

## #195

### COMBINING ENVIRONMENTAL PSYCHOLOGY AND SPACE SYNTAX ANALYSIS:

The extent of users well-being influencing variables control, protection and privacy in an open plan office

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STEPHANIE WACKERNAGEL  
RBSGROUP, Munich, Germany  
stephanie.wackernagel@dreso.com

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#### ABSTRACT

In an environmental psychology study by Wackernagel (2017), 191 employees from many different professions and many diverse industries assessed a number of elements of design in their workplace environment in a questionnaire procedure. Via a factor analysis, three space factors were identified and a new type of questionnaire was developed. In the 2017 study the three space factors, *Positive Stimulation Through the Space*, *Coherence of the Space* and *The Space Provides Control* showed a significant connection between health, well-being, and contentment with the design. In this study the floor plan of an automotive company is checked via various space syntax analyses for the features of the *The Space Provides Control* factor. In addition to this floor plan, this research work also examines various layouts for optimizing the space. The analysis visualises the space configuration with which the workplaces in an open plan office have a high level of the following features: the workplace is protected from the eyes of other users; it is not possible to look on the screen; it is not possible to approach the workplace from behind; people do not walk by the workplace; colleagues are not directly aware of your presence at the workplace; colleagues' workplaces cannot be taken in entirely with one glance; there is a visible demarcation of one's own workplace; there is an agreeable distance from colleagues' workplaces; demarcations enable protection from acoustic disturbances; there are retreat possibilities for concentrated working, for quiet and tune out, and there is the possibility of confidential talks.

#### KEYWORDS

Space syntax, environmental psychology, well-being, open plan office, privacy, control, workplace design, visibility graph analysis, agent analysis

#### 1. INTRODUCTION

Many people in today's information age do their work at a computer in an office environment (Flade 2008). And yet office work is not a stressless activity. According to the German Federal Institute for Occupational Safety and Health (BAuA 2010), commercial and administrative jobs show the highest number of days absent due to illness. Occupational psychology has in the last decades identified many risk factors that can affect the health of employees. Approaches for the optimisation of operational work conditions mainly relate to the organisation of the working environment. But what effects does the built work environment has on the user experience? Individuals in western societies spend up to 90% of their lifetime in buildings (Evans & McCoy, 1998). Thereby we live and work the majority of our lifetime within rooms (cf. Flade, 2008). According to Bechtel and Churchman (2002) the goal of every planning of built environments,

is to enable the maximum quality of life for the people. To achieve that, unfavourable building structures that induce stress and negatively influence our well-being, have to be identified (cf. Bell, Greene, Fisher & Baum, 2001).

## 2. THEORETICAL BACKGROUND

Ulrich's (1997) *Theory of Supportive Design* shows that an environment conducive to health enables control, privacy, social support and access to nature. Similar aspects are named by Evans and McCoy (1998). The authors analysed the studies conducted until 1998 by environmental psychology. The results found were summarised by the authors into five dimensions of stress influencing interior design elements that can influence the experience of stress by people and therefore are related to their state of health: Stimulation, control, coherence, restorative and affordances.

Stimulation	Control	Coherence	Restorative	Affordances
intensity, complexity, mystery, novelty, noise, light, odor, colour, crowding, visual exposure, proximity to circulation, adjacencies	Crowding, boundaries, climatic & light controls, spatial hierarchy, territoriality, symbolism, flexibility, responsiveness, privacy, depth, interconnectedness, functional distances, focal point, sociofugal furniture arrangement	Legibility, organisation, thematic structure, predictability, landmark, signage, pathway configuration, distinctiveness, floor plan complexity, circulation alignment, exterior vistas	minimal distraction, stimulus shelter, fascination, nature, solitude	Ambiguity, sudden perceptual changes, perceptual cue conflict, feedback

Figure 1 - Interior design elements influencing stress (Evans & McCoy, 1998)

