Plants in a creative office environment
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Abstract:
This paper investigates the design potential of incorporating vegetation in renovation of an existing office building to improve the creativity of creative ‘mobile knowledge workers’. To be able to do this creativity and the creative process of office workers needs to be defined. It is also important to define how the design of a work environment can facilitate creativity and the creative process. The (affective and cognitive) response of people to plants can be used to support creative work processes. The response of workers depends on the degree of sensory stimulation preferred for specific work tasks. Sensory stimulation by the office environment is not just depended upon plants, but also the design of the office and the proximity and activity of other workers. To investigate these topics literature on creativity, the influence of plants on people and the incorporation of vegetation into design will be used, together with case studies of existing flex office space and green workspaces. Finally a work task space quality preference experiment will be used to define how the work environment can facilitate creativity and creative work processes. Creativity is a process with several stages that can expressed in office design in multiple ways: it can be expressed as a statement, it can be facilitated by creating a wide range of work setting that stimulate the senses and by promoting social cohesion. The effect plants have on people can improve this as long as it does not cause overstimulation. The preferred amount of stimulation depends on the creative work task. Natural environments are strongly preferred for relaxing activities and for individual reflecting, brainstorming and evaluating. Natural environments are considered distracting for focused work, formal meetings and administrative work.

Keywords: office, plants, creativity, work task, stimulation

Introduction/background
Currently there is 7,62 million square meters of empty office space in the Netherlands (NVM, 2012). Partly this surplus has been created by overproduction and the other hand it is a result of innovations in information and communication technology (ICT) that have made office work less time and place dependent. There is however a growing group of ‘mobile knowledge workers’ that take advantage of the possibilities of working place and time independent. These ‘mobile knowledge workers’ are highly educated people who have freedom in choosing where they work. This group consists of flexible and independent employees and has been growing in the last six year, while the number of permanent employees has been declining in the last three years (CBS, 2011). Offering them a new kind of work environment in existing vacant office space could make existing office environments more desirable. There are a number of initiatives with different names that offer varied office space with high facilities for varying amounts of time. What they offer is office space that can be rented for just a couple of hours, on a weekly basis or permanently. This results in an office building with many varying tenants, which offers networking possibilities traditional work environment do not. The common factor of these initiatives is that they attract users with high quality facilities found in larger office buildings that individuals and small companies usually cannot afford. They are also located in strategic places, close to highways and public transport. As the number of initiatives keeps growing it becomes more and more important to stand out and offer something new. Improving work performance by stimulating creativity with plants in office design can do that.
Hypothesis

To investigate the design potential of incorporating vegetation in renovation of an existing office building to improve the creativity of creative ‘mobile knowledge workers’, by:

- Defining creativity and the creative process of office workers
- Defining how a work environment can facilitate creativity and creative work processes
- Investigating how the (affective and cognitive) response of people to plants can be used in office design to support creative work processes
- Investigating the potential of vegetation to improve worker creativity through the design of environments that provide sensory stimulation, focused on thermal stimulation through the development of different climates

Methodology

To prove the hypothesis an extensive literature review was used to investigate creativity, current office environments and the influence of plants on people. Case studies of an existing flex office environment (Beliën, 2012b) and a green office environment (Beliën, 2012c) were used to validate the hypotheses. Finally a Space typology questionnaire was used to investigate the preference for natural environments for specific creative work tasks. (Beliën, 2012a) These results can be found in appendices one, two and three.

Data Analysis

Facilitating creativity in the workplace

To be able to facilitate creativity it is important to establish what creativity is. The Oxford dictionary defines creative as: relating to or involving the use of the imagination or original ideas to create something (Oxford, 2005, p. 406). The Dutch dictionary defines creative as: 1. scheppend: stadium van rust tussen voorbereiding en inspiratie in het scheppingsproces; met sterke scheppingsactiviteit 2. (in zwakkere opvatting) betrekking hebbend op of dienend tot de zelfwerkzaamheid op het gebied van verbeelding en vorming (Geerts, den Boon, Geeraerts, Vos, & van der Sij, 1999, p. 662) (creating: stage of rest between preparation and inspiration in the creative process, with strong creative activity 2 (in weaker conception) pertaining to or serving the self-activity in the field of imagination and creation) The Dutch definition defines three stages; preparation, rest and inspiration. Wallas adds one more stage in the creative process:

Wallas (1926 in Kristensen (2004)) recognises four phases in a creative process:
1) preparation (facilitating data and information for the process)
2) incubation (implicit cognitive process, primarily individual)
3) insight (a ‘flash’ that occurs when the winning concept cuts cross the barriers of consciousness)
4) elaboration and evaluation (comparing results to the goals of the preparation stage: are goals and values met?)
(Martens, 2008)

The creative process is not just a moment of insight, but is a process with different stages with different activities. *The whole process includes highly cognitive individual and collaborative tasks.* (Martens, 2008) Taking into account the collaborative social aspect of creative work, G. Mangone defines 17 different work tasks with a clear distinction between group work and individual work. The first stage of preparation is a bit underrepresented in his list of work tasks. Administrative work and listening to lecture are facilitating tasks for creative work, but the act of gathering information and consuming it by reading are missing. The second stage of incubation is very well represented in his work tasks, apparent activities like taking a break and having lunch, but also exercising and informal meetings. Brainstorming is a work tasks that could belong to the second stage, but also to the third stage depended on what time in the process it is used. For instance it can be used to put gathered information into context, but also as a way
to come to new ideas. The third stage of insight is the hardest to assign to a specific work task. Insight can happen at any time at any place. Archimedes got his while taking a bath and Isaac Newton when he saw an apple fall from a tree. The final stage of elaboration and evaluation can be translated into the following work tasks: focus work, reflection, evaluation, formal and informal meetings. With the comment that formal meetings and informal meetings can happen at any time during the process to inform, gather information and further specify the project.

Now creativity is defined as a process with several stages and it is clear how work tasks relate to those, this can be translated into office design. *Facilitating creativity from a creative process and activities perspective could mean different workspaces for different activities, but also one workspace that supports all the entwined activities.* (Martens, 2008) Florida and Worthington (Florida, 2002, Worthington, 2002) describe the features of new workspaces that accommodate creativity:

- **Corporate real estate has to serve a statement and is used as a marketing vehicle.**
- **The workplace has an experimental component:** creative workers like visual stimulations.
- **The new workspace is productive in the sense of being adjusted to the flow of modern creative work.** It provides **diversity:** a wider and richer range of work settings that can support creative and collaborative work.
- **Sharing:** increased amount of shared space, space that is not owned and can be used by different staff over time.

Martens also describes creativity facilitating workspace, but makes a distinction into three categories:

- **Express creativity to outsiders and its users:** by using colourful materials, unusual furniture and presenting physical representations of the organisations work (models, posters, artefacts). An appearance which reflects the identity of its users can also lead to higher satisfaction and a greater sense of belonging
- **Stimulate the mental process of creativity:** by providing comfort and well being for individual creativity, and spaces for objects and presentations to be inspired by these artefacts and the work of colleagues.
- **Facilitate creativity:** by designing dedicated spaces which support the number of users, the required noise level (enclosed/open) and stimulate the senses (relaxed or triggered and inspired).

