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Human Health and Organisational Benefits by Using Neuro-design within Property Development of Offices

A Case Study regarding the Terraces of NCC's Office Building, MIMO

Master's thesis in Design and Construction Project Management

KARIN HAMMARQVIST

DEPARTMENT OF ARCHITECTURE
AND CIVIL ENGINEERING

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MASTER'S THESIS ACEX30

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Department of Architecture and Civil Engineering
Chalmers University of Technology
SE-412 96 Göteborg
Sweden
Telephone: + 46 (0)31-772 1000

Cover:
A visionary picture of the terrace at level 11 of NCC's office building MIMO.

Department of Architecture and Civil Engineering
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ABSTRACT

This thesis investigates research in neuro-design and how to optimise office properties by human well-being in focus. Human sustainability can also lead to added value such as efficiency, focus, recovery, performance, creativity, and prevention for illness, leading to less sick leave and financial savings for an organization. The aim is to find some common factors contributing to people feeling well-being in the physical environment. The thesis also aims to be an external trend analysis and inspirational for future property developers and project managers to take social sustainability into consideration and be responsible when planning the project scope. The thesis is a collaboration with NCC Property Development. The focus is the project of the office building MIMO in Mölndal. MIMO is a project that will offer a 'Feelgood-Office', where it will be easy to solve the puzzle of life and easy to make the choices that make people feel good. The thesis theories on neuro-design appeal to both the office in general and the specific assignment from NCC; is to do a case study of the existing architectural draft for the terraces with neuro-design as a literary base, which fits into 'FeelGood-Office'. The method for the thesis is to create a background and base through interviews to deepen the knowledge in literary sources, which will then be discussed and culminate in a researched-based case review and recommendations for the terraces. The result and recommendations can also be applicable guidelines for offices in general.

keywords: human sustainability, social sustainability, neuroaesthetics, brain, property development, real estate development, humans, inhabitants, psychological, commercial property, Gothenburg, Sweden, architecture, urban planning, city, city planning, environmental psychology, neuroscience, neuro-design, real estate optimisation, project management

Människors välmående och organisatoriska fördelar av neurodesign inom fastighetsutveckling av kontor.

En fallstudie av terrasserna i NCC: s kontorsbyggnad, MIMO.

Examensarbete inom mastersprogrammet design & construction project management

KARIN HAMMARQVIST

Institutionen för arkitektur och samhällsbyggnadsteknik
Chalmers tekniska högskola

SAMMANFATTNING

Detta examensarbete redovisar forskning inom neurodesign, hur kontorsfastigheter kan optimeras med fokus på människan välmående. Genom att använda neurodesignen som verktyg även gynna den mänskliga hållbarheten som även kan leda till mervärden som effektivitet, fokus, återhämtning, prestation, kreativitet, sjukdomsförebyggande vilket leder till färre sjukskrivningar och ekonomiska besparingar för en organisation. Målet är att finna några av de gemensamma faktorer som bidrar till att människor upplever ett välbefinnande i den byggda miljön. Examensarbetet syftar också till att vara en trendanalys och inspirerande för framtida fastighetsutvecklare och projektledare att ta hänsyn till social hållbarhet och ta ansvar vid planering av projektets omfattning. Uppsatsen genomförs i samarbete med NCC Property Development. Fokus är på projektet av kontorsbyggnaden MIMO i Mölndal. MIMO är ett projekt som ska erbjuda ett MåBraKontor, där det ska vara enkelt att lösa livspusslet och lätt att göra de val som gör att människan mår bra. Uppsatsens undersökning av neurodesign vänder sig både till kontoret, men även det specifika uppdraget från NCC gällande MIMOs terrasser. Sedan projektet utvecklats har ett designförslag tagits fram. Metoden för uppsatsen är att skapa en bakgrund och bas genom intervjuer för att sedan fördjupa kunskapen i litterära källor som sedan kommer diskuteras och mynna ut i rekommendationer gällande terrasserna. Resultatet och riktlinjerna kan också appliceras på kontor generellt.

Nyckelord: mänsklig hållbarhet, social hållbarhet, neuroestetik, hjärna, fastighetsutveckling, människor, invånare, psykologisk, kommersiell fastighet, Göteborg, Sverige, arkitektur, stadsplanering, stad, stadsplanering, miljöpsykologi, neurovetenskap, neurodesign, fastighetsoptimering, projektledning

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Preface

Karin Hammarqvist has carried out this master thesis in the master programme of Design and Construction Project Management at Chalmers.

The master thesis has been executed during the period of June-November of 2021 and has included 30 credits. The period has been interesting, instructive and the knowledge in real estate development has developed. Which i hope will inspire and develop in the area of human focused property development and neuro-design.

I want to thank essential people who contributed during the master thesis project:

Thank you!

NCC Property Development, and especially the team at MIMO-project, Sarah Pennycook, Lotta Kallberg Walldén, Anna Rynäs, Lena Brixtedt, and the project team, for welcoming me and for a great collaboration and knowledge exchange. You have guided me through the work and taught me a lot about the property development industry and the new building of MIMO. Sarah has been great at including me in their schedule. After each meeting, I felt inspired and encouraged to continue writing.

Thank you!

Sam and Björn for reading, reviewing and opposing the thesis. Moreover, for one and a half, kind of weird years due to Covid-19, together at Design and Construction Project Management master program. Which is also aimed at the rest of the class of 2020.

Thank you!

Nina Ryd who has been the examiner and supervisor. Because you have helped by giving good advice, stick to the time-plan, structure the text and discuss different subjects and solutions.

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Most importantly, to my family and friends who have been a support throughout the process.

Göteborg October 2021

Karin Hammarqvist

1 Introduction

There is a correlation between people who feel well and people who perform well. Architecture and built environment impact our mind and body to influence how people live and feel (Ellard C, 2015). Creating offices with neuro-design and human well-being perspective in focus will make both humans and organisations thrive (Cobaleda Cordero et al., 2020).

Covid-19 has shown new insights in how to work out of office. The flexibility of working from home is something many people enjoy and can solve some of the daily struggles. Furthermore, there will come a time when it is necessary to attract the employees back to the offices, and people may realise that they have better conditions out of the office than in the office (Toivanen S. 2021). The overall goal with an office environment is to receive a management tool to achieve higher efficiency, interactions between employees and to be able to motivate organisational behaviour (e.g., Becker, 1982; Brill, Margulis, & Konar, 1984; Inalhan, G. 2003; Bodin Danielsson & Bodin, 2008).

Offices are often located in urban areas. The urban living is usually dominated by long working hours, heavy workloads, tight deadlines, and unsatisfied working environments (Facey et al., 2015). In today's urban climate rapidly, growing cities and a faster lifestyle can lead to various consequences on human health (van Diepen, A.M.L. 2009). One such consequence is mental illnesses which is a significant public health problem. The main issues are stress, anxiety, worry, distress, sleeping problems, and depression (Folkhälsomyndigheten, 2021). In 2017, 62 billion SEK of organisations money went on to pay sick leave, and half of the cost was mental illness (Svenskt näringsliv, 2017).

People spend around 90% indoors, whereas the time at the office is a large part of the percentage (Klepeis N, Nelson W, Ott W, et al. 2001). Development of the work-life needs to be done to exclude the office environment from human health problems. There needs to be more focus on well-planned offices since humans spend a significant amount of time there. Therefore, this thesis investigates how humans, significantly how the human brain, are affected by property development, focused on offices and how to use neuro-design to plan smarter, health beneficial or salutogenic - "the origins of health", offices where the people and organisations thrive.

The construction industry is building a significant amount and has come a long way in mastering the ability to accomplish it efficiently, economically, and with good technical quality (Macmillan, S. 2004). Therefore, the social perspective should take a larger part in the design phase of a construction project. As a property developer and project manager in the design phase, it involves responsibilities of creating a project scope that is ecology, economically and socially sustainable. It is important to consider the "soft values" and make the building sustainable. Since the construction will be permanent for a significant amount of time forward.

The research will focus on neuro-design and human well-being when performing property development and project management in the design phase, focused on offices. Optimising office properties to benefit human sustainability can result in added values for the organisation such as efficiency, focus, recovery, performance creativity, and prevention for illness, leading to less sick leave and more financial savings for an organisation. The subject is an external trend analysis for an upcoming topic where change is needed in the industry. Moreover, the project manager must consider upcoming trends and be at the forefront when creating project scope since the process to construction completion is a significant time. Considering social sustainability and a focus on humans will also add value to the project outcome, organisations, and humans. The construction industry's emphasis should be to build for humans; they are the end-users and the final costumer.

The human brain is in ways still in the state of the past life on the savannah. To put the time that humans lived at the savannah with modern time, where one hour represents the time humans have existed, then the humans have lived as hunters and collectors for 23 hours and 59 minutes and the last minute of the hour in the modern world. Urbanisation and digitalisation have developed quickly, and our brain's evolution has not kept up (Sjövall, 2020). People do not meet with the lion; people meet with the daily workload and a full e-mailbox.

Findings state that the brain's neuroplasticity can change autonomy by encountering different physical spaces and surroundings. The brain can develop when engaging in different surroundings and through well-planned property design, and the awareness of the sensorial senses receive the right stimuli for the experience (Sjövall, 2020). The basic “feel good” hormones are called dopamine, endorphin, oxytocin, serotonin. Those hormones should be considered when planning urban spaces for humans to feel well-being in the city. The hormones can be activated by involving for example physical exercise, social meetings and designing a physical environment that feel cosy (Breuning, L. G, 2016).

However, when it comes to property development, some common elements seem to trigger the brain and create the feeling of comfort and well-being. For instance, there are two concepts of *prospect* (be able to receive an overview) and *refuge* (shelter and protection) (Appleton, J. 1996). Prospect means that humans prefer open environments, where there is a good overview of the area. The second concept is ‘*refuge*,’ which is explained as follows, on the savannah, some trees were located, which offer protection by providing vegetation, nutrients, and water. It is signalling to humans a place to relax and recover. Studies made on what surroundings are most appealing to humans, and even though different backgrounds, gender, and ethnicities, people prefer the more savannah-like environments (Appleton, J. 1996).

Neuro-design is when neuroscience investigates how physical environment, architecture and design features impact humans and the brain. It is the way the brain reacts to the surroundings consciously or unconsciously, for instance, design features such as colour, shape, scents, light, or nature (Sjövall, 2020). There are neural mechanisms behind aesthetic experiences. The neuroscientist Anjan Chatterjee (2017) focuses his research on spatial cognition and aesthetic experience. Chatterjee has reached the research result that there is a connection between what humans experience as beautiful, pleasant, and harmonic. Factors like symmetry, balance, and places that remind us of the African savannah are some examples that appeal to the human. The explanation found in our brains and the evolutionary argument is that humans are attracted to savannah-like environments; symmetry and balance have reproductive benefits. The population likes it and is with the humans until this day (Chatterjee, 2017).

It is essential to locate the common neural responses people receive by architecture and the physical environment to improve human well-being. For example, find what triggers stress, how people feel calm and safe, what rooms trigger productivity, creativity or activity. Therefore, it is essential to locate the correct neuro-design elements in the property development that support, enables activities and make people thrive. It may even lead to anti-inflammatory effects and prevent diseases. To keep the focus on the human perspective and benefit human well-being by planning for elements that make humans thrive, such as a sense of community, physical activity, recovery, biophilia, creativity, focus, and surprises, human curiosity is of importance (Sjövall, 2020). Would it not be great if humans living in cities may receive unconscious health benefits by well-planned property development? It is important to remember that we humans have ourselves with us all the time and want to feel good.

2 Method

This chapter clarifies the different methods used in the report. The methods are presented, justified, and a discussion of their advantages and disadvantages. A literature study of previous research of the relevant subjects has worked as a foundation of proven models and theories around neuro-design in the office. The interview study is conducted with experts which has served as a different perspective of the various topics. Together, these methods have created a broader view of neuro-design in offices.

2.1 Aim

This thesis investigates how humans, the human brain, are affected by the built environment focused on offices. Moreover, to locate research what benefits neuro-design has on humans in the office. Also, how neuro-design can be used as a tool to optimise office properties to benefit human sustainability which also can lead to added values for the organisation such as efficiency, focus, recovery, performance, creativity, and prevention of illness, leading to less sick leave and financial savings for an organisation. The thesis also aims to be an external trend analysis and inspirational for future property developers and project managers to take social sustainability into consideration and be responsible when planning the project scope. To plan more innovative and health-beneficial offices where the people and company thrive. Further, due to the limited and relatively new research in neuro-design, this thesis aims to gather relevant research on the subject.

Another aim is to collect research of neuro-design and to understand how to use, adapt and implement to future work within property development. Find research on how the brain is affected by the surroundings which people encounter in the city. Further on how humans can improve their wellbeing from different design features. The thesis findings may educate and contribute to future property development and create human- and social sustainable property development projects. To emphasise the focus on the human perspective when developing properties. The following table present the thesis research questions:

Research Questions
1. How does the brain/humans experience offices today?
2. What is neuro-design?
3. What benefits may an organisation receive from implementing neuro-design in the office?
4. How will learnings about neuro-design (in this project) be helpful to property developers in future projects?

2.2 Research Strategy

The research strategy is to use data collection to create an overall reality-based picture of the issue. There will be a literature study and an empirical interview study, and the process is abductive. The motivation for this research strategy is, the collected qualitative from the different data should elevate, support, and motivate each other to create an accurate overall picture that reflects the issue fairly, improving the thesis creditable and validate. (Bryman & Bell, 2017). The text's structure is IMRAD; Introduction, Method, Result, Analysis, Discussion/conclusion.

2.3 Examination Method

Investigating the research area of the thesis includes the use of several research methods. These include; An interview study and a literature study. The argument is to reach a more profound qualitative knowledge in the area and create an overall picture of the research area, triangulation (Bryman & Bell, 2017).

2.4 Literature Study

The literature study aims to examine the research of neuro-design in offices and the built environment. The literature study has been critical in creating an understanding of the subject and supported by a foundation made from the interview study. The literature study consists of both printed and digital sources. The books used in the thesis are from Chalmers Library, Gothenburg City Library, and the authors own library. Reports, e-books, websites, and digital sources have been retrieved mainly from Google Scholar searches and the Scopus, ResearchGate, ScienceDirect and other scientific databases. A selection of the keywords used is 'neuro-design,' 'office,' 'human wellbeing,' 'neuroscience in office design,' and 'office design.

2.5 Interview Study

The interviewees have professionals to match the subject and aim of the thesis result. They contribute with knowledge and inspire. The picked interviewees aim to complete each other and the aim of the thesis. For a deeper understanding and a broader perspective of the subject, the idea is to conduct qualitative, semi-structured interviews with a selection of experts in the field (Bryman & Bell, 2017). It is a collection of researchers, professors, property developers, neuro-designers, architects, work-life professionals. There are three professors, two architects and two independent researchers. The interview study is a foundation and guidance to continue researching relevant literature sources and for the reader to receive a background in the subject. A problem considering the interview study is the limited time and ability to contact too many interviewees. It leads to not everyone getting their voice heard, that accommodating people receive more space.

Moreover, the choice of interviewees is influenced by who is accessible. The decision to have semi-structured interviews, unlike structured interviews, is for it to attend to a deeper discussion within the topic and open up for reflections from the respondent. Using interview study as a method is time-consuming. However, the hope and ambition are that the interviews will provide valuable aspects and a more profound understanding that makes the time worthwhile. The semi-structured method opens up for deviations from the questions, leading to unexpected discoveries and insights. Still, it can also result in getting away from the subject and wasting valuable time. The semi-structured method also places higher demands on the interviewer as interviewers than the fully structured method. Therefore, it is essential to have an indication of the wanted result and the research area to ask relevant follow-up questions and follow the respondent's reasoning (Bryman & Bell, 2017).

The interviewees are:

Christina Bodin Danielsson, *Architect SAR/MSA, PhD Associate Professor in Architectural Design at the school of architecture, Royal Institute of Technology (KTH).*

Isabelle Sjövall, *Neuro-designer (Independent specialist in architecture, interiors, and design based on research and neuroscience to improve health, human sustainability, and life quality).*

Maral Babapour Chafi, *PhD in Human-Techniques-Design, Institute of Stress Medicine.*

Marco Testa & Pernilla Kindell, *Architects SAR/MSA, Reflex (architects of NCC's project MIMO).*

Ulrika Ahlqvist, *Independent researcher and inspirer within brain health for good working environments, Hjärnberikad AB.*

Susanna Toivanen, *Professor of sociology and a work life researcher, University of Mälardalen.*

2.6 Case Method

The method for developing the case of the terrace of MIMO with a foundation in neuro-design features from the theory, interviews, reference objects, and the result. By clarifying, identifying, and framing the terrace's desired outcome, the aim is to review the architectural draft and investigate if there are neuro-design features applied on the terrace for employees and users of the building to enjoy and contribute to well-being. When establishing the terrace review case by neuro-design tools, the features will be theoretically based. It is also a collection of inspirational projects to enhance the concept and match the neuro-design features. There is a combination of external research of existing cases, ideas, and values from interviews and internal idea generation from the authors thoughts. The theory and interviews have been analysed and applied to the case study. The foundation of the case study will be the Swedish University of Agriculture Science study's eight dimensions about the sensory perception of natural environments and human health: serene, space, nature, rich in species, refuge, culture, prospect, and social (Grahn, P & Stigsdotter, U. 2010).

Further on, the case study has been done through discussion and SWOT-analysis, conducted of the author, of the terraces to locate the strengths, weaknesses, opportunities, and threats. A reference project in a likeworthy location was visited and experienced to identify good and bad features. The analysis and discussion of what are sustainable solutions lead to one review. The review was an iterative process, updated and re-evaluated to achieve the best-finished result. The case study concludes with a reflection on what the concept performs (Isaksson. n.d.).

