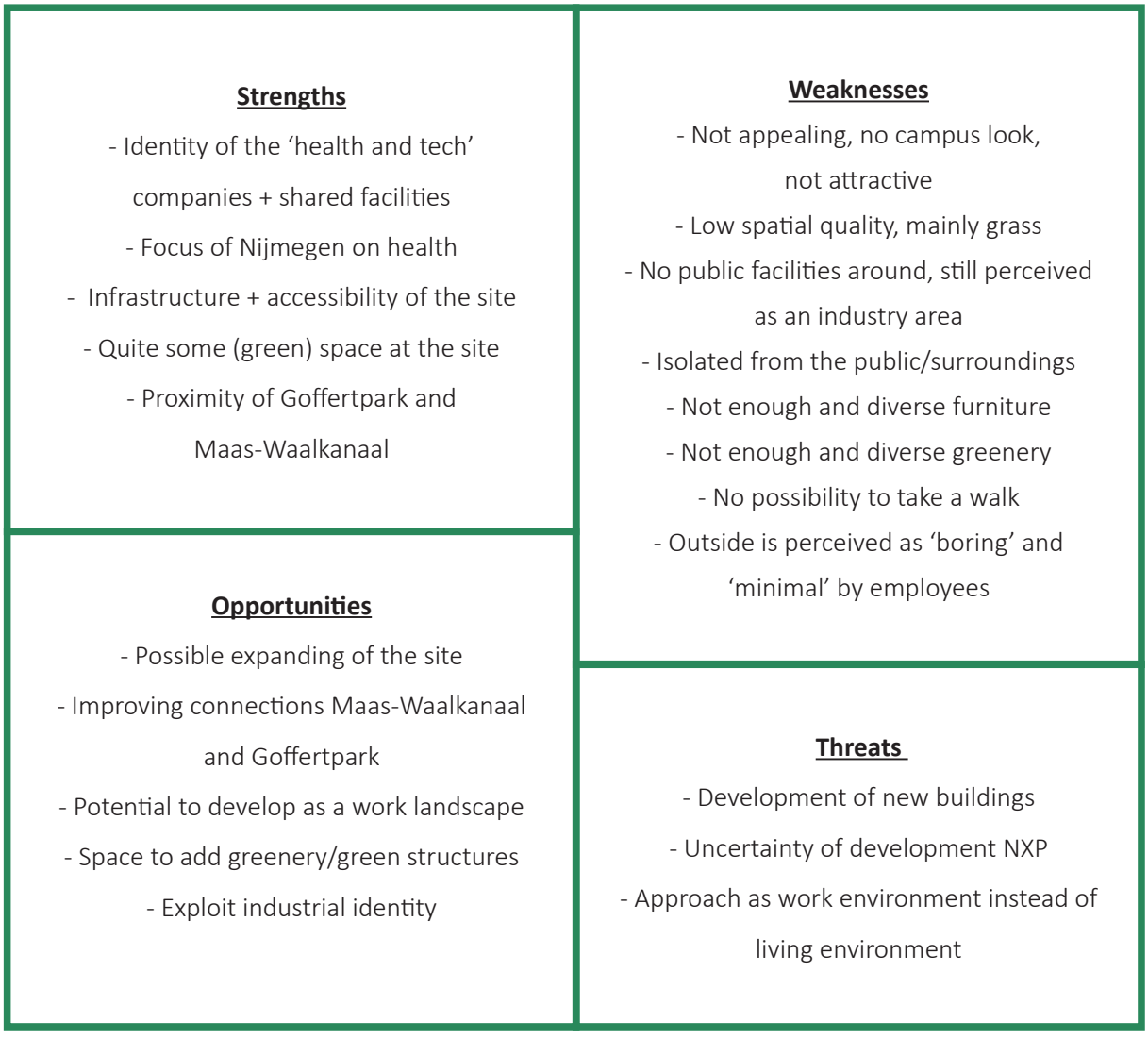


Fig. 5.28 SWOT-analysis of NTC.

6 MODELS

6 MODELS

6.1 THREE MODELS

Models

It is important to implement both private and public zones in an outdoor work environment, according to the design principles set up in chapter 4. Same applies to the general design principle 'add greenery and water elements for sensory engagement', which is an important principle for the materials used in the design. Three models are generated to show the possibilities within the combination of the design principles. The models differ in ratio of private and public zones. The first model shows a ratio of 20-80, private against public space, the second one is 50-50, and the third one is 80-20. The ratios are connected to landscape typologies, since the goal is to develop a work landscape as well. The used typologies are meadow, park and forest and are easy to imagine and understand for everyone (see figure 6.1). In this way, the focus can be on the implementation of the design principles. The surface of the models is based on the expansion plans of the municipality, discussed in the previous chapter. The base of the models is shown in figure 6.2.

Fig. 6.1 The three typologies; meadow, park and forest.

Fig. 6.2 The base of the models.

Procedure

The procedure of the design phase, including the models, is shown in figure 6.3.

First, three different models are described and evaluated. The models are evaluated on the implementation of the design principles, focused on the use of private and public zones. Even as the use of greenery and water elements. Advantages and disadvantages of the typologies are discussed as well.

After, some other important aspects for developing the Novio Tech Campus are discussed, such as the potential to become a work landscape, the wishes from the employees extracted from the questionnaire, and the future development. Important from the concept of work landscapes are: the connection with the surroundings, the public facilities and liveliness, the spatial quality and identity, the accessibility, and the openness to other target groups. The main wishes from the employees are: the possibility to take a walk, to have enough and different furniture, and to have more greenery. For the future development it is important to discuss: the flexibility of the design, the integration of new buildings and the possibility of phasing. Challenges and opportunities are discussed for all three topics.

Finally, one model is chosen for further exploration. This further exploration of the model is shown in chapter 7 and shows how to deal with the particular challenges and opportunities, and how the model can be developed towards a healthy work landscape for the Novio Tech Campus.

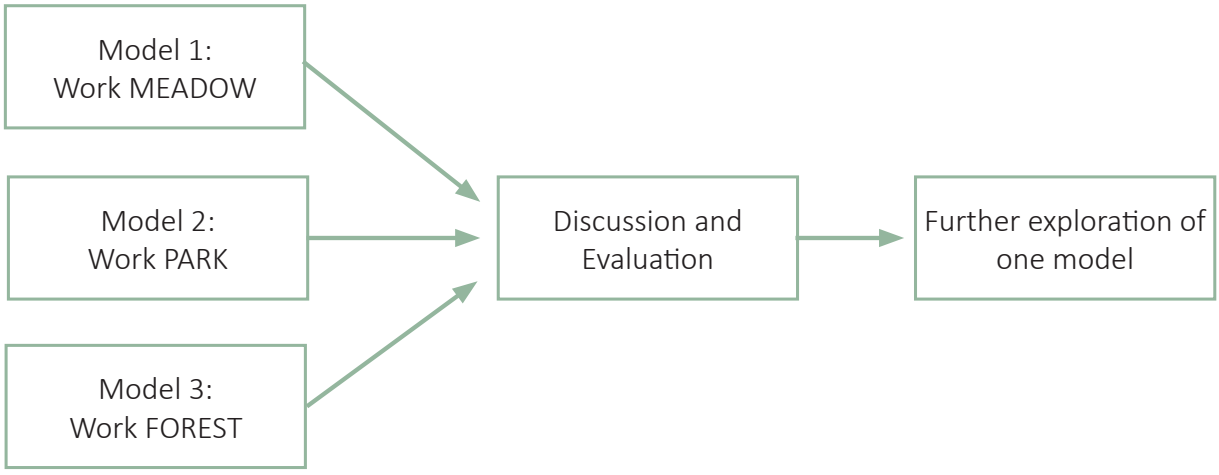


Fig. 6.3 Procedure of the design phase.

6.2 MODEL 1: WORK MEADOW

Work MEADOW

The first model is based on the landscape typology of the meadow (see figure 6.4 and 6.5). It has an open environment, with a few enclosed spots to sit undisturbed. The enclosed spots are connected to the exploring paths crossing the site. The exploring paths are mainly surrounded by flowery meadows, contributing to the sensory engagement, even as a few water parties. The pathways are inviting to take a walk. A strong grid ensures the easy and clear access of all buildings. Besides, two open, public spaces are easy to reach by these pathways as well.

Design Principles

In figure 6.6 the design principles are indicated. The first category 'general design principles' is not indicated, since these principles are present at the entire site. Greenery is the main material used, but in a monotonous way. Mainly flowery meadows, some thickets, and solitary trees are covering the place. Furthermore, there is no (green) structure that guides the grid of clear routes. An advantage of the meadow typology is the chance for prospect and overview. However, there is a need for enclosed spaces, to be able to rest, as well. These enclosed spaces are placed randomly

Fig. 6.4 Model work MEADOW including reference images.

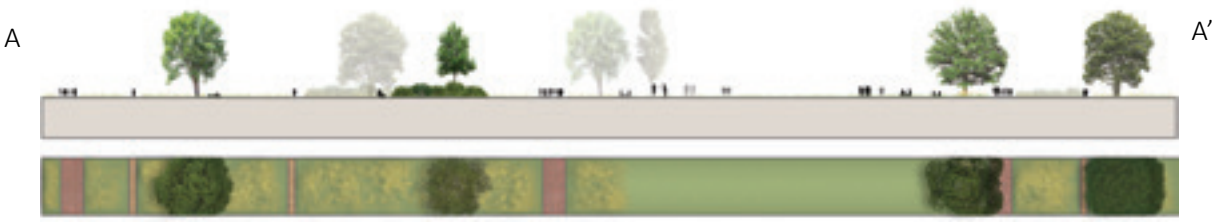


Fig. 6.5 Section AA' work MEADOW, 1:2000.

over the campus, still in an open environment, which could feel uncomfortable. It is important to make sure that the enclosed spaces are closed off on three sides. One side could left open to have a nice view and something to watch, which can easily be provided in a meadow landscape. The enclosed spaces are located around the open and public spaces, where people can watch other people, and located in a calm environment, where people can watch the flowery meadows or the water parties.

Conclusion

All three design principle categories are possible to implement in this model. For further exploration, it is key to explore different ways of using greenery in a way it is less monotonous. Additionally, flowery meadows are not present year round. Further playing with alternation of closed and open is important as well, because really closing of from the surroundings is difficult in this model. Because of the open environment, it would be helpful to emphasize and guide the main route to make the environment more easy to read and to create edges.

2. Private Design Principles

a. Create enclosed spaces. b. Create blocked sights, alternated with views. c. Place furniture in the enclosed spaces. d. Create the possibility to take a walk e. Design exploring routes. f. Place the enclosed spaces along the exploring route.

3. Public Design Principles

a. Create open spaces. b. Create views. c. Place furniture in the open spaces. d. Create the possibility to do group activities. e. Design clear routes. f. Place the open spaces along the clear route.

Fig. 6.6 Design principles indicated in the work MEADOW.

6.3 MODEL 2: WORK PARK

Work PARK

In the second model, the typology of a park is used to show the ratio of 50-50, private versus public space (see figure 6.7 and 6.8). A park is often a place where people can find different kind of spaces, since a park has regularly a broad target group. People can walk, relax, or play sports for example. In this model the environment shows different places and identities, such as an 'island' on the left, a large pond in the middle, and a water party with a tribune near the station on the upper right. The greenery is more diverse, even as the water elements. There is a distinction in high and low green, open and closed alternate, and important axis are guided by rows of trees.