Mathissen and Einarsen describe other factors that influence creativity in the work environment that are less related to design:

*Work environment factors that promote creativity are: a feeling of shared, clearly-specified objectives, as well as a possibility to challenge them; exchange of opinions or ideas; constructive controversies; freedom; challenges at work; trust and safety; team participation and collaborative idea flow; and open relationships between colleagues, as well as between supervisor and subordinates. Most of these factors have demonstrated predictive value in relation to creativity and innovation.* (Mathissen & Einarsen, 2004)

In conclusion a task related office design for creative work can be used to:

- **Make a statement:** to express creativity (with unusual design) to others, as a way to express their work towards and to reflect their identity
- **Facilitate creativity:** designing for individual and group work a wide range of work settings (enclosed and open, loud and quiet, private and public) and by stimulating the senses
- **Create social cohesion:** that furthers collaboration, supports open relationships between colleagues, supervisors and subordinates, helps the exchange of ideas and knowledge

**What plants can do for creative work tasks**

To be able to understand what plants can do for creative work task, it is important to first establish how plants impact people. From the model of Bakker (2009) we learn that people react to plants in three ways: a physical/physiological response, an affective response and a cognitive response. In relation to what plants can do for creative work task this paper will focus primarily on the affective and cognitive response, although the introduction of planted areas in the office environment will also have a positive physical/physiological response.
In Maslov’s hierarchy of needs creativity falls under self actualisation, together with morality, spontaneity, problem solving, lack of prejudice and acceptance of facts. According to him (although the needs are interrelated) other more basic needs need to be fulfilled before self actualisation can be achieved. Green can help fulfil these needs and help achieve self actualisation and creativity. It is important to first establish the factors that influence how green is perceived. Perceiving green is a process that depends upon:
- the time of day and the season
- personal characteristics, like age, experiences and interest in green

According to de Jonge (1977) most city dwellers associated green with; free time, relaxation and escaping overload at work or escaping less desirable social contacts. His research found that green objects in the city have secondary connotations: good, happy, strong, interesting, beautiful, quiet, healthy, liberating, variably, cozy/sociable, unconstrained, familiar, relaxed and calming. Natural objects (like dunes, forest and heather) are more strongly associated with these meanings and urban places (streets, squares etc.) are less strongly associated with them. He states that overall city dwellers appreciate green in the urban context as positive, because it: has a calming and relaxing effect, influences their health in a positive way, gives variation, is familiar and beautiful. This appreciation increases when city dwellers get older (more experience with green) and are more educated (a better understanding of the natural environment)(de Jonge, 1977, p. 15). The positive appreciation of green can add to productivity in several ways. Productivity covers a diversity of activities such as routine work and creativity. Creativity tasks and complex knowledge work need inspiration and deepening. Through history many statements of famous philosophers, writers and artists such as Nietzsche or Liszt refer to the inspiring and deepening effect of nature. Our hypothesis is that in case of routine work plants might help to support wellbeing and as such keep people going on, whereas in case of creativity work a positive effect is expected in relation to inspiration and deepening. (Bakker & van der Voordt, 2010, p. 417)

The positive appreciation of green can be used to make a statement, especially when it comes to sustainability, ecology and the importance of well-being of employees related to corporate identity. Twee atria aan de gevel, voorzien van beplanting, zorgen voor voldoende natuurlijke lichtinval en als ontspanningsruimte voor de callcenter medewerkers. Two atriums connected to the facade, with planting, ensure sufficient natural light and a relaxation area for call centre employees. (Architectenbureau Paul de Ruiter, 2011) The new headquarters symbolizes the banking and insurance conglomerate as a dynamic, fast-moving international network. Transparency, innovation, eco-friendliness and openness were the main starting points for the design. (Meyer en Van Schooten & Ibelings, 2003)
Planted areas can help facilitate creative work tasks in several ways: improve the mood of personal, stimulate the senses, improve concentration, improve cognitive manipulation, improve problem solving capacity (Mayer & Frantz, 2004), higher effectiveness, perceived productivity and appreciation of perceived space (Shibata & Suzuki, 2002). Although improvement of concentration and measured productivity is contradictory, some studies show an improvement and others a decrease. The deepening effect of nature is especially helpful during the second stage of the creative process (incubation: implicit cognitive process, primarily individual). Isen and Shalker (1982) found that positive phenomena (like plants) stimulate the brain for recalling more information and they initiate more cognitive manipulation that causes a higher level of creativity. Plants put people in a better mood, this raises their creativity (Isen, 1990, 1993; Knez, 1995) and their perceived productivity increases, whereas the measured productivity decreases and concentration is reduced. (Larsen, Adams, Deal, Kweon, & Tyler, 1998) Another study showed that concentration actually improves after spending one hour in a green space (Ottoson & Grahn, 2005).

The relation between plants and social cohesion is difficult to specify, but the improvement in mood, employee morale (Isen, 1990, 1993) and evoking a positive feeling of alliance are effects of plants that will influence social cohesion in a positive way. An internal study has shown that workers in the Genzyme Center office building have a strong sense of increased concentration, productivity, well-being and community feeling, and at the same time the rate of absenteeism through illness has been reduced by 5%. (Falkenberg, 2011, p. 145) In the Lumen office building employees find the winter gardens especially beneficial for social interaction (short breaks, lunch, informal meetings) and brainstorming (deepening effect), which proves that plants are beneficial to creating social cohesion (Beliën, 2012c).

What plants can do to support the creative process is clear, but to be able to translate that knowledge into design it is important to know the work space typology preference for creative work tasks. The space typology questionnaire of G. Mangone shows the preference for natural space and current office space typology for several creative work tasks (appendix 1 (Beliën, 2012a)).

For taking a break natural spaces are preferred, but for an individual break the cave is chosen and for a break with a group the natural lecture space is preferred. When asked to pick an inside space for taking a break the more informal spaces informal private, informal open and the lounge are chosen.

For having lunch the green natural spaces are also favourite, followed by the café space and the cave. The lounge space that was preferred for taking a break is actually the least favourite for having lunch. For having lunch and taking break, nature offers participants a change of environment, nature makes them feel free and they enjoy the fresh air.

For informal meetings an enclosed natural space (forest space with tables) is preferred. The café, the cellular office, the informal private space and the meadow are also mentioned. So participants prefer private or semi-private spaces but still open. Spaces that are very formal or very public are not preferred.

Similar spaces are chosen for administrative tasks and formal meetings, probably because in both cases privacy is very important. For a formal meeting the conference room, the cellular office and the open floor office are preferred. Depending on the meeting the meadow, the cave and the café are also mentioned. For administrative tasks participants mention that they do not like distractions, while others do not seem to be bothered by other people around or nature. The cellular office is most preferred, followed by the open floor office, the forest space with a table and the meadow.

Brainstorming is a work task that shows very different preferences depending upon if it is a group activity or not. With individual brainstorming there is a strong preference for natural spaces and inside spaces that are open and private. Participants mention that they want to be able to focus and be stimulated by their surroundings. When brainstorming in a group the forest lecture space, the open floor office, the café and the informal open space. These are all open spaces with other people around and that seems to work for brainstorming. Some participants do not like extra stimulation from their surroundings and prefer the cellular office for group brainstorming.

There is a strong similarity for the space preference for group and individual focus work, but the order of preference does differ a bit. For individual focus work the forest space with tables, the cellular office, the conference room and the lab are preferred. All enclosed spaces with little or no distractions. For focus work in a group the lab, the open floor office, the conference and the forest lecture space are preferred. They offer freedom of movement, visual contact and interaction.

Evaluating and reflecting are work tasks that are different, but participants do not think that they are and give the same answers. When evaluating and reflecting with a group the meadow, the informal private,
informal public and the conference room are preferred. For individual reflecting and evaluating the café, the forest space with table, the forest lecture space, the informal private space and the forest park space are preferred.

For listening to a lecture or presentation the lecture hall is most preferred and then the forest lecture space. The trees in the forest lecture space gives order and focus. One participant feels that nature improve perception of the lecture. For exercising the park is most popular place to exercise, then the meadow and the forest lecture space. One participant found the steps in the forest lecture space a nice challenge. Nature makes them feel free, they like an open environment. The gym is not popular. For exercising it needs to be mentioned that the results might not be valid. Participants associate natural spaces with other forms of exercise then they do the gym and this heavily influences the results.

The preference for natural environments for creative work tasks is very dependent on the participant. However a strong preference for natural spaces is evident for taking a break, having lunch, individual evaluating, individual reflecting and individual brainstorming. For focused work, administrative tasks and formal meetings similar spaces are chosen that are enclosed and offer less stimulation. Natural spaces are not a preference for focused work, administrative tasks and formal meetings, because participants find them too distracting. If the natural space is more enclosed (meadow) or has a focal point (forest-lecture), participants do prefer it for focused, administrative tasks and formal meetings. Open natural and office environments are preferred for brainstorming, reflecting and evaluating in a group, although the cellular office and conference room are sometimes considered for occasions that require more privacy. For informal meetings participants prefer open private or semi-private spaces. Formal space or public spaces or not preferred.