In a current study by Wackernagel (2017) it was reviewed, if these five dimensions of stress influencing interior design elements can be detected in office environments. The author researched by means of a unique online survey 191 office workers in Germany. The participants came from many different professions and many diverse industries. For the survey of the dimensions mentioned above, a novel questionnaire was developed. In doing so 105 items were applied for the first time. Via a principal component analysis (orthogonal varimax rotation) and a reliability analysis subsequently 41 items, associated to three factors, were identified. Factor 1 is unambiguously related to the topic stimulation ( $\alpha = .88$ ) by Evans and McCoy (1998). Factor 2 (14 items) unmistakably represents the topic control ( $\alpha = .88$ ). Factor 3 (12 items) can also definitely be related to the topic coherence ( $\alpha = .83$ ). Thereby three of five space factors that Evans and McCoy had been positing, were proved. A more accurate description of the dimensions is 1. *Positive Stimulation Through the Space*, as only positive elements of the dimension stimulation have flown into this space factor, 2. *The Space Provides Control* and 3. *Coherence of the Space*.

All three space factors show at a one-sided level of significance a significant to most significant positive relation with health, well-being and contentment with the design. For the survey of well-being WHO-5 (Bech, 2004) with five items was used. For the survey of health the BEL\_PSSM – discomfort acquisition list by Iwanowa (2004) was used with 40 items. The scale of contentment with the design was newly constructed and consisted of two items.

Generally the correlations of stimulation, control and coherence with health, well-being and contentment with the design intensified with a high attendance ( $\geq 36$  weekly hours) in the company (median split). Important hereby though is that these effects are diminished or cancelled out through the existence of negative organisational work conditions. The evaluation of demographic variables showed slight, but negligible influences on the result.

<i>The Space Provides Control</i>	Positive Stimulation Through The Space	Coherence Of The Space
Protection against insights Comfortable distance to colleagues No approach from behind Confidential conversations possible Retreat for concentrated work Retreat for quiet Protection against noise No view to screens Areas for tune out	Interesting additional areas Diversified design Interesting furniture Colourful objects Colourful design Interesting floor areas Extraordinary forms Attractive design Plants	System in design recognisable Consistent structured space Central theme in design Good orientation Functions of rooms/furniture clearly recognisable Purpose/use clearly recognisable: technics & room setup Different areas discernible

Figure 2 - Three space factors - and their elements - correlating with health, well-being and contentment with the design (Wackernagel, 2017)

The study at hand has the goal of combining the environmental psychological study of Wackernagel (2017) with a Space Syntax Analysis to examine spatial configurations of an office environment in relation to the factor *The Space Provides Control*.

### 2.1 THE SPACE PROVIDES CONTROL

People have the need to make events and conditions in their environment controllable. Even if an environment may offer more possibilities for control than an individual may want or be able to handle (Lawton, 1989), the need for control is motivator for many behavioural patterns of the individual (Fischer und Stephan, 1996).

From an environmental psychological perspective, the human pursuit of control is also an expression of the fact that we want to regulate the extent of stimulation by environmental excitation (Cohen, 1978). Too strong an influence of excitation going hand in hand with overstimulation may be seen by the individual as an impairment of control over the environment. Cohen, Evans, Stokols and Krantz (1986) bring continuing experiences of uncontrollable environmental conditions into a relation with learned helplessness. This again stands in connection with distress as well as physical diseases (Peterson, Maier & Seligman, 1993). Interior design elements that do stand, according to Evans and McCoy (1998), in relation with the factor control, are physical demarcation, regulation of light and climate, territoriality, privacy, crowding, flexibility, responsiveness, spatial structure (like depth), functional distances, defensible space and certain symbolic elements. The study by Wackernagel (2017) proves, that the spatial configurations of an office environment with a high characteristic of the following features provide control for the user.