2.7 Limitations

There are certain limitations to the thesis investigating how office design can contribute to humans' well-being, focusing on neuro-design. However, humans are complex, and there are surrounding topics included, such as psychological, psychosocial workspace environment and organisations, and the values such as performance, efficiency, recovery, stress prevention, creativity, health, well-being. The limitation are the human well-being, neuro-design and benefits of an organisation implementing it. Another limitation is the review case of NCC's building MIMO, where a design review of the terraces is the requested task of the thesis.

There are also knowledge limitations to neuroscience within property development. It is a relatively new research area of neuro-design, neuro-aesthetic, and neuroarchitecture. There is a lack of research to investigate specific brain areas active in particular spaces and places or specific design features. The choice of which design/architect features are included, depending on the research found and available, and are limited to time and relevant to support the aim of the thesis.

3 Introduction to the Case at NCC

NCC is one of Sweden's largest construction companies which consists of different departments to complete the whole construction process. The case of the thesis is in collaboration with NCC and their department Property Development. NCC Property Development develops and sells commercial properties in defined emerging markets in the Nordic region. The business focuses on sustainable office, retail, and logistics properties in good locations (NCC, 2021). This Chapter is about their new office building, MIMO.



Image 1: An overview of Mölndal and a visionary picture of MIMO's future location. (The house in centre in colour, with green rooftops)

3.1 Office Building - MIMO

NCC Property Development has developed an office building in Mölndal Centrum called MåBraKontor - Feelgood Office. The aim is that the office building will contribute to human health by a smart planned building, including in architecture, technique and for the tenants and Mölndal inner city. The goal is to create a building where there is good corporate culture and where people thrive and develop. The building will be performed and constructed by the criteria for Bream level excellent. MIMO will be located in Mölndal, right by the bridge over Mölndal station and next to Mölndal Galleria, completed in 2018, and the organisation Essitys' headquarters, moved in 2016 (NCC, 2020).

Facts About MIMO	
Start	2021
Completion	2024
Location	Mölndal, Sweden
Office Area	33000 square meters
Commercial area	5000 square meters
Levels	18
Slogan	MIMO in Mölndal - everything you need within reach. (MIMO i Mölndal - allt du behöver, inom räckhåll.)
Certification	Breeam - excellent
Architect	Reflex arkitekter

Tabell 1: Facts about MIMO.

The office buildings mainly focus on intelligent techniques, work-life balance, office of the future-air, sound, and light. Which will be presented further in the following headlines.

3.1.1 Smart Technique

In MIMO's FeelGoodOffice, the purpose is to make people feel good and comfortable by offering exercise facilities and healthy food options. Moreover, there will also be a focus on lighting, materials, colour, ventilation, social spaces, and other parts of the work experience to help people feel good in their office. People who thrive in their workplace reduce staff turnover, perform optimally and increase profitability (NCC, 2020).

3.1.2 Work-Life Balance

The office building MIMO aims to help to create a work-life balance. The smart location will achieve this in the middle of Mölndal's inner city, close to shops, cafés, restaurants, a mall. Also, close to a commute centre. The office is accessible by communication such as trains, buses, and trams. There are also good bike possibilities and bike storage in the building. There is also the ability to receive help from Mindpark, a coworking company that provides services to help with everything from arranging after work, breakfast, or conference (NCC, 2020).

3.1.3 Offices of the Future

NCC believes that the future office involves practical matters for the people spending time in the building. There is an extra focus to create an office where air, sound, and light are essential to make the office tenants thrive and perform as the organisation wishes (NCC, 2020).

Perform Better with Good Air

It is confirmed that good air makes the office workers perform better. MIMO will therefore have a well-planned air regulation. The correct ventilation and temperature do this to receive a work environment where the users can perform and keep down companies' sick leave (NCC, 2020).

The Sound is A and O

Working in noisy office environments is tiring, stressful, and affects performance. Sound is, therefore, an essential factor when sustainable offices are designed. NCC will work with adding and covering sound instead of absorbing. It is possible to knock out specific frequencies and create a sound image that is more pleasant cognitively to stay in (NCC, 2020).

The Future is Bright

Being exposed to good light may lead to good health. In Sweden, where the winter darkness arrives, it is vital to have good light not negatively affected by the lack of light. But with the proper lighting in the office, a lot is gained. New technology also allows the light to be controlled according to morning, noon, or evening, which gives the building's user a pleasant experience (NCC, 2020)..

3.2 NCC's request

The request made by NCC is to focus on the terraces, with a view over Mölndal and towards Gothenburg. The aim is to review the architectural proposition and investigate if the terraces will benefit the office workers' health and have applied the neuro-design features, which will fit the Feelgood Office's offer.

3.2.1 Terraces

There are three terraces in the project of MIMO on level 4, level 11, and level 17. The terraces aim to apply to the Feelgood office. The wished outcome is to receive well-being among the office workers by implementing neuro-design and architecture with human focus and supporting activity to experience well-being by, for example, recovery, daylight, activity, social, meetings, productivity, and match the feel well concept.



Image 2: A visionary picture of the terrace at level 11.

Level 4

Level 4 is the largest terrace and is available for the whole building, with a total area of 645 m². The following image is the current architect's proposal for the terrace on level 4. Focus on activity and physical exercise.



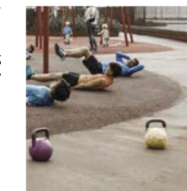
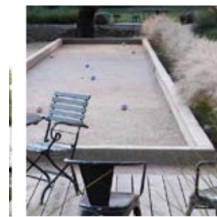
Image 3: Architectural plan, North ▲

FEATURES:

- Cultivation boxes
- Pergolas that create space for meeting places
- Boule
- Walk & Talk exercise loop through an inspiring landscape
- Falling ivy on trellis walls
- Outdoor gym
- Rubber asphalt or equivalent as a soft surface for exercise and training
- A place for yoga and meditation

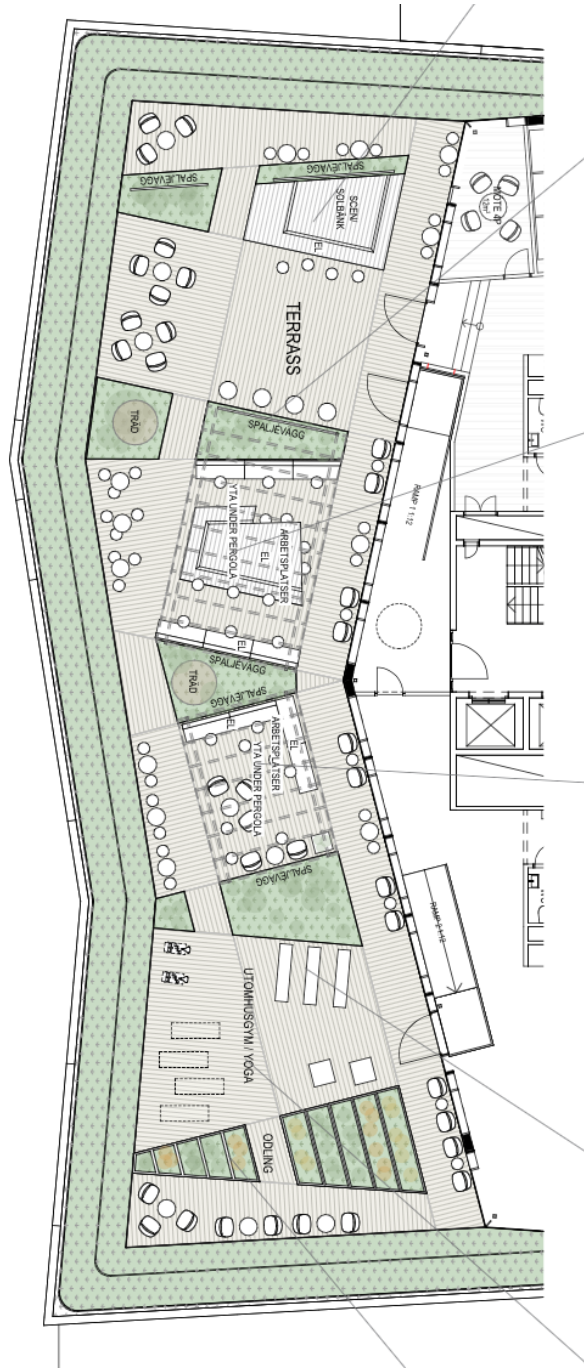
GROUND:

- Kebony decking as floor and fixed furniture
- Rubber asphalt or equivalent in earthy colours as exercise pads and activity surfaces
- Single
- Dry meadow
- Ivy (shade resistant) as vertical greenery



Level 11

The terrace will be available for the tenants at level 11, with a total area of 613 square meters. The following image is the current architect's proposal for the terrace on level 11. Focus on social meetings and breaks in the sun.



FEATURES:

- Sun bench/seating area that can be used as a stage
- Trellis with climbing plants for spaciousness and wind protection
- Workplaces with electricity
- Pergolas to create spaciousness and space for meetings
- Outdoor gym with lighter gym furniture
- Place for yoga
- Cultivation boxes

GROUND:

- Kebony decking as floor and fixed furniture
- Dry meadow
- Perennials
- Sun-resistant climbing plants

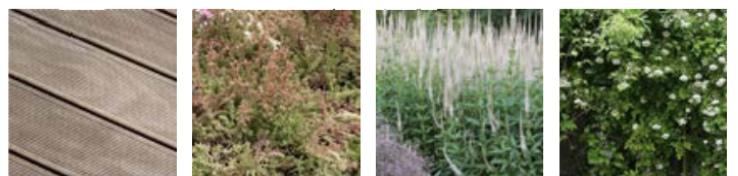
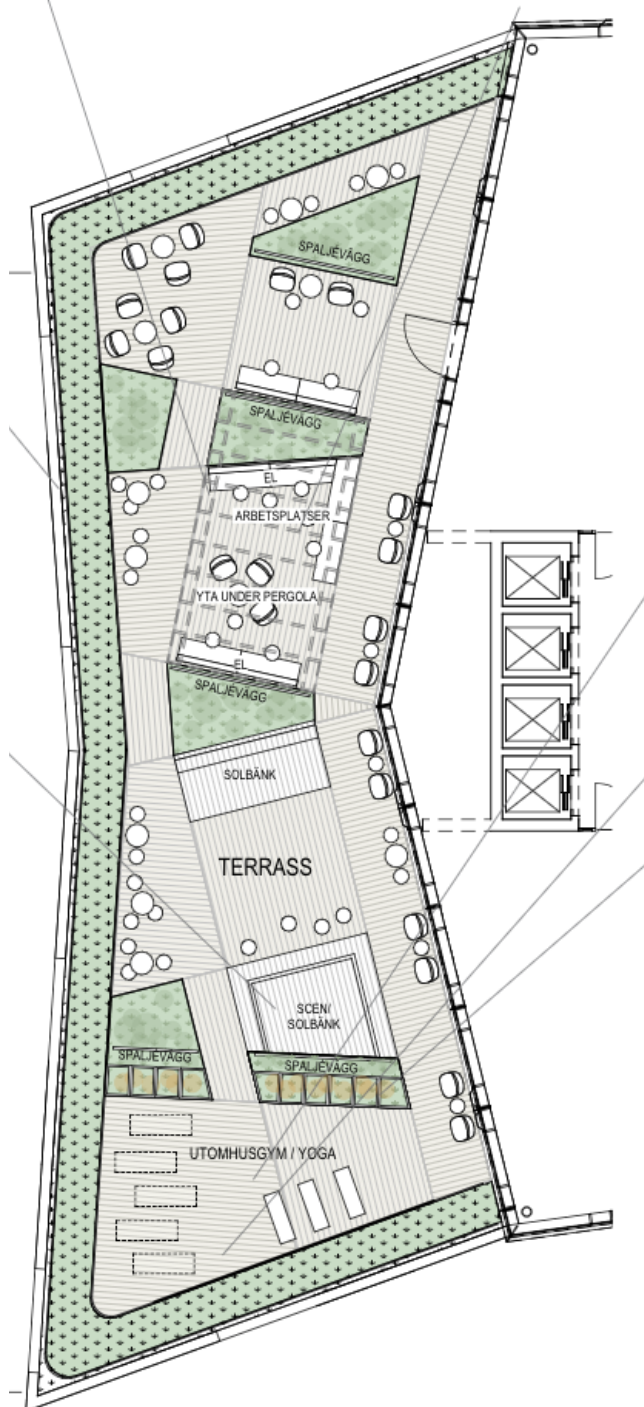


Image 4: Architectural plan, North ▶



Level 17

The terrace will be available for the tenants at level 17, with a total area of 305 m². The following image is the current architect's proposal for the terrace on level 17. Focus on social meetings and breaks in the sun.



FEATURES:

- Sun bench/seating area that can be used as a stage
- Trellis with climbing plants for spaciousness and wind protection
- Workplaces with electricity
- Pergolas to create spaciousness and space for meetings
- Outdoor gym with lighter gym furniture
- Place for yoga
- Cultivation boxes

GROUND:

- Kebony decking as floor and fixed furniture
- Dry meadow
- Perennials
- Sun-resistant climbing plants



Image 5: Architectural plan, North ▲



4 Literature Study

The literature study aims to investigate what an office is to humans today, the well-certification, and how it is beneficial for human well-being—continuing to the human factors to well-being both in the experienced well-being and what happens in the brain. Lastly, neuro-design is presented and how property developers can use the practice to optimise offices and benefit the organisation.

4.1 Offices Situation

As mentioned in the introduction, people spend around 90% in buildings, whereas the time at the office is a large part of the percentage (Klepeis N, Nelson W, Ott W, et al. 2001). The goal with an office environment is to receive a management tool to achieve higher efficiency, interactions between employees and to be able to motivate organisational behaviour (e.g., Becker, 1982; Brill, Margulis, & Konar, 1984; Inalhan, G. 2003; Bodin Danielsson & Bodin, 2008). Employees want an office, organisation, and employer to offer; meaningfulness, community, stimulus, achievement, flexibility, mobility, creativity, collaboration, individual development, better opportunity for focus, learning and development, health and sustainability, automation and efficiency, and an attractive employer (Pingle, S. S., & Sodhi, H. K. 2011, Grensler. 2012). Further on, there is a demand for offices to be ecological, socially, and economically sustainable and be responsible organisations where people can thrive (UN, n.d).

The most known offices are cell offices, shared rooms, open landscape, activity-based offices, co-working or home offices, or some hybrid (Bodin Danielsson, C. 2018). A crossroad has occurred deciding which direction the offices are going due to covid-19. The work has taken a rapid development towards digitalisation, and the workplace is more flexible than before. The offices need to create a value to attract the employee to the office (Toivanen. S, 2018).

The typical work today is boundless, meaning that there are long days at work, employees can often somehow always be connected to work whether they are at the office or not. The work has a high tempo and psychological demands. Due to this, depression, stress, and exhaustion have become the most common reason for sick leave and are an enormous public health problem—contributing to high costs for the individual, the organisation, and society (Försäkringskassan, 2016).

Bodin Danielsson has researched the Architectural Design's Impact on Health, Job Satisfaction and Well-being from seven office types. Which is; cell office (own room), shared room (2-3 people per room), office landscape; three variants: small office landscape (4-9 people), medium-sized office landscape (10-25 people), and large office landscape (over 24 people), as well as the more flexible office variants flex office and combined office where people also have elements of open floor plan to varying degrees. After interviewing 491 persons at 26 different companies in different branches, Bodin Danielsson found that cell offices and flexible offices were the most preferred choices due to a work environment and health perspective. While the open landscape with many employees in the same room considers the worst, however, it is the most common office type (Bodin Danielsson, C. 2010).

The office design that is the right fit for an organisation is shifting due to the different users, companies, and trends. A neuro-designed office with the human perspective aims to find common factors contributing to the user experience of well-being. It is essential to locate the stressors of an office and eliminate them to work as a precaution (Sjövall & Gospic, 2016).

4.1.1 Well-Certification

An organisation that works with human health and safety in the built environment is the International Well Building Institute. The institute is a non-profit organisation that has developed a certification called Well-certification. The well-certification aims to create a platform to make it easier to create interior and exterior environments beneficial for humans and have human needs in the centre when developing buildings. By using a rating system, the International Well Building Institute wants to prioritise the safety and health of the staff, visitors, and stakeholders. There are two editions of the certification, and the latest is called Well v2. The well-certification appears in various sectors and building types, such as office buildings, residential and retail spaces, schools and educational institutions, restaurants and bars, healthcare facilities, hotels, stadiums, and concert venues. Well-certification wants to drive the industry in the right direction where the healthy choice is planned for and built-in (WELL, 2021).

The WELL health-safety rating includes strategies to help keep spaces clean and sanitised, provide essential health benefits and services, communicate health and safety efforts, prepare for an emergency and assess air and water quality. Many of the concepts also match the UN's global goals for a more sustainable future (WELL, 2021). The following image states the WELL institute's ten concepts to receive a certified building. To understand what each concept includes, see appendix 1. Many concepts scientifically enhance public health by establishing environments where humans thrive and are safe in the urban surroundings (WELL, 2021). In the picture below are the ten concepts of Well v2:


Well v2 The Ten Concepts		
		
Air	Water	Nourishment
Light	Movement	Thermal comfort
Sound	Material	Mind
Community	Innovation	

Table 2: The WELL-certifications ten concepts for a socially sustainable building.

In Sweden, there are thirty-nine projects WELL-certified. Criticism towards the WELL-certification, the company is based in the USA; for example, in Sweden, WELL criteria are fulfilled due to regulation or the Swedish Standard. However, therefore the Swedish building standard can even further be developed than the WELL-certification implies (Caldera, C. n.d.).