Improving creativity by providing sensory stimulation with plants

Incorporating plants and planted areas into office design in a way that improves creativity, means that plants have to used to stimulate the senses of the ‘mobile knowledge worker’. Plants can stimulate all five senses: sight, hearing, taste, smell and touch. For the design one sense will be chosen to focus on. Sight is automatically stimulated, but hearing, taste, smell and touch are more difficult to stimulate. Taste and smell can be stimulated depending on the type of plants that is used and the season, while a plant can only be heard if the plant moves (usually by an air current). This makes hearing a sense that is difficult to stimulate with plants. Taste and smell can be stimulated by design, but require an active involvement of people in the office and this is not easily controlled in design. Stimulating touch in design can be achieved taking into account the complicated nature of the senses. Touch can register pressure, temperature, humidity and air currents. Plants also respond to temperature and humidity. Plants are indexed by the climatic region they are originally from. Introducing them into a building, means simulating the climate they are originally from. Simulating a climate that is comfortable for a curtain plants has the additional benefit of stimulating touch.

Apart from the inside office climate and the outside Dutch climate, there are more climates that are becoming more common in offices (Beliën, 2012d). This paper will use the distinction that is made by Falkenberg (2011) into four climates:

- **Hot** (room-temperature location – temperature 20-24°C, year round)
- **Temperate** (moderately warm location – winter temperature 10-17°C)
- **Cool** (non-heated green house – winter temperature 0-10°C, frost free)
- **Cold** (non-heated green house – winter temperature 0°C, light frost of up to -5°C)
- **Outside** (on average between -5°C and 30°C)

Most office environments have a temperature that fluctuates between 20°C and 24°C all year round, while plants outside are subjected to the seasons. Some tropical and subtropical plants don’t mind this hot climate where insulation, heating and cooling creates an almost constant temperature. They are known as houseplants and a common feature in most homes. This climate is simulated in the oasis garden of the ministry of finance in The Hague, the ING office building and the UPC office building. See appendix 6 (Beliën, 2012d)

In parts of the office building that are protected from the elements to some degree but still warmed by the surrounding building a temperate climate can serve as a thermal buffer and be an ideal place for Mediterranean plants. During the cold winter the temperature doesn’t drop below 8°C, with an average between 10°C and 17°C. A good alternative for relaxation during the cold winter, it has additional energy saving possibilities.
which make it a sustainable solution. This climate is simulated in the interior gardens of the Lumen office building. See appendix 6 (Beliën, 2012d)

There is also the option of not heating the planted area and keeping it thermally separated from the rest of the building. Large glass surfaces (usually single) let the sun warm the space, but in winter the temperature can drop quite low. Depending on the orientation and materialisation of the green house, an average winter temperature between 0° C. and 10° C. without frost or an average winter temperature of 0° C. with light frost, can be achieved. The olive tree winter garden of the ministry of finance in The Hague has this temperature.

Then there is also the outside Dutch climate with cool summers and mild winters. The Dutch moderate sea climate means plenty of rain, a moderate amount of sunny days and strong winds.

The problem of using plants inside buildings is the reduced amount of natural daylight. On a summer day the illuminance can be between 20 000 lx and 100 000 lx, while average room lighting is around 800 lx (Falkenberg, 2011, p. 209). This difference can be made up by using artificial lighting, taking into account that plants prefer a different spectrum then people. Large amount of glass can also help, as long as glare does not interfere with work, but there is always a loss due to reflection and absorption (Falkenberg, 2011, p. 186). This loss varies between g-values of 0,18 and 0,85 depending on the type of glazing (Falkenberg, 2011, p. 184).

Humidity in office building is generally lower than outside, because of computer, printers and in some cases air-conditioning. When the relative humidity becomes too low stomata in the leaves of plants close (stomata are tiny openings in the leaves of plants that take in oxygen and let out carbon dioxide). Plants raise the relative humidity in a space and people find higher humidity pleasant (Falkenberg, 2011, p. 146). Another additional benefit is that more dust is laid.

Plants need to be maintained on a daily and a seasonal basis. Watering plants and supplying them with additional nutrients can be done by staff or an automated system. Pest control and pruning plants has to be done on an as needed or seasonal basis. When pests occur in an indoor environments, they spread with more ease (higher temperature and lower humidity), but most conventional toxic pesticides cannot be used inside. Ecologic pesticides are often toxic for people, but biological pest control is a good alternative. Taking this into account seasonal maintenance when designing natural spaces in buildings can save additional cost for scaffolding, especially since dust need to be removed as well. When plants are outside wind and rain stops dust from accumulating, indoors leaves need to be washed to make sure it does not reduces a plants photosynthesis performance (Falkenberg, 2011, p. 200). The maintenance of the structure around the plants also needs to be taking into account. In the Lumen office building all cleaning is done with natural cleaning products that do not harm the plants.

Conclusion

Creativity is a process with several stages that can expressed in office design in multiple ways: it can be expressed as a statement, it can be facilitated by creating a wide range of work setting that stimulate the senses and by promoting social cohesion. Plants can be used to make this statement and can stimulate creativity by evoking positive feelings, well-being and deepening effect. Plants also have a positive effect on social cohesion, although the relation is more difficult to define. Incorporating plants into office design can only be done after establishing for which work tasks natural environment and/or current office space typology is preferred. Natural environments are strongly preferred for social activities, like taking a break and having lunch. They are also strongly preferred for individual reflecting, brainstorming and evaluating and this probably has to do with the deepening effect of nature. Natural environments can also be considered distracting, that is why natural environments are not chosen for focused work, formal meeting and administrative work. Although there is a strong preference or dislike for natural environments for curtain work tasks, in the end it is very much depends on the participant. Specifically the participants ability to isolate himself from his/hers surroundings and amount of stimulation he/she favours.

When designing planted areas in an office building it is important to approach this from a climatic perspective, to make sure plants and people are comfortable. When done correctly it can provide sensory stimulation that improves creativity. Next to climates, light, humidity and maintenance need to be take into consideration when designing interior planted areas.
Appendix 1: Space typology questionnaire

During the last couple months Giancarlo Mangone has been my teacher and helping him with his research has given me useful input for my design. The space typology questionnaire I will discuss in this chapter took up most of our time. Unfortunately right now the results have not been calculated, but I hope soon they will be more exact.

1.1 Description of first interview

First part of the interview

Introduction:
Please take one minute to arrange all the space from most to least preferred space (in general). This first question is used to get accustomed to all the cards.

Short explanation:
For each question, please take at most 30 seconds to select the four spaces you would most prefer to perform the activity, and the four spaces you would least prefer to perform the activity. At least three not nature spaces for each activity (not counting gym for worst), if nature is not picked ask for it.
For making your decision, all spaces are equally close to where you are currently sitting in the office, all have equal access to bathrooms, internet, electricity connections, coffee machine, printers, secretary, and other support services.
For all the spaces, including the nature spaces, both forests and cave, it can be assumed that it is summertime, the weather is comfortable, and the spaces are protected from rain, snow, etc. The nature spaces have internet, electricity connections, and access to all tools.
For all activities, the nature spaces, both forests and the cave, can have any furniture from any of the office spaces. If you would prefer specific furniture in the nature spaces for a task, please tell me when you make your selections.
Please think out loud when making your decisions.

For activities 1 to 15 participants can choose from cards A to O.
For activity 16 (listen to lecture) participants can choose from all the nature space (E, F, H, K and L), D, N and new card P. The difference between them has to be explained. The windows can be confused as art.
For activity 17 (exercise) participants can choose from the nature spaces and the gym.