Design Principles

The design principles are indicated in figure 6.9. In this second model, there is more overlap between the private and the public spaces. For example, the large pond is an open space and people often like to sit around the water in groups, making it a lively and public space. However, it could be a calm place with the possibility to rest as well, when an employee sits alone or walks around the pond. A more clear distinction is made on the two spaces on the left. At the 'island' a distinction is made by the water, with the public space in the middle and the private space on the outside. In the other space, in the front is a public space and walking further is a more private space.

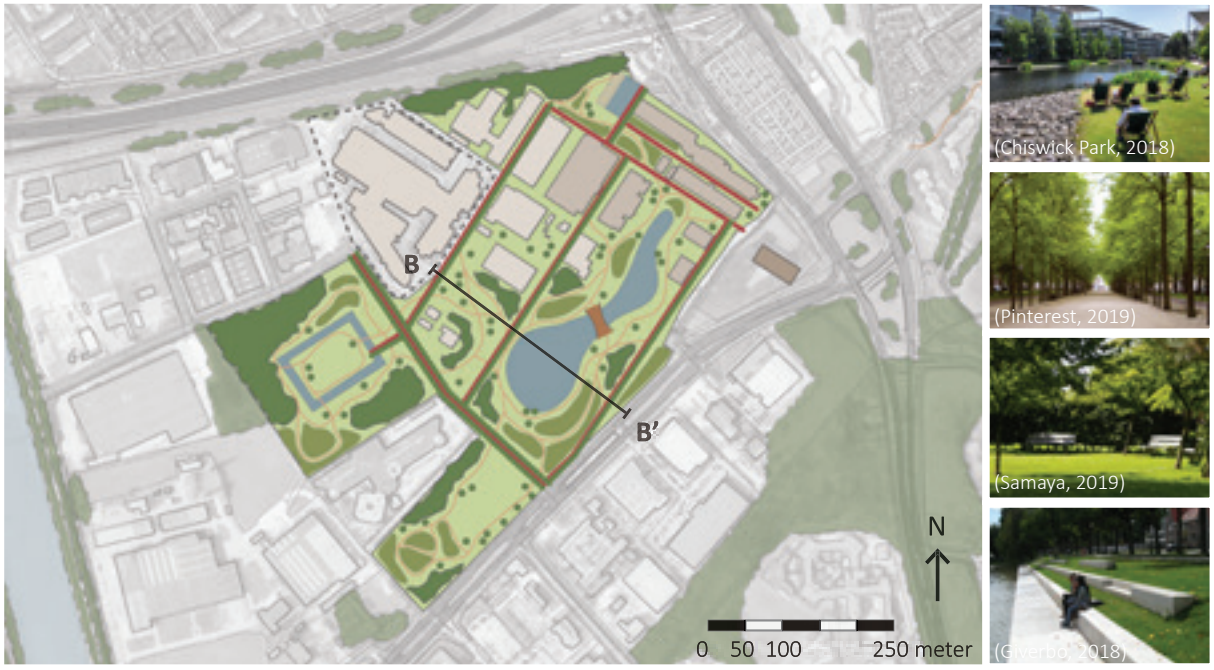


Fig. 6.7 Model work PARK including reference images.

Fig. 6.8 Section BB' work PARK, 1:2000.

The advantage of a park typology is the ability to create different identities within the spaces, instead of one identity as in the meadow or forest typology. Besides, the diversity in greenery is useful to create different places and structures. A disadvantage is the less clear distinction between private and public, because elements in a park are more integrated.

Conclusion

The park typology is an easy way to integrate all design principles. Within the park typology there are many possibilities regarding greenery and water to create open and enclosed spaces, fitting the typology. The only aspect to take more carefully into account, is the distinction between private and public space, since it is easy to overlap these in a park-like environment.

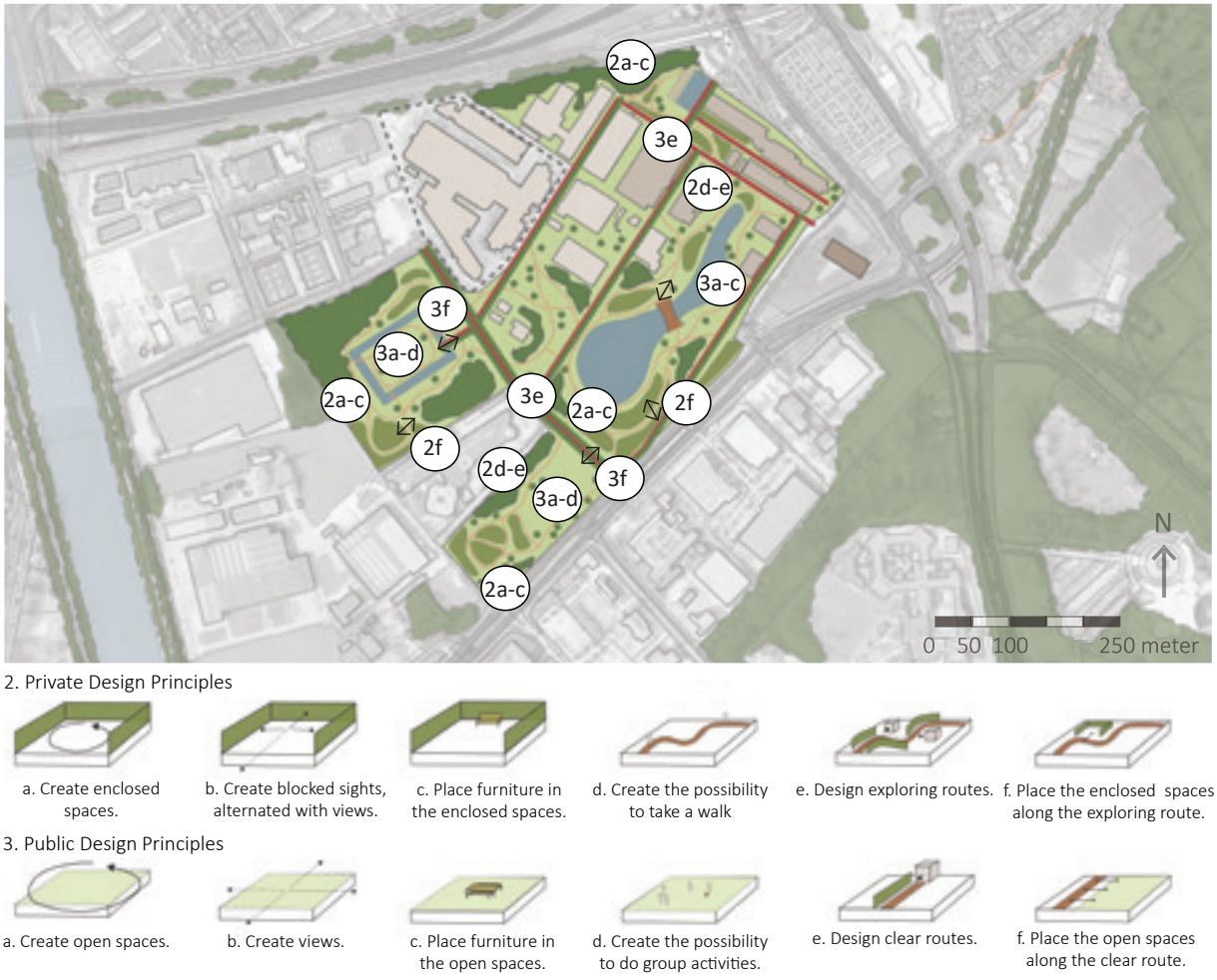


Fig. 6.9 Design principles indicated in the work PARK.

6.4 MODEL 3: WORK FOREST

Work FOREST

In the third model the focus is more on enclosure and creating private spots to sit undisturbed (see figure 6.10 and 6.11). A forest is an enclosed environment and ensures a lot of privacy. Two open spaces are created within the forest, to integrated public space as well. These open spaces can be used for group activities and to gather with colleagues. The work forest could be a nice expansion of the existing forest at the Goffertpark. An exploring route is crossing the forest, and along this route different private spots are implemented. Greenery consists of trees and grass, which could become monotonous. Furthermore, a forest can be dark. Therefore, it is important to decide on the type of trees in relation to transparency.

Design Principles

In the model there is a clear distinction between private and public space (see figure 6.12). The enclosed spaces are spread through the forest. A disadvantage is the similarity of the enclosed spaces and the limitation of views. Sightlines or the possibility to watch other people are more difficult in this typology. An advantage is that people are really closed off from the surroundings,

Fig. 6.10 Model work FOREST including reference images.

Fig. 6.11 Section CC' work FOREST, 1:2000.

such as the road and the buildings. The two open spaces are easy accessible from the main pathways, even as the buildings. The open spaces are large enough to give prospect. However, overlooking the campus is not possible. The main pathway, or the clear route, is crossing the forest. Nonetheless, the forest is not particularly guiding the route.

Conclusion

The forest typology is a good way to be closed off from the surroundings and to create the feeling of being away. However, this high enclosure is the pitfall as well, since the enclosed spaces are fully closed off and enjoying views or watching other people is difficult. Besides, the main routes should be more clear and emphasized, because it is all surrounded by trees and overview is difficult. The lack of overview, or prospect, conflicts with the feeling of safety as well.

Fig. 6.12 Design principles indicated in the work FOREST.

6.5 DISCUSSION

Further Exploration of one Model

In the previous paragraphs three models are discussed. All three models have their own advantages and disadvantages. The models work MEADOW and work FOREST are most challenging. This makes sense, since the focus is more on the public design principles in the work MEADOW and more on the private design principles in the work FOREST. Where the work PARK is more balanced.

Since the work PARK is the balanced option, it is interesting to explore the possibilities of the other two models. Within the time frame of this study, it is not possible to explore both models further. Therefore, the focus is on one of the models. Because most work environments are in an open environment, even as the Novio Tech Campus, the work MEADOW is chosen for further exploration. The main challenge is to create comfortable, enclosed spaces in an open environment. This further exploration shows how advantages can be exploit, disadvantages can be solved, and how a certain typology can be developed towards a healthy work landscape.

Other Aspects for further Development

The design principles are important to create a healthy work environment for employees. However, more aspects are essential when making a design for the Novio Tech Campus. These aspects are: the potential to become a work landscape, the wishes from the employees extracted from the questionnaire and the future development of the site.

Work Landscape

Within the concept of work landscapes, a few aspects are important to take into consideration when designing (see figure 6.13 and paragraph 5.3).

One of those aspects is the connection with the surroundings. In this case Maas-Waalkanaal and Goffertpark offer great opportunities to connect NTC with the surroundings. For the connection to Goffertpark, it is crucial to overcome the barrier of the Jonkerbosplein.