Personal space for the individual starts with the existence of physical boundaries. This personal space constitutes a function of defence for the individual and serves to regulate intimacy (Fischer, 1990). In the office environment the user experiences control if the workplace is protected from the eyes of other users and the user cannot be watched working. Colleagues should not be directly aware of the presence at the workplace and have the possibility to look on the screen. But also colleagues' workplaces should not be possible to be taken in entirely with one glance (Wackernagel, 2017). The experience of privacy is, according to Kruse (1980), closely related to the rooms where individuals live. They protect the human from unwanted view and uncontrolled access. Distances protect against noise and sounds that you don't want to hear and the ability to hide adds to the feeling of security. Privacy also means that a room is not for all and not at all times to be entered by others (cf. Kruse, 1980). Thereby the experience of privacy enables the protection against unwanted onlookers und unwanted critics and offers protection for behaviour that is not for everybody to be seen, as, according to Kruse (1980), with every self-exposure comes vulnerability. For Evans and McCoy (1998) the experience of privacy enables the possibility to regulate social interaction and adds, according to Altmann (1975), strongly to a feeling of control indoors. Users do not feel safe, if other persons are able to approach them from behind. To approach a workplace from behind should not be possible (Wackernagel, 2017). The User experiences control if his workplace has an agreeable distance from colleagues' workplaces and when there is the possibility of confidential talks.

The study at hand further underlines that physical demarcation is an important aspect of control. The user experiences control, when there is a visible demarcation of one's own workplace (Wackernagel, 2017). That can be achieved either by demarcation or by other nonverbal signs like markings (cf. Altmann, 1970). Furthermore it should not be possible that people walk by the workplace (Wackernagel, 2017). Well designed nodes are located centrally close to multiple main routes, act as neutral territory and offer wide views (Bechtel, 1976; Becker 1990). For workplaces with a high extent of *The Space Provides Control* the opposite is true. They should not be placed directly at main routes, as users will experience here more distraction (Kupritz, 1998).

The ability to control the environment is also experienced if a regulation of physical workplace conditions like sounds or noise is possible (Walden, 2008). The study of Wackernagel (2017) furthermore shows that users experience control when demarcations enable protection from acoustic disturbances, also if there are retreat possibilities for concentrated working, for quiet and tune out. Opportunities to retreat offer the individual the possibility of a timeout from overstimulation, continuing environmental demands, stressors and work routine. That reduces stress because opportunities to retreat offer a break which in turn supports the recovery of cognitive abilities (cf. Flade, 2008). Also niches for retreat and shielding from stimuli reduce the straining effect of high levels of stimulus and reduce the negative effects of crowding and noise (Wachs & Gruen, 1982).

### 3. METHODOLOGY

For the analysis of the space factor *The Space Provides Control* it was possible to use the planned introduction of a new workplace concept at the headquarter of a German automobile manufacturer. The company buildings at the site have all very similar floor plans. Before the new workplace concept is implemented in all office spaces, a pilot space is to be set up and tested. This pilot space is to be developed for a complete regular floor with about 170 employees. For evaluation and optimisation of the new workplace concept the current floor plan is contrasted with the draft of the new workplace concept. Thereby the decision making process during the planning phase is to be facilitated.



Figure 3 - Comparison of the old and the new floor plan in the same building on the same floor

The old workplace concept equates a classic open plan office. The whole floor is an open space. In the area the workplaces are arranged in cubicles, separated by dividing walls – mainly 160 cm high – from the aisles. At the insides cellular offices – mainly single offices – for managers are situated. In addition there are four conference rooms for the whole 170 employees. The central core cannot be crossed regularly.

In the new workplace concept the big area is more often crossed. Here too the workplaces are arranged in the open space. There are no individual offices, but a large number of meeting rooms and retreat rooms that can be used by all of the employees. Furthermore there are informal zones established at the inside. The central core in this floor plan can be regularly crossed. In the front area a vast encountering zone was established that can be adapted specially to the requirements of the departments.

Both the floor plans are being examined with regard to the space factor *The Space Provides Control* by means of a visibility graph analysis (VGA) and an agent-based analysis by UCL Depthmap.

#### 4. ANALYSIS

In the following the interior design elements of the factor *The Space Provides Control* are successively presented and the respective graphical analyses explained.