4.2 Human Well-being

The construct of human well-being refers to all of the circumstances in which people feel well and do well, implying their optimal functioning and the presence of positive life experiences (Cobaleda Cordero, A, 2020). There are different theories which have studied the human well-being. There are Maslow's pyramid, which argues that there is a hierarchy of human needs, and if the human can fulfil all, they can reach self-actualisation and satisfaction (Maslow, A.H. 1968). Then there are Ryff's six-factor (Ryff, 1989) model also claims to have found that for an optimal functioning human concerning self-acceptance, positive relationships with other people, autonomy, environmental mastery, purpose in life, and personal growth. Moreover, Ryff's (1986) well-being theory suggests that individuals' perceptions differ depending on their age, gender, cultural background, or personality.



Image 6: Maslow's pyramid of human needs. Authors illustration.

The Well-certification institute has determined well-being and good mental health as follows; “a range of socioeconomic, biological and environmental factors, such as work conditions, lifestyle and health behaviours and genetic components that influence chemicals in the brain” (Well, 2021).

Further on are the two other branches of well-being: firstly, the hedonic well-being approach defines by the presence of frequent positive feelings, infrequent negative feelings, and overall life satisfaction. Positive and negative feelings refer to affective states and indicate how pleasurable an individual experience something. Overall life satisfaction refers to cognitive states and involves individuals' judgement and evaluation on how far or close they are from their ideal situation. Secondly, the eudaimonic well-being positively, this approach is associated with terms such as engagement, self-realisation, autonomy and meaning in life; in this case, individuals partake in activities aligned to their values, purpose and identity (Cobaleda Cordero, A et al. 2020).

Ulrika Ahlqvist's company Hjärnberikad have in collaboration with Swedish neuroscientists, developed ten good habits for the brain. The ten habits aim to create well-being for humans by educating them. Therefore, taking care of basic needs will satisfy the brain (Ahlqvist & Bellvik, 2019).

Ten Good Habits for the Brain	
Food & nutrition	Repetition
Physical training	Variety & challenges
Positive thought	Make own decisions
Handle stress	Friends & relations
Learn new things	Sleep

Table 4: Ten good habits for the brain, retrieved from Hjärnberikad (Ahlqvist & Bellvik, 2019).

4.2.1 Well-being in the Physical Environments

To refer the well-being theories to offices and physical environments, a model that can be applied is Platslow, which is based on humans in the development of urban spaces compared to Maslow's hierarchy of needs. What makes a physical place perceived as attractive differs between individuals and can depend on people's different phases of life, personal preferences, and conditions. The consulting and analysis company Kairos Future surveyed 6,000 participants across Sweden, asking questions about which perceived functions and qualities as most important for a physical place. There were similarities among the answers in the survey, and based on these, Kairos Future has compiled a ranking model, sorting and grouping the answers to give an overall picture. Like Maslow's hierarchy, the Platslow pyramid moves to the next step in the scale when the essential criteria of the environment are fulfilling the need. The most successful places meet all levels of the pyramid (Kairos Future, 2015).

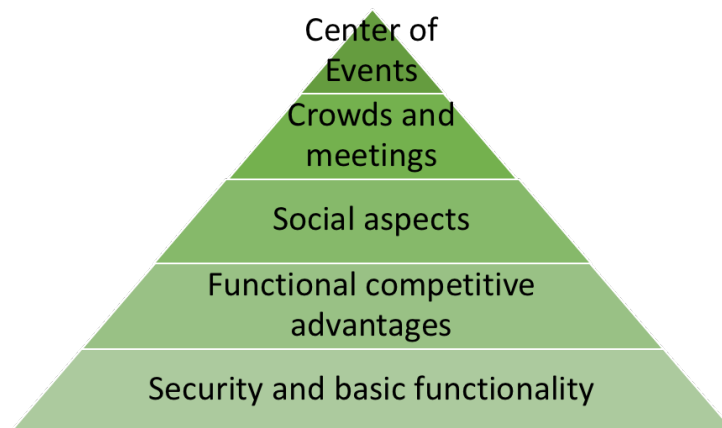


Image 7: Platslows pyramid, Author's illustration.

At the bottom of the pyramid is '*security and basic functionality*'. Essential functions are clean and tidy, calm, safe/low crime, close to nature, good communications, and housing. These are answers that recur from the respondents in the Kairos Future's survey. If there is a lack of the basic criteria, the higher levels in the pyramid do not matter. The next step in the pyramid is '*functional competitive advantages*'. In this step, some factors are considered important for many, but not for

all, such as good job opportunities, being close to the grocery store, good opportunities for sports and leisure, green areas, and water. The importance of these factors also varies among different individuals. A further step up in the pyramid is '*social aspect*'s such as closeness to relatives, friends, neighbourly relations, community in one place. That one can identify with the place / feel welcome in the area, having a Social Contexts. The second highest heading in the pyramid is '*crowds and meetings*'. When the place has a rich people's life, it creates a chance for meetings between the city's residents. There is a wide variety of shopping, dining culture, and entertainment. At the top of the pyramid is the '*centre of Events*' to be in place, creating "the feeling of being where it happens" (Kairo Future, 2015).

Similar to Kairo Future's, researchers at The Swedish University of Agricultural Science, department of landscape architecture, found eight perceived sensory dimensions to contribute to urban green space and stress restoration. Grahn and Stigsdotter (2010) investigated the relationship between the sensory perception of natural environments and human health. The research consisted of 953 randomly selected respondents from nine cities in Swedish. The eight dimensions people generally prefer are Serene, followed by Space, Nature, Rich in Species, Refuge, Culture, Prospect, and Social (Grahn. P & Stigsdotter. U, 2010).

The Eight Dimensions	
Serene	Undisturbed, silent and calm environment, which can be interpreted as an environment for retreat.
Space	Spacious and free green environment.
Nature	Access to nature environments, 'close to nature'.
Rich in Species	Finding a wide range of expressions of life: many birds, butterflies, flowers, etc.
Refuge	Enclosed and safe environment, where people can play or watch other people being active.
Culture	Values, understanding of the space.
Prospect	Areas with an overview, to see the surrounding vistas.
Social	Social activities, interest in other people, service, amusement, festive.

Table 5: The eight perceived sensory dimensions to contribute to urban green space and stress restoration (Grahn. P & Stigsdotter. U, 2010).

4.3 The Human Brain

This chapter intends to inform about the human brain concerning neuro-design. The human brain is complex. Fundamental explanations of the brain will be presented to understand how the built environment affects humans and explain what happens in the brain when humans encounter design and architecture. Further on, the importance of considering what urban areas and the built environment result in for the human brain. To further understand neuroscience, humans need to know what affects us and what reactions create well-being in humans.

4.3.1 Basic knowledge

The development of the brain is slow; research has found that humans have a similar brain as individuals did 40 000 years ago (Neubauer et al. 2018). It is important to remember that humans have lived as hunters and gatherers for an extended period. (Sjövall & Gospic, 2016). It gives an insight into where the brain heritage comes from and why humans react to the constant information flow, the urban areas, the built environment, offices, and the routines of an everyday person in city life.

Studies have shown that the brain's autonomy can change due to the surrounding physical environment. The brain can change due to reactions to repeated activation, affecting the brain by planning and designing well-thought-out cities and buildings. In environments where the negative stress stimulus is located and removed, the positive stimulus of sensory experience evokes (Sjövall & Gospic, 2016).

In accordance with Sjövall and Gospic (2016), Cynander (2013) claims that the surroundings shape the brain's neuroplasticity, together with the experience's humans have had. Neuroplasticity includes our memory, involvement in learning, and recovery from neurotrauma or stroke. Cynander (2013) claims that "neurons that fire together, wires together." It means that memory of, for example, grandma - what she looked like perceived by the visual cortex, what she sounds like perceived by the auditory cortex, what her skin feels like perceived by the parietal cortex, and what she smells like perceived by the somatosensory cortex. These are always active when interacting with grandma and active at the same time. If the smell of grandma's perfume reaches the nose, the memory of grandma is right there, evoked by just the scent. When only one of the senses is activated, the neurons connected to the wired neurons between the cortexes can connect all senses from earlier experience for a more vivid sensory. The exposure to one sensory experience involves and awakes of all senses connected. The sensory encounter can activate the neural experience by encountering the right sensory trigger. Sleep and physical exercise can enhance it, doubling new brain cells (Cynander, 2013).

4.3.2 Parts of the Brain Activated in the Built Environment

The part of the brain activated when perceiving the built environment is based on the sensory experience. When the brain is experiencing a scene of design, architecture, or the physical environment, the primary source of information is through vision and processing of the brain in the visual cortex. With the help of neurons, the visual cortex detects lines and corners and involves the ventral and dorsal areas (Milner and Goodale, 2008). The ventral stream is the visons tool for perception and asking the question of; what? It processes shape, colour, and objects in general. The second involvement is in the dorsal stem, a tool for action and asking; where and how? The dorsal stem processes luminance, motion, and spatial location (Chatterjee, 2011). Research made on the neural substrate for aesthetic appreciation found that when experiencing aesthetic appreciation, the brain's reward circuit is triggered, *dopamine*. Which also can be triggered by favourable behaviour and stimulus and creates pleasure and the experience of reward. The *hippocampus*, *amygdala*, *cingulate cortex*, and *prefrontal cortex* engage in the reward circuit process involving and

incorporating other functions such as emotions and memory (McClure, T & Siegel, J 2015). Image 6 illustrates a map over the location of the different parts of the brain concerned in this chapter.

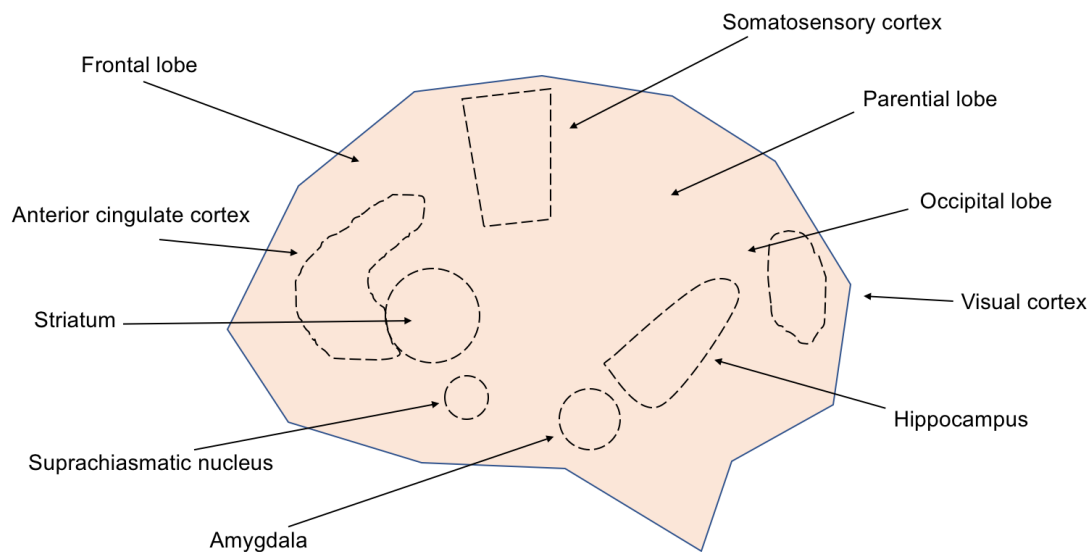


Image 8: Map over the brain, Author's illustration.

Hippocampus activates when humans navigate in, for instance, urban areas or buildings. The hippocampus also holds the memory structure, memory trace and is active when learning (Gospic, K & Sjövall, I, 2016). Research on mice has shown that the hippocampus is active when the mice are running in a maze trying to navigate. Even after completing the maze and the mice are asleep and dream of the path in the maze, the *hippocampus* is active due to spatial memory stored in the *hippocampus*. While sleeping, the memory is being processed and spread to different areas of the brain for storage and processing (Giri, B et al., 2018). The hippocampus can grow by performing physical exercise (Hansen, A 2016).

Amygdala is another part of the brain which is active when encountering urban areas. *Amygdala* holds the brain's primitive emotional structure. It alarms when there are potential threats and dangers. It does, for example, react when an unfamiliar person is in their personal comfort zone and considered being too close. When the amygdala encounters stressful environments, humans experience stress, and the *sympathetic nervous system* is activated (Abbott, A, 2011). The *sympathetic nervous system* is "the body's gas pedal" when triggered, the heart frequency raises, the blood pressure raises, and the breathing becomes faster and lighter. The body is ready to encounter the stress stimuli and releases the stress hormone *cortisol* (Gospic & Sjövall, 2016). In contrast to the *sympathetic nervous system*, there is the *parasympathetic nervous system*, "The body's brake pedal." It lowers the heart frequency when active, and the blood pressure sinks (Gospic & Sjövall, 2016).

The *suprachiasmatic nucleus* is the body's inner clock and steers the *circadian rhythm*. The *suprachiasmatic nucleus* positions in the *hypothalamus*. Which is closely related to the sleep hormone *melatonin*. The hormones are at different levels during the day and partly regulated by light and darkness (Scheer, F. A. J. L. et al. 2001).

By its unique location in the brain, the *anterior cingulate cortex* connects to the "emotional" *limbic system* and the "cognitive" *prefrontal cortex*. The *anterior cingulate cortex* is likely to integrate the understanding between what people experience and feel and understand the reaction and act on the impulse. Such as empathy, impulse control, emotion, and decision-making (Stevens F et al. 2011).

To understand what stimuli trigger different brain parts, the researchers use an fMRI (functional magnetic resonance image), which scans the brain, and the results are images of brain activity. The fMRI is being used in most of the researchers' experiments in the area of neuroscience to measure and locate which part of the brain is active in the encounter with, for example, a built environment or how the brain reacts to nature (Heeger. D & Ress. D, 2002).

Understanding the mechanisms in the brain that contribute to creating a well-planned office where the neuro-design and human well-being are in focus, the human well-being hormones also play a central role. Some human mechanisms give a feeling of well-being *dopamine*, *serotonin*, *oxytocin*, and *endorphin*. The different hormones are triggered in different ways but still respond to human mammalian survival prospects, as the brain has learned during all the years at the savannah. There is a possibility to change the circuit and to feed the brain with positive experiences repetitively makes it easier to have positive responses from the brain (Breuning. L. G, 2016).

Dopamine motivates people to work for what they need, even when it takes much effort. *Dopamine* was triggered when the human ancestor looked for food. Since knowing when the next meal was taking place was uncertain, there was a constant search—rewarded by the good feeling and extra energy created by the hormone *dopamine*. *Dopamine* is released when humans are close to the goal, such as a marathon runner seeing the finish line, and it gives them joy and the extra energy to continue the last meters. "I did it," experienced by hormones. When dopamine is released, it erases the cortisol feelings for a moment (Breuning. L. G, 2016).

The *dopamine* does not necessarily have to be triggered by berries. The circuits are programmed by life experience and waiting for the programmed "good feeling" actions, so dopamine can also trigger by receiving career goals. Each step along the way to the wanted position triggers dopamine. Remembered experience of dopamine can activate by sights, sounds, and smells with a particular encounter (Breuning. L, G2016). Dopamine has been found in the brain when experiencing appealing and beautiful aesthetics (Gospic & Sjövall, 2016). *Endorphin* motivates to ignore pain are triggered when training, for example, when running far by runners high. It can also be triggered by laughing and crying (Breuning. L. G, 2016).

Oxytocin is released when connecting with other people; it motivates to trust others, to find safety in companionship. It stimulates by touch and trust. Social alliances may help avoid trouble, and *oxytocin* makes people feel good while being safe together (Breuning. L, 2016). Social interaction is a critical factor in a healthy and happy life, calming the nervous system, lowering blood pressure, anxiety, worrying, and pain. The hormones have even made patients heal faster (Gospic & Sjövall, 2016). *Serotonin* is also a hormone that is triggered by feeling safe by having enough resources and food. Also, a bonding hormone and experienced when feeling respected, trusted and loved. It is the hormone responsible for the experience of happiness and well-being (Breuning. L., G 2016).

The striatum is part of the brain's reward structure, and this is where an encounter with an appealing environment or something beautiful is activated. It may even contribute to antioxidative and anti-inflammatory effects (Tsai. S et al., 2010).

4.4 Neuro-design

This chapter aims to explain the conception of neuro-design. The fundamental theories, and various design features studied by neuroscientists. Examine the research on what happens to humans when encountering the physical environment.

4.4.1 Basic knowledge

The explanation for neuro-design is; “how the brain reacts to design features. It includes the way it consciously or unconsciously influences humans” (Coburn. A et al. 2020). Since the brain is complex, many aspects to consider when investigating neuro-design: perception, production, judgment, appreciation, and emotional response. All neuro responses are produced and experienced by humans when encountering an aesthetical physical environment. Further on, researchers claim that emotions are highly involved in the neuroaesthetics experience. Based on appreciating a view, and if it is connected to a memory or gives an emotional response, it is the ultimate reward (McClure. T, & Siegel. J, 2015).

There are three large-scale neural systems to experience the built environment and architecture (Chatterjee & Vartanian, 2014; Coburn et al., 2017). The systems are; knowledge meaning, emotion-valuation and sensorimotor systems. They interrelate with the psychological processes of cognition, emotion and behaviour. (Izard, Kagan, & Zajonc, 1988; Lench, Darbor, & Berg, 2013; Stangor, 2015).