Another aspect is the addition of public facilities, increasing the liveliness of the campus. Public facilities attract other people to the campus and

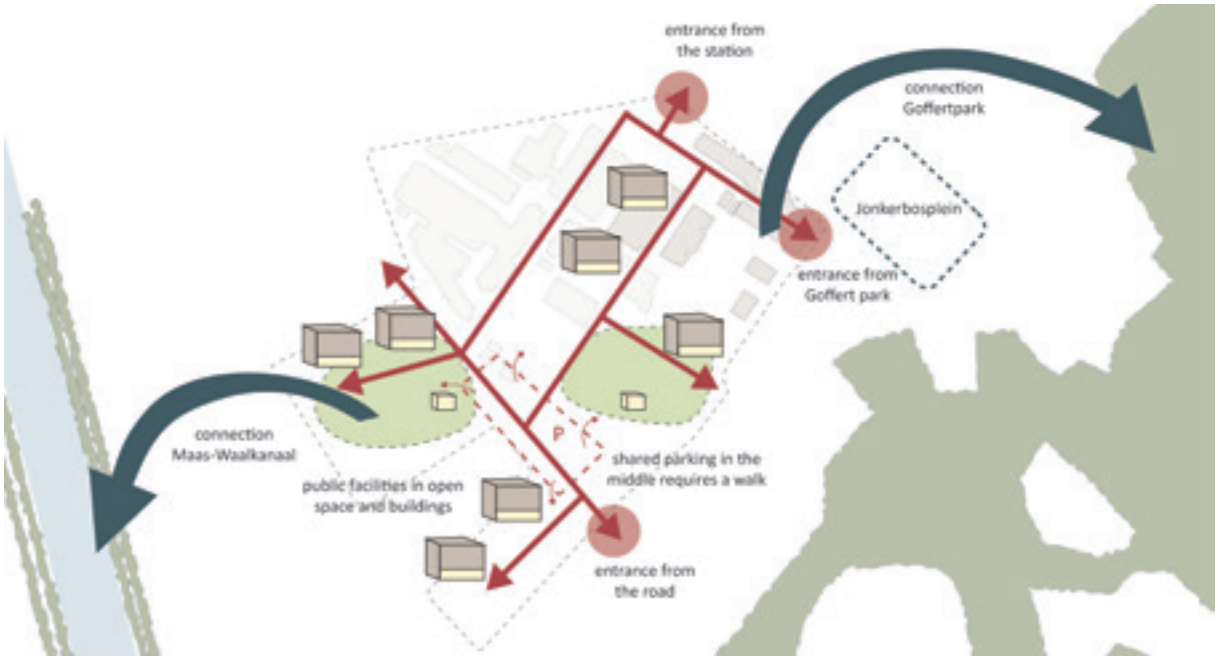


Fig. 6.13 Important aspects of a work landscape.

ensure the place is not only used between 9 and 5. Public facilities could be added in the public, open spaces and on the ground floor of buildings. By implementing public facilities on the ground floor, the building gets a more open atmosphere and are not only meant for the employees.
The third aspect is spatial quality and identity. Spatial quality is difficult to measure, but adding greenery, water elements and creating a more living environment, instead of a work environment, will definitely increase the spatial quality of the site. Besides, focusing on one landscape typology helps to create a more clear identity as well.
The last aspect to take into consideration, is the accessibility for both employees and other target groups. It is important that the main entrances are clear and there is enough space to park the car and the bike. The main entrances could be connected to the axis of clear routes even as shared parking facilities. Choosing for shared parking facilities assure that people have to walk through the healthy work landscape before entering the building.

Wishes Employees
The wishes of the employees are made clear through the questionnaire. Main wishes are the possibility to take a walk, to have enough and different furniture, and more greenery (see paragraph 5.7). Two of them: take a walk and more greenery, are also covered by the design principles. The wish for furniture is important to take into account when the design becomes more detailed. In figure 6.14 a few examples of different types of furniture are shown.
A few other wishes mentioned by the employees are ‘more corners for privacy’, ‘roofed places’, ‘shadow’, and ‘possibilities of entertainment’. The first one fits perfectly within the design principles. The other three should be taken into consideration as well, when developing the Novio Tech Campus.

Future Development
The Novio Tech Campus is still under development. Therefore it is important to include flexibility in the design and consider different phases. New buildings will be constructed through the years. These buildings should be placed properly within the design. For that reason, it is helpful to indicate building plots in advance, helping to design and construct pathways in one time as well. Furthermore, within the design it should be possible to expand the grid of main routes when new buildings are constructed, since they should be easy to reach as well. Challenge is to maintain the landscape typology and not let the buildings become dominant. In former plans of NTC, the buildings covered circa 50% of the total surface (gemeente Nijmegen, 2019). This number is taken as starting point for the design.

Fig. 6.14 Examples of furniture.

7 DESIGN

7 DESIGN

7.1 HEALTHY WORK MEADOW

New Buildings

It is important to include new buildings for the future development of NTC. Gradual elevation of the buildings is strong recommended. Gradual elevation ensures the building is optically located further and it is better for the human-scale (see figure 7.1). Furthermore, it gives the opportunity to create roof terraces. The roof terraces are a place solely used by the employees, in contrast to the rest of the outdoor space. In addition, the view from and to the buildings is much nicer. From the inside, employees see more greenery and the outdoor is closer to their work place. From the outside, the buildings have a greener appearance. The new building plots are mainly placed on the edges. In this way the buildings enclose the outdoor space, block the noise and avoid a view on the busy road.

NTC during the Week

One of the goals is to develop NTC towards a work landscape. To reach this goal it is important to include facilities attracting other people than employees, during the day, evening and weekend (see figure 7.2). These facilities increase the liveliness of the place. Especially in the evenings and in the weekends, the place should offer activities for other people, because employees won't be there. Sport activities are a good opportunity to maintain the liveliness, since exercise is possible any time of the day. Furthermore, placing public facilities on the ground floor ensure that the ground floor remains illuminated. In addition, a canteen for the employees can be turned into a restaurant and be visited by other people in the evening. Besides, a big grass field is always useful. It serves as public space for the employees to have lunch for example, and it can serve for other recreational goals in the evenings and the weekends.

Healthy Work Meadow

In figure 7.3 the further development of the model work MEADOW is shown. In the design the clear route is emphasized by tree rows, making the place more easy to read. Between the strong and guided grid of routes, the openness of the meadows are maintained with only some solitary trees and some thickets for enclosure. In addition, between the new buildings pockets are created to sit undisturbed, away from the public space. A parking garage is established in the middle of NTC, forcing employees to take a short walk to their office. For some buildings the railway station is even closer than the parking garage, stimulating the convenience of public transport. Besides many tree rows, there is one tree lane emphasizing the main entrance of NTC. Public facilities are located near the main entrance, making other people feel welcome at NTC as well.

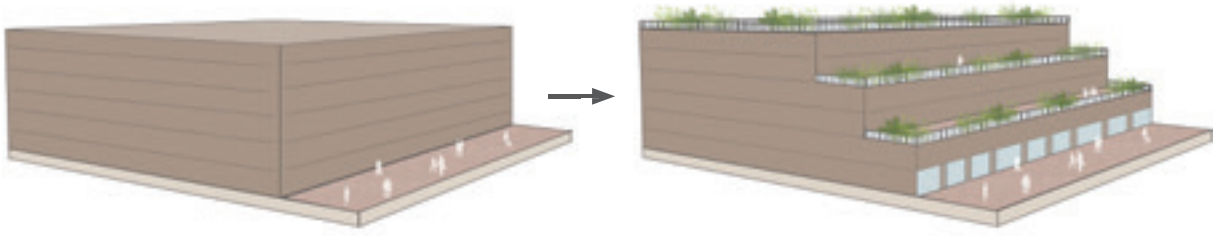


Fig. 7.1 Gradual elevation of new buildings.

> Fig. 7.2 Images of the program at NTC.

(Chiswick Park, 2018)

(Londonist, 2016)

(Zuidas, 2017)

(The golfclub, 2019)

(Utrecht Science Park, 2019)

(Visit Philly, 2018)

(Pinterest, 2013)

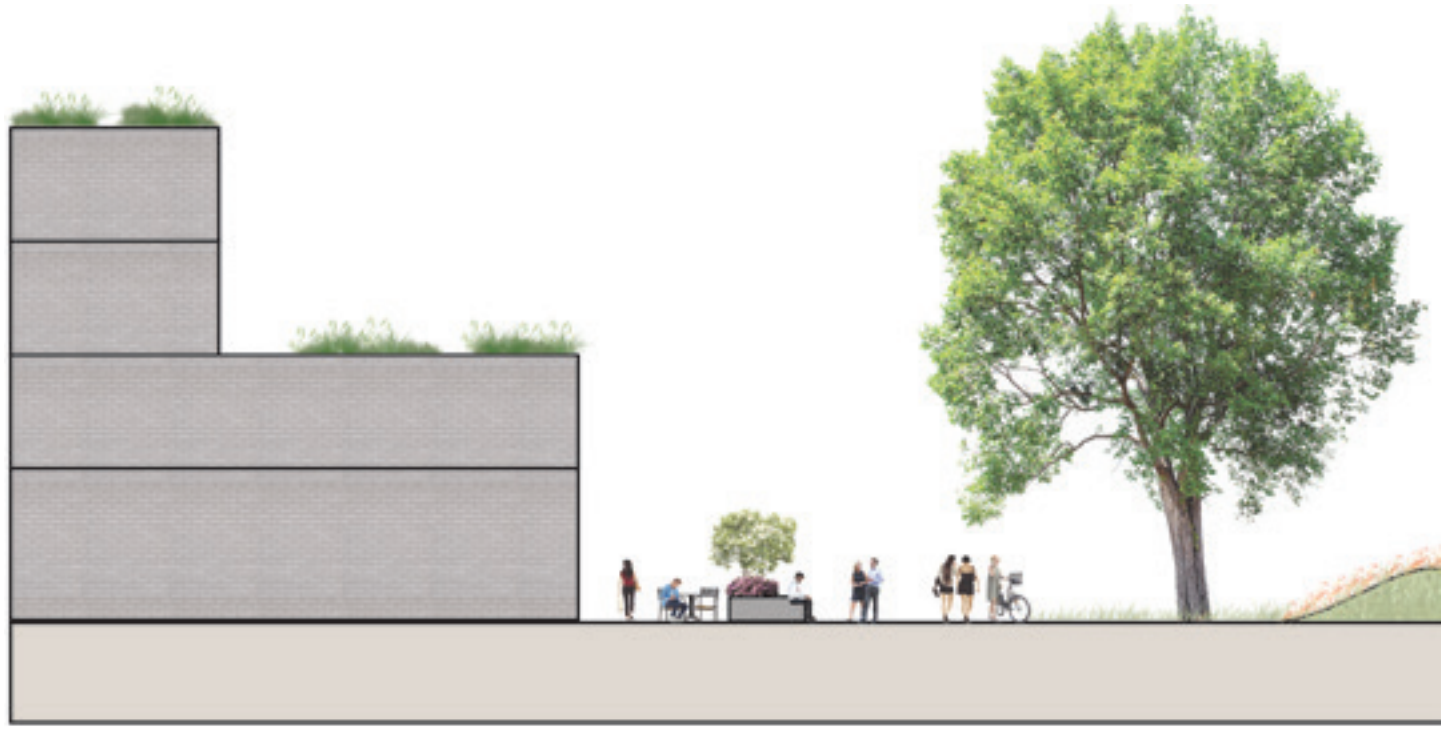
(In de buurt, 2019)

Fig. 7.3 Design healthy work meadow.

Legend
Tree lane/row
Thickets with trees
Solitary trees
Flowery meadows
Grass
Water
Buildings plots
Public facilities
Bicycle and footbridge
Clear route
Exploring route
Main entrance
N
0
40
80
120
160
200 meter

The Boulevard

In the new design for NTC a boulevard is created (see figure 7.4 and 7.5). At the boulevard the clear route is twice as wide as the common clear route. On one side the boulevard is guided by a row of trees, on the other side public facilities are located on the ground floor. The boulevard is meant to be the most lively place on the campus, with an easy connection to the open grass field, meant for public use as well. The public facilities established at the boulevard are for example: a yoga studio, a day-care, a coffee bar and a lunchroom. A few facilities have a terrace outside on the boulevard, separated from the main stream by plant borders. Around the open grass field, a restorative walk can be made. The exploring route is guided by a flowery strip of grass, placed on a small slope. The slope ensures the structure remains in the winter, when there are no flowers. The slope at the side of the clear route is higher, ensuring a strong separation, then the slope at the side of the open grass field, giving the opportunity to watch other people in the open space.