##### 4.1. THE WORKPLACE IS PROTECTED FROM THE EYES OF THE OTHER USERS

A - old floor plan

B - new floor plan

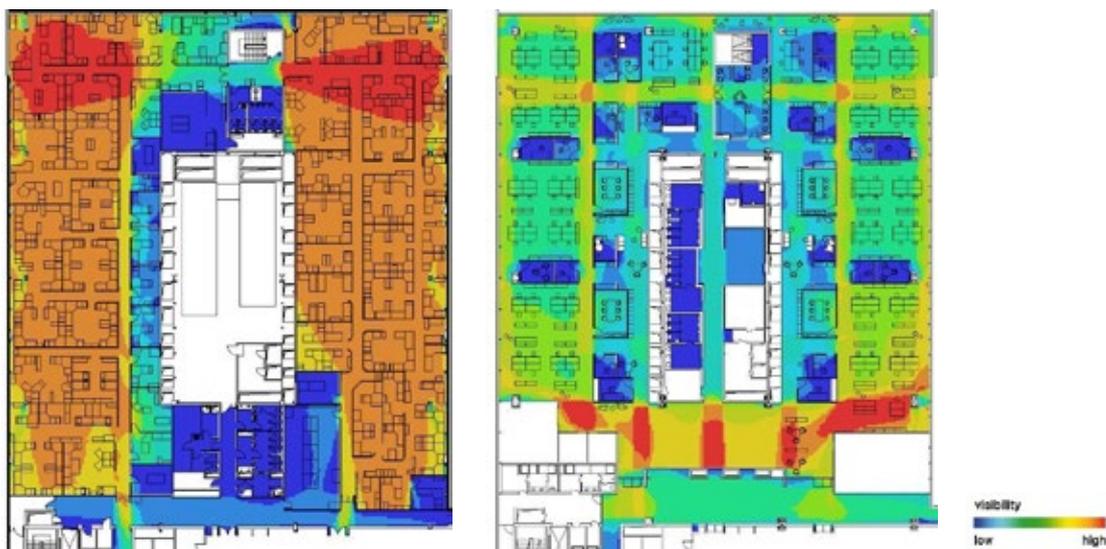


Figure 4 - Visualisation of the interior design elements *The workplace is protected from the eyes of other users, Colleagues are not directly aware of your presence at the workplace and Colleagues' workplaces cannot be taken entirely with one glance* (Wackernagel, 2017) while standing, walking or crossing the area, method visual integration (VGA)

Initially the visibility while standing, walking or crossing the area was examined. For the application of the VGA all components of the area smaller than 2.5 m were removed. This result is however only valid if all employees are standing, as at farther distances sitting colleagues cannot be seen directly.

Figure 4, 5 and 6 show the spatial indicator of visual integration (Hillier/Hanson). High integrated spaces are visualised in warm colours like red, orange and yellow. More distant and inaccessible areas - segregated spaces or low integrated spaces - are shown in cooler colours like green and blue.

A – A very high integration exists in the red-orange areas which includes the major part of the workspaces. Hereby the standard workplaces exhibit a high measure of insight. The offices of the managers consist of glass, so these also show insight, even though they only show little integration. The closed rooms show the lowest integration (dark blue). Solely here the user is protected from the eyes of other users. Cf. Figure 4 A.

B – The VGA of the new workplace concept exemplifies that only the front area, reserved as encountering zone, shows a very high integration. The working areas show a medium characteristic (green). The meeting rooms with glass walls have medium blue portions and therefore lower visibility. The closed think tanks and meeting rooms have a low visibility (dark blue). Therefore standard workplaces have a lower visibility as in floor plan A. Locally the users still can be seen by their colleagues. The users nevertheless have a lot more retreat rooms where on demand and temporarily they are protected from the eyes of other users. Cf. Figure 4 B.