<table>
<thead>
<tr>
<th>Card</th>
<th>Name</th>
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<th>Name</th>
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<tbody>
<tr>
<td>A</td>
<td>cellular office</td>
<td>I</td>
<td>open floor office</td>
</tr>
<tr>
<td>B</td>
<td>lounge</td>
<td>J</td>
<td>lab</td>
</tr>
<tr>
<td>C</td>
<td>informal - private</td>
<td>K</td>
<td>forest - lecture</td>
</tr>
<tr>
<td>D</td>
<td>café / cafeteria</td>
<td>L</td>
<td>forest - park</td>
</tr>
<tr>
<td>E</td>
<td>meadow</td>
<td>M</td>
<td>conference room</td>
</tr>
<tr>
<td>F</td>
<td>forest - tables</td>
<td>N</td>
<td>lecture - hall</td>
</tr>
<tr>
<td>G</td>
<td>informal open</td>
<td>O</td>
<td>gym</td>
</tr>
<tr>
<td>H</td>
<td>cave</td>
<td>P</td>
<td>lecture - window</td>
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**work task** | **description given during interview**
---|---
1 | administrative work | writing e-mails, scheduling meetings
2 | break individual | incubate: short break on your own ‘koffiepauze’
3 | break group | incubate: short break with a group (3 to 7 people)
4 | brainstorm group | ideate: exchanging and generating new ideas (3 to 7 people)
5 | brainstorm individual | ideate: coming up with new ideas, setting up research/design/etc. on your own
6 | focus work individual | design + analysis: concentrated work on your own
7 | focus work group | design + analysis: concentrated work in a group (3 to 7 people)
8 | reflect group | reflect: thinking about decisions and ideas, not valuing/judging in a group (3 to 7 people)
9 | evaluate group | evaluate: evaluating decisions and ideas, giving value, making decisions in a group
10 | reflect individual | reflect: thinking about decisions and ideas, not valuing/judging on your own
11 | evaluate individual | evaluate: evaluating decisions and ideas, giving value, making decisions on your own
12 | informal meetings | with colleagues
13 | formal meeting | with clients, supervisors
14 | lunch individual individual | listen to lecture/presentation (20 to 50 people)
15 | lunch group group | fitness: to avoid confusion with sport activities that are possible in outside spaces, but not inside

Second part of the interview:

- Please indicate your preferred surrounding noise level, and maximum level you will tolerate, for each work task.
  (1 to 7, 1 = complete silence, 7 = continuous talking/active public space, such as cafe)
- Please indicate your preferred level of privacy, and maximum level you will tolerate for each work task.
  (1 to 7, 1 = being completely private, 7 = open and public)
- Please indicate how important the following topics are to you on a scale from 1 to 7,
  (1 = not important at all, 7 = very important)
  The preservation of natural ecosystems and environments
  The restoration of natural ecosystems and environment
  Visiting natural ecosystems and environments

**1.2 Envisioned goals of first interview**

The goal of the interview is to discover the effect natural space can have in creativity in the workplace. To do this Mangone first choose 16 work spaces found in current offices as a basis. He then added spaces that are said to improve creativity, like; the gym and the cafe. He also added five nature space; four different kinds of forest and a cave as a control group.

He chose pictures to represent the different space, because word labels for rooms, such as ‘cafe’, do not convey all the spatial qualities that define a café. By only using words, each participant will define each space based on their own familiarity with that type of space. This would have resulted in every participant giving answers for different spatial qualities. By using picture he controls the spatial qualities participants are reacting to. The pictures were chosen to be as typical as possible for every work space typology. He tested this by an initial picture selection, using a 10 person focus group, several times, in order to evaluate if they were perceiving what he wanted them to perceive in the pictures.

The different work tasks used in the interview are derived from the research on creative phase tasks. The noise level and privacy level questions are asked to get an idea of the noise and privacy level people prefer for each
work task. Most cellular offices are currently replaced by combi and flex offices. This usually means an increase in noise level and a decrease in privacy, which makes these questions relevant. The questions that deal with the importance of natural ecosystems and environments were later added to test if people with a strong preference for nature were more interested in working in a natural environment.

1.3 Preliminary results of first interview

Administrative tasks
Administrative tasks include phone calls and making arrangements so more important tasks can be done. Participants mention to like to be isolated so they don’t disturb others with their phone calls and prefer natural light. Some employees prefer the outside place; they perceive them as quite, isolated and relaxing. While other participants find the natural spaces too distracting and instead choose spaces with as little distractions as possible, which makes it easier for them to concentrate; no view, no other people around and a desk so they can make notes. Privacy is very important to do this task. That is why the cellular office is a popular choice, but participants would prefer not to see people passing by. This distracts them from their work. The open floor office could also work, as does the forest space with tables and the meadow. Participants mention the ideal place would be their own space with their own stuff that has a view of nature.

Break, individual
A very strong preference for the natural space, except for H (the cave), they like to have a horizon. Nature makes them feel free and they like the fresh air. The more informal work spaces also score high (C,G,B). Participants mention that they like to go for a short walk outside the office, this also gives them the opportunity to isolate themselves. The smaller spaces and the cave, lecture hall, conference room are the least favourite.

Break, group
The natural spaces are still popular, especially forest-lecture, H as well. For the inside spaces the lounge space is popular. They prefer a space with a horizon, to like to meet people and interact with them. In their break participants like to get out of their normal office environment and move around. The least favourite spaces are small enclosed inside space without a view, that feel like their workplace.

Brainstorm, group
It needs to be place where you can discuss freely, need to see everyone in the space. Some participants like to be stimulated by their surroundings, while others find it to distracting. Participants who prefer stimulation chose the forest lecture space, the open floor office, the café and the informal open space. Participants who do not like stimulation from surroundings prefer the cellular office space. All participants want a well-equipped space (beamers, table, white board), isolated so they can speak freely.

Brainstorm, individual
To be able to brainstorm participants need focus and some stimulation from their environment. This makes the natural spaces popular with the addition of a table to sketch and make notes. Inside space that are private, but open also do. Some participants feel that brainstorming is always a group activity. The worst spaces are noisy, like the lecture hall, the gym and the open floor office. Not all participants like nature spaces, they find them to distracting and think there is too much distracting movement in nature.

Focus, individual
For focused work participants prefer closed space. The forest space with tables is chosen, because it is enclosed space in nature. The cellular office, the conference room, the lab are favourites. The worst spaces for focused work are places where a lot of people walk by, that are large and that are to relaxing, like the open floor office, the park, the lounge, the informal private space, the lecture hall and the forest lecture space.

Focus, group
For focused work in a group, spaces with interaction, visual contact, talking and freedom of movement, like the lab, the open floor office, conference room and the forest lecture space are preferred. The worst spaces are the lounge, the lecture hall and the gym.

Reflect, group
Participants felt that a relaxing space, where you can see each other, like the meadow and an open environment like the informal private space, informal public space and conference room. The worst spaces are the cave, forest space with tables and the open floor office. Other participants felt that it was important that there are no distractions; no noise or other disturbances. Depending on the setting, it could be informal and outside, an open
relaxing, but you would probably still need a table for displaying work. If the setting is more formal, then the conference room or private office could do, with the possibility to present on a screen.

Evaluate, group
A lot of participants did not feel there was a difference between reflecting and evaluating in a group. A few did feel that evaluating was a bit more important and formal, that it was an occasion for them to present to their management.

Reflect, individual
One participant likes to watch people when reflecting. The café, forest with table space, forest lecture space, informal private space and the forest park space are preferred. Participant mention that they like an open space, others think you can do it everywhere and that exercise sometimes helps. Some like a lot of distraction and chaos, while others prefer an isolated space, not to relaxing or distracting.

Evaluate, individual
A lot of participants did not think there was a difference between reflecting and evaluating, especially when you do it on your own. Nature spaces are preferred as is the café. Some participants like to isolate themselves and some natural spaces give that opportunity. The worst spaces to evaluate on their own is the lounge space.