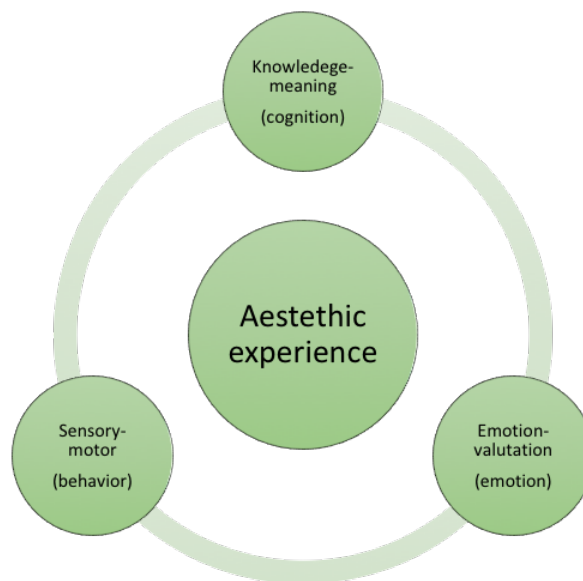


Image 9: The aesthetic triad and associated psychological domains (Coburn A et al. 2020), Author's illustration.

The three different systems have defined underclasses to be able to rate the experiences. Cognitive judgment of architecture: it discusses five key measures of cognitive review in the built environment: complexity, organisation, modernity, naturalness, and beauty. Emotional response to architecture: Eight criteria of emotional experience in the built environment: personalness, hominess, relaxation, comfort, stimulation, uplift, vitality, and valence. Behavioural-motivational responses to architecture: The final class of aesthetic response scales encompasses the psychological measures of behaviour, movement, and motivation, which may be to a first approximation linked to sensorimotor processing in the brain. Focusing on three behavioural measures: interest, approachability, and exploitability (Coburn A et al. 2020).

The brain is processing the most information about neuroaesthetics in the syntax visual cortex. The aesthetic information could be in lightning, colour, movement, faces, bodies, and landscape. There

is the evaluation of if an object is beautiful or not, which is a complicated judgment. The triad uses emotion, behaviour and the cognitive in combination with memories and earlier experiences (Gospic & Sjövall, 2016).

Human brains engage by interior design, architecture and art. However, the engagement may be positive or negative due to the stimuli, deciding which brain systems to engage. For example, when humans experience an appealing view, the parasympathetic nervous system kicks in, "the body's brake pedal". Then the heart freaking slows down, and also the blood pressure decreases. There is also an anti-inflammatory effect. Then, on the contrary, when humans react to something ugly, unpleasant or provocative, the sympathetic nervous system, "the body's gas pedal", humans feel uncomfortable, and it starts a stress reaction (Gospic & Sjövall, 2016).

There are theories rooted in evolutionary survival and states that humans appreciate landscape art (McClure. T, & Siegel. J, 2015). For instance, an artist made "America's most wanted painting". By conducting a poll where the participants could vote for what they would like to have in the painting. The painting ended up looking like the image 11 down below. Different countries answered the poll; most of them appealed by the same aesthetic features, and the polls resulted in similar pictures (Dissanayake, E. 1998; Komar & Melamid, 1994).



Image 10: Americas most wanted painting, and the result of the polls from different countries (Komar & Melamid, 1994).

4.4.2 Neuro-design Features

This chapter presents various neuro-design features studied by researchers and how humans perceive the design features encountered in urban areas and properties. It is essential to consider how the buildings affect humans and how the design and architecture can benefit humans. Chatterjee's (2020) research have identified three components that explained 90% of the variance in ratings: *coherence* (the ease with which one organises and comprehends a scene), *fascination* (a scene's informational richness and generated interest), and *hominess* (the extent to which a scene reflects a personal space) (Chatterjee, 2020). This by using, shapes, colour, nature, sensory features, light and the total experience of the physical environment.

Space, Shapes & Geometry

Humans are programmed to be appealed by symmetry and proportions, for instance, the golden ratio. The same mathematical proportions occur in many different aspects and patterns in nature. The brain finds this relation and the golden ratio symmetry appealing with exciting environments that intrigues the brain just the right amount—one of nature's finest examples of the fern (Gospic & Sjövall, 2016).

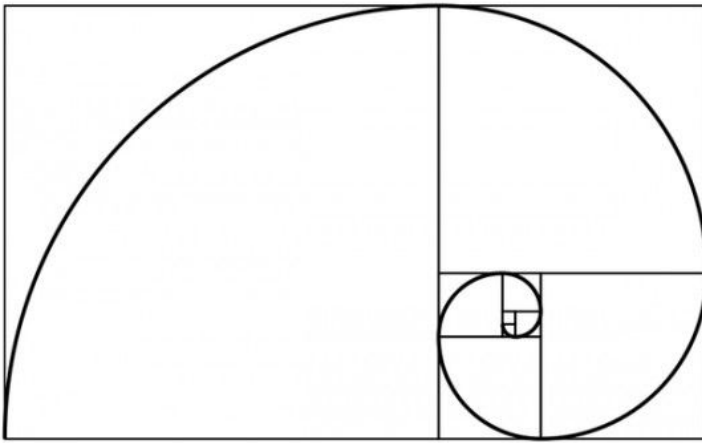


Image 11: Left, The golden ratio, author's illustration. Image 12: Right, Fern, illustrating the golden ratio in nature.

The neuroscientist Anjan Chatterjee has focused his research on how different architectural spaces affect people. Chatterjee has found that three spacious features mainly affect people, ceiling heights, enclosure and curvature. The preferred ceiling height is, on average, at three meters (Baird, Cassidy & Kurr, 1978). The research aimed to investigate how humans are affected by the ceiling height, which results in; aesthetic perception and neural activity. Spaces with higher ceilings received higher beauty ratings than the low. The fMRI scan results show that rooms with high ceilings, differentially activate the neural structures involved in visuospatial attention and exploration. Areas such as the left middle frontal gyrus and the left praecuneus (Vartanian et al., 2015). The psychological factor to ceiling *height* is that rooms with *higher* ceilings give a feeling of freedom and create space for creativity (Stamps, 2011).

The second architectural feature is *enclosure* which creates activity in the brain regarding aesthetics and psychological responses in interiors. The research indicates that the prospect theory can give an overview of space and refuge without being seen. It has followed humans since the survival of the wilderness and how to hide from potential threats (Appleton, J. 1996). People feel safer in more open spaces with some kind of enclosure to frame themselves but still have an overview (Stamps, 2005). The interior is preferred with a visual connection with the external surroundings to receive control of the area (Vartanian et al., 2015). Research made of the psychological and neural response to the openness and closedness of the interior resulted in people being appealed and engaged in the open room. The open rooms also received higher scores in the beauty rate in contrast to the enclosed interiors. The visual motion perceives the neural areas activated in open spaces and the enclosed rooms activated by neural areas involved with fear processing. Enclosed rooms may increase vulnerability to stress and prolong occupants' stress response (Vartanian et al., 2015).

Research on how different geometry shapes of, for example, rectilinear and curvature affect humans. People are often more profound of *curvilinear* shapes than rectilinear. Rectangular shapes and patterns do evoke more unpleasant emotions (Coburn et al., 2020). The study made by Coburn (et al., 2020) aimed to investigate the perception of architectural curvature. The result shows that humans judged curved building interiors as more beautiful than rectilinear spaces. There is a theory

that our preference for curved forms is because they regularly occur in nature(Coburn et al.,2019; Kellert, 2003; Salingaros, 2015).

During a research when neuroscientists have people walk through rooms in different shapes and geometry at the same time as they scan the brain for reactions in an fMRI (functional magnetic resonance imaging). The neuroscientists found that people preferred the curved interiors over the rectilinear forms. The round and curved shapes created a more positive response in the brain with pleasure and arousal, and the rectangular shape tended to have lower pleasure and arousal levels (Banaei. M et al. 2017). The research shows how people react and respond to the physical environment. The *anterior cingulate cortex* is responsible for the first affective response to the architectural features of the environment (Banaei. M et al., 2017). Image 10 shows the different rooms the people of the research was encountered by and how the first impression of different shaped rooms has affected them.

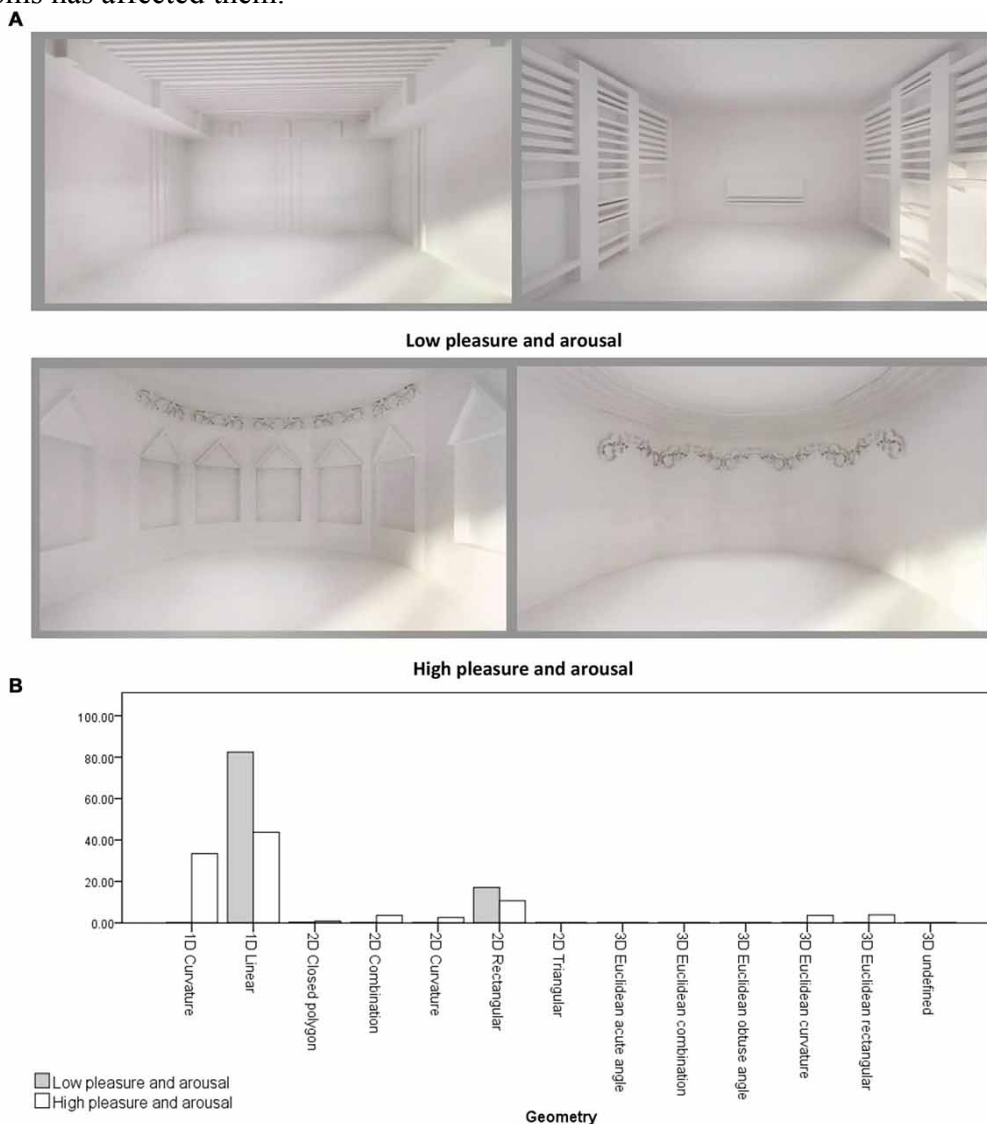


Image 13: (A) Samples of virtual rooms created by form features, 1st row: two rooms belong to low pleasure and arousal group, 2nd row: two rooms belong to high pleasure and arousal group. (B) Geometry differences between two emotion rating groups (Banaei. M et al., 2017).

Roelfsema et al. (1999) have also concluded that too many curved forms could also cause stress. It is essential to find the right balance and symmetry.

Humans are programmed liking to have a prospect, an overview of spaces. Nevertheless, refuge, to feel protected by the environment by a wall behind the back or a tree above the head. It helps provide security and comfort. (Appleton, 1975). Therefore, it is essential to develop spaces where these meet the need, for instance, split a room to avoid someone sitting in the middle of a room exposed.

Colour

The research discusses whether colours are a product of the visual cortex unaware of stimuli or an effect of the cognitive and symbolic perception of the colour. The researchers who have seen a pattern are the artists of "America's most wanted painting" who collected data from ten countries and found that in each country, blue was reported as the most picked colour, followed by green (Dutton, 2003). It may connect to the human evolutionary brain, where humans tend to like the colours that are beneficial for our survival. Green indicates life, red signalises ripe fruits and blue a feeling of space, heaven (Gospic & Sjövall, 2016).

Then lighter colours may work as an enhancer of the light and catch the light and make a brighter room, which is essential in an office building. Colour is a design feature to use when emphasising a company identity, shape and enhancing the space. It is also a tool to organise the building to make it easier to orientate and mark different areas and understand where to perform an activity. Colours stimulate human senses, and a more significant amount of strong shades may result in overstimulation. There needs to be a balance between the colour elements (Nilson L & Nordenknekt. M, n.d).

Colour can even be a tool for localisation and help the brain to navigate in the urban areas or buildings. For example, to know which floor the person is on. When people are navigating, the hippocampus is activated. There have been studies made on Alzheimer patients and their cognition in the built environment. Studies show that they benefit from having colours as guidance when finding their way back to their room (Kuliga, S et al., 2021).

Nature & Biophilia

The human brain reacts well to nature and biophilic architecture; it may result in beneficial effects such as improved mood, sleep, reduced stress, and enhanced overall well-being (Coburn et al., 2017). However, researchers have yet to identify the precise neural and psychological mechanisms that may mediate biophilic architecture that has predicted long-term healing effects (Coburn et al., 2017; Ryan et al., 2014).

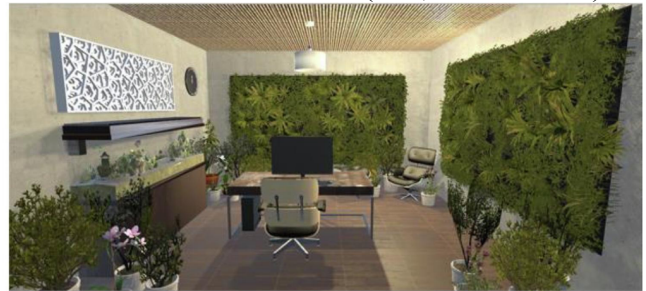
A study made on recovery from surgery, and how the window view affects it. The participants separated into two groups, one with windows with a view of nature and a window facing a brick wall. The research showed that the patient staying in the room with a view towards nature shortens the stay at the hospital and recovers faster after surgery, 7,96 days with nature view vs 8,70 days with brick wall. The patients with the nature view were also more stable and received fewer negative notes from the nurses in the journal than those in the rooms facing the brick wall (Ulrich, R. 1984). Further on, research also concluded that schools also see a positive effect of having nature outside the classroom window, which has helped the students perform better at tests due to the biophilic effect of stress recovery and prevention of mental fatigue (Li, Dongying & Sullivan, William. 2016).

The human response activates the *parasympathetic nervous system* and reduces psychological stress by being exposed to nature. It claims to originate from an innate preference for natural environments developed through evolution (Ulrich et al., 1991).

Studies have shown that people in a biophilic indoor environment have better recovery responses, stress, and anxiety after a stressful situation than those in non-biophilic environments. This experiment was examined in virtual reality and showed the same effect as natural biophilic environments. The participants encountered four different environments, one non-biophilic (A), one with no windows but biophilic features (B), one with small windows (C) and the last one with a combination of windows and biophilic elements (D). The measured psychological calmness from being in all the rooms with a biophilic environment is instant. The biophilic interior design has a more significant impact in the first four minutes of the experiment's 6-minute recovery process. Room D with the most windows and biophilic features received the best result (Yin, J et al. 2020).



A: Non-biophilic



B: Indoor green



C: Outdoor view



D: Combination

Image 14: Four VR-sceneries of environments with different amounts of biophilic features (Yin, J et al. 2020).

Moreover, there are more positive effects with biophilic design. Moss species can bind up to 80% of fine dust in the air and produce new oxygen, creating significantly much better air quality and cleaner air. Moss and lichen plantations are positive in several senses; they are health-promoting, stress-reducing, the green colour appeals to our brains, partly by naturally purifying the air but also that they have a noise-absorbing effect (Sjövall, 2020). More plants which improve the air quality in the interior, and performed best in a research from NASA is ivy, silver kale, golden vine, dracaena and bamboo palm (Wolverton, B. C et al. 1989).

When it comes to the office, research found that potted plants in the office increase employee efficiency by 15% (Kamarulzaman, N et al. 2011). Another research found that the more Greenery and plants the office workers are exposed to, the better the effect; productivity increased by 38%, creativity by 45% and well-being by 47% (Knight, C. 2013).

Research about working outdoors has examined employees' preferences and perceptions of different natural and built environments for different work tasks. The results show that natural outdoor environments are considered most suitable for as much as 75 % of different types of work activities. The judging criteria are fascinating, relaxing, open, bright, and quiet compared to the indoor environments. These studies also show that natural outdoor environments are flexible and suitable for everyday office activities. Employees also appreciate that there is access to work environments with different spatial characteristics (Mangone G et al. 2017). There are positive effects from working outdoors in nature, even if it concerns a garden, courtyard, terrace, forest or park. The outdoor office varies in the work situation, the stress levels decrease, and the faster recovery.

Natural access to daylight increases people's well-being. It improves health and strengthens the immune system. The outdoor environment stimulates the mind, and creativity is enhanced (Toivanen. S, 2019).

Sensory

The use of different materials may stimulate the tactile, scents, auditory and visual senses. The materials apply a surprise moment that benefits the human brain positively when thinking creatively and changing habitual thought patterns. By using different materials, the mind is stimulated and intrigue the curiosity of the human brain (Nilson L & Nordenknekt. M, n.d.).