A - old floor plan

B - new floor plan

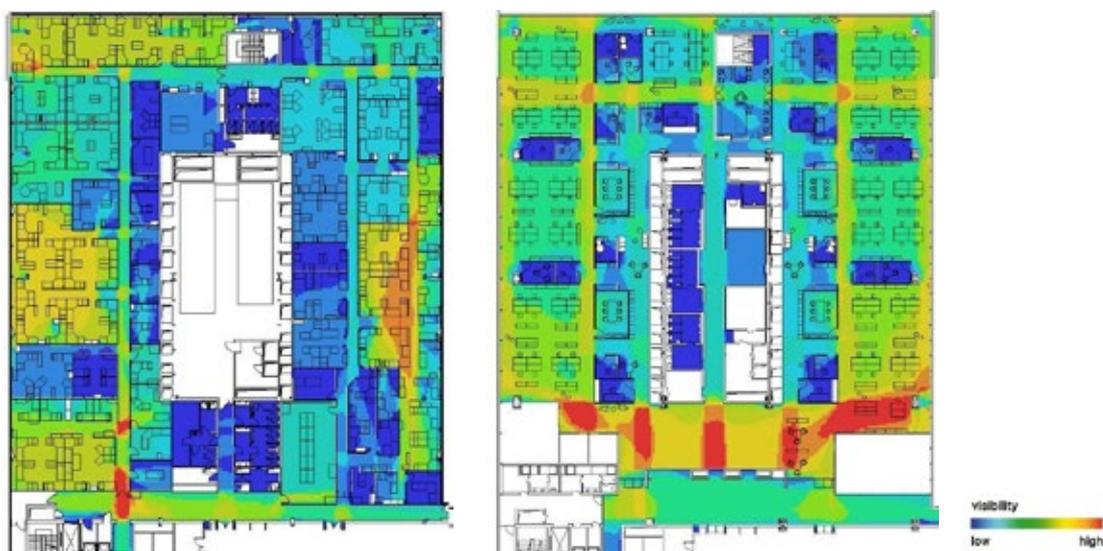


Figure 5 - Visualisation of the interior design element *The workplace is protected from the eyes of other users, Colleagues are not directly aware of your presence and Colleagues' workplaces cannot be taken entirely with one glance* (Wackernagel, 2017) while sitting, method visual integration (VGA)

To examine the visibility while sitting, e.g. at the workplaces, another VGA was conducted. For this all components of the area smaller than 1.6 m were removed.

A – First of all it becomes clear that the areas with standard workplaces show a different rate of integration. A very high integration exists in the red – orange areas, these workplaces are not protected from the eyes of other users. However some workplaces show a low integration (middle to dark blue) as well as the closed offices and meeting rooms. Cf. Figure 5 A.

B – For this comparison the same VGA of the floor plan was used as in figure 4, as there are no dividing walls. The visual integration of the workspaces is very evenly distributed and even though the employees are less exposed to the eyes of their colleagues the workplaces are not protected. Cf. Figure 5 B.

#### 4.2. COLLEAGUES ARE NOT DIRECTLY AWARE OF YOUR PRESENCE AT THE WORKPLACE

This characteristic is covered by the analysis under 3.1.

#### 4.3. COLLEAGUES' WORKPLACES CANNOT BE TAKEN IN ENTIRELY WITH ONE GLANCE

This characteristic is also covered by the analysis under 3.1.