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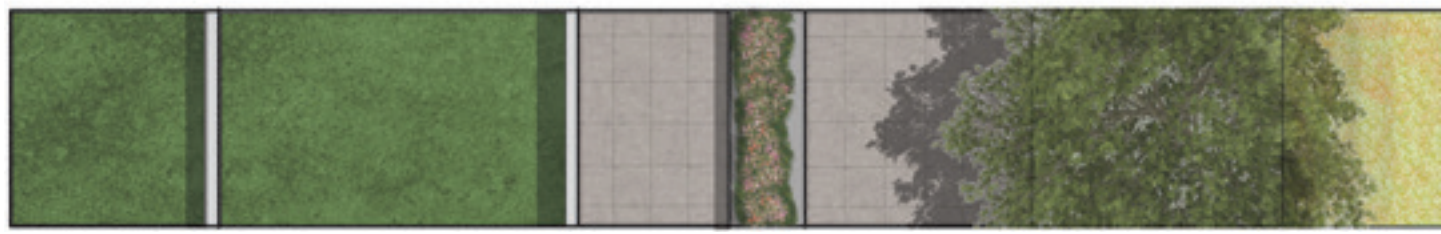
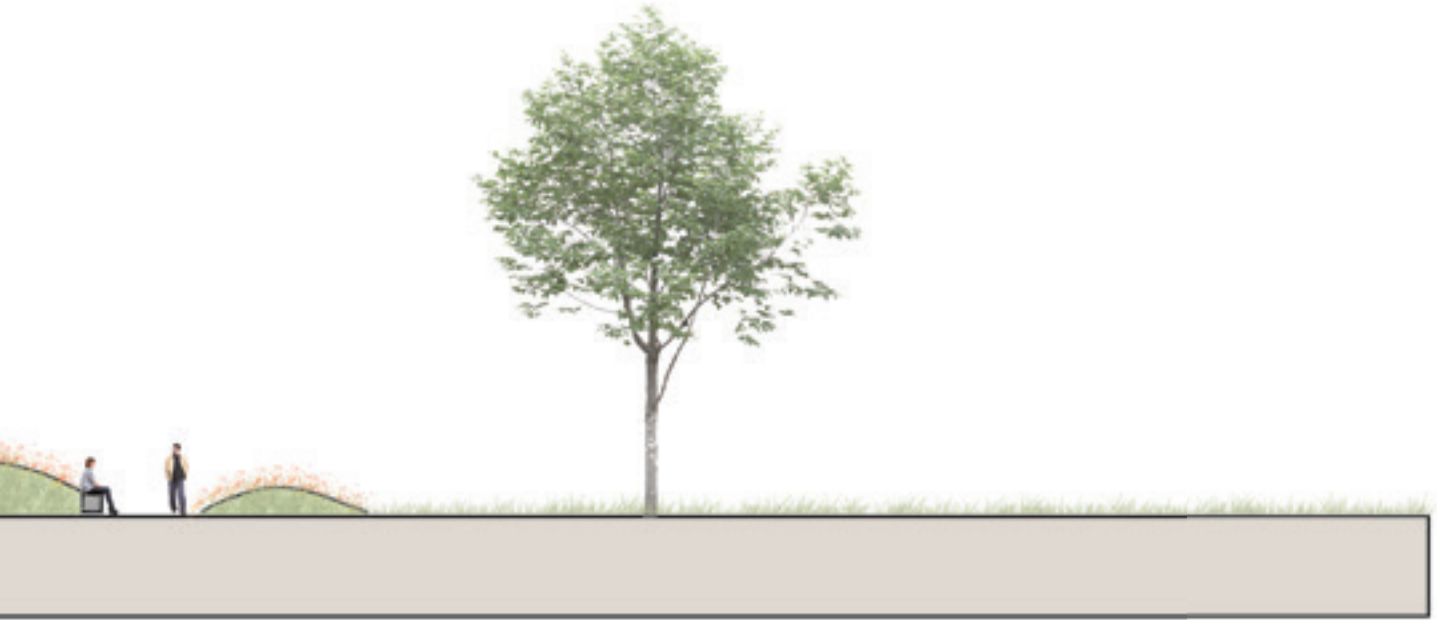
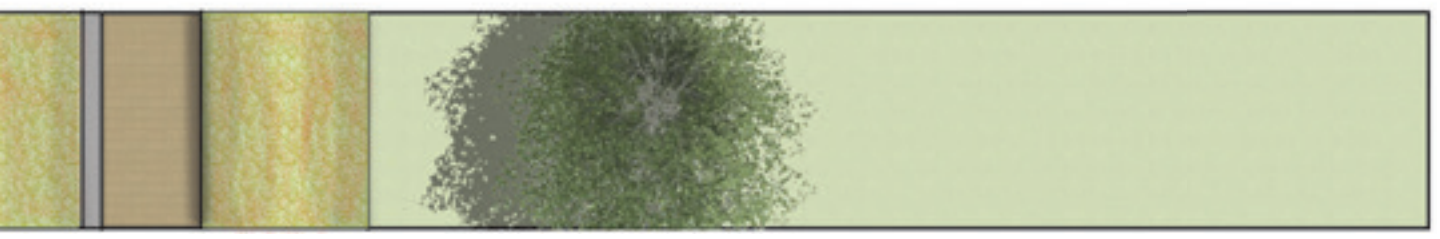


Fig. 7.4 Section AA' of the boulevard at NTC, 1:200.

Fig. 7.5 Section AA' indicated.





Connection Maas-Waalkanaal

To connect NTC to the surroundings, two important connections had to be made. One of them is the connection with the Maas-Waalkanaal. The Maas-Waalkanaal is a beautiful place to sit, and to restore attention and to recover from stress by gazing upon the water and the ships passing by. Walking to the Maas-Waalkanaal could be a nice walk during lunch. From NTC an exploring route goes to the Maas-Waalkanaal, making it easy to go and walk around. Along the water a few concrete blocks are placed, providing the opportunity to sit (see figure 7.6 and 7.7). The visual impact of the intervention is low, changing the current appearance of the Maas-Waalkanaal as minimal as possible.

Fig. 7.6 Reference sitting at the water.

Fig. 7.7 Exploring pathway and sitting along the Maas-Waalkanaal.

Connection Goffertpark

The other made connection is with the Goffertpark. To go to the Goffertpark a busy crossing had to be crossed. A bicycle and footbridge offers the opportunity to cross without waiting for traffic lights, and makes the connection with the Goffertpark more clear (see figure 7.8 and 7.9). Furthermore, the bridge is not only connecting NTC with the Goffert, it is also an opportunity to extend a fast bike route to NTC and Dukenburg, a district on the other side of the Maas-Waalkanaal. Besides, the bridge is connected to the roof terrace of the building fifty-two degrees as well. When constructing the bridge it is important to be aware of the different paths for bikers and pedestrians to ensure safety.

Fig. 7.8 Reference bicycle bridge Eindhoven.

Fig. 7.9 Bicycle and footbridge crossing Jonkerbosplein.

7.2 DESIGN NTC PHASE ONE

A more detailed design is made for the current site of NTC (see figure 7.13 and 7.14). The current site of NTC is considered as phase one, since the expansion plans for NTC are still uncertain and can proceed for quite a time.

Enclosed Spaces

One of the challenges of the MEADOW model is to create enclosed spaces. In the design enclosed spaces are created in three different ways: within pockets of the new building, in niches surrounded by greenery, and by height differences (see figure 7.10-7.12). The pockets are more oriented inwards, and the niches and the small slopes are more oriented outwards with views on water, flowers and other people.

Year-round

Places to sit year-round are added to the design. Attached to the buildings a serre and two verandahs are situated, both decorated with greenery. When it is raining, employees are still be able to sit outside and have a breath of fresh air.

Furniture

The furniture in the outdoor space indicates the use of a particular area. For example, in the niches surrounded by greenery, only benches and loungers are placed to avoid group gathering. In the open, public spaces in turn, group gathering is stimulated by placing large picnic benches.

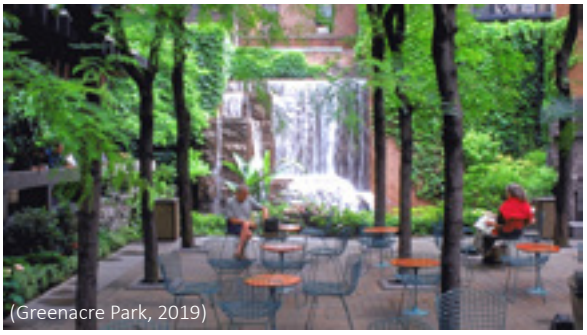


Fig. 7.10 Enclosed space by creating a pocket.

Fig. 7.11 Enclosed space by creating a niche.

Fig. 7.12 Enclosed space by creating height differences.

Legend

Roof gardens

Solar panels

Serre

Veranda

Furniture

Tree row

Solitary trees

Thickets

Flowery meadows

Grass

Clear route

Exploring route

Seating hills

Slope

Water

Fig. 7.13 Legend design NTC phase one.

Fig. 7.14 Design NTC phase one.

