Wellbeing at new ways of working – acoustics

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ABSTRACT
The world of work has changed for knowledge workers. Exchange and collaboration is enormously important as well as concentrated work to generate new ideas and foster innovation. But often it is not so easy in the open spaces of the new office areas. The article highlights the concerns of employees and their challenges to deal with all the noise on modern workplaces as well as the advantages these also have. In the first part will be shown what people need to feel good at work and to be productive and healthy. In the second part different design solutions are shown with examples how to solve the challenges concerning noise and control at your own workplace. It also will be discussed how architects and change manager could help by explaining and monitoring the change process, support the understanding and help to get through the difficult phases of transformations. Layout proposals and helpful product solutions will be shown, which help to reduce noise. Ideas are explained for workshop sessions to get a better understanding from the people involved and which also help to learn to deal with noise.

Keywords: new workplaces, collaboration, noise reduction

1. INTRODUCTION
The world of work has changed for knowledge workers. Exchange and collaboration is enormously important as well as concentrated work to generate new ideas and foster innovation. But often it is not so easy in the open spaces of the new office areas. On one side you have the advantage to sit together, see each other and be able to exchange your ideas and work easily together, on the other side there are a lot of challenges to deal with, like noise, visibility, lack of privacy, interruptions and so on.

Every detail counts to support the wellbeing for employees at the workspace. Architecture that connects people with natural light, open offices that facilitate communication with colleagues and other overarching strategies provide the framework for the new work environment, but it’s in the details where a workplace becomes a good place to work.

The need for privacy at work, at least sometimes, is as basic to human nature as is the need to be with others. But the way each person controls distractions is very different. Too much noise can cause hypertension, sleep disorders, cardiovascular disease, impaired cognition and being annoyed. All are possible outcomes of too much noise around us. Many people complain about noise, but fewer realize how harmful it can be.

Another factor for complaining about noise in the working environment is dissatisfaction with other things at the workplace, like the leadership or stress with colleagues.

1.1 What does it mean – wellbeing at work?
There is a shift in the modern workplace. Wellbeing and care have become very important, as being essential parts for the modern knowledge worker to be productive and healthy, in order to deliver creative and innovative solutions. Lots of companies offer free, often healthy, meals at work, besides the free coffee and water, have ergonomics, yoga, massage and other courses and take care of the health of their employees.
But what is wellbeing for humans? To feel comfortable means to have a good mood and feel healthy. In the definition of the World Health Organization Health includes mental, social and physical wellbeing. (figure 1) Synonyms for wellbeing are sense of well-being, good health, welfare, comfortable feeling, complacency, wellness and so on. To feel well means a high level of felicity, inner quietude and a well balanced and good adjusted proportion to all forms of stress and hectic in the daily routine. To feel very well also means to be proactive in having a high level of initiative for your own wellbeing and your own satisfaction. The subjective wellbeing in psychology is the felt feeling of happiness in life or the satisfaction with one’s own live. Over all this means quality of life.

Concerning wellbeing at work in the mental and social context, that means to feel important, to know I and my work is appreciated and I, with my knowledge, can provide important contributions to the overall work done in the company. For the organization the general wellbeing of the staff is crucial to reach the level of innovation and creativity an organization needs to be successful.

Studies indicate that users can experience health impairments as the number of people in the office increases. In general, the incidence of psychosomatic symptoms is lower in smaller offices than in larger offices. There is a much lower rate of illness-related absence in single offices than in offices with 2-15 people and offices with even more workers. Individuals in offices with more than 16 people were most frequently absent due to illness (2). But if we want to reach a high level of collaboration, which is also important in the knowledge society, we no longer can sit in single offices, we need transparency and spaces for exchange and team work.

1.2 Influence of office environments

Studies show that there are lots of different features which influence our state of health. (3). In figure 2 all these features which have an important impact of our office spaces are shown graphically.
Spaces with good features on health trigger a positive stimulation through their interior spaces. They provide a high-quality range of diverse work environments, optimally matching to the specific requirements of certain work processes. Interesting extra areas with varied design and different furniture allow to have a conversation away from the desk, read in a relaxed atmosphere or even have a power nap to refresh the mind. The focus remains on the employees, who can choose the appropriate work environment flexibly according to current tasks and individual needs. Color and finishes as well as plants are carefully chosen, according to the culture and mindset of the organization. In addition to that, neighborhood zones are created to host teams and to provide orientation in the office environment.

Also important is that the space offers a certain personal control for the employees. Very important is to have protection from onlookers and an appropriate distance to colleagues. People feel unsafe if someone can approach them from behind and look at their screens without noticing. Confidential discussions should be possible as well as private calls. People also favor to have the ability to retreat in order to concentrate on work or for peace and quiet during a break as they feel a need of protection from noise.