Informal meeting
For an informal meeting some privacy is desirable. The forest space with tables, the café, the cellular office, informal private space and forest park space are preferred. The worst spaces are formal meeting spaces like the conference room and the lab. The meadow, the forest lecture space, the cave and the gym are also not desirable.

Formal meeting
For a formal meeting the space needs to be controlled and has to be private. The conference room, the cellular office, the meadow and the cave fulfil the requirements. The open floor office would also do and maybe the café. The worst spaces are the forest space with tables, the cave, the gym and the forest lecture space.

Lunch
As with other relaxing informal activities green natural spaces are popular but the forest space with tables is the least popular. After the natural space the café and the cave are popular. A few participants like to eat lunch behind their desk. The worst place for lunch is the lounge space.

Listen to lecturer
The lecture hall is most preferred and then the forest lecture space. The trees in the forest lecture space gives order and focus. One participant feels that nature improve perception of the lecture. The worst spaces for a lecture are the cave, the café, the meadow and the park.

Exercise
The park is most popular place to exercise, then the meadow and the forest lecture space. One participant found the steps in the forest lecture space a nice challenge. Nature makes them feel free, they like an open environment. The gym is not popular.

1.4 Preliminary conclusions of first interview

Natural spaces are very popular for social activities like breaks, informal meetings and lunch. With doing individual social activities nature offers the change of being isolated. For more concentrated tasks participants find nature distracting, especially natural sounds, but they do like to have a view of nature. It is very depended on the participant if they find nature inspiring and stimulating, but in general brainstorming, reflecting and evaluating are also activities that benefit from a natural environment.
8.5 Description of second interview

The goal of the second interview is to get an idea of why participants prefer some places. We also want to discover what qualities they perceived in the different pictures. During the first interview we asked participants to think out loud when picking places. Words and themes that recurred we used as a basis for the second interview. After some discussion and a test interview we altered the definitions and decided to use cards with a scale to make the 1 to 7 scale less abstract.

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8.6 Envisioned goals of second interview

The envisioned goal of the second interview is to get an idea of the spatial and not spatial qualities participants associated with the pictures used in the first interview. We hope the average grade given to the pictures will correlate with work tasks.

8.7 Preliminary results of the second interview
Appendix 2: Employee satisfaction with flex office: Actio Wageningen

Offices of the facility management department of the University of Wageningen
Architectural office: Elemans, Postma, van den Hork
project architects: Peter Elemans and Ingrid Benjert
Design focus: natural daylight,
EPC: 0,67 which is 30% below the legal requirement
Gross Floor Area: 1670 square meters
Interior architectural office: Rietmeijer concepts + interior design
Living wall: 35 square meters, 2800 plants

The office is an extension of an existing office building and houses the facility management department of the University of Wageningen (Wageningen UR). Many of the employees work part-time and that is why the flex office concept was chosen. The flex office takes into account a seventy percent employee occupancy level and is designed to accommodate this. Every employee has one meter of shelf space and there are no personal workstations, with the exception of the secretaries. (Wageningen UR, 2011a) In accordance with the Dutch flex office interpretation called ‘het nieuwe werken’ which translates as ‘the new way of working’, different kinds of workstations have been created for different kinds of work by the interior architects of Rietmeijer concepts + interior design. Their vision on “the new way of working” is described on their website:

There are many possible reasons why an organisation should switch to the New Way of Working (NWW). They may include closer cooperation, more freedom and mobility for the employee, a better occupancy level at the office and avoiding rush-hour traffic. Or saving money by needing to rent less office space. Or even providing a new generation of employees with a more suitable working environment.

NWW goes further than creating an open, flexible office environment. In fact it takes many forms and is certainly not uniform. That's why we prefer to talk about innovative forms of working that give centre stage to the individual and support his/her activities. NWW is about the optimum interaction between the physical office environment, digital facilities that allow work to take place irrespective of time and place, and good (change) management.

Rietmeijer Concept + Interior Design has wide knowledge and experience in innovative ways of working. We work according to a tried-and-tested method in order to investigate the optimum match between the organisation and its accommodation and to develop concepts that enhance this match. Of course, we also provide advice on the ICT facilities that are needed to ensure the success of the project as a whole and we provide recommendations on the change programme that should be deployed. (Rietmeijer concepts + interior design, 2012)
The different kinds of workspaces they created in Actio are;
- hot desk spaces
- private focus rooms
- semi public focus room (also referred to as the library)
- lounge spaces
- semi public meet spaces
- public meet spaces
- conference rooms

For the secretaries there are permanent workstations, because they need to answer their phones and stay behind their desks so they can be found when necessary. There is also a mailroom and a reception area that together with the conference rooms, the library and the lounge spaces is kept separate from the rest of the office. This has been done to improve the noise levels in the office and to create a division between employees and people who visit for meetings. This separation insures a certain level of privacy for the employees and their work.
2.1. Employee satisfaction with different workspace typologies

Private focus rooms
**Description:** A small room with a narrow desk, a desk chair and two stools. The room has two fully glazed walls, one partly glazed walls and the other wall are rendered white. The space is situated in the office part of the building on the ground floor and the first floor with a small corridor between the room and the facade.

**Positive:** The space is well insulated for noise, which makes it suitable for phone calls and private conversation. The space gets a lot of natural light and is very bright.

**Negative:** The room has large glass surfaces which lead to two problems. Employees cannot fully isolate themselves. People still see them and come in to ask questions. They feel like they are on display for the rest of the office. One employee suggested installing curtains to give people the option of not being visible from the outside. The private focus room is placed close to a sunny facade and that combined with the large glass surfaces results in a hot space that cannot be ventilated. Another problem of the private focus room is that there is only one desk chair and a small stool for others to sit on. This makes it difficult to work with two people in the room. If there was another desk chair employees would like to use the room for work discussions that require a desk without disturbing other people in the office. In my opinion as an architect keeping the rooms separate from the facade creates a loss in usable floor space without any clear benefits.

Semi public focus rooms (library)
**Description:** A large room with a bookcase and several desks that are facing each other. The chairs for these desks have a cocoon like shape that is intended to keep the noise out. The room is not in the office part of the building but in the more public conference part on the first floor.

**Positive:** There are not many people around and it is possible to work there in silence. Employees who work there are far from their colleagues and are less likely to be disturbed by them. Talking on your phone or to other people is not allowed so there are fewer distractions. One employee found that especially comfortable when reading, but most find it a good place to do concentrated work.

**Negative:** Some employees do not like that is so quiet and prefer some more background noise. The idea that they have to be quiet can also make them feel uncomfortable. Employees also find it quite far from the rest of the office and especially far from the printer. The special chairs are difficult to move and some employees find them uncomfortable.

Hot desk spaces
**Description:** A large table suitable for six people to work at with screens and keyboard that can be connected to laptops. On the ground floor it is situated in a place where a lot of people walk by. On the first floor it is more isolated from the rest of the office and because more people work fulltime on this floor it is not used that much.

**Positive:** Employees who work there find it suitable to work for a short time. They are happy with the option to use the screen and keyboard that are available on the table. On the ground floor a lot of people walk by, which means that employees can easily find each other, talk and keep each other updated on their work. On the first floor it is quieter corner of the building and that makes it suitable for concentrated work. There are always spots available for employees.
Negative: Originally there were no screens and keyboard on the table, but they were added later after employees who asked for them. Employees that don’t use them find that they take up a lot of space on the table. On the ground floor where a lot of people walk by it is a quite a chaotic place to work and it is hard to concentrate when working there. When employees work there with a group they feel that there is not enough privacy. When they discuss out loud they also feel that they are disturbing other people. The height of the table is not adjustable and when employees work there for a longer time that becomes uncomfortable.

Lounge spaces
Description: The lounge space has a small bar/ kitchen that separates it from the rest of the office. Two walls of the space are made of glass with curtains for more privacy and the last wall has a circular window that is also covered with a curtain. In the space there is white rectangular table with eight white seats.
Positive: Employees find this space the warmest homeliest part of the office. They like taking their breaks there and also use for short more informal conversations and reading. It is good place to meet colleagues in an informal setting and this is where birthdays are celebrated in the office.
Negative: The popularity of the space is also its downfall during lunch. Then the space is simply too small for everyone. The table itself is also too small to read a newspaper or simply reading while other people are having lunch. It is against the rules to play music out loud in the office and most employees would like to play music here during breaks. Working here is also a problem, because there are no sockets for powering laptops.