7.3 A REGULAR DAY OF AN EMPLOYEE

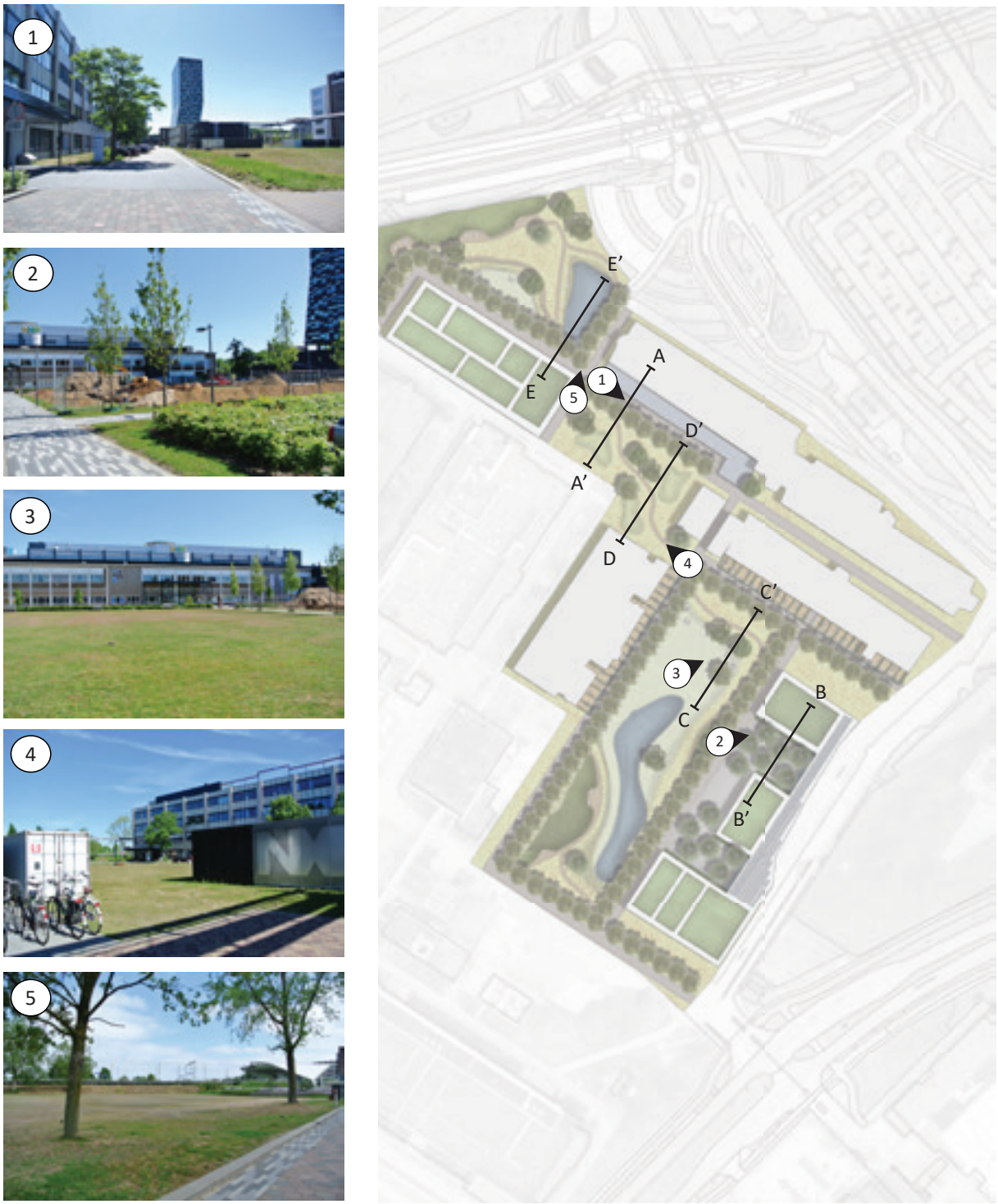


Fig. 7.15 Direction of visuals and sections indicated.

8.30 Walking to the Office

After arriving by train, the employee walks to the office, located in the new building south of the campus. The employee takes the clear route, guided by trees for easy orientation (see figure 7.16 and 7.17). On the left, one sees the serre with climbing plants against the pillars, and on the right, the seating hills surrounded by flowery grass. There are no people on the seating hills yet, but during the lunch break they are used by employees, creating their own comfortable spot. Especially when the sun is shining, the place is very popular.

Fig. 7.16 Section AA', 1:1000.

Fig. 7.17 Visual 1: 'Walking to the office'.

10.30 Short Coffee Break

After a few hours of work, it is time for a short coffee break. Because the employee has just 15 minutes, one stays close to the building. Near the buildings an enclosed pocket is created (see figure 7.18 and 7.19). The walls of the building, covered by greenery, enclose the space. A grid of trees creates the idea of a roof. The pocket is a comfortable place to sit, also on colder days. Because of the moveable furniture, employees can choose to sit in the shadow or the sun. Besides, they can choose to sit more closely to the main route and watch other people, or more inwards the pocket to sit more quietly.

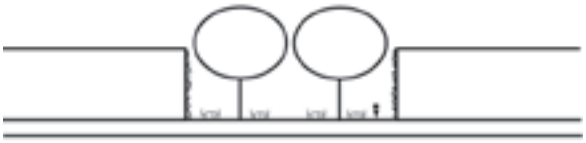


Fig. 7.18 Section BB', 1:1000.

Fig. 7.19 Visual 2: 'Short coffee break'.

12.30 Lunch Break

During the lunch break, most employees sit together with other colleagues and perceive this moment as an opportunity to socialize. The open space on the grass field is a good place for group gathering and have lunch (see figure 7.20 and 7.21). Employees can use the picnic benches or can gather on the grass when it is sunny. Another option is to provide folding beach chairs, which employees can place wherever they want. Others prefer to make a stroll, and walk behind the public space on the exploring route. This route is guided by flowery grass on a small slope, ensuring the structure remains in winter time.

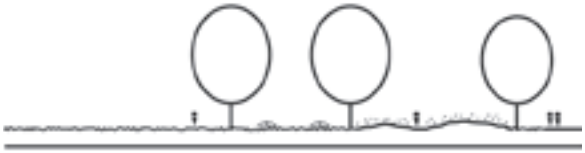


Fig. 7.20 Section CC', 1:1000.

Fig. 7.21 Visual 3: 'Lunch break'.

13.00 Lunch Walk

After socializing with colleagues, the employee may need a moment alone, before starting a productive afternoon. A short walk of 10 to 15 minutes is useful to clear the mind. A nice walk can be made towards the northern part of the site. The employee crosses the space with the seating hills, where a few employees made themselves comfortable (see figure 7.22 and 7.23). The exploring route goes through the flowery meadows and is situated partly along the water, increasing the sensory engagement and distracting the employee of worrisome thoughts.

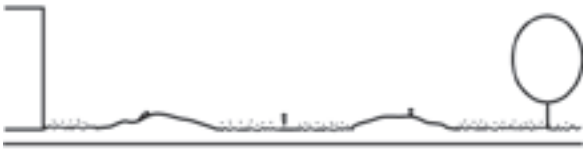


Fig. 7.22 Section DD', 1:1000.

Fig. 7.23 Visual 4: 'Lunch walk'.

17.15 Going Home

At a quarter past five, it is time to go home. The employee walks in the direction of the railway station. One day one takes the clear route, and the other day the exploring route. Before catching the train the employee decides to get a drink at the public facility, located in the new building near the station (see figure 7.24 and 7.25). The train leaves in 10 minutes and the employee stays to chat with a colleague. After 5 minutes, one slowly walks in the direction of the station, along the row of trees and the water.

Fig. 7.24 Section EE', 1:1000.

Fig. 7.25 Visual 5: 'Going home'.

7.4 PLANTATION

Flowery Meadows

Greenery is the main material used, ensuring a high level of sensory engagement. Especially the flowery meadows are an important aspect of the design. A mix of perennial plantings should be randomly distributed over the designated fields and grass strips. There are many wild flowers and it is key to compile a mix, giving a colourful image from early spring to late autumn. Furthermore, nectar-rich flowers should be added to the mix, as an opportunity for maintaining the bee population, such as Papaver rhoeas (poppy), Linum usitatissimum (blue flax), Helianthus annuus (a low sunflower), Trifolium repens (white clover), and Avena sativa (summer oats) (see figure 7.27) (Advanta, 2019).

In the winter there will be no flowers, but the structure in the design still exists through height differences and mowing regime (see figure 7.26). Mowing should be done twice a year. Once in autumn, after flowering, and once in the spring, before flowering to create space for the perennials to grow and to remove dead plant material. Besides, it is important to mow the grass fields for public use regularly, distinguishing the different areas, public and private, in the design.

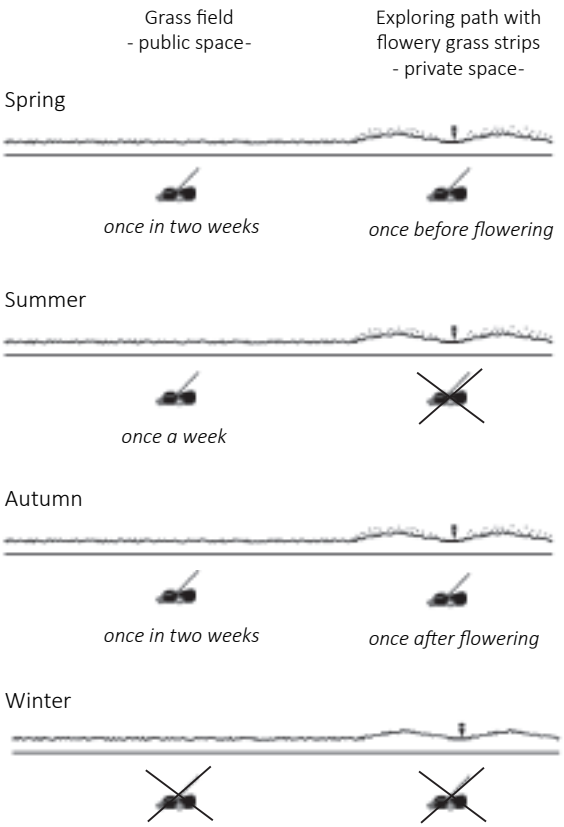


Fig. 7.26 Mowing regime.

Fig. 7.27 Nectar-rich flowers.

Trees

The trees determine an important structure in the design. Especially the rows of trees, guiding the clear route, and the trees in the pockets, forming a roof. It is key to select the right trees with appropriate characteristics.

The trees in the rows should have a compact structure and shouldn't be too broad. They have to form a clear structure and tolerate pavement. A suitable tree is the Tilia cordata 'Greenspire' (linden) (see figure 7.28). In addition, the tree is valuable for bees and butterflies. The 'Greenspire' is a fast growing specie and can become 15-20 meter. Furthermore, the tree is resistant to frost and to wind (van de Berk, 2019a).

The trees in the pockets between the buildings should form a roof. Therefore it is important that the tree crown is fan-shaped. In addition, the crown should be half-open to filter the sunlight. A suitable tree is the Styphnolobium japonicum (honey tree). This tree is used in Paley Park, another pocket park, as well (see figure 7.29). The honey tree flowers cream-white in July and is valuable for bees and butterflies. The tree tolerates paving, is resistant to frost and is moderate resistant to wind (van de Berk, 2019b).

Fig. 7.28 Tilia cordata 'Greenspire' (van de Berk, 2019).

Fig. 7.29 Styphnolobium japonicum in Paley Park (Smartcities, 2017).

8 CONCLUSION

8 CONCLUSION

8.1 CONCLUSIONS

This thesis aimed to expand the knowledge on the healing effects of nature, by developing design principles for healthy work landscapes. The relation between nature and mental health has been researched thoroughly, but lack clear operationalisation. This thesis could be seen as a way to increase the awareness of the relation between nature and health, and to motivate designers to integrate this aspect in future designs, because the environment contributes to the mental health state of people. Nature reduces stress and restores attention, and this can prevent burn-outs among employees. Besides, this thesis shows an example how to integrate the design principles as well. This design case is carried out for the Novio Tech Campus in Nijmegen, showing how to turn the campus into a healthy work landscape.

In order to achieve this, a research has been conducted. The first part of the research was focused on developing design principles, and the second part on the case: Novio Tech Campus. The results were used to answer the design question, proposing a healthy work landscape. A short recap of the results of the research questions are given below. Thereafter, the design question will be answered and discussed more thoroughly.

Research Question 1: Which design principles can be developed to support mental health in a work landscape?

To answer this question a literature study is conducted, and a questionnaire is send to the employees of the Novio Tech Campus. This resulted in 14 design principles, categorized in three groups (see figure 8.1).

The categories help to understand the contrast between the principles. All three categories are necessary for designing a healthy work landscape. The challenge is to design the two opposite groups, public and private, in an integrated way.

Group 1: General design principles:

a. Add greenery for sensory engagement.

b. Add water elements for sensory engagement.

Group 2: 'Private' design principles:

a. Create enclosed spaces to sit privately and to be able to rest.

b. Create blocked sights to close off the surroundings and to give protection, alternated with distracting views.

c. Place furniture for individuals or small groups in the enclosed spaces.

d. Create the possibility to take a walk, alone or in a small group.

e. Design exploring routes to wander, with intermediate goals and alternately open and closed along the route.

f. Place the enclosed spaces along the exploring route for more seclusion.