The scent is a strong sensory experience for humans, and the smell is the mind that affects our memory the most. Humans are a hundred times more likely to remember something they smell than something they see, hear or touch. Scents generate 75 percent of all our emotions perceptions. The scents can give the room another sensory experience than just the visual (Warrenburg. S, 2005). The scents help create a feeling. Research shows that people smelling coffee and pastry are more helpful, up to two to six times as helpful as people in non-scented areas (Sjövall. I, 2020).

Moreover, there are acoustics and noise, encountering a noisy room and staying there is not beneficial for the health. Noisy environments lead to sleeping disorders, tiredness, worrying, anxiety, memory disorders, and increased stress. It is essential to plan for areas where there can be quiet (Sjövall, 2020). Research also states that a noisy environment may decrease productivity by 66% and increase the risk of myocardial infarction (WELL, 2021).

It is important to avoid the reflection of the sound. To consider different absorbents, where the possibility of reflecting noise is limited, by soft materials, blockages and fewer areas where the sound is trapped and may reflect back and forth, enhancing the disturbing noise. It is beneficial to create a local area where the acoustic is good. It can be done by implementing absorbents around the activity area, such as having a lot of vegetation and green absorbents. It is essential with a lot; one bush will not do it. It has been shown that having grass by the tram tracks helps reduce the noise locally (Hammarqvist. M, 2021-10-22, personal communication).

Moreover, to have one sound covering the disturbing sound can be difficult. It works better to have a similar sound to trick the brain into thinking the disturbing sound is more pleasant by connecting the sound to another source. Like a car road can be covered by a fountain and water sound. An experiment investigated how a sound from a car road is perceived. When first looking at a video of a car road and hearing the sound from a car road and then the same sound while looking at a waterfall. The sound of the car road was less disturbing when people looked at the waterfall. Since the sound is connected to the waterfall is perceived as much more pleasant (Hammarqvist. M, 2021-10-22, personal communication).

Light

An important neuro-design feature is windows, the proper lighting, and access to daylight. Light is one of the most powerful mechanisms to regulate the human day rhythm. The light can bring energy, help relax, and encourage and enhance cognitive performance and mood. Good lighting helps create a feeling of physical and mental comfort (Nilson L & Nordenknekt. M, n.d.). Going out or sitting by a window helps regulate *cardiac rhythm*, *suprachiasmatic nucleus*, *cortisol* levels and the sleep hormone, *melatonin*. Access to the right light leads to better performance, concentration, well-being, and decreased stress levels. When considering indoor lighting, the blue light acts invigorating, and the warm, yellow light is calming. There is also artificial lighting which aims to match natural daylight, called human-centric lighting. A certain lux-level has not been verified by

science as best yet (Sjövall I, 2020). Daylight and sunlight make humans happier, and serotonin is responsible for that experience (Breuning, L. G. 2016).

User Experience

Researchers made a study at a hospital to investigate if the patients were affected by the hospital environment. The participants are divided into two separate groups, one where the hospital room was plain and functional for the staff and one where researchers decorated the room with more enjoyable details: wood material, softer light, soft colours at the wall, plants, textile rugs, furniture/sofa/armchairs and paintings, creating a feeling of home. The study resulted in patience in the more hominess room recovered quicker than those in the plain, classic hospital room. It is an effect of feeling comfortable and safe but also that relatives and friends stay longer. Further on, when giving birth, the mums were happier in more relaxed settings (Hodnett, E. D. et al. 2005). The same effects are found at retirement homes (Haslam, C 2014). Furthermore, when people are among other people and socialising, oxytocin is released, and oxytocin can work as an anti-inflammatory (Olf, M, 2013).

To fulfil an inviting and pleasant environment, the individuals' ability to control the space is good. Research on having control over the environment have an impact on well-being. Adjusting where people sit or decorating the office and making it more personal is preferable (Cobaleda Cordero, A, 2020). Studies show that if people marvel at something they think is beautiful, such as art, music, or nature, it can have an anti-inflammatory effect and even stimulate the release of the neurotransmitter dopamine, which is central to reward and well-being (Seresinhe, 2019).

Moreover, a way to promote positive behaviours is nudging and priming. It can be by nudging, as in being lured into taking the stairs instead of the elevator. Alternatively, priming is more unaware, and there can be inspirational photos or paintings, motivational words, and symbols that motivate. (Vlaev, I. et al. 2016).

4.5 Organisational Benefits by Optimising Offices with Neuro-design

The researchers behind the article "feel well and do well at work" argue that several architectural attributes to an office contribute positively to hedonic and eudaimonic well-being. As earlier mentioned, access to big windows, glass partitions and the proper lighting in the office to receive daylight exposure. Also, the accessibility to colleagues and openness in spaces. Meeting rooms for all types of functions and sizes, and spaces for break rooms for different occasions and sizes. The design of the office should look "fresh" and "modern" and have spatial diversity for different work activities (Cobaleda Cordero, A et al. 2020).

The workplace influences the physical, mental and social well-being of employees. Moreover, World Green Building Council (2014) states that there is a correlation between the office workers' well-being and the work environment's support for their activities. When the employees are satisfied, and there are higher levels of well-being at the office, it is the foundation to happier and more productive people (Bodin Danielsson. C, 2016).

There are also benefits of having nature near. Environmental and psychological research has shown that it lowers stress and increases empathic ability, collaboration, and well-being, which are beneficial for an organisation (Toivanen. S, 2019).

To evaluate the office environment and find possible stressors, are beneficial for the organisation. Optimise the organisation by preventing the usual health problems such as stress, depression and sick leave in total. It saves personnel, resources and money. The work is made proactive to hinder possible issue. It can even help attract talent by having an inviting office environment and radiates care for employees, supporting their tasks by a supportive environment and contributing to their well-being (Cobaleda Cordero, A, et al. 2020).

4.6 Organisational Management for Well-being, Terrace

A well-constructed office environment with features of neuro-design implemented may lead to positive effects such as happier individuals, which leads to better organisational results. However, the organisation might need some form of education, leadership, organisational management and change management to succeed with the health-promoting organisation.

It is known to take around 66 days to break habits (Lally, P 2010). To succeed in implementing well-being promotion in an organisation promoting well-being, more knowledge about physical, cultural and mental conditions or limitations for an increased degree of healthy activities supported by the work environment during the working day. If the organisation is moving from cell offices to activity-based offices, there might need some education on using the space. When planning a terrace where the possibility to socialise, eat, work, walk and talk or recovery, it might be a new way of operating both for the employee and the leaders and organisation as a whole (Toivanen. S, n. d). Therefore, it is wise to offer education on how to use the spaces and what organisational culture accepts. Toivanen (n. d) also considers the terrace's usage as part of an activity-based office, where the space supports certain wanted work activities. Think about the questions, what do people have to do in the workspace? Where is the best place to do it? Furthermore, what is needed to fulfil the task? Then shape the environments after the task for support in the workday and well-being (Toivanen. S, n. d).

5 Interview study

An interview study was conducted where interviewees were asked questions about property development concerning their expertise—focused on office buildings, city planning, neuroscience, neuro-design, and how to create well-being among humans in the built environment. The interview study is initiated by presentations of the six interviewees, followed by an account of the result of the interviews and personal communication divided into headlines of the mentioned common topics of the interviews.

Presentation of Interviewees

Christina Bodin Danielsson

Architect SAR/MSA, PhD Associate Professor in Architectural Design at the school of architecture, Royal Institute of Technology (KTH).

Christina Bodin Danielsson practices architecture (SAR/MSA) and is a teacher and professor at the Royal Institute of Technology in how the physical environment and architecture correlate and influence human behaviour, psychology, and well-being. Bodin Danielsson has focused explicitly on how offices affect humans and how offices should develop to make humans thrive. Bodin Danielsson has written popular scientific articles and science books in Swedish and English, French, and over 25 scientifically reviewed articles on the impact of the office environment on health, sick leave, leadership, outdoor work, etc., published in international journals as well as reports. Bodin Danielsson has carried out several different architectural projects based on research and then not just office projects, but they are focused in this interview. The companies Prevent's new office headquarter, Svensk Byggtjänst's new headquarter, and evaluate the Swedish Migration Agency's office for a lean-adapted office environment. Interview conducted 2021-08-22.

Isabelle Sjövall

Neuro-designer (Independent specialist in architecture, interiors, and design based on research and neuroscience to improve health, human sustainability, and life quality).

Isabelle Sjövall has, from an early age, thought about and been interested in how the built physical environment affects the people in the city. After high school, Sjövall started her own company, where Sjövall works with neuro-design, finding new research and planning environments according to human sustainability. Sjövall is an educated interior designer and have studied psychology. She has also written two books, one in collaboration with Katarina Gospic, neuroscientist, and the joint work resulted in Neuro-design, and her own sequel is called Designfulness. Today, Sjövall works as a neuro-designer, writer, and inspirer and collaborates with two schools in London where they research neuro-design. Sjövall works to optimise buildings so they meet the total value. Sjövall's perspective is to think from a human perspective, both how the brain reacts to architecture and physical environments and how spaces and places affect us psychologically and physiologically. Interview conducted 2021-09-22.

Maral Babapour Chafi

PhD in Human-Technology-Design, Institute of Stress Medicine.

Maral Babapour Chafi has a background in Industrial Design and Human Factor Engineer, studied at Chalmers. Then she doctorated in a subject in the same field as human technology design, where Babapour Chafi looks at the interaction between humans and technology and the built environment. Babapour has primarily looked at the interaction in the office environments in relation to the working life. How design affects and supports or sometimes hinders work and health—

investigations of different work environments for instance in the car industry and production environments and offices. Babapour Chafi wrote a thesis on that subject and received a work environment award. Babapour Chafi worked at Chalmers for ten years and is currently in the second year at the department of stress medicine. There Babapour Chafi led a research project about activity-based offices and investigated the challenges for future work. There is much more technology to come and the built perspective of how it affects people and how people can affect it than different perspectives in the office environment. Many people look a lot at the social or organisational perspective. Babapour Chafi tries to have more of the socio-technical view to look at both the technology and the social organisation. Interview conducted 2021-09-17.

Marco Testa & Pernilla Kindell

Architects SAR/MSA, Reflex (architects of NCC's project MIMO).

Marco Testa, VD and architect at Reflex and Pernilla Kindell, Architect at Reflex. Both Testa and Kindell have worked with architecture within houses, dwellings, commercial, office, and hotel buildings. Testa graduated as an architect in Italy and worked internationally in Japan and the USA. Kindell began her architectural career at Reflex. However, after nine years, Kindell left Reflex and has worked in various architectural offices, primarily with significant housing projects and schools in Gothenburg. Kindell has run an own business in Klok Arkitektur. Nevertheless, now Kindell has returned to Reflex as responsible for the newly opened office in Gothenburg. Reflex Arkitekter offers qualified architectural services in house construction, interior design, and planning - from idea and project development to complete design and interior design. Their customers are often major property owners and tenants in the private and public sectors. Testa and Kindell are involved with the architecture of MIMO, NCC's project in Mölndal, where well-being is a high priority. Interview conducted 2021-08-24.

Susanna Toivanen

Professor of sociology and a work-life researcher, Mälardalen University, Sweden.

Susanna Toivanen has been a working life researcher since 2002 and a professor of sociology at Mälardalen University since 2017. She has also worked three years as an in-house researcher at NCC Property Development. Susanna Toivanen's research is about health inequalities in working life and social determinants of health such as housing areas and working environments and living conditions. They are important determinants of public health and contribute to differences in health between social groups. For instance, if people live in residential areas where they do not have access to environments that support physical activity or the possibility of recovery and recreation, this negatively affects their health compared to groups with better access to such environments.

Susanna Toivanen mentions that as a professor, it involves many types of projects, and most of them deal with working life, work environment, and health. Presently, Susanna Toivanen is investigating outdoor offices and their influence on office workers' recovery and health. The starting point is in activity-based offices where employees do not have fixed workstations or rooms. Previous research shows that noise and lack of privacy are common work environment challenges in open-plan offices, and they also influence work performance and employee well-being. Taking advantage of digitalisation and the flexibility that activity-based offices offer, Toivanen's research group investigates if regular outdoor office work and new sustainable ways of working influence recovery and health among office workers. Interview conducted 2021-08-20.

Ulrika Ahlqvist

Researcher and inspirer within brain health for suitable working environments, Hjärnberikad AB.

Ulrika Ahlqvist was initially a math-science teacher, but she became interested in making the school available to more students early on. Many young people skip school, stay in the corridors, or do not even get there. Ahlqvist and a colleague investigated how to develop the school environment into inclusive, accessible, and more attractive to everyone. The environment, meaning the physical environment (almost 20 years ago). It is a large part of the education as a preschool teacher to protect the environment of a three-year-old and what the environment plays for the role of pedagogy. They found it strange that school environments are not designed for the specific work intended, for the subject, and to perform different tasks. Ahlqvist and the colleague were interested in finding research and how the learning plan could support the ideas. Ahlqvist started consulting in the school environment, and then the physical environment only intended to focus on school development. To see the students, design an environment where people feel comfortable physically and psychosocially. At Kattegatt Gymnasium, they made a room to train the brain where students' brains can grow. Together with the brain, researchers explore the possibilities of spaces. Ahlqvist's concept is; "what does the brain need to develop, for us to feel good and function." Then Hjärnberikad put together the "ten good habits for the brain," aiming to inspire well-being.

There has been an increased demand in people in the room and the soft values. Ahlqvist works a lot in the early stages of the process because no one works a lot with thinking about these values before and not when it is too late, after started the construction. Ahlqvist is hired by property, building, and architect offices. It does not just have to be about the physical environment but also health-promoting work initiatives. Interview conducted 2021-09-16.

5.1 Socially Sustainable Building

The interviewees have some different perspectives of what a socially sustainable building is. One of the interviewees mentioned UN's seventeen sustainability goals. Maral Babapour Chafi also started by mentioning the UN's seventeen sustainable goals and specifically goal number three, which is about human well-being. Many theories deal with social sustainability, and that also touches on the neuro-design concept. Positive psychology looks at health promotion, what people do, what makes people feel good, and what makes people good. There is a lot about people having goals and purpose. People can achieve the purpose and feel competent in an office. Maintaining good relationships, makes people feel like they belong. It is also essential to have control over the physical environment. From the positive psychological perspective, it can be the employee's control; over time, when actively working. However, it can also be about where people work.

Nevertheless, from a design perspective, Babapour Chafi thinks it can also be about whether people can control various factors in the environment, such as sound and light, can one keep personal belongings, or if it is possible to decorate and personalise the immediate environment. Another perspective, called the salutogenic health perspective, focuses on factors that support human health and well-being rather than on factors that cause disease (pathogenesis). Which has similar building blocks as positive psychology, by the essentials from the social environment, relativeness, important that people understand and comprehend the immediate environment. The researcher of the theories about salutogenic was a sociologist, not the designer. However, suppose one has the salutogenic design perspective and look at what it can imply in the built environment. A lot in semantics and design can help understand how different environments hold together, what to do in the environment and how to be. The built environment can guide us without there being arrows (Babapour Chafi. M, 2021-09-17, personal communication).

There were answers from interviewees about the building as a real estate and how it is perceived by the surroundings. Christina Bodin Danielsson states that the buildings' height and scale affect how humans perceive the environment, both from outside and inside. The scale affects humans in various ways, such as the perspective of the surroundings or sunlight to the streets. Kids can perceive facial expressions to a maximum of five stories and by that feel safer being out. The real estate owner plays a vital role in making the two lower stories of a building come alive to make the area appealing and attract people to spend time at the place. There are "eyes on the street" when people are in the area, contributing to safety. CPTED - Crime Prevention Through Environmental Design. Bodin Danielsson also connected the question to neuroscience and stated that it is necessary with a clear architectural language to make the place orientable, intrigue emotions and smells that awakens good memories and give a sense of calm at the place.

Marco Testa answered by stating that it is done by equality. The building is available for all and open, public, vivid, and active. Offices used to be drawn by the architect for a specific purpose of the office needs, but now people want to achieve a living room-feeling at the office. Testa believes there needs to be a perfect combo of the office adapted part and the activity-based and more free space areas. Testa also claims that it is also essential to look for all needs, not just one person. The office should fit all employees, and which may require more office elements. Due to the different work chores, such as communication, meetings, travelling, the office should fulfil all needs of the specific company the specific company housing in the office (Testa. M, 2021-08-24, personal communication).

Pernilla Kindell answers that the office building often could be a heterogeneous mix. Kindell claims that the building instead should combine different office functions is essential and creating an activity-based office with separate areas for different tasks. Which Kindell considers may be messy if the mixed offices are not well thought out, designed and planned correctly. The different areas give a chance for new interactions and a social office. Kindell also agrees with Testa that it is crucial to consider all individuals' needs and what tasks they are working on for the office to be focused on and adapted to the different needs. Kindell also referred back to the project of MIMO, which has a ServiceDesk in the lobby where there is a living room feeling, welcoming, meeting place, and food available. Kindell believes it is smart elements to a socially sustainable building with the human perspective in focus. Kindell also emphasises the impact of receiving the perfect mix in an office building to intrigue and try to match all needs for a well-planned and well-functioning office.

The last perspective was the human perspective; the built environment serves the humans engaging in the building. Isabelle Sjövall has taken social sustainability further and referred to it as human sustainability. Sjövall refers to what is written in the book 'Designfulness' and how our brains operate in the built environment. It is one thing to optimise and design a space or place and get the best possible result; it is crucial that people also understand how to use the surrounding environment. Sjövall believes in further education to make people more aware of using the neuro-design to their advantage.