#### 4.4. IT IS NOT POSSIBLE TO LOOK ON THE SCREEN

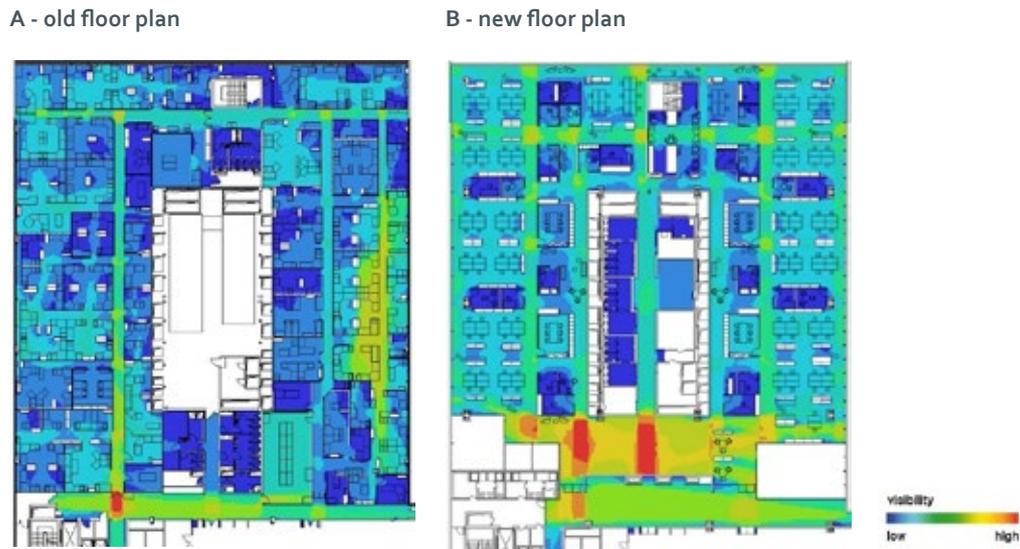


Figure 6 - Visualisation of the interior design element *It is not possible to look on the screen* (Wackernagel, 2017), method visual integration (VGA)

To examine the possibility to look on the screen of the user, another VGA was conducted. For that all components of the area smaller than 1.22 m were removed. Lockers up to 1.22m and dividing walls up to 1.6m were left to stay in the floor plan.

A – Under figure 6 it becomes apparent that the major part of the workplaces do have a low visual integration (mid to dark blue). Here the workplaces and with that the screens are only visible to a small number of persons (mid blue) or not at all (dark blue). Generally there is a high protection against the eyes of their colleagues.

B – The visual integration of the workspaces in this analysis is again very evenly distributed with a low integration (mid blue). Even when the protection is not as high as in floor plan A, there is just a small possibility by other colleagues to look on the screen. Additionally the retreat rooms are available to every employee without a possibility for other persons to look at the screen.

#### 4.5. IT IS NOT POSSIBLE TO APPROACH THE WORKPLACE FROM BEHIND

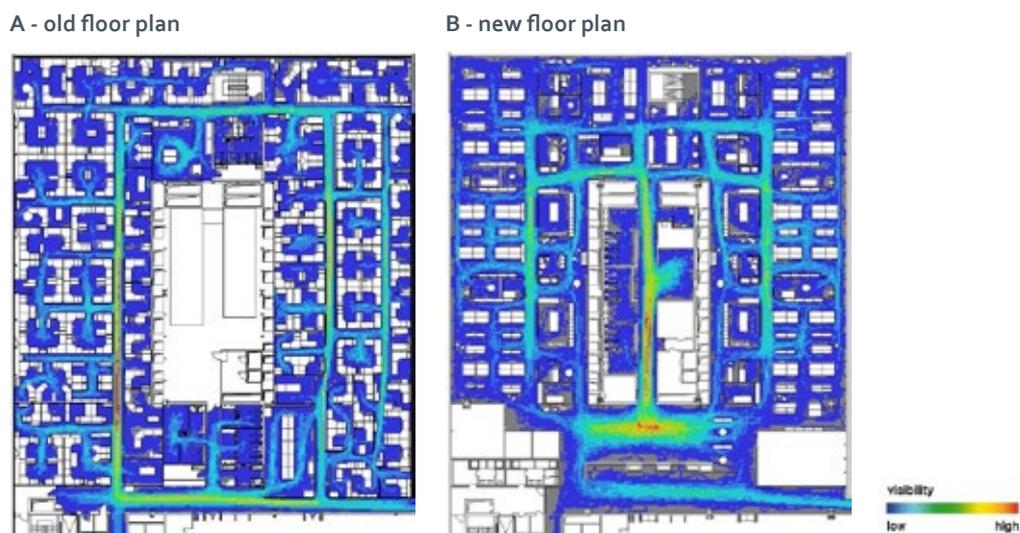


Figure 7 - Visualisation of the interior design element *It is not possible to approach the workplace from behind and People do not walk by other workplaces* (Wackernagel, 2017), method movement density

For the examination of the interior design element It is not possible to approach the workplace from behind a limited agent-based analysis can be conducted.

Figure 7 shows the agents' movements in space. Mid to dark blue areas depict less frequented areas and a low overlap of path network. Yellow, orange and red areas visualise highly frequented areas with a high overlap of path network.