Group 3: 'Public' design principles:

a. Create open spaces for group gathering and activities.

b. Create views to orientate and overlook the area.

c. Place furniture for groups in the open spaces.

d. Create the possibility to do group activities.

e. Design clear routes to move quickly to main goals, guided and with clear orientation.

f. Place the open spaces along the clear route for direct and easy access.

Fig. 8.1 Design principles.

Research Question 2: What is the current situation of the outdoor work environment of the Novio Tech Campus in Nijmegen?

The case study is based on different methods, such as a questionnaire, a consultation with the municipality, a landscape study, a document study, a field visit and first-person observations. All serving the goal to generate a broader

understanding of the case. The results are summarized in a SWOT-analysis, indicating the strengths, weaknesses, opportunities and threats, and providing an overview of the potential of the site and important aspects to take into consideration (see figure 8.2).

The SWOT-analysis helped to summarise the results of the case study. Key is to increase the spatial quality, by treating the place as a living environment, instead of solely a work environment. Boost the liveability by adding public facilities and creating connections with the surroundings. There is quite some space at the campus to develop the place towards a healthy work landscape, however, the construction of new buildings should be taken into account as well.

Design Question: How can the Novio Tech Campus in Nijmegen become a healthy work landscape for employees?

The design for the Novio Tech Campus is based on the two research questions, and the interpretation of the designer. The outcome is a design for a healthy work landscape, improving the mental state of employees. Conclusions can be made for several aspects, such as the applied design principles, the liveliness of the campus, the meaning of the design for the city Nijmegen, and the integration of other aspects than health.

Design Principles

In order to create a healthy work landscape, all three design principle categories are used.
Greenery is the main material used in the design, stimulating sensory engagement together with some water elements. The water elements are not dominant, because of the disadvantage that the surface of water can't be entered by employees, in contrast to grass fields. Water serves mainly as an element to gaze upon.
The second category, focused on the private design principles, is present primarily through the exploring pathways crossing the entire site. Along these exploring pathways, enclosed spaces are situated, shown more clear in the design for phase one and the visualizations. The enclosed spaces are created in three different ways: within

Strengths
- Identity of the 'health and tech' companies + shared facilities.
- Focus of Nijmegen on health.
- Infrastructure + accessibility of the site.
- Quite some (green) space at the site.
- Proximity of Goffertpark and Maas-Waalkanaal.

Weaknesses
- Not appealing, no campus look, not attractive.
- Low spatial quality, mainly grass.
- No public facilities around, still perceived as an industry area.
- Isolated from the public/surroundings.
- Not enough and diverse furniture.
- Not enough and diverse greenery.
- No possibility to take a walk.
- Outside is perceived as 'boring' and 'minimal' by employees.

Opportunities
- Possible expanding of the site.
- Improving connections Maas-Waalkanaal and Goffertpark.
- Potential to develop as a work landscape.
- Space to add greenery/green structures.
- Exploit industrial identity.

Threats
- Development of new buildings.
- Uncertainty of development NXP.
- Approach as work environment instead of living environment.

Fig. 8.2 SWOT-Analysis

pockets of the new buildings, in niches surrounded by greenery, and by height differences. Of which the pockets are a grey area between 'private' and 'public'. In the pockets employees are able to sit alone, but also with other colleagues. Besides, the front of the pockets is closely to the main route and could therefore be more perceived as 'public' space.
The third category, focused on the public design principles, is present primarily through the axes of paths and trees, and the open spaces on the grass fields. The axes of paths form the main route and ensure easy and fast access to the offices. The open spaces are meant for group gathering and are easy accessible from the main route.

The 'private' and 'public' spaces are situated next to each other. It is not possible to divide the campus in half 'private' and half 'public' space. The buildings are distributed over the campus and should all be easy to reach by a clear, public route. In addition, open and enclosed spaces should be distributed over the campus as well, otherwise employees have to walk to far and are not able to enjoy the places in short breaks, or they don't want to make the effort to walk to the place.
It is possible to intertwine both categories in one design. Consequently, the borders between the two categories are important to take into account. In the design for the Novio Tech Campus the border is created by small height differences and distance. Besides, the enclosed spaces can best be applied on the edges, and the open spaces in the middle. In this way it is easy to create protection in the back, nice views in the front, and the opportunity to watch other people.

A Lively Campus

Another important aspect to design a healthy work landscape for NTC, is to treat the place as a living environment instead as a work environment. Meaning, the place should not only be attractive during the day, but also in the evenings and in the weekends to attract other people than employees. One way to create more liveliness is to add public facilities, such as a coffee bar, a lunch room, a restaurant, a gym and a day-care. These facilities can be used both weekdays and weekends. Furthermore, open spaces, such as grass fields, are always practical for organizing all kind of activities. In addition, clear entrances are important to welcome other people.

In the design, public facilities are added. A few are connected to a boulevard, meaning to create the most lively place on the campus. Others are situated in the open, public space as pavilions. Key is to create the public facilities in het 'public' space of the campus, not disturbing the 'private' spaces. The entrances to NTC are made clear, but from the surroundings there is no overview. Buildings close off the space, creating a nice environment inside, but can be perceived less inviting to the outside. Therefore, it is important to promote the campus as a public and accessible space. Creating connections beyond the boundaries of the site are helpful as well. In the design a connection is made with the Maas-Waalkanaal and the Goffertpark. Besides, the routes are expanded to the Winkelsteeg.

Design for Nijmegen

NTC is the health and high tech campus of Nijmegen. It is important not to isolate this campus from Nijmegen, but to connect with the surroundings and to add value to the city.
The new bicycle and footbridge is a good example. This bridge doesn't only increase the accessibility of NTC, but also extends the fast bike route to Dukenburg, a district on the other side of the Maas-Waalkanaal. Furthermore, it creates a safer environment around the crossing and it can become an iconic element.
Close to NTC the Goffertpark is located, a well-known park in Nijmegen. Goffertpark is a city park with a large grass field for concerts and

festivals. The park attracts many visitors a year. NTC is not an extension of the Goffertpark, but a more small-scale park, with alternated open and enclosed spaces. In addition, NTC offers public facilities, in contrast to the Goffertpark, and is more intertwined with buildings, giving a more urban ambiance.
Nijmegen as a city is focused on the topic of health. The design for NTC can serve as an example to other cities, and the city can profile itself on the health topic even more. Besides, the design can be a start signal to green the whole industry area the Winkelsteeg, and make this part of the city more attractive.

Other Aspects than Health

The design is focused on supporting the mental health state of employees. Is there the possibility to include other aspects, such as energy, climate and biodiversity, as well?
The suggestion is to construct new buildings with a flat roof, to be able to create roof gardens. Green roofs increase the insulation value, providing lower heating costs and a cooler building in the summer (Hiemstra et al., 2018). Beside roof gardens, there is the possibility to place solar panels to generate energy.
Greening a work environment is not only valuable for health, but for climate as well. Heat stress is not solely for the city, but also for industry areas. Due to large surface area of buildings and pavement is it usually warmer than in the surrounding area. Heat stress reduces the labor productivity and can decrease the health of employees. Greenery limits the heat around buildings and causes less heat stress. (Hiemstra et al., 2018). Furthermore, greenery purifies the air and lowers the concentration of carbon dioxide.
Greenery can also contribute to the biodiversity. In the design mainly trees, shrubs, and flowery meadows are used. Selecting the right species can be valuable for the conservation of bee and butterfly populations.
Concluding, other aspects are present as well, but not emphasized in the design and in this thesis. Further research could focus on the optimal integration of the different aspects, in order to create a work landscape including the aspects health, energy, climate, and biodiversity.

Conclusion

This thesis shows how a work environment can be turned into a work landscape.
The three categories of design principles can easily be combined. Besides, the principles give spatial guidelines as well. Within the principles there is still enough freedom for the designer to experiment and to be creative. For example the three models are all different, but based on the design principles. The proposed design is a balanced combination of the ‘private’ zones and the ‘public’ zones. The zones are distributed throughout the campus, enabling employees to choose a preferred space close by.
The design principles create solely a landscape supporting mental health, by contributing to stress reduction and attention restoration. For the Novio Tech Campus the goal was to create a work landscape as well. Public facilities, connections with the surroundings and the possibility to organize activities, are included in the design. Key is to combine these functions with the ‘public’ zones on the campus, in order to not disturb the ‘private’ zones.
Furthermore, NTC contributes to the city of Nijmegen, by creating an example of a healthy work landscape, making important connections with the surroundings, and to give Nijmegen a different urban, green space. The contribution of NTC to the city can provide more support from the municipality.
Finally, the option to integrate other aspects as energy, climate and biodiversity within a healthy work landscape, is absolutely possible. As long as the design principles are present, the design will support mental health.

8.2 DISCUSSION

Reflection on Theory

The design principles are based on three theories: the Prospect-Refuge theory, the Stress Reduction theory, and the Attention Restoration theory. The theories are developed in the 20th century, but still relevant and leading in the research regarding mental health and environment (Joye and van den Berg, 2018; Marcus, 2018). Therefore, I am confident the right theories are used for this thesis. The explanation of the theories are based on several articles and different authors, giving a good summary of the components of each theory. Marked words in the explanations are used to set up a table. Both the words used to write the explanations and to select the marked words, are chosen by me as designer, focusing on extracting spatial implications from the literature. Besides, the choice of the spatial factors in the table are based on own interpretation of the marked words. I expect the table and chosen words would be different if someone else would do the same research, but the message will still be the same, since the theories are very clear and thorough.

Design principles were set up, based on the spatial factors. It became clear that there was some overlap between several principles, and some principles complemented each other. Therefore, the principles are categorised in 'general', 'private' and 'public', making clear the differences and similarities. The choice for the terminology of these categories has been very decisive for this thesis. I think 'private' and 'public' indicates a well-known contrast, but can also be confusing, since 'private' and 'public' spaces in the design are both public space- a public space is generally open and accessible to all people, such as the Novio Tech Campus.

Reflection on the Case

The Novio Tech Campus was the selected case for this study. I think this was a good case regarding the type of work being performed at the campus. Employees are working inside, conducting challenging research and focusing whole day. A landscape lowering stress levels and restoring attention, will help these employees to maintain a positive mental health.

However, NTC was already assigned to become a work landscape. For that reason, there was enough space already to be turned into a landscape or park. Applying the design principles to an existing work environment full of office buildings, will be more difficult and challenging. Principles have to be used on a minimal scale.

Reflection on Process and Results

Research for design and research on design were two suitable processes for this study. Research for design focused on the theory, design principles and the case study, were research on design focused on the models and the design. Due to time constraints, the process was less iterative then I wanted. Research for design was first needed, followed by research on design. During the evaluation of the models and design, I reflected on the design principles. This reflection could have been used to elaborate on the design principles and make them more specific.

The results of this thesis are a combination of pragmatic solutions and own interpretation and creativity. Therefore, I tried to be as transparent as possible, showing the parts derived from theory and the parts derived from me as designer. When this study would be carried out by another designer, I expect the design principles will stay highly the same, but the models and the design will be different. However, the message of the research will still stand.

Limitations of the Research

For this research a questionnaire has been send to the employees of NTC. Although, I was satisfied with the responds, a higher response rate would have even been more helpful to strengthen the component 'compatibility'. Other ways to collect more information from the employees, would

have been interviews or organizing a small event for example. Due to time constraints, only the questionnaire has been used.
Furthermore, I consulted Joost van der Zanden, urban planner for the municipality of Nijmegen. He is involved with making a strategy for NTC. The consultations were very valuable for understanding the case and the current issues playing. Although, contact with more experts would have been even more informative, to hear other opinions as well.
A significant limitation of the research is the difficulty to proof the effectiveness and value of the design. The design is based on the design principles, and in turn the principles are based on grounded theory. Therefore, the prediction of the design being effective is high, however, convincing evidence is not there yet. The employees should be monitored after the implementation of the design.
Another limitation is the one-sided, spatial view of me as designer with the focus on health. Beneficial for the design would be views from other experts, such as a developer and an environmental psychologist, integrating their expertise in the design and making the design even more feasible.