Besides all that a certain consistency of space is important like order in the spatial structure, a common design theme and a good orientation. Different zones should be distinguished, room functions and furniture clearly discernible and the use of technology and room fixtures clearly recognizable and usable.

If you compare the satisfaction level of employees with different features at the work environment you always find that noise is the one which needs most attention, followed by having control over air quality and temperature.

Communication is important in the office, but you have to be aware that people talking can create a lot of noise. Studies show that small offices for three or four employees are the worst constellation concerning noise.

Figure 3 – Satisfaction level of employees (4)
Noise from people talking in a small room has a lot of influence on the behavior, the quality of the performance of work, the motivation of people and often means a loss of attention and concentration. It is very clear when it comes to factors such as acoustics, lighting, air quality and temperature. "If you don't invest in these prime factors, don't invest at all. Acoustics are key. Time and again, people fail to put enough effort into getting the acoustics right. Acoustics affect our behaviour and our productivity. The office design and the IT are the enablers." (6)

2. ACOUSTIC QUALITY AT THE WORKSPACE

What can we do to make a workplace a good workplace under acoustic conditions? Especially in open space projects you can face a high noise level because of the summing up of a lot of single conversations.

2.1 Basic principles and acoustical requirements

For a good room utilization with speech you should take into account the following aims for acoustical planning of rooms:
- Support the speech loudness, so that even unpracticed speakers are able to be understood without electro acoustic systems.
- No dependence on the speaking direction in case that the communication requires a changing speaker direction.
- High understandability of speech that permits the listener to follow the speaker without difficulties.
- Reverberation time reduction.

2.2 Requirements for open space

Most important for open space offices is, that there is, besides team oriented work, also the possibility to work concentrated and individually.

Technical and acoustical properties mean, that it must be possible that different people can have discussions without disturbing others and without compromising the accommodation of others and harass them. In those complex spaces it is not enough to reduce the reverberation time, to guarantee a good use of the space. It is also important to look into the requirements of the sound pressure level and the speech intelligibility.

An essential assumption for a successful acoustical planning for an open space is a zoning concept based on an occupancy and functional planning concept. Different work groups should be separated as well as communication zones and most frequented traffic infrastructures.

2.3 Example of an acoustic simulation

To fulfill the acoustic requirements and to get pleasant and comfortable spaces an acoustic
consulting with simulation of different solutions is necessary. (7) To explain the investigation concerning sound more deeply a small example of an open space area is used, shown in Figure 5. The position of the speaker is marked with a red triangle. The dispersion of the sound is directed to the left.

Figure 5 – open space area for the simulation

In the middle of the area is a phone booth to structure and divide the area. The space is for 28 workspaces, for the simulation 50% are occupied. Workspaces are in groups for 4 and the files are in shelves for 3 file heights, which means roughly 1,20 meters, to shed the workstations from the through traffic. On the floor is a continuous carpet. The suspended ceiling is from Rigips, with a ceiling height of 3 meters.

The first calculation of the room is used as a basis for the following acoustic measures. The space configuration is carpet on the floor (Heuga 725 from Interface) and Rigips Gyptone Quattro 20 for the ceiling.

Figure 6 – Basis model

In the first variation the influence of a different carpet is investigated. In the second one the acoustic influence of acoustic fonts for the furniture is studied with an acoustic blind. In the third and last variation it is examined if acoustic umbrellas between the workstations make a significant improvement of the space acoustics. (Figure 7)
2.3.1 Sound level

The next figures (Figure 8) show the results of the simulation. The graphics show the sound level in the space caused by one speaking person. It is obvious that the sound level is not much changed by the changed carpet (Variante 1). Outside of the direct area of the speaker (yellow spaces) the noise could be reduced through the acoustic ceiling. The noise level is 40 dB(A) in adjacent areas and 30 dB(A) in more distant areas, which is permissible.
Also variation 2 (Variante 2 in Figure 8), with the additional absorber at the fronts of the shelves doesn’t show much of an effect as the good acoustic ceiling is already sufficient. To reduce the noise from the speaker in the direct surrounding of the acoustic source it is necessary to add an acoustic umbrella between the two opposite workstations, which is shown on variation 3 (Variante 3 in Figure 8). However, the noise level behind the speaker is increased by the reverberative surface of the baffle board by 5 dB(A) which easily could be avoided with a sound absorbing panel.

2.3.2 Speech intelligibility

To have a good speech intelligibility is preferable with team oriented workstations. In larger distances in an open space is speech intelligibility rather a disadvantage.

The speech intelligibility is measured by the speech transmission index (STI). The index describes the voice transmission and the intelligibility in a room. Next to all room reflections the static