A – The highly frequented paths (yellow to red) offer no access to the workplaces from behind the users. A general access from behind is made difficult. By looking at the floor plan it is evident that in most cases four users sit back to back, for these four users it is possible to approach the colleagues from behind.

B – In the new floor plan the highly frequented paths (red to yellow) also do not offer direct access from behind the user. By looking at the floor plan it is evident that all standard workplaces are protected at the back. This is achieved by lockers and walls. Access to the workplace can take place from the side. With this floor plan it is therefore made difficult to approach the workplace from behind.

#### 4.6. PEOPLE DO NOT WALK BY THE WORKPLACE

To analyse if people do not walk by the workplace the agent-based analysis from figure 7 is used. An overlap of many paths is shown in red, while an overlap of few paths is shown in blue.

A – The highly frequented paths (yellow to red) directly lead past the standard workplaces. As a separation to the workplaces there are however 1.6m high dividing walls along the main paths. The offices of the managers are also shielded by dividing walls from the highly frequented paths. Workplaces that are positioned next to the exterior walls offer a much higher protection against passers-by.

B – Also in the new floor plan highly frequented paths (yellow to red) lead past standard workplaces. Because of the opening up of the building core, a major part of the user streams will be diverted from the higher frequented paths in the area of the standard workplaces. At standard workplaces with green – yellow characteristics of medium movement density, demarcations 1.22 m high in the form of lockers are situated to divert the flow of traffic. Also in this floor plan the situation of the workplace close to the exterior wall increases the probability that people do not walk by the workplace.

#### 4.7. THERE IS A VISIBLE DEMARCATION OF ONE'S OWN WORKPLACE

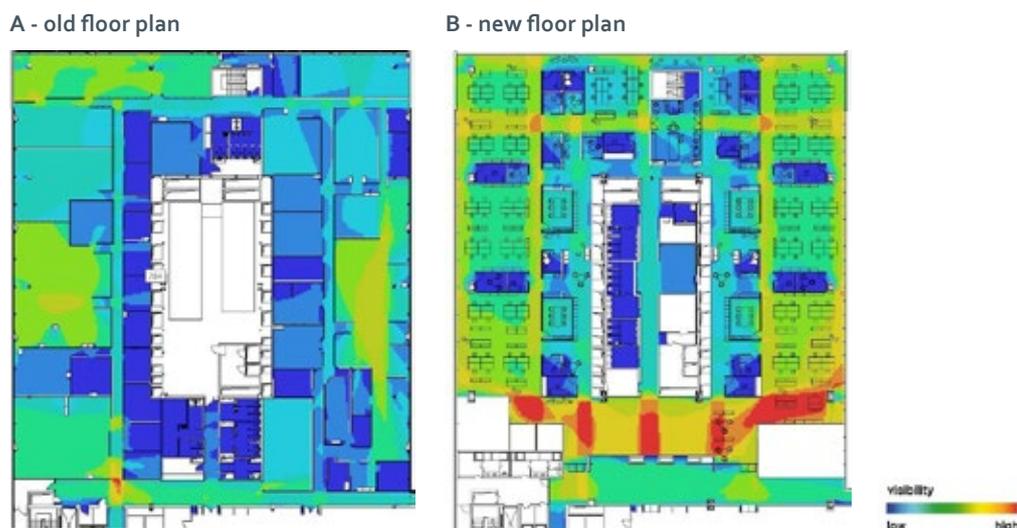


Figure 8 - Visualisation of the interior design element *There is a visible demarcation of one's own workplace* (Wackernagel, 2017), method visual integration (VGA). Floor plan A shows only walls and dividing walls to illustrate the existent demarcations.

The analysis of this interior design element by means of a Space Syntax Analysis is only limited possible. The utilisation of a VGA only plays a minor role.

A – In figure 8. the 1.6m high dividing walls were deliberately delineated, however these demarcations contain in most cases several workplaces. Other visible demarcations of one's own workplace cannot be identified.

B – By means of visual analysis of the floor plan there are hardly any visible demarcations to be identified. Only at eight desks that border on higher frequented traffic paths, 1.22m high lockers offer a visible demarcation of one's own workplace.