More than Design
Designing a healthy work landscape is part of the solution in the battle against stress and burn-outs. A healthy work landscape improves the view from the windows and attracts employees to go outside during lunch break. But an important change should be made in the daily routine of employees as well. How many employees are having lunch behind their desk? How many employees are feeling too busy and don't experience a short walk as effective? Employees should become aware of the importance and effectiveness of nature in relation to their mental health. The change will be slowly, but should definitely be made.

8.3 RECOMMENDATIONS

To conclude this thesis, several recommendations can be made for further research.

First, it is important to research the value of a healthy work landscape. The goal of the design in this thesis is to decrease the amount of burn-outs. Additional research could discover if the design will be profitable, in other words, will the costs to construct and maintain the design be lower, equal or higher than the absence costs of the employees due to burn-outs? However, decreasing the amount of burn-outs is not the only benefit of a healthy work landscape. A green work environment is beneficial for the productivity and the work fun of employees as well. Even as the 'battle for talent' could profit from an attractive environment. Furthermore, other benefits regarding climate and biodiversity for example, can be achieved. It will be a challenge to find out the exact financial numbers, but with so many benefits, it should be profitable.

Second, in a follow-up research it would be interesting to measure the stress levels of employees, implement the healthy work landscape proposed in this thesis, and monitor the stress levels again for a few years. This would add more practical evidence to the existing body of research.

Third, a collaboration with an environmental psychologist would be valuable to increase the feasibility of the design, as already mentioned in the discussion. An environmental psychologist is an expert in the influence of the environment on the experience and behaviour of humans.

Last, the aspect of health should be integrated in designs for work environments. Furthermore, next to aspects, such as energy, climate and biodiversity, health should be considered in all future designs. I hope this thesis created more awareness and emphasized the necessity of this highly important topic.

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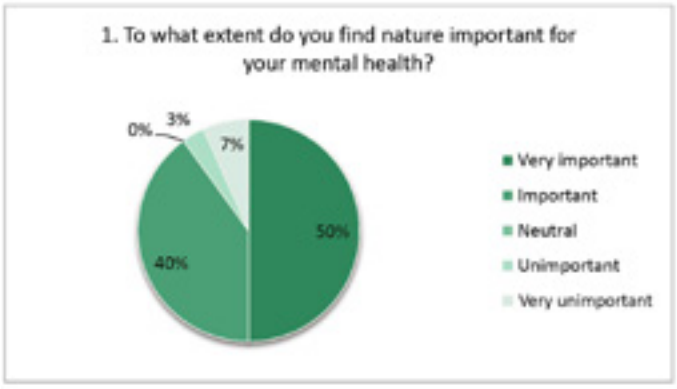
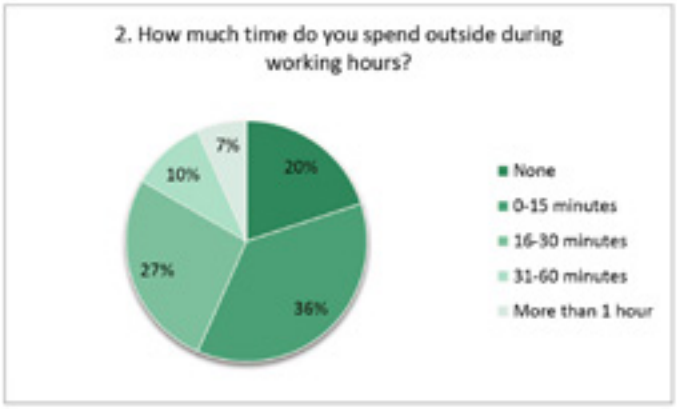
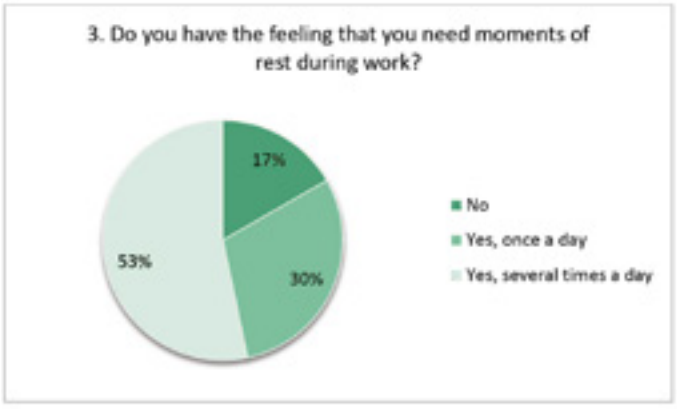
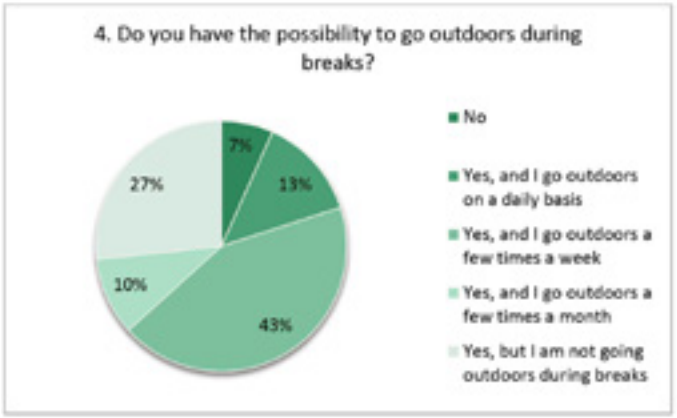
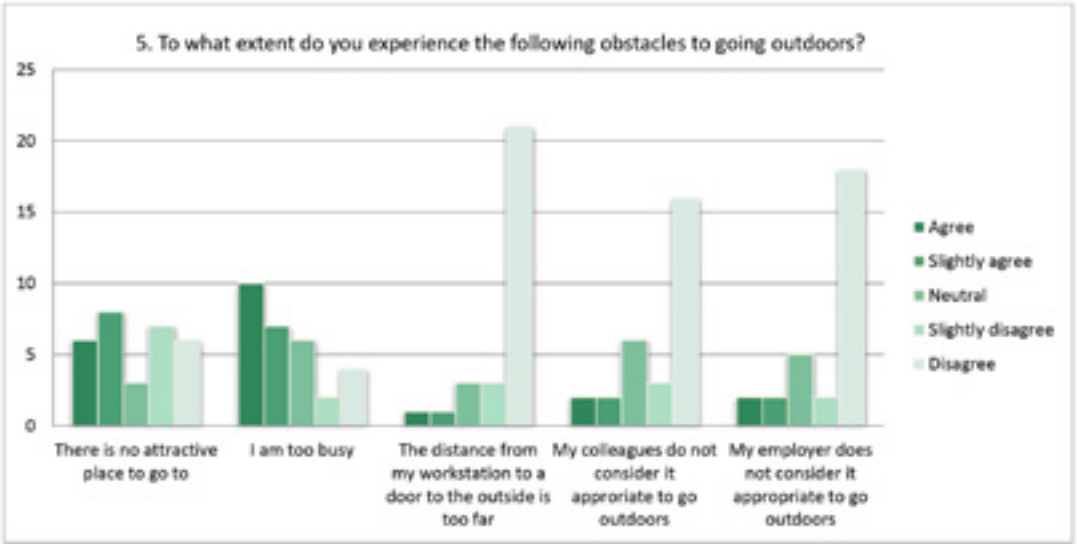
APPENDIX: QUESTIONNAIRE