In accordance with Sjövall, Ahlqvist also considers that an environment must contribute to good habits. Make people's fundamental needs possible: food, physical activity, sleep, and recovery. Nevertheless, also a variety, because if people only see the same thing, people will think the same thoughts, changeability or the unexpected is also essential. It is what will make us form new synapses in the brain. To alternate both the safe environment that is constantly repeated as people know and what is expected. People know where to hang the jacket and know where the coffee cups are. Variety, repetition, physical activity in every way, get movement in the room, and take care about the recovery (Ahlqvist. U, 2021-09-16, personal communication).

5.2 Office

The well-being depends on the choice of office types; Bodin Danielsson has researched seven office types. Cell office (own room), shared room (2-3 people per room), office landscape; including three variants: small office landscape (4-9 people), medium-sized office landscape (10-25 people), and large office landscape (over 24 people). Also including the more flexible office variants flex office and combined office where people also have elements of open floor plan to varying degrees. How many people are sitting in the room is a significant factor to comfort. There exist support environments where the employees can recover, have more focus, or perform any task that needs a more specific environment. In the same way, people need to control their stressors in the office, for example if it is noisy, are the employees able to cancel it. Is the office too dark, the employees have the possibility to move to a brighter seat (Bodin Danielsson. C, 2021-08-22, personal communication).

Testa and Kindell state that the biggest challenge is to create rooms where the area of use can be changed into anything later since the area may not be the same office eternally. Offices are constantly developing due to the work chores.

Testa believes that the pandemic has shown that people have preferred to be home and that it is difficult to get the employees back to the office. Office planned at its finest; the employees would have preferred the office over working at home. Many companies have renovated the offices to match the new reality and support the activities relevant to the work chores (Testa. M, 2021-08-24, personal communication).

5.3 Outdoor Office

Toivanen usually says that there are three types of outdoor office work. The first is just to go outdoors, to some green area, maybe in the yard where are some trees or a park. One can go there by themselves or have a Monday meeting. The second is that the company provides outdoor offices. Lastly, according to the same concept, terraces adjacent to office buildings add value to all tenants, using either the fixed outdoor office or the terrace. Toivanen claims that it is usually the news value for people to use outdoor offices, and the use decreases over time. The employees have to learn something new by working outdoors. Toivanen has concluded that it should be firmly anchored by the management, for the management to express that they want the employees to work outdoors when needed. Do the job where it is easiest and best for the employee; if individual think it is best to do it out in a park, feel free to do it, only if the employee delivers. It is essential to get legitimacy from the boss to dare to start working outdoors (Toivanen. S, 2021-08-20, personal communication).

Outdoor offices can act as a zone in the activity-based office. The employees have different zones indoors an addition is to have the possible to go outdoors and fulfil needs, such as exercising, moving, getting creative after being stuck, rest the brain, or recovering. Employees should be able to go outdoors without feeling guilty. Outdoor work needs to be an anchored way of working, and that people use the digital tool to their advantage. People can access everything on the smartphone; email can be read, the PowerPoint reviewed, calculations made. Employees do not have to sit in the office all the time (Toivanen. S, 2021-08-20, personal communication). Maral Babapour Chafi has also investigated the technique question of the outdoor office. Right now, there is plenty of news about outdoor offices. It is essential to find solutions to build offices close to natural environments. Alternatively, have urban environments and the public space that there should be an opportunity in

a park or forest to be able to work outdoors for a while. Also, to have access to digital tool at the same time as people gets natural light (Babapour Chafi. M, 2021-09-17, personal communication). Toivanen additionally suggests using digital tools, as usual, book rooms in outlook and include outdoor environments. Moreover, if it rains, it is possible to go to a specific area where the meeting can continue or go inside (Toivanen. S, 2021-08-20, personal communication).

There is limited research on outdoor offices, and Toivanen hopes that more will arise. In Toivanen and the team's research so far, they are breaking new ground. Toivanen and others lean on the extensive research on the impact of nature on humans and health and well-being. It is pretty detailed; there has been examines of different parameters. There are numerous mechanisms suggested, for what it is that affects human health in the exposure of nature. There can be indirect effects, such as when people are outside, it affects behaviour and health. It can directly affect when inhaling in nature and forests, strengthening our immune system and thus strengthening health. There are a bunch of mechanisms and combinations of different mechanisms. Further on, organisations will need a method to get the outdoor office up and running. Covid-19 has helped speed up the development of moving the office out. These outdoor environments are important (Toivanen. S, 2021-08-20, personal communication).

5.4 Well-being & User Experience

If offices can be planned to benefit human well-being, all the respondents were optimistic. Bodin Danielsson answered, "We know that it is possible ", for the best result, it needs to be in combination with the organisational elements as well. Testa and Kindell both said, of course, to create offices that benefit human well-being.

Bodin Danielsson states that people often look for safety at the offices, which can be fulfilled by having some demands and control over the work environment. For example, the employee does receive some freedom to personalise their offices to receive the right amount of stimulants. The opposite is a modern office where the environment is professional, equal, sterile, and has no direct expression; this does not create safety/hominess/thrives (Bodin Danielsson. C, 2021-08-22, personal communication).

Bodin Danielsson carried on by explaining what her research has found is beneficial for human well-being at offices. Humans ask for similar elements in an office, but the good elements of an office may vary a bit depending on the tasks or work situation that requires different physical offices designs. Bodin Danielsson states that it is essential to ask oneself when planning an office why people would like to be at one place in the office and not the other. What elements make the difference? (Bodin Danielsson, 2021). Testa, in agreement with Bodin Danielsson and mentioned that there is still a variance between the different companies. Lawyers do not usually like the 'open landscape'; they want privacy, being able to focus, which is best in a closed room. In contrast, a game company is looking for extreme creativity with games, playfulness, and social (Testa. M, 2021-08-24, personal communication).

Bodin Danielsson stated that it is essential to locate the different possible critical stressors to eliminate the wrong areas in the office where no one likes to sit. Bodin Danielsson mentions that if the furniture is well planned, there can be better results from the users, for example, students performing on a test. In activity-based offices, some of the elements that the office employees prioritise are a spot with windows with a view and to be openable and receive fresh air. The seat should also be without disturbance from a passing corridor, and peoples back should be protected (Bodin Danielsson. C, 2021-08-22, personal communication).

Bodin Danielsson claims that the office may serve different purposes even if an office is not particularly good for the employees. It may be for the companies' well-being, for example, economically. Also, a part of the well-being in an office in the community of co-workers is a primary reason people longing back to the office. It is wanted to talk and discuss cases more efficiently with colleagues over the desk or by the coffee machine. Nevertheless, to have closed areas where focused work can take place without being disturbed (Bodin Danielsson. C, 2021-08-22, personal communication).

Testa stated that it is expected that most companies like different kinds of services, and also for all services to be nearby. It is a habit of a rich country. Most companies also strive to create company identity, what the company stands for, for example, luxury, playfulness, company colours. It helps create a feeling of belonging and security. Furthermore, by letting people bring personal belongings to their room, it can bring comfort. It has to be carefully carried out, so the culture does not get lost in all the employees' decorations (Testa. M, 2021-08-24, personal communication).

Kindell continued by talking about MIMO. When Reflex designed the offices, there was a type of office in different sizes adapted to the tenant company later in the process. Kindell then continued by explaining essential features of the MIMO- office building, which gives a human benefit. There is a welcoming entrance open for all. The rooms will be in raw materials, and there is a natural colour scheme. All of the rooms are planned to be active and with greenery (Kindell. P, 2021-08-24, personal communication).

Sjövall believes in finding the common keys and applying biological factors and knowledge about the brain in future design. This approach is a much more sustainable solution over time. Because organisations are agile and fast today, and it is changing fast. Starting from the humans and the body people always have with them, is the most intelligent approach because our brains do not develop as quickly as our environment (Sjövall. I, 2021-09-22, personal communication).

There is comprehensible, relatable, meaningfulness. The person who looked at this was a sociologist and looked at how to find meaning in life by helping others or doing things people like. Then consider what it means from the design perspective, what is meaningful to a user in an environment. Colours can signal a specific meaning; humans can perceive a red and very angular shape as a slightly aggressive environment. Further on, in offices where people do not have their places, people can feel alienated. However, people cannot decorate the space as usual (Babapour Chafi. M, 2021-09-17, personal communication).

In Babapour Chafi's field, the user experience is essential, both as something in a physical environment. However, it can also be a user experience as an interface in the digital work environment. There is a lot about all the stimuli around humans, not just the designed tools but also what is connected, for example, sitting in a room with lots of other interior features, a computer may be great, but it might not fit in the specific room. All the stimulus, plus the previous abilities and expectations of the physical environment, how the understanding of the environment will affect, is shaped, and guides. When it comes to offices, the relationship to the physical environment can grow when involved in the design process. People can create, shape and decorate, adjust the office, have control over the environment. Researchers have written about the IKEA-effect; people got asked to rate furniture based on the experienced value, a self-assembled IKEA furniture, and an already assembled chest of drawers. The most valued was the IKEA furniture mounted themselves. Regardless of how good or bad it is mounted, it received the most value. It is the creation that makes people feel ownership and relationship to the furniture. It is an aspect that modern offices often miss, it becomes slightly sterile and standardised (Babapour Chafi. M, 2021-09-17, personal communication).

The group often has some identity and develops design to strengthen the team of the organisation, but the individual aspect is missed. When there is a change in an office or organisation, it affects people. New experience and numerous new stimulus. The environment is then tested and accustomed by the employees in this testing process. Hopefully, humans will find some form of stability after a while. Change of a new office is a bit like a collision, people get distracted from the activities in focus. However, if the change is not good, people always have to find a new optimal solution because otherwise people will never come to stability. Which may cause regression or frustration. It is also essential to consider the time aspect, which is critical to the change process (Babapour Chafi. M, 2021-09-17, personal communication).

5.5 Human Brain

Isabelle Sjövall and Ulrika Ahlqvist were the two interviews with the most knowledge about the human brain. Both of them have worked closely with neuroscientists and engaged in research in the area of neuro-design. Sjövall and Ahlqvist explain the basics of neuro-design; Sjövall states that in neuro-design, certain parts of the brain recur, at least the more prominent parts. Neuroplasticity is affected by the physical environment and is shaped by the experiences, memories, and environments humans encounter. Hippocampus is the memory centre used for localisation. In city planning, people often orient themselves with the help of landmarks or street patterns.

Further on, the amygdala is the spot where the brain handles stress and is also home to emotions. Sjövall points out that it is essential to look at the stress stimuli towards the built environment as it is one of the significant factors affecting humans. Where in the built environment, the stress response is detected from fMRI. If people do not handle the amount of stress and can lead to inflammation. However, planning environments where people thrive has been proven to have an anti-inflammatory effect (Sjövall. I, 2021-09-22, personal communication).

Ulrika Ahlqvist states that there is still more research to come in neuroscience and the built physical environment; the existing research does not entirely agree. Since the brain is complex and there are uncertainties around what area of the brain reacts to what kind of stimuli. However, the brain acts as a network, and the more areas people activate, the more power humans have. The brain is plastic, which means that the memory people can change places in the brain, and even functions that control different body parts can change positions in the brain. An injured person can move the function to another part of the brain with proper rehabilitation. For example, if a person has lost the feeling in the right hand and becomes paralysed. With the appropriate training, one can force the brain to activate another place to gain activity again, start forcing the brain to work. Then the brain changes location for that activity (Ahlqvist. U, 2021-09-16, personal communication).

The brain is a giant network. Humans have about 100 billion brain cells, and they contact each other in about 1000 billion synapses. When the synapses are to contact each other, it requires both electricity and chemistry. It is the chemistry that lies between the synapses that are called chemical neurotransmitters. The neurotransmitters are the ones that make people think, have an opinion, feel, act and remember (Ahlqvist. U, 2021-09-16, personal communication).

When it comes to human senses, a scent or visual experience can trigger a multimodal sensory stimulation, and it can be from an enriched environment with many different experiences. A reaction starts in the brain, and it is like the computer's save button due to the connections made and remembered in the brain. Ahlqvist considers the most exciting part to be that the hippocampus grows in intriguing environments. It is about the fact that the impression of the mind is significant for the brain, and people react to words, symbols, smell, tastes, and often it is even the case that this sometimes happens unknowingly (Ahlqvist. U, 2021-09-16, personal communication).

5.6 Neuro-design

Testa and Kindell agrees that they did not know much about neuro-design, more than it has to do with design to benefit the human brain. Testa and Kindell continued the discussion that they know what architectural features do and affect humans physically. Also, emphasised the importance of planning the chosen object for the human to sell the architectural designs and retrieve a value of the plan and time invested (Testa. M & Kindell. P, 2021-08-24, personal communication).

Ahlqvist has noticed that there is limited research in the area of neuro-design. Ahlqvist believed there to be more research made in school environments, but there is a lack of research regarding neuro-design. Now more research is starting to appear. Umeå University, together with some other educational institutions, is compiling an extensive database of all Swedish research that has been going on around learning environments. However, it is still so meagre that one does not dare to trust it because the studies are still relatively small. More is needed! (Ahlqvist. U, 2021-09-16, personal communication).

Bodin Danielsson has lectured in neuroscience focused on architecture and is familiar with the concept of neuro-design. Bodin Danielsson claims that there is more to it than just signals in the brain from the architecture. All human senses are included in the equation of neuroscience, smell, touch, vision, hearing, and (taste). Further, culture is a part in what is considered intriguing and considered as well-planned architectural building; culture helps create a complete picture. Bodin Danielsson gave an example of the architectural differences there are between the USA and Italy. The USA is a relatively new country where cubism is a sizeable architectural branch, and the buildings are not supposed to be viewed up close. Compared to Italy, where the architecture is a heritage, the fine planned architectural features are essential to match the existing buildings' grand expression. Moreover, the value of great architecture has a vital role in society (Bodin Danielsson. C, 2021-08-22, personal communication).

When Isabelle Sjövall explained what neuro-design is, in short, Sjövall explains neuro design as to how the human brain reacts to the built environment. Sjövall is especially interested in the psychological and physiological effects of the built environment, i.e., how the brain and body are affected by architecture and design. The progress of brain research linked to objective measures (e.g., fMRI) and biomarkers is also a fascinating area and space syntax (Sjövall. I, 2021-09-22, personal communication).

It has been proven that the city stresses humans and many stimuli around staying in the physical environment. Design / architectural elements that have proven to be calm stress stimuli are biophilia and how people like green areas. Daylight is also essential to follow the natural circadian rhythm, control the cortisol, and how exposure to the light is crucial for feeling good, sleeping well, and staying alert. Good lighting conditions are essential; a constant and poor acoustic environment can lead to a heart attack (Sjövall. I, 2021-09-22, personal communication).

Sjövall then adds that it is essential to work with those with universal areas of neuro-design that give a positive effect to all people. Regardless of activity or individual, people are equal in how the brain responds. Even people who do not say they are affected by the office environment, are affected, it is pretty black and white when it comes to the brain's reactions. Because it is seen in magnetic resonance imaging that the same parts of the brain are switched on when exposed to the same type of stimuli. Then absolutely, if a person is stressed, that person may not be seated in a red-painted room with high stimuli as the person is calmer and more available to handle stress. People may need different type of stimuli depending on the life situation, "you do not go to the doctor and

get the same things" there are different aspects of life that affect people and what is needed for the moment (Sjövall. I, 2021-09-22, personal communication).

A theory that Babapour Chafi has written about and is the basis of her research is called activity theory. It is a theological development strategy about how humans develop and how humans learn in life—the study started by looking at how children learn languages or learn to do things. The founding was that children and adults do things in social contexts and with the help of what is in the physical environment, i. e all the tools humans have created historically, and there is a connection to neuro-design theories. The brain is not born with all the routines and practices; humans have developed them over many years. Humans learn; they look at how others do and what others have done.

It can be applied to offices; humans have not worked at offices for too many years. It was in the early 20th century when Marxism developed. People would share the tasks and did not know what others were doing and when people had a boss who would watch and control. Then history has changed us; digitalisation has made us work differently. In the 1960s, the labour movement was active, and organisations constructed more cell offices. It is connected to what people do now, why people are here, and why they do as they do. In the activity theory, discussions are about how our consciousness is connected to what humans do, and humans are conscious when they think of a matter and are active doing and are engaged with the world (Babapour Chafi. M, 2021-09-17, personal communication).

The theories are based on humans doing things on three levels: conscious, semi-conscious, and automated. Imagine when typing, this is an automated task. There are more tasks that humans have automated, talking, depending on what is talked about, it can be more or less automated if one knows less of the subject. It is that there will be conscious actions and more unconscious actions and automated. There is this range in our environment, both if humans have noticed books in the interior, will everything in the room support the activity that humans do. The physical environment can also sabotage; it may be that the automated actions or actions are seen as actually happening unconsciously. Then people may suddenly become aware of the design because it is being a problem. The situations when humans are in an environment can be more consciously or unconsciously. Do humans have to concentrate on solving something in the physical environment which may need focus, or is the environment easy to follow and give the brain a break in the work? Work does not always have to be concentration-demanding a conversation or eating together because it is suitable for our recovery. However, the environment can limit us and influence us not even being able to recover. All our activities, in the best of worlds, the environment should support and enable. In many ways, similar to this nudging philosophy that one can enable, encourage support, or avoid. There are many design strategies around nudging (Babapour Chafi. M, 2021-09-17, personal communication).

An exciting concept, according to Ulrika Ahlqvist, is priming which is almost like nudging. Priming, compare it to the product used when applying makeup to get the makeup to stick. The brain works in the same way; it reacts to the associations. Studies show that if everyone gets to see dollar signs on their desk saver, there is monopoly money laid out, there is money everywhere. The participants have not been informed of the priming. The result seen is that the employees became efficient, they worked faster but became less helpful. Further on, did researchers want to test if priming could get people to contribute to the coffee money collection. The employees did not do it at the moment. The test included placing posters above the coffee money collection box, first on an adorable kitten. If people see a cute kitten, the employee becomes friendlier, and then they pay. However, nothing happened. The poster was changed after a few weeks, and a poster with two big

eyes looking down at the coffee money collection box was placed on the wall. Then people started paying. Priming and nudging are pretty similar, but priming is more unconscious.