Semi public meet spaces
Description: The semi public meet space consists of several chairs that have pieces sticking out on the eye level. This gives privacy from the rest of the office while the people who sit there can still see each other.
Positive: Employees can seclude themselves from the rest of the office while still being visible and being able to talk to others. The chairs are quite comfortable to sit in.
Negative: The level of noise the chairs absorb is debatable. Although perhaps a part of the sound travelling sideways is blocked, the sound can freely travel upward to the first floor. The space is not used much and some employees find it superfluous in the office. It is difficult to work there with a laptop or pen and paper for two reasons; the lack of table and the elbow rest of the chair.

Public meet spaces
Description: There are several public meet spaces in different arrangements. Some are a bit more secluded from the central corridor and some are next to it. Red couches with a high back are positioned against a low wall with a wood pattern. These couches are designed in two ways; perpendicular to the low wall so people sit next to each other and with a corner so people don’t have to sit next to each other. Next to the couch there is a white table that is adjustable in height and can be pushed away and towards the couch. Employees find it a cosy place, where you have a bit of seclusion and privacy.
Positive: Employees mostly use the public meet space for short informal meetings. Employees like the fact that the height and position of the table can be altered. For longer meetings the seats are not comfortable.
Negative: Getting into the seat is not comfortable, especially if the user is a bit bigger. Placing the seats in a corner or making the table able to rotate would solve this. The space has no electrical outlets and that becomes a problem if employees are working there for a longer time. Right now you can only work there with two people and that’s not enough for a lot of meetings. Adding some seats are putting couches opposite to each other would solve that problem. During meetings employees have to talk softly and they do not use it for serious conversations, because the sound is not absorbed by the seats.

Conference rooms
Description: The Actio building has various conference rooms that vary in size. There is one on the ground floor with a round table that seats about five people. During meeting the glass wall can be covered by a curtain. On the first floor there are more conference rooms. The biggest one seats 20 people. All the conference rooms have beamers, white boards and can be used for video conferences.
Positive: Employees find the conference room well facilitated. They like the fact that the tables are oval or round with seats that can turn so that there is always a good view on the screen and the speaker.
Negative: The conference rooms on the first floor are next to a corridor, because these rooms cannot be closed off with curtains people that walk by are distracting. The fact that the conference room is visible from the outside is also a problem when there is a confidential meeting. The secretaries do not have a seat that is adjustable in height in the conference room. That makes it uncomfortable to make minutes during meetings. The climate of the room is not ideal. Employees point out that it is only heated during meetings. So it can be quite cold when it is first used. On sunny days it can be rather hot and the space is not ventilated well enough when there are a lot of people in the room. One of employees suggested putting a coat rack in the room, because guests like to keep their stuff with them and don’t like to put it in the wardrobe downstairs.

2.2. Other aspects

Green wall
Although most employees do not interact much with the green wall, they generally like it. They command on how beautiful it is and that it fits with the university (the University of Wageningen focuses on nature). Recently the wall has been badly maintained and the employees would like to see this improved.

Climate
The temperature in the building varies depending on where you are in the building. Employees describe the South facade as too hot on a sunny day and the North facade as too cold. The conference rooms and private focus room are especially troubled by overheating.

Daylight
The architect tried to get as much natural light into building as possible. To do this he used two skylights in the middle of the building and light shelves. These shelves reflect high sun in summer, but let the low sun in winter pass. There is also automatic sun shading on the outside to control the amount of light entering the building. The employees like that the building is bright and sunny, but the sun also causes some trouble. The sun shading does not always work and as a result employees complain of glare on their computer screen. The Southside of the building is also warmer than the rest of the building on a sunny day.

Acoustics
In an open office environment noise can be a big problem. The architect tried to solve this by separating functions and using acoustically absorbing materials. This seems not be sufficient for the meet spaces in the building and for group work.

General remarks
The flex space typologies works on a simple principle. Money can be saved by reducing the number of personal workspaces. This money can be spend (as was the case when designing the Actio building) in creating more different kinds of workspaces of high quality. The employees lose their own workspace and some privacy, but have more freedom to choose where to work. In the case of Actio this was not achieved. The flex space should also give employees the freedom of working from home, but the management of Actio does not allow that. There were also a number of strict rules in the office, it was not allowed to play music and to eat behind their desks. The freedom employees got in Actio are supposed to get with the flex office space concept is questionable. On the other hand employees that work fulltime do not wish to use all the different kinds of office space. They prefer to work on the same desk with the same people every day.

Another goal of the flex office is to stimulate to flow of information between employees and interpersonal contact. Employees seem to agree that this goal is achieved in the office. The rule of management that they have to work at the office tries to stimulate this even further. Some employees feel like communication can be just for breaks and miss their old shared room office with more privacy.

In recent years it became clear that flex office space works better for knowledge workers (van den Dobbelste, 2004). This can be seen in the Actio building. The hot desk spaces are more popular for more creative people who work part time on the ground floor. On the first floor the accountants who do more repetitive work, choose to sit with the same group of people on the same desk every day. The exact opposite of what the flex office was designed for.

The office was designed to be as light and neutral as possible. White and grey tones were used to achieve this. Furniture in different colours and some artwork were used to add some colour. Employees remark they would like their office to be more homely and warm. They would like to add plants and remark that the
lounge space used for lunch is the only space that feels homely.

2.2. Main conclusions

Actio is an open plan office with a clean desk policy and this was a big change for the employees who used to work in a shared room office. After changing to the new concept they requested and got more screens and keyboards in the hot desk space. They would have liked to have more adjustable tables throughout the office, but that request was not fulfilled. The meeting public and semi public meet spaces are not very practical, especially because in an open office like Actio sound travels in all directions. The public meet space is event totally superfluous, because of its design, but also because of its position in the building. This is a place meant for discussions and call, but placed in a double height space the sound travels upwards. When picking the furniture for the building design aesthetics often won from practicality. Some furniture arrangements are placed in awkward positions where they will not be used or the furniture itself is beautiful but uncomfortable and unpractical.

A solution could be to create more divisional elements in the office that can absorb sound. Design for group work and meet space with more privacy, because the lounge space that has privacy is a clear success. Giving the employees insight into the availability of meeting rooms would stimulate them to use them. Adding some sun shading devices on the inside would solve some overheating and glare problems as well, with the additional benefit of giving employees more control over their environment.
Appendix 3: Green office space: Lumen

Offices and laboratory for Alterra and the environmental science group (ESG) of the Wageningen University
Architectural office: Behnisch Architekten
Design focus: harmony with nature
Gross Floor Area: 11 800 square meters;
500 square meters of laboratory
350 square meters of educational spaces
Volume: 70 000 cubic meters
Garden design: Thijs van Hees
Design of pads, water features and arbour: Michael Singer
Landscape design: Stefan Behnisch, Thijs van Hees, Ger Londo

The building was commissioned in 1992. It was a pilot project of the EU for ecological construction (Behnisch Architekten, unknown) that tries to be environmental friendly and human friendly at the same time. It was finished in 1998 and the first building of the new campus of the university of Wageningen. The building has E-shaped form. The back of the E are laboratories and the legs are offices. Between the offices there are glass-covered atriums with gardens. These gardens are in contact with the outside, so births, animals and insects can come in and out of the garden. In winter these gardens help warm up the building and in summer they help ventilate and cool the building. The plants in the atriums help humidify the air in the building. The gardens extend to outside the building; there is a meadow garden, a wetland garden and a large natural garden with a pond. The rainwater of the building is collected in the pond and used for flushing the toilets in the building and feeding the ponds in the interior gardens. (Wageningen UR, 2011b)
3.1. Preferred creative work tasks in interior gardens

**Parts of the garden that are used the most**
All the people that were interviewed agree that they prefer to spend time where there is a bench were they can sit. Especially the more isolated bench in the pond, that is only accessible through the adjoining office. The benches of the pergola and on the balcony are also mentioned.