#### 4.8. THERE IS AN AGREEABLE DISTANCE FROM COLLEAGUES' WORKPLACES

An analysis of this interior design element with a Space Syntax Analysis is for the time being not possible. An outlook is depicted under item 4.4.

#### 4.9. DEMARCATIONS ENABLE PROTECTION FROM ACOUSTIC DISTURBANCES

The analysis of this interior design element with a Space Syntax Analysis is hardly possible. Here the utilisation of a VGA does not play a role.

A – In figure 8 the 1.6m high dividing walls were deliberately delineated. Also under the present item they constitute a visible demarcation that not only limits the diffusion of sound and noise, but is also a visual symbol for an acoustic protection from acoustic disturbances. Even if these demarcations encompass several standard workplaces, in this workplace concept demarcations enable protection from acoustic disturbances.

B – By means of a visual analysis of the floor plan there are hardly any demarcations that enable protection from acoustic disturbances to be identified. That is why you can only assume a very minor characteristic of this interior design element.

#### 4.10 THERE ARE RETREAT POSSIBILITIES FOR CONCENTRATED WORKING, FOR QUIET AND TUNE OUT

To analyse if there are retreat possibilities for concentrated working, for quiet and tune out, the VGA of figure 5 is used

A – The VGA visualises the few meeting rooms as low integrated (middle to dark blue). These could be used sporadically as a retreat for concentrated working, but the function of these rooms indicates that they were not thought for this purpose. Furthermore there is much too small a number of these rooms for the about 170 employees working on this floor.

B – In this floor plan there are additionally to the standard workplaces and the four larger meeting rooms a multitude of retreat possibilities planned. These can be used for either concentrated work as well as for tune out or to follow a need for quiet. For this, about 25 modules are planned. These are small rooms like think tanks, library, small meeting rooms and downright relaxation rooms. These are shown in figure 5 as low integrated (mid to dark blue). So the design element There are retreat possibilities for concentrated working, for quiet and tune out is depicted in floor plan B.

#### 4.11 THERE IS THE POSSIBILITY OF CONFIDENTIAL TALKS

For the analysis of this design element there is here also the reference to the VGA under figure 5.

A – As explained under item 4.10., the VGA shows the few meeting rooms as low integrated (mid to dark blue). These might be used sporadically for confidential talks. Furthermore there is a possibility of confidential talks in the single offices of the managers, these also show a colour range from mid to dark blue and can provide as the case may be, visual as well as acoustic confidentiality.

B – In addition to the bigger meeting rooms the users have, as already mentioned, a multitude of retreat possibilities available. These provide acoustic as well as visual confidentiality. Furthermore there is a high number of possibilities for informal meetings in the form of benches, seating corners, bean bags or standing tables. These are shown e.g. under figure 4 and 8 as low integrated (light blue) and may also offer an increased measure of confidentiality. So for the 170 employees there is a much higher number of possibilities of confidential talks available as in floor plan A.

## 5. CONCLUSION AND OUTLOOK

This paper had the goal of combining the environmental psychological study of Wackernagel (2017) with a Space Syntax Analysis to analyse spatial configurations of an office environment in relation to the factor *The Space Provides Control*. The attributes of the latter could mostly be analysed by means of a visibility graph analysis (VGA) and an agent-based analysis by UCL Depthmap. This makes it possible to review floor plans with a Space Syntax Analysis ahead of the approval of implementation into the working environment of the office and to optimise them based on these results. Thus this kind of analysis should be integrated in planning processes to design a new workplace. Furthermore it is a very good change management tool to meet the needs and concerns of users. The user can be informed and integrated into the planning process at an early stage.

The factor *The Space Provides Control* is a significant factor in relation to health, well-being and contentment with design. The Space Syntax Analysis thus can have a positive influence on the condition of the user of an office environment.

Based on this evaluation the workspace concept as shown here will be further optimised for the roll-out. For the 11<sup>th</sup> Space Syntax Symposium in July 2017 the 3<sup>rd</sup> draft will also be analysed and contrasted with the other two floor plans.

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