Nudging means getting an urge to do something. It is the healthy stairs, where people are urged to walk in a stair that plays music. While priming has a more unconscious impact. Priming can be used in, for example, a job or a school environment to program the brain from the beginning by symbols or shapes or how people perceive things. It can help prepare the environment, for the brain understands what to do within the given environment (Ahlqvist. U, 2021-09-16, personal communication). Furthermore, scientists have examined a lot in this area, and the brain responds to words. What people say to the brain and what people see is based to react to such things, not expose us to danger, and always make sure that we work as efficiently as possible. It exists to regulate our body's resource budget. If people feel safe, then people have plenty of resources. If people have eaten, slept, and managed their stress, then people have plenty of resources. It is a form of proof that it is essential to work with health-promoting offices because organisations get more efficient employees (Ahlqvist. U, 2021-09-16, personal communication).

5.7 Shapes & Colour

Ahlqvist refers to Katarina Gospic and Isabelle Sjövall and their neuro-design book, the fact about studies that if people work creatively, it is an advantage to have high ceilings and bright rooms. If people work with more detail-oriented task, it may be preferable not to have a high ceiling and more muted colours. Ahlqvist, among others, has designed the learning lab, a working lab located on Johanneberg in Science Park, Akademiska Hus. The research included what people need for different work chores and what they have to do with the interior to support the activity. There is a vast area in the learning lab where there is a high ceiling, and it is called the studio. In connection with the studio, there is a slightly smaller room that has slightly different conditions. It is called the cutting room, in the studio where the movie is created. The movie also has to finish and need to cut together details and do the work. Then a set designer has created a room that appeals to different moods. The room is designed with three different environments, concentration, creativity, and collaboration. Then the set designer made three setups or set designs, as it is called in film language, where different moods are projected. The room is empty but and people are supposed to pick up elements that allow creating a sensory experience (Ahlqvist. U, 2021-09-16, personal communication).

Bodin Danielsson claims that there is no direct evidence of the brain's reaction to colour and shapes. However, an "feeling" of example, calm, can be experienced by implementing specific colours, as people may experience cold by the colour blue, and warm colours and materials could appear warm. The colours are primarily symbolic, and humans have learned to connect the colours with a feeling and expression. However, colour may also be used as a building code, one-story receives one colour to help identify the building element and navigate the people moving in the built environment (Bodin Danielsson. C, 2021-08-22, personal communication). Babapour Chafi agrees that colours can also be used as orientation markers to help Alzheimer's patients find. Both colour and shape, rounded shapes, or if the furniture is close together or distributed. There are many design aspects to adjust in an environment, both with the choice of furniture, location, directions. Walls and ceilings can vary, and different objects can signal a particular function. Babapour Chafi has looked at many environments where it can be unclear, and people do not receive a clarification. If the environment should be quiet, but the environment does not signal that activity. It does not contribute to the understanding of being a quiet room. There are sometimes clashing messages in the design (Babapour Chafi. M, 2021-09-17, personal communication).

Testa agrees that colour has the ability for orientation in an office. It can help to radiate the company brand, so customers know where to go and the employees get a feeling of hominess, comfort, and security. Further on, Marco Testa gave an example of the studies made in the 50th of behaviour connected to colours. For example, a fast-food company chose red as an interior colour to hurry up the stay or instead in a hospital where more natural and calming colours are usually used (Testa. M, 2021-08-24, personal communication).

5.8 Sensory

Ahlqvist refer to research of air having a significant impact on our office environment. The room needs to have a good temperature. Research also stated that air pressure can affect our concentration, which affects us more than people previously wanted to know or have thought. Also known is that multimodal sensory stimulation is essential for the brain, and it means that scents and tastes will affect our memory and the ability to concentrate. Because if one looks at how the brain is designed, it is designed to be in dynamic environments, an outdoor environment. The terraces at MIMO will probably be shaped according to what the brain needs. The brain needs to have sound, light, colour, shape. However, the outside environment and nature are best for this; people are used to dynamic environments where a lot is happening (Ahlqvist. U, 2021-09-16, personal communication).

Testa mentioned that, for example, ESS groups hotels have specific scents for all their rooms. The hotel industry uses many scents, smells that remind of youth, natural scents like flowers or the gym smells, leather, and like a boxing ring, for an extra sensory experience (Testa. M, 2021-08-24, personal communication).

Ahlqvist has come across research about testing of scent impulses. Hence, people know that different scents, such as citrus, give a feeling of happiness, and rosemary strengthens the ability to concentrate. The researchers have even tried to operate on scent implants under the skin of children who have reading and writing difficulties, i.e., learning problems. While the children are studying, they should have a direct sensory experience by the scent, which helps them focus (Ahlqvist. U, 2021-09-16, personal communication).

The scent is essential due to human receiving associations. Researchers claim not to underestimate the power of fragrance chemistry because scent receptors are incredibly well connected to the brain's memory centres. Scents are the sense humans have the easiest to shape memories around. Usually, humans can directly associate a place, an event with only scents or flavours. It is designed for humans to remember where we found food back in the day. Humans have evolved to remember smells and tastes (Ahlqvist. U, 2021-09-16, personal communication).

What is problematic is to have such scents, as essential oils, can be allergenic. There are no procedures on how to implement accents in, i.e., offices. Depending on the environment, sometimes people may want peace, but then people are not particularly alert. There might not be sync between people in the office. However, the research tells that scents matter. Then the sound is a relevant question as well. Isabelle Sjövall claims that we receive more recovery from hearing five or more species of birdsong. Ahlqvist also spoke about having birdsong in a staircase to tickle the sensory experience (Ahlqvist. U, 2021-09-16, personal communication).

There is much technology to use in a building. There are sensors, like intelligent technology, where one tries to optimise locally. For instance, there should be many sensors in this workstation that remember the preferences for sound and temperature. There are many future upcoming concepts.

Like when employees check in with their blip, the workplace adjusts to the wanted preferences. There are existing concepts where people check-in and the table remember the height one has installed, and the screen will be set to the proper selection. Some technologies deal with both physical ergonomics and indoor environmental qualities (Babapour Chafi. M, 2021-09-17, personal communication).

5.9 Light

Sjövall refers to daylight as crucial and good for the human inner clock. The human suprachiasmatic nucleus affects the circadian rhythm and controls the cortisol response, which keeps humans awake and alert when needed, sleepy when it is time to go to bed. The daylight does good for both concentration and helps people recover faster (Sjövall. I, 2021-09-22, personal communication).

Ahlqvist considers the area of indoor lighting to develop and improve. There is much potential for improvement in this area. There is a big difference if the office building works with dynamic lighting with much daylight in the middle of the day and not too many yellow lights. People are more alert by the slightly colder blue light; it is more reminiscent of sunlight (Ahlqvist. U, 2021-09-16, personal communication).

5.10 Recovery

Ahlqvist claims that she has been involved in discussions about recovery in all office contexts, but the organisations do not know the whole meaning. It has not been completely implemented by working methods or in the physical environment. If there is a vision of recovery in the workplace one has to identify how it will be fulfilled. Similarly, to recovery is the meaning of stress, and has not identified what the word means, but there are states of mind involved. There is no common language for the meaning of recovery. It is something Ahlqvist's company, Hjärnberikad, has noticed that everyone wants. Hjärnberikad collaborates with Katarina Gospic, a well-known Swedish neuroscientist. Gospic has designed VR products for recovery, where people receive help with recovery. It was initially developed for a hospital- and care environment to speed up rehab. However, the VR technique is also tested in office environments and investigating whether this can be an alternative for a quick recovery during the working day. So far, it has had positive effects. The research is still in an initiating, small state to draw any significant conclusions at the moment. There are different recovery programs in VR to choose from depending on what to achieve; there are such quiet environments and many natural environments (Ahlqvist. U, 2021-09-16, personal communication).

It is listed that seven different types of recovery will then interact with each other. Either people need physical recovery, after sitting still all day; people need to move as recovery. If people have been moving all day, they need to sit or rest. All these concepts are in every direction. If people have many social contexts, they may need to be alone; recovery can be either way. Creative recovery is also such that people do not think about either; it can be enjoyable to be creative. What Ahlqvist also finds interesting is that repetition is part of recovery. Doing tasks people already possess, doing things one is good at, is less cognitively stressful. When the brain has difficulty keeping focus, then it is better to do repetitive tasks. Necessary for the brain is to let thoughts go away and change focus. If people move to another environment but still think the same thoughts, it is not recovery. Nevertheless, moving the thoughts to a different focus is essential, to develop different ideas (Ahlqvist. U, 2021-09-16, personal communication).

Ahlqvist considers recovery at the office is in need to develop a common language and a shared culture around a healthy work environment. Find a foundation and put the meaning of recovery into words, what a healthy work environment means to the organisation and how to work by it. Because if the organisation has not done that work, it does not matter what a pleasant environment they have, because then it will not harmonise. Especially when implementing an activity-based office. It is no idea if people have not done the preparatory work of educating the staff to know how to use the environment (Ahlqvist. U, 2021-09-16, personal communication).

Maral Babapour Chafi refers to the digital technology where people try to encourage or nudge to remember mindfulness and train to remember things. It is also a lot about our cognition and the importance of having cognitively demanding tasks or physically demanding jobs; then, it requires variation. Both the brain and physical body like variation, by that Babapour, means intensity in the task. Think of a muscle in how much weight it can carry and the length of exposure both cognitively and physically. The body and the brain like variety, and it is also good with repetition; that is when people learn. Recovery is important. There are many stimuli in, for example, an office, email or people. One must understand the task and what is the limit of the brain. What makes the brain and the body happy is the basic human needs, sleeping well, and eating. Neuroscientists have written research on the area, but then designers must try to understand how to interpret them in design practice. Then an office can enable a siesta during the day because it is good for the brain to take a power nap. Babapour Chafi considers there to be a lot of good research and theories and try to implement the theory while designing (Babapour Chafi. M, 2021-09-17, personal communication).

5.11 Motion & Activity

Ulrika Ahlqvist received the question about what in offices are recurring but should change. Ahlqvist considers that people do not even question whether everyone should sit still as much as they do every day. Ahlqvist considers the best alternative is thirty-minute breaks to sit still and the rest of the day in motion. It would have been beneficial to program the environment to support activity that does not mean to sit all the time. Nowadays, the offices are furnished for sitting still. The offices that have taken advantage of this make sure to have bare walking trails or suitable outdoor environments or desks that can raise and lower and ensure that this is used (Ahlqvist. U, 2021-09-16, personal communication).

5.12 Organisational

When talking about well-being and recovery, the management team, managers have to take the lead and say that this is okay, and they have to use the theories themselves; the leaders are the ones who have to go first and set a good example. The employees do not dare if there is not an okay work culture around these topics. Ahlqvist has noticed that it does not help to put massage chairs, create a resting room, or get other products if there is a lack of culture to support it. Then it is engaging with organisations who are at the forefront; they have everything to contribute to well-being and recovery in their offices. Then the tools are still not used in an intended way (Ahlqvist. U, 2021-09-16, personal communication).

Babapour Chafi has completed numerous evaluations of offices; the organisation development of the physical environment depends on companies and what they value. From the human factors design perspective then an environment should be built to promote health and well-being, and performance in the human design perspective. Moreover, from a classic perspective, Babapour Chafi usually says that the modern work environment perspective must also contribute to ecological

sustainability and not just to the person and the organisation's presentation because it cannot work in the long run. Suppose organisations do not think about the office environment. It is also an aspect essential to highlight; as a tradition, organisations have not talked about the work environment field, but in the design experience perspective, there is considerable discussions about ecologically sustainable development. It is something Babapour Chafi is promoting. It is essential to look at different factors, like what resources it is and knowing what people are using and what is affecting people in what way (Babapour Chafi. M, 2021-09-17, personal communication).

5.13 Terrace

Three interviewees had the opportunity to provide suggestions on the design of the terrace. Sjövall considers it important with rules, and the managers must show that it is okay. People do not go out and sit down to have coffee on the spot; it is instead something secondary. It is essential to show that this is how the organisation works. The terrace, have highlights, for example, the access to daylight, which is extra important in our part of the world with restrictions during large parts of the year. Access to daylight does good for both concentration and helps people recover faster. There is nothing that beats natural daylight, and it is something people need during the bright hours of the day. It is appropriate for the human inner clock, suprachiasmatic nucleus and circadian rhythm and the cortisol response. Go out in the middle of the day and not sit directly in the sun, in case people get sun-burned.

The biophilic design and preferably with as many different species as possible, a species richness, for there to be diversity. Research have found that the more species, means greater restorative effects. It is important that the environment do not feel too messy, because the brain finds it difficult to keep track. Nevertheless, it seems to be developed into our brains that a bit of mess is better when it comes to nature and plants. The same effect goes for many species of chirping birds; the more species that sing, the greater the retroactive effect. Even if it is only green plants, many different species are positive. Also, to bring in ferns that are the perfect example of nature's fractals that give the brain the perfect dose of stimulation and recovery. When it comes to noise, people do not want too many stimuli when it comes to sound. However, people talk about masking sounds. Covering up the bad noise with a positive sound Noise is not good, especially not traffic, and what to do is clean up from the noise and use some absorbents outdoors and then add some nice sound. The noise may disrupt concentration and can increase the risk of a heart attack. Try to make the terrace as functional as possible. For people to sit out there and use it as another room (Sjövall. I, 2021-09-22, personal communication).

Babapour Chafi considers the terrace a perfect opportunity to walk and talk; it is a great thing. Babapour Chafi thinks it is good to expand it and that the type of meeting might limit the walk and talk if people, for example, need to take notes. Instead, people may go out to have coffee, which might require some protection where people can sit and lookout. Also, to be able to work and to have furniture set up to put the computer. There should be good internet coverage, charging options, either a power bank that people can borrow and take in their pocket or power outlets somewhere. Further on to have the possibility to sit next to each other and work. Or to have some form of outdoor training, outdoor gym, it does not have to be a gym but different opportunities to be physically active. It is good that there are a few different types of movements that people may be able to stand on something for balance and something to hang on to close by, considering injuries and insurance (Babapour Chafi. M, 2021-09-17, personal communication).

People do not like to be exposed; it is good to have some trellis where people are a bit like in "British mazes," labyrinths, where people walk in and are a bit private. Refuge and prospect to get

protection and to be able to see. Babapour Chafi was part of a project that was about sitting in public spaces. The project had many glass cubes, like bus shelters, which would make it a little calmer when people sat in the cubes. Bus cubes sheds or mazes may also be used as a workshop surface to put post-it notes. However, it is also protected from different weather (Babapour Chafi. M, 2021-09-17, personal communication).

There are places on Chalmers, Babapour Chafi explains, that they have cucumber plants to grow together. It does not have to be advanced cultivation, but more straightforward variety as people can look at the development. Maybe pick for the salad, but it depends on how big the office is. Humans are visual and tactile; to grasp things and to experience things in slightly different ways, as different materials are essential. It is such a simple thing that may be fixed in an office, Chalmers has no terrace, but they just put some pots and planted cucumbers there (Babapour Chafi. M, 2021-09-17, personal communication).

According to Ahlqvist, having plants and seeing different colours and shapes, preferably also changing the seasons, is good. Humans like nature. The environment may change after the seasons; it is enjoyable, making the room dynamic and exciting. However, to somehow sit out on the terrace in the form of a greenhouse, to get this outdoor feeling, even later in the fall (Ahlqvist. U, 2021-09-16, personal communication).

Ahlqvist considers the walk and talk loop to be a great idea. When working with children and young people, it is positive to stay in hilly terrain. Because when people work with balance, it affects their ability to concentrate. The balance is something that adults do not train as much. Ahlqvist would probably try to implement some form of balance for people to have a balance path during the walk and talk, because humans need to train for the rest of their lives. Balance walking or some form of encouragement to work out is preferable. There is much research on when humans start to lose their sense of balance; it is primarily related to concentrating. It is essential to develop the movement pattern and balance. Research has shown that it can counteract dementia and Alzheimer's because when people do not develop their motor skills anymore, their brains cannot keep going. The balance part does not have to be an obstacle to the loop, and it does not have to be a sweaty activity. It may just be to stand on one leg or engage the body differently as usual. Nevertheless, there may be something a little different, only at some point during the transfer of the walk and talk. It is also good if the path goes up and down. Ahlqvist had probably tried to add balance elements even though not everyone would use them (Ahlqvist. U, 2021-09-16, personal communication).

6 Design Review

This chapter aims to analyse and review the case from NCC Property Development. Investigate if the architectural design of the office building MIMO's Terraces has adapted to neuro-design. Moreover, to motivate the terrace to well-being concept of the building. Using the result of the thesis, the analysis tool; SWOT and the eight dimensions from the research made by The Swedish University of Agricultural Science as a foundation, the review will result in recommendations and guidelines for the terraces and future property development projects.

6.1 Analysis

A SWOT-model made by the author initiates the analysis for the three terraces of MIMO, based on the potential strengths, weaknesses, opportunities and threats. The aim is to make the terraces a part of the well-being concept, and it should be easy to make the right choices. By optimising the terrace with neuro-design as a tool, contributing to the beneficial human aspects as physical exercise, recovery, serene, well-being, focus, community and more values for the employees, tenants and organisations. The SWOT-analysis states possible aspects important to consider when reviewing the project.

SWOT-Analysis	
Strengths More value for the tenants Access to daylight View / prospect Walk and talk View at nature and forest	Weaknesses Close to a car road- Acoustic and Air Limited sunlight Sweden, due to the weather Height
Opportunities Address neuro-design and MåBraKontor Well-being for users A place to relax, hang out, eat lunch Focus point from inside	Threats Not being used- organisational habits Weather (wind, sunlight, rain, snow..) Smoking Sunlight for screens Open space

Table 6: SWOT analysis made by the author to map the strengths and weaknesses of the terraces.