**Amount of time spend in the garden**
Most people spend 15 to 30 minutes in the garden for lunch and coffee breaks. During lunch breaks the garden is very busy and it is difficult to find a place to sit. That’s why some employees only use the garden for short breaks after or before their lunch break. One employee also uses the garden for meetings and then he spends one to one and a half hour in the garden.

**Time and season the garden is used**
The building does also have outside gardens and the surrounding area is very green and well maintained. Most employees prefer to go out for a walk and enjoy the landscape. In winter when it’s colder they do use to winter garden. They mention it is only comfortable when the sun is shining. When the sun is not shining the garden is a lot colder. One employee was very specific about the moments the garden is most comfortable; in spring and autumn 10-16, in winter 11-15 and in summer 8-18.

**Preferred work activities in the garden**
The garden is most preferred for social activities, like taking breaks for lunch and coffee with a group or alone and for informal meetings. Some employees don’t like to take breaks in the garden when they are alone, because they feel like they are being watched from the adjoining offices. Other employees also like to use the garden to brain-storm either with a group or alone and mention that looking at nature and animals helps with that. One employee only uses the garden for reading.

**Undesirable work activities in the garden**
The gardens are surrounded by offices. This means that the people working there can be bothered by noise coming from the interior gardens. That is why some employees don’t think it is a good place for a meeting and group work. Other employees are too distracted by the nature, the animals and the people passing by in the interior garden to be able to concentrate on their work. That is why they believe that doing administrative work, evaluating on your own and focus work in the interior garden is not a good idea.

**Effect of the garden on the work performance for different activities**
Employees believe that the garden has a very positive effect on their work performance if they use the garden for taking a break, reflecting on their own, an informal meeting and eating lunch. Brainstorming, focused work on their own and reflecting in a group our also activities which are positively effect by working in the garden. Employees do not think that evaluating on their own or in a group is affected by working in the garden. Administrative work, focused work in a group and formal meetings are badly affected by doing them in the garden.

**Improvements that can be done to garden**
Employees like the gardens very much and there no comments on the garden design itself. They do comment that the benches and other seats are not clean. Probably because of the birds who can freely enter the garden. They also want more places to sit, because especially during lunch it is very busy and there are not enough spaces to sit. Adding electricity to the places where you can currently sit would make it easier to work there and have meetings.
3.2 Conclusion

The winter gardens of the Lumen building are very popular. Employees prefer to use them for social activities, like lunch, short breaks and informal meetings, but also find them beneficial for brainstorming alone or in a group. Social activities do create noise for the surrounding offices which can be distracting to employees. That is why employees prefer to use it during lunch when they are not disturbing people in the offices. The gardens are protected from rain, wind and have sun shading, but in general the temperature difference between the inside and outside is very small. That is why the garden is only slightly more comfortable than the outside in winter time and then only when the sun is shining. Animals (especially birds) can come into the garden and they soil the seating areas. The current seating areas are not cleaned enough and this is a problem when people want to sit. Employees would like to have more seats and in the garden and more power outlets. Still most employees find the garden a good addition to the building. The view of the garden is the best on the ground floor and the first floor. The second floor does not have a good view and easily overheats in summer.
Appendix 4
Boundary conditions of offices from the seventies and eighties

As mentioned in the background chapter office buildings that are thirty to forty years old are most likely to be transformed. This chapter will first discuss the boundary conditions of office building build between 1970 and 1989 in the Netherlands. The boundary conditions that will be discussed are: form, structural design, materialisation of the structure, facade, repetition, fire safety and daylight requirements. Secondly it will focus on two specific office buildings in Sloterdijk Amsterdam; Molenwerf 1-3 and Haarlemmerweg 506-511. Finally Haarlemmerweg 506-511 will be discussed in more detail, focusing on the boundary conditions of transformation.

4.1 Form

Although many different shapes of office buildings were build in the Netherlands between 1970 and 1989 two are dominant: the tower office and the elongate low office. The tower office building has a central core with egress stairs and elevators that ensures structural stability. Depending on the size this is sometimes not enough and extra stability elements are added in the facade. The elongated low office has stairs and elevators in the middle of the building and egress stairs at the end of the building. The building depth is generally 14,0-16,5 m. To obtain structural stability, stability walls in one or two directions are added.

4.2. Structural design

In the early seventies it was common to make a two way spanning floor on columns. An edge beam or a cantilevered floor was used along the facade. In the late seventies and early eighties a single span floor on beams that rest on columns became more popular. The beams were used either perpendicular or parallel to the facade. Standardized elements became more prominent in structural design and facade design. In facade design elements of 0,9 m and 1,8 m meters wide became more dominant. As a result the bay size in structural design also became a multiple of 1,8 m.
4.3. Materialisation of the structure

There are three dominant ways to materialise structural design in the seventies and eighties. The first way is using cassette slab on columns. This floor spans 9 to 15 meters. The second way is using a single span slab on beams parallel to the facade (breedplaatvloer). This floor can span up to 12 meters. The third way is using ribbed floor on hidden beams perpendicular to the facade. This floor also spans 9 to 15 meters.

4.4. Facade

A couple of changes occurred to the design of office facade in the seventies. Insulation and insulated prefab elements are used more and more after the oil crisis of 1973, which resulted in a vast increase in fuel prices. Aluminium window frames, insulating and sun reflecting glass are introduced as a new building material. Curtain walls also become common in the Netherlands. Where it leads to its own version called ‘de klimaatgevel’. ‘De klimaatgevel’ consists of insulating glass on the outside, a cavity with sun shading and then a single glass facade which can be opened. This facade doesn’t only span floor to floor, but also uses daylight, solar heat and natural ventilation to control the interior climate. In the eighties prefabrication of facade elements continues. It results in self-supporting prefab elements and modular facade elements. Strip windows and fully glazed facades become popular in facade design.
4.5. Repetition

Repetition can be seen as a result of the prefabrication of building elements. In office building from the seventies and eighties repetition becomes more common. In structural design bay widths of 5.4 meters and 7.2 meters are widely used. In facades a repetition of 1,8 meters is mostly used, 0,9 meters and multiples of 1,8 meters are also common.

Currently both commercial and public buildings currently tend to be based on an office module of 1.8 m x 5.4 m. Employees can get an office of one module (1.8 m X 5.4 m), two modules (3.6 m x 5.4 m), three modules (5.4 m x 5.4 m) etc. Research has shown that this type of module is not that efficient from a space planning point of view. But, apparently, both clients and architects regard these sizes as appropriate. Another crucial factor is that the construction industry uses these sizes for the production of products such as prefabricated floor slabs, ceilings and HVAC units.(van Meel, 2000, p. 135)
Picture A4.10 Construction and ceiling height

Picture A4.11 Bay size in office buildings
4.6. Fire safety

Dutch fire safety regulations for office building strongly influences the shape of office buildings. The size of the smoke compartment depends on the number and length of escape routes. If there is only one exit the gebruiksoppervlakte (see glossary) cannot be more than 250 square meters and the distance exit of the verblijfsruimte (see glossary) to the exit of the smoke compartment cannot be more than 15 meters. If there is more than one exit the maximum size of the smoke compartment is a 1000 square meters. The length of the escape route can be 20 meters maximum if the smoke compartment is undivided and 30 meters if the smoke compartment is divided.

![Image of smoke compartments]

Picture A4.14 Smoke compartments < 250 square meters, undivided < 1000 square meters and divided < 1000 square meters

4.7. Daylight requirements

Dutch office buildings generally make sure that every employee has a lot of natural daylight and is close to a window.