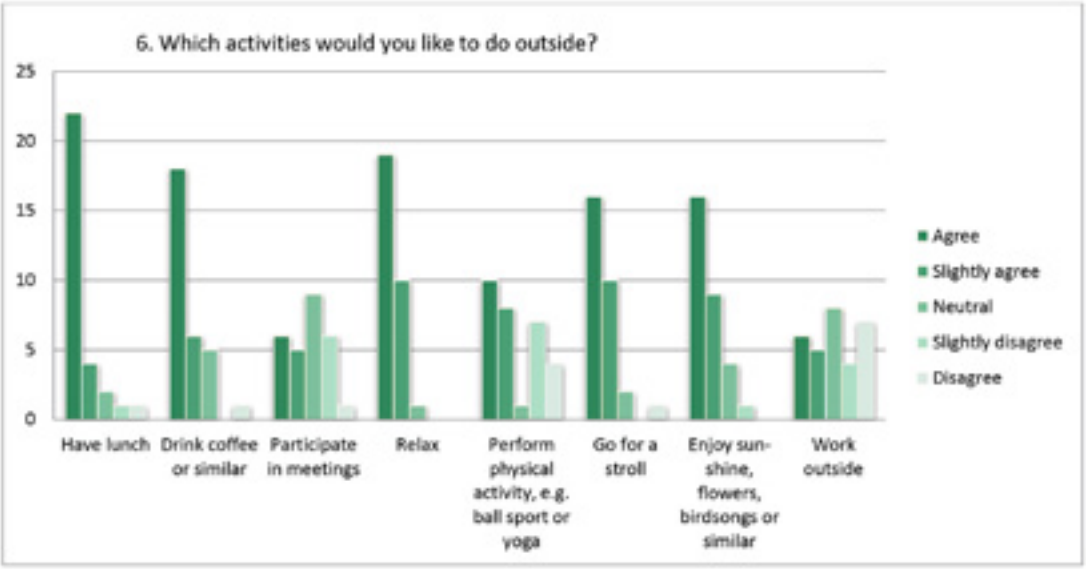


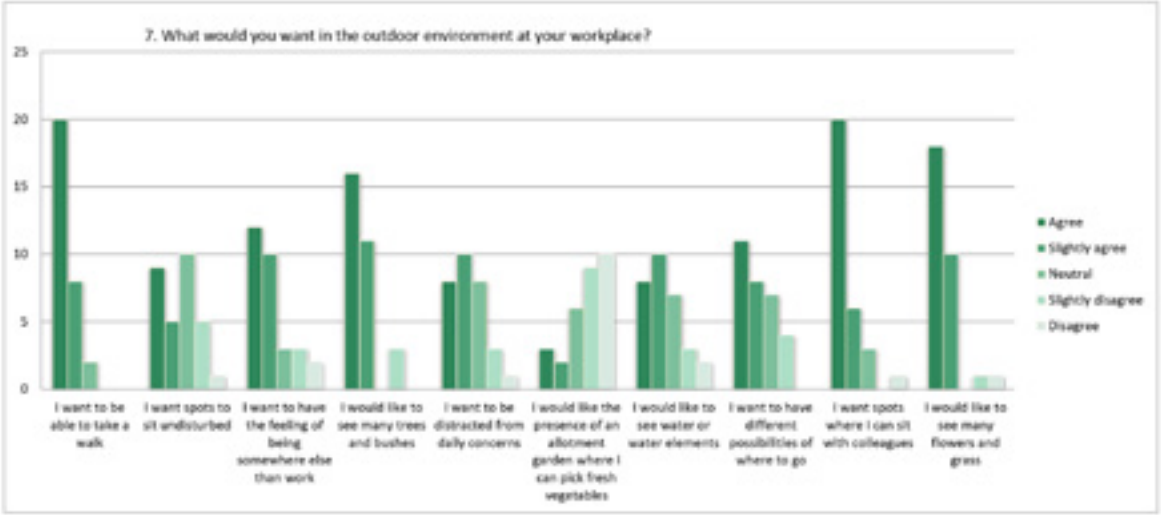


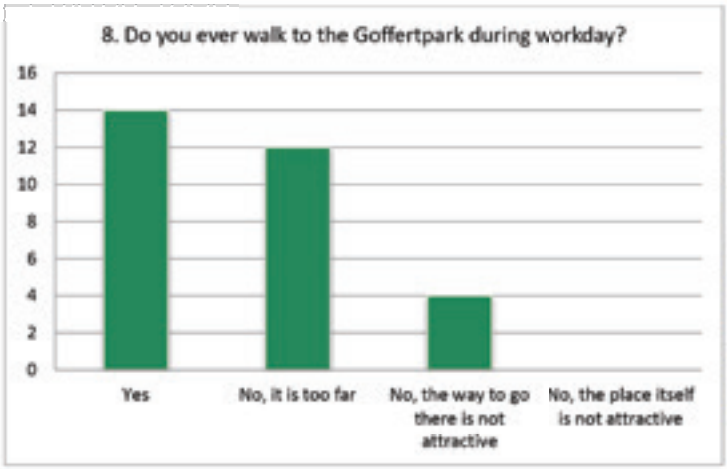


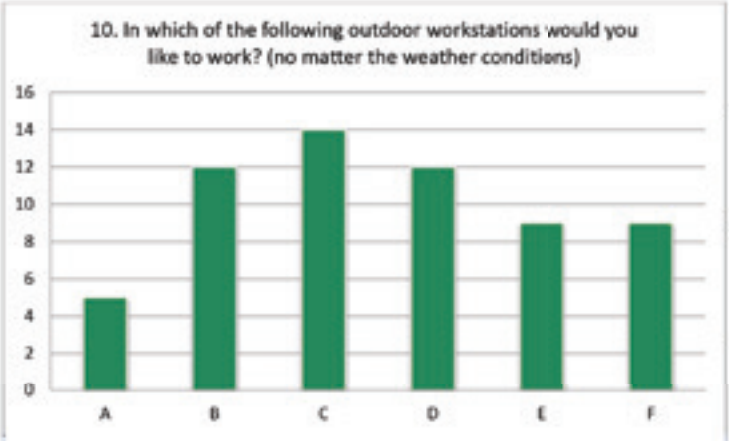



5. To what extent do you experience the following obstacles to going outdoors?
25
20
15
10
5
0
There is no attractive place to go to
I am too busy
The distance from my workstation to a door to the outside is too far
My colleagues do not consider it appropriate to go outdoors
My employer does not consider it appropriate to go outdoors
Agree
Slightly agree
Neutral
Slightly disagree
Disagree


6. Which activities would you like to do outside?
25
20
15
10
5
0
Have lunch
Drink coffee or similar
Participate in meetings
Relax
Perform physical activity, e.g. ball sport or yoga
Go for a stroll
Enjoy sun-shine, flowers, birdsongs or similar
Work outside
Agree
Slightly agree
Neutral
Slightly disagree
Disagree


7. What would you want in the outdoor environment at your workplace?
25
20
15
10
5
0
I want to be able to take a walk
I want spots to sit undisturbed
I want to have the feeling of being somewhere else than work
I would like to see many trees and bushes
I want to be distracted from daily concerns
I would like the presence of an allotment garden where I can pick fresh vegetables
I would like to see water or water elements
I want to have different possibilities of where to go
I want spots where I can sit with colleagues
I would like to see many flowers and grass
Agree
Slightly agree
Neutral
Slightly disagree
Disagree





Extra comments:

- I need a more or less closed environment
- I would prefer an area with as much physical contact with nature as possible
- No reflection on the computer screen is an important factor

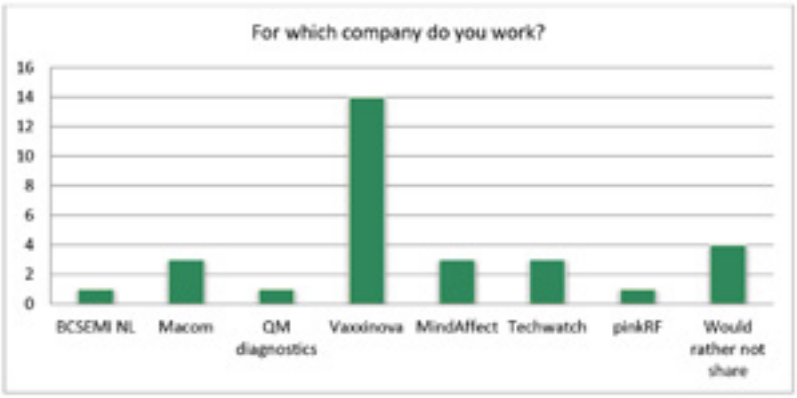
11. What do you think about the current outdoor work environment at your workplace?

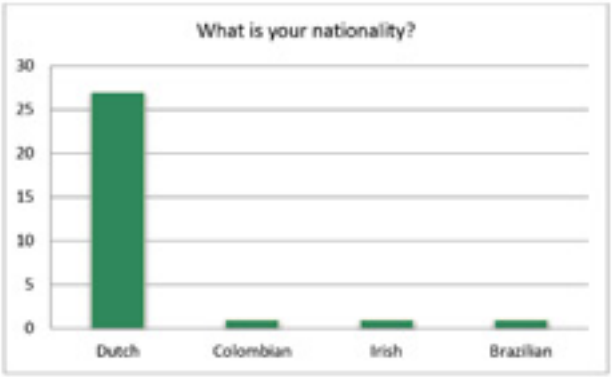
-	-	Limited tables, no power outlets
-	-	A bit boring, too much stone and too little nature
-/+	-	It's really basic a lot of grass, but it looks okay. The biggest obstacle for me is that my colleagues and boss go never outside so I think they find it a bit odd when I go outside.
-	-	There could be more trees and plants, and nice seating places. There is space for it.
-	-	Boring
-/+	-	Very minimal, however, I like that there is some space between the buildings with grass.
-	-	I hope that it is not completely full of buildings and that there is enough room to sit outside.
-	-	Ugly, only buildings and streets
-/+	-	Like the grass area at NTC. Should be more places to sit.
-/+	-	At least there is one
-	-	Not very attractive to sit outside
-	-	Not always enough seats/tables, unfortunately the outdoor environment is changing. More buildings, less grass.
+	-	It's okay
-	-	Not attractive, no birds, only a few trees, no variation
-	-	Too windy, not enough shadow
+	-	It is OK (the question is if a nice environment would be economically feasible)
-/+	-	It's something. We can sit outside and have lunch and there is a possibility of walking.
-/+	-	Quite OK. Can sit outside to take lunch an chat with colleagues.
-/+	-	Not too bad.
-	-	Not good. No place to sit, no trees, or shadows.
-/+	-	It's nice but could have more places to sit. The furniture is all the same, there could be more difference between them also in size, it could have more flowers.
-	-	The current outdoor environment on the NTC is a bit dull, windy and open. With small alterations, the outdoor environment could be much improved, like arranging some wild flower beds or rearranging the picnic tables on the lawn in a more free/natural setting.
-/+	-	It's okay. Unfortunately that NTS is coming now.
-/+	-	It's okay, but a bit simple (only some benches on grass)
-	-	Boring uninviting and not enough places to sit
+	-	OK
-	-	Not enough green and flowers, no shade (too hot during summer month)
-	-	I would like to have enough places to sit, also for a bigger group then 6.

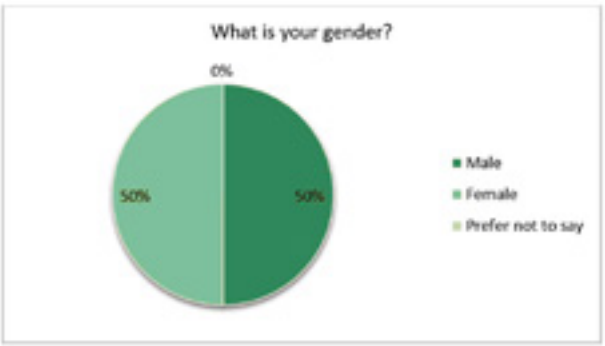
12. What do you want in the outdoor environment at your workplace?

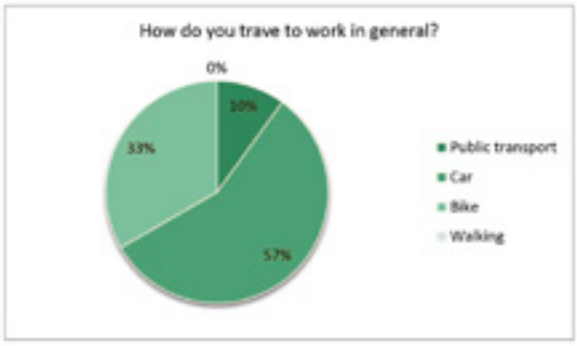
- I would like to have enough places to sit, also for a bigger group then 6.
- Add tables/sitting place, power outlets
- More nature
- For me it works really good. I am a student and have a part-time job. I always study outside when the weather is nice because it works really motivating and it is inspiring and relaxed.
- Plants and seating places
- Flowers, trees, birds
- Enough tables and benches and preferably also green, such as grass and trees
- Nature
- More 'corners' for privacy
- Keeping it... no other buildings being put there
- Trees and bushes
- Grass, trees, tables, seats.
- More places to sit
- More tables and chairs, more trees and plants
- More shadow
- Some more small parks with trees/bushes
- Nothing in particular
- It's OK
- More flowers and water
- Which one?
- Trees, places to sit, flowers
- More flowers and trees, more and different furniture
- Flowers, trees, and a roofed place to sit outside during lesser weather conditions.
- Enough sitting places to take a break.
- More plants and trees, more diversity in possibilities for entertainment
- Nice greenery and enough places to sit outside
- Trees, flowers shade

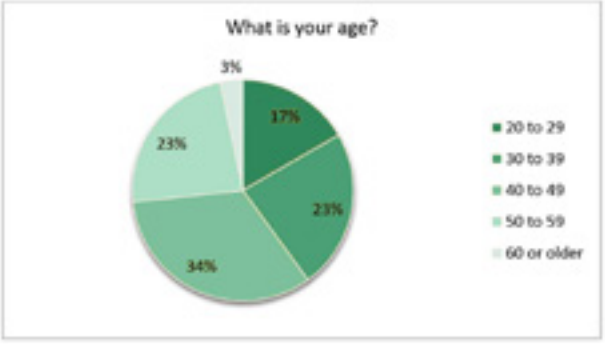
nature/greenery
furniture
water
refuge/enclosed spaces
social support/
physical movement


For which company do you work?
16
14
12
10
8
6
4
2
0
BCSEMI NL
Macom
QM diagnostics
Vaxxinova
MindAffect
Techwatch
pinkRF
Would rather not share


What is your nationality?
30
25
20
15
10
5
0
Dutch
Colombian
Irish
Brazilian


What is your gender?
0%
50%
50%
Male
Female
Prefer not to say


How do you trave to work in general?
0%
10%
33%
57%
Public transport
Car
Bike
Walking


What is your age?
3%
17%
23%
23%
34%
20 to 29
30 to 39
40 to 49
50 to 59
60 or older

WAGENINGEN
UNIVERSITY & RESEARCH