6.1.1 Reference project

A reference project is portrayed as guidance and visualisation of a similar space, along the same car road, and scenery at a like worthy position. Notes from the inventory:

- The views are fantastic; there are prospects towards the inner city of Gothenburg (north) and Mölndal (south) and nature (west and east).
- Acoustics from the road is a stressor.
- The large areas of the wooden floor made it difficult for the eyes to focus and difficult to relax.
- There were limited power outlets too, for example, charging the computers.
- When visited in October, no one used the terrace; there was no refuge, cover to sit under, a weather-protected area.
- There was an outside gym, which was not too inspiring. Also, preferable to have some roof/shelter/wind protection, to be able to access it even in fall/winter/spring.
- Socially, it looks nice with the pergola and is a great space for eating, socialising when the weather allows.

- Lack of natural elements. The grass may be pretty; however, more would be preferable to make the terrace more dynamic with the seasons and create the feeling of hominess and amusement to follow the natural elements through the seasons.
- The terrace went around the building. There was also a space on the other side from the pictures taken, which were unfurnished.



Image 15: The main area, furnished by tables and chairs, a pergola, and plantings of grass for room dividers (authors images).



Image 16: Prospect towards south, north and west ((authors images).



Image 17: Design features of the terrace, gym, pergola and seating with light and power outlet (authors images).

6.2 Recommendations & Guidelines

This chapter aims to review the architectural plans and motivates and give recommendation where to be improved.

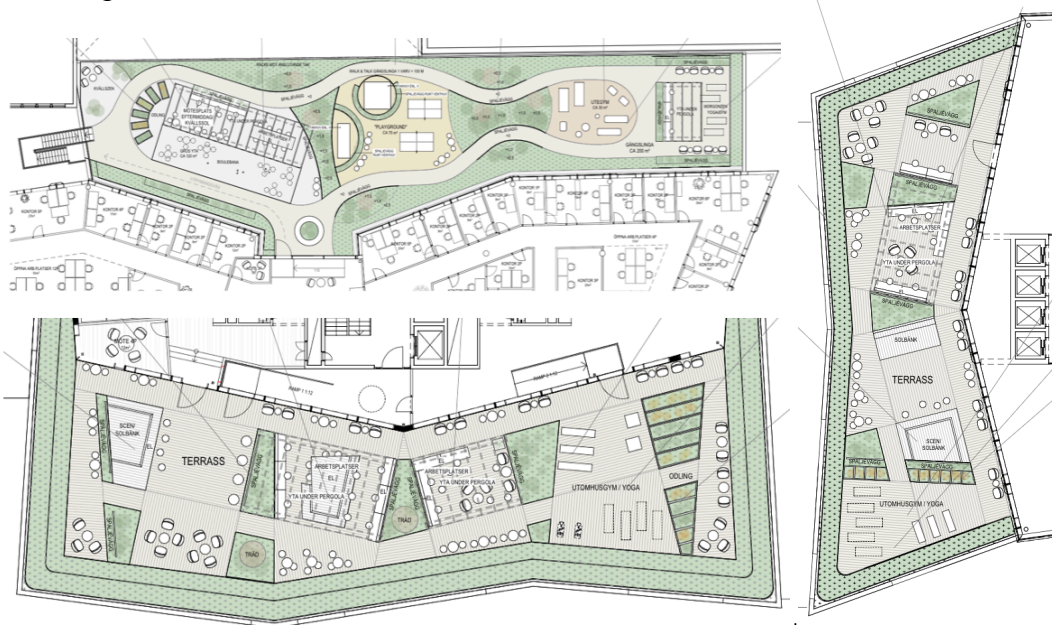


Image 18: The architectural designs for level 4, 11 & 17.

Serene

The terraces are a place where everyone should be able to access and have a serene experience. It should be an excellent place to take a break and focus on recovery.

A recommendation is to divide the terraces into different areas to enable the serene of the space. To be able to hide away and, for example, focus or recover. It can be by shelter from wind, rain or distancing from people and impressions. It can be smart having the serene places at the ends of the terraces to avoid too many people walking by when trying to have a serene moment.

A possible stressor is the acoustics and needs to be investigated for a serene space. The terraces are located behind the main building concerning the roads, and however, the noise will reach the terraces. The acoustics can be improved by having higher glass to block the noise or glass hubs, but not hinder the feeling of being outside and enjoying a quieter environment and the view. Also, to work with softer material which will stop the noise from reflecting and create an unpleasant place to be. It can be absorbents such as vegetations, moss or using softer ground materials. At least make one spot locally quiet by focusing the absorbent to the area.

Similarly, how rich in species appeals to us in flowers and are restorative, does the rich in species appeal to us in how many birds are singing. Apply a natural sound to the area, such as bird noise. Or a fountain and water stream to cover up the sound from the road.

Space

The space is infinite towards the sky but limited to the ground area of the terrace. A large pro for the terrace, is the contribution to easily getting access to outdoor air and exposure to daylight. The exposure to daylight; it is crucial for well-being. Since living in a country where it is dark. Suppose the building user uses the terraces daily to receive some daylight. They will be able to affect their cardiac rhythm, and it may help improve sleep.

A stressor could be height. Therefore, it is wise to plan for spaciousness to make it more hominess and accessible. It is good with the pergolas on levels 4, 11 & 17 and to divide the space into different sections. Further on, it is thoughtful of the architectural design to plan for ground plants between the wooden floor and the glass fences. To avoid the experience, fear of height and looking down on the ground over the fences. Even innovative to be able to have glass fences with an extra barrier to feel safe.



Nature

MIMO has beautiful views of the city and prospects of nature. The terraces will be an excellent place to recover and have a focus on nature. The architectural design involves different natural materials. Such as ground cover, ivy on the trellis walls (level 4), plantings beneficial for recovery, refuge, wind protection, and the feeling of "hominess". To boost the biophilia which originates within humans.

Different materials intrigue the brain. the planned materials for the ground are kebony deck, rubber asphalt, single, dry meadow, ivy (shade resistant) as vertical greenery, perennials sun-resistant climbing plants. Then the natural material gives depth to the terraces by applying different plants with different colours, textures, smells, and feelings, even sounds from wind catching on. It gives a sensory experience and something to be attractive for humans. Scent-jasmine/lavender/rosemary; as Ahlqvist told could rosemary enhance the sensory experience and help to concentrate. visual- autumn lilac, ivy. Tactile- lambs ear, different ground materials.

Good to have the cultivate-boxes, on levels 4, 11 & 17, to grow something and the positive effect of the "IKEA-effect". It might need to be asked to the organisation if this is wanted. Otherwise, the plantation should stay but replace by other plants with less management. Check if the restaurant in the building is interested in managing and applying to the sustainability focus of the building. It does not have to be advanced. It can be an "after work" activity where everyone gets to plant a sunflower and even have a competition of who receives the tallest one at the end of the season.

Rich in species

Diversity among plants acts restorative. Even if it is just green plants, a variation is beneficial. Fern is a species human are appealed by and would fit nicely into the well-being proposition because of the golden ratio found in its' shape and restorative effects on humans.

When it comes to plants, it can be a bit messy for the environment to be more attractive. The recommendation is to collaborate with the dynamics of nature and having plants to follow the seasons can intrigue humans. Trellis with ivy is good because they are evergreen (level 4). To find a suitable collection of plants that blooms in different seasons. It is an excitement in seeing the seasons change in nature. The element of surprise and change is important to develop the mind.

Even having the possibility of experience different animals is beneficial, insect hotels, butterfly bush, and birdhouses to attract species to the terraces. It can be a great attraction from inside and outside.



Refuge

The terrace will work as a perfect refuge. It should be thought of as a part of the activity-based office and contribute to the activities that are difficult to receive in the office—recovery, changing from an office environment to rest the mind and change thoughts. Outdoor environments can be a health-promoting zone used for both recovery and other activities during the working day. Trellis with climbing plants for spaciousness and wind protection (level 11 & 17)

The walk and talk at level 4 are great for boosting well-being at work and fits nicely into the feel-good proposition. Essential to work with the surroundings to make the loop interesting, by different plants, artwork, topography. Moreover, it could be beneficial to work with other ground material or have a side path with some balance features to make it even more active.



‘The outdoor gym’, ‘rubber asphalt or equivalent as a soft surface for exercise and training’ and ‘a place for yoga and meditation’ on levels 4, 11 & 17. These are good to encourage for exercise but limited to the weather conditions. The recommendation is to make them more accessible year-round by having roofing. It can be a bit colder when working out but having shelter from rain or sun is preferred.

Comfort and somewhere to sit protected from the weather. Pergolas at levels 4, 11 & 17 are exemplary and create spaciousness. It is important to consider having seats where the users feel comfortable, with the back against a wall or being protected by a roof. The recommendation is to make them, even more, weather protected and more accessible by having heat lamps or local underfloor heating to keep them comfortable all year around. Imagine having meeting rooms on levels 11 and 17 outside to impress customers, possible employees with the view and unique scenery. Also, to motivate the well-being concept on nature, daylight and scenery bringing many benefits for humans. Or Platslows top of the pyramid, be at the place where it happens.



Culture

The culture of the building will be well-being. In that sense, it is positive to give the terraces a bit of work to encourage the office users to go out. Level 4 focuses on activity and physical exercise, while levels 11 & 17 focus on social meetings and daylight. Which fits great into the office buildings' well-being concept, concerning social bonding, releasing oxytocin, activity for endorphin.

The new value of the terrace may make it more used in the beginning. When the novelty has worn out the goal is to involve the terrace in everyday work for health benefits. There should be an allowing organisation and consider it as a part of the activity-based office.

It should be easy to make the right choices and address the well-being concept. Ten good habits for the brain is it possible to perform at the terrace in combo with the office. To make it easy, nudging and priming might be something to consider. For the walk and talk to start by lines indoors on the different levels and guide to the outdoor loop. Arrows pointing on “good choices due to well-being” and encouraging to, for example, take a break, eat, exercise, go outside. Or educating text what happens to the human body when seeing nature. The priming and nudging can even be having the ten good habits on the wall as a poster to bring awareness to well-being of the brain.



A place for innovation is something to consider as well. When working outside, the ability to charge the computer or have a big screen would be beneficial. Make the possibility to work and have meetings outside available. Using techniques such as solar power to provide for the electrical gadgets or some power bank options or making sure of sustainable and renewable energy from wind power also works as a statement and artwork. Moreover, a bike/cross-trainer which benefits both physical exercise and paddles for electricity. Or also consider using recycled materials, to promote an ecology sustainable culture.

Prospect

The terrace is an excellent opportunity for prospect coming up from the ground and receiving an overview of the surroundings. The challenge is to create this space on the area of the terrace, find vistas where people can feel safe but still have an overview of the surroundings.

It is good to work with curvature, charming on the walk and talk level, but the round design can improve on the 11 and 17. The round shapes are more restorative for the brain and finds it more appealing and arousing.

The prospect from the reference project to be aware of, the wooden kebono floor have long stripes carved in the wood which on long areas may make the eyes a bit dizzy and having trouble to relax.

The terraces will bring a focus to rest the eye upon when inside as well. Having the features planned by the natural greenery, possible birds, and butterflies brings interest and stimuli to glance at for a moment. Even recycling and using the rainwater for art features that appeals to the human appreciation for aesthetics. Dynamic and surprising. It should be wise to work with lights for prospects in the darkness, for it will not get all black outside the window and have contrasts.



Social

The architectural design has suitable spaces for sitting down together, eating and socialising. The boule, on level 4, is a smart feature, it is something to gather around and activity to perform together. The bonding hormone oxytocin is released. To consider is by the areas to have meetings- which tools do people need. Workplaces with electricity (level 11 & 17).

Sun bench/seating area can be used as a stage (level 11 & 17) suitable for creating spaces to hang out. Also good with and second use of a stage, which the organisation can use when having office events.

It is essential to make the terrace coherent and understandable. It is an area with a more Livingroom-like feeling when socialising, stricter and refuge when working and quiet when recovering.



7 Conclusion

The thesis has described an aim and method, followed by a literature study and interview study about the office situation, human perspective on well-being, neuroscience, and neuro-design. Which is the foundation for a design review regarding the terraces of the office building MIMO. Moreover, a source for recommendations, guidelines and inspiration.

The sources of the thesis have claimed that it is possible to design environments to benefit human well-being by implementing common neuro-design features that humans are appealed to and receive positive stimuli by. It is not only a benefit for the individual to implement elements in the physical environment which will contribute to human health, the organisations will thrive, “people who feel well do well at work”. When having the human perspective in property development and project management, there are a lot of benefits, such as value creation economically, social and organisational. Making people feel comfortable in the office can lead to creativity, performance, efficiency, knowledge exchange, and less sick leave. Ecological, economic and social or human sustainability do interrelate.

It is essential to start thinking about neuro-design within property development and project management, to plan physical environments that support humans and enable activities for well-being. Because earlier experiences and encounters with different environments shape our brains plasticity, imagine spaces making the brain develop and grow without being aware. Alternatively, at least not be exhausted by all the stress stimuli an urban area or offices contains. Would it not be great if humans could receive unconscious health benefits by encountering well-planned and thought out physical environments?

There are many aspects when encountering an environment and focusing on the human perspective. Neuro-design is complex; humans provide many perspectives, such as psychological, physiological, symbols, culture, emotions, sensory and earlier experiences. The field of neuro-design is waiting to be further investigated. It will be interesting to follow the development because more exciting research is to come in neuro-design in property development and urban areas. The thesis aims to be an external trend analysis and inspirational for future property developers and project managers to take into consideration and be responsible when planning the project scope. Remember, the construction industry is building for humans, and therefore should the social or even human sustainability be in focus!

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Further research:

Investigate the possibility with an outdoor office, like a library where everyone is welcome.

Connect with a neuroscientist and do more experiments on a specific case in the physical environment to receive more data.

Research the retail work environment and how neuro-design could enhance the experience of retail employees.

9 Appendix

This chapter contains attached files for further reading.

9.1 Appendix 1



The Ten Concepts of Well v.2	Features
AIR	<ul style="list-style-type: none">• Fundamental Air Quality• Smoke-Free Environment• Ventilation Effectiveness• Construction Pollution Management• Enhanced Air Quality• Enhanced Ventilation• operable windows• air quality monitoring and awareness• pollution infiltration management• combustion minimization• source of separation• air filtration• active VOC control• microbe and mold control
WATER	<ul style="list-style-type: none">• Fundamental Water Quality• Water Contaminants• Legionella Control• Enhanced Water Quality• Water Quality Consistency• Drinking Water Promotion• Moisture Management• Handwashing• β Onsite Non-Potable Water Reuse
NOURISHMENT	<ul style="list-style-type: none">• Fruits and Vegetables• Nutritional Transparency• Redefined Ingredients• Food Advertising• Artificial ingredients• Portion Sizes• Nutrition Education• Mindful Eating• Special Diets• Food Preparation• Responsible Food Sourcing• Food Production• Local Food Environment• β Red and Processed Meats

LIGHT	<ul style="list-style-type: none"> • Light Exposure and Education • Visual Lighting Design • Circadian Lighting Design • Glare Control • Enhances Daylight Access • Visual Balance • Electric Light Quality • Occupant Control of Lighting Environments
MOVEMENT	<ul style="list-style-type: none"> • Active Buildings and Communities • Visual and Physical Ergonomics • Movement Network and Circulation • Active Commuter and Occupant Support • Site Planning and Selection • Physical Activity Opportunities • Active Furnishings • Physical Activity Spaces and Equipment • Exterior Active Design • Enhanced Ergonomics • Physical Activity Promotion • Self-Monitoring
THERMAL COMFORT	<ul style="list-style-type: none"> • Thermal Performance • Enhanced Thermal Performance • Thermal Zoning • Individual Thermal Control • Radiant Thermal Comfort • Thermal Comfort Monitoring • Humidity Control • β Enhanced Operable Windows • β Outdoor Thermal Comfort
SOUND	<ul style="list-style-type: none"> • Sound Mapping • Maximum Noise Levels • Sound Barriers • Sound Absorption • Sound Masking • β Impact Noise Management • β Enhanced Audio Devices • β Hearing Health Conservation
MATERIALS	<ul style="list-style-type: none"> • Fundamental Material Precautions • Hazardous Material Abatement • Exterior Materials and Structures • Waste Management • In-Place Management • Site Remediation • Pesticide Use • Hazardous Material Reduction • Cleaning Products and Protocol • Volatile Compound Reduction • Long-Term Emission Control • Short-Term Emission Control • Enhanced Material Precaution • Material Transparency

	<ul style="list-style-type: none"> • β Contact Reduction
MIND	<ul style="list-style-type: none"> • Mental Health Promotion • Access to Nature • Mental Health Support • Mental Health Education • Stress Support • Restorative Opportunities • Restorative Spaces • Restorative Programming • Enhanced Access to Nature • Focus Support • Sleep Support • Business Travel • Tobacco Prevention and Cessation • Substance Use Education and Services • Opioid Emergency Response Plan
COMMUNITY	<ul style="list-style-type: none"> • Health and Well-Being Awareness • Integrative Design • Occupant Survey • Enhanced Occupant Survey • Health Services and Benefits • Health Promotion • Community Immunity • New Parent Support • New Mother Support • Family Support • Civic Engagement • Organizational Transparency • Accessibility and Universal Design • Bathroom Accommodations • Emergency Preparedness • Community Access and Engagement • β Housing Equity • β Emergency Resilience and Recovery • β Responsible Labour Practices • β Support for Victims of Domestic Violence



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