In the majority of office buildings nobody is sitting more than 7 m from a window. The advantage of shallow floor plans is that they provide employees with an outside view, daylight and the ability to control the indoor climate. About 80% of Dutch office buildings has openable windows and possibilities for individual climate control. (van Meel, 2000, p. 131)

This is not a result of Dutch building regulations. Dutch building regulations dictate that the glass surface of the facade needs to be at least 5% of the verblijfsruimte surface. Employees in the Netherlands have quite a lot of say in the way their office is designed and this is the reason that they have such excellent work environments.
In the design of office buildings, works councils play a crucial role. Depending on the size of the project, management must seek its advice and even its consent. This leaves its mark on the design of office buildings. It explains why Dutch office buildings are so much focused on the satisfaction of individual employees rather than on cost-benefits or flexibility for the organisation as a whole. A recurrent theme in the involvement of works councils is the extent to which employees have the possibility to control environmental conditions (e.g. light level, temperature, and flow of fresh air). Piet Vroon, a Dutch psychologist, has stated that individual control is crucial for the well-being of employees. Open spaces with air conditioning, artificial lighting, little outside view and no possibilities of opening a window are regarded as harmful. Works councils have picked up this issue and made it one of their main criteria in judging office design. (van Meel, 2000, p. 141)
Appendix 5:
Boundary conditions of two Sloterdijk offices:
Molenwerf 1-3 and Haarlemmerweg 506-511

5.1. Location

The two office building discussed in this appendix are built in the early and late eighties. When travelling from Haarlemmerpoort towards Sloterdijk the Haarlemmerweg 506 - 511 office building is an orientation point, while Molenwerf 1-3 is situated next to the exit of the A10. For each building the following boundary conditions will be analyzed; size and number of floors, repetition and sun on the building.
5.2. Molenwerf 1-3

architect: unknown
building year: 1981
size: 2000 m² - 11229 m² (rentable units)
14 000 m² vvo
7 floors
81 parking spaces
egress: 4 egress stairs, 4 elevators,
1 freight elevator

Picture A5.3 View of Molenwerf 1-3 from the Haarlemmerweg toward Teleport

Picture A5.4 Drawing with number of floors and dimensions of the building
Picture A5.5 Drawing of the building with egress points (stairs and elevators) in grey and the grid of the building in dotted lines

Picture A5.6 Sun study Molenwerf 1-3, 21th of March 2012 at 9:00

Picture A5.7 Sun study Molenwerf 1-3, 21th of March 2012 at 13:00
Although Molenwerf 1-3 has a large base, the terrain is not densely built. A large portion of the building does not exceed two floors. This results in large roof surfaces which could be used to create rooftop gardens.

The sun study shows that the South facades of the building get the most sun all day long, but in the morning the sun on this facade is blocked by the six story high East wing. The morning also casts a large shadow on the lower floors of the building. The afternoon and evening sun cast less shadow on the building.

5.3. Conclusion

The building has a complicated shape, with a couple of towers (probably for installations) and a large base. The facade of the building does not have a large window surface, but is adequate according to Dutch building regulations. This results in a building with a large roofsurface and a limited amount of daylight inside the building. That would make it difficult to incorporate plants into the current building, without making large and drastic changes to the facade. I think the building facade is important to the stability of the building and thus question if drastic changes to the facade are even possible.

Haarlemmerweg 506-511

architect: Arthur Staal
building year: 1971
size: +/- 9070 m² vvo
egress: 4 egress stairs, 8 elevators
Picture A5.10 Drawing with number of floors and dimensions of the building

Picture A5.11 Drawing of the building with egress points (stairs and elevators) in grey and the grid of the building in dotted lines

Picture A5.12 Sun study of Haarlemmerweg 506-511, 21th of March at 9:00

Picture A5.13 Sun study of Haarlemmerweg 506-511, 21th of March at 13:00

Picture A5.14 Sun study of Haarlemmerweg 506-511, 21th of March at 17:00
Appendix 6: Planted areas within and around office buildings

6.1 Ministry of Finance, the Hague

<table>
<thead>
<tr>
<th>Architect</th>
<th>Plants</th>
<th>Climate</th>
</tr>
</thead>
<tbody>
<tr>
<td>architect: Meyer en Van Schooten garden architect: M. van Gessel</td>
<td>Tamarind, Philodendrons, Ferns, Orchids</td>
<td>Room temp. 20-24° C.</td>
</tr>
<tr>
<td></td>
<td>Olive trees</td>
<td>Wint. temp. +/- 0°C., min. -5°C.</td>
</tr>
<tr>
<td></td>
<td>Palms, Peace lilies</td>
<td>Room temp. 20-24° C.</td>
</tr>
<tr>
<td></td>
<td>Platanus</td>
<td>Outside</td>
</tr>
</tbody>
</table>

Picture A6.1 Interior garden

Picture A6.2 Wintergarden
### 6.2 ING House, office building, Amsterdam

<table>
<thead>
<tr>
<th>Architect</th>
<th>Plants</th>
<th>Climate</th>
</tr>
</thead>
</table>
| architect: Meyer en Van Schooten  
interior architect: Trude Hooijkaas  
garden architect: M. van Gessel | Bamboo trees  
Ficus                  | Room temp 20-24° C.   |
| Figs  
Ferns                          | Room temp 20-24° C      |
| Ferns  
Clivias                        | Subtropical            |
| Livingstonia palms             | Subtropical            |
| Scots firs  
Ferns  
Blueberries  
Japanese anemones              | Outside (loggia North side) |
| Jagged lime trees              | Outside (loggia East side) |

![Picture A6.6 Section of building](image)

![Picture A6.7 Bamboo garden entrance](image)

![Picture A6.8 Jungle garden](image)
### 6.3 UPC office building, Leeuwarden

<table>
<thead>
<tr>
<th>Architect</th>
<th>Plants</th>
<th>Climate</th>
</tr>
</thead>
<tbody>
<tr>
<td>architect: Paul de Ruiter</td>
<td>interior garden</td>
<td>Room temp 20-24° C.</td>
</tr>
<tr>
<td>interior architects: Hollandse</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nieuwe, Inside/Outside, Concern,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Femke van Gemert</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>roof terras, grass</td>
<td>Outside</td>
</tr>
</tbody>
</table>

- **Picture A6.9** Fir garden
- **Picture A6.10** Bamboo garden third floor
- **Picture A6.11** Interior garden
- **Picture A6.12** Interior garden
6.4. Lumen office and laboratory building, Wageningen

<table>
<thead>
<tr>
<th>Architect</th>
<th>Plants</th>
<th>Climate</th>
</tr>
</thead>
<tbody>
<tr>
<td>architect: Behnisch &amp; Partners</td>
<td>Mediterranean</td>
<td>Wint. temp. 0-10°C., frost free</td>
</tr>
<tr>
<td>garden architect: Copijn Tuin en Landschaparchitecten, Hyco Verhaagen artist: Michael Singer</td>
<td>(Liriope muscari)</td>
<td></td>
</tr>
<tr>
<td>garden architect: Thijs van Hees, Ger Londo</td>
<td>Grass garden, marsh garden, semi-natural landscape</td>
<td>Outside</td>
</tr>
</tbody>
</table>

Picture A6.14 Island in the pond of the garden

Picture A6.15 Interior garden

Picture A6.16 Interior garden

Picture A6.17 Outside garden
References

Literature


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Picture A3.1 - A3.4:

Picture A4.1 - A4.6:
Pictures of Monique Beliën

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http://www.panoramio.com/photo/28595504

Picture A4.8:

Picture A4.9:
Picture of Monique Beliën

Picture A4.10:

Picture A4.11 - A4.13:

Picture A4.14:
Drawing by Monique Beliën

Picture A5.1:
maps.tudelft.nl
Picture A5.2:
Google (2013), Sloterdijk, Images retrieved 08-02-2013, from
https://maps.google.nl/maps?q=Sloterdijk&hl=en&ll=52.386366,4.852685&spn=0.005356,0.013937&sll=51.999535,4.363698&sspn=0.172903,0.445976&hnear=Sloterdijk,+Government+of+Amsterdam,+North+Holland&t=h&z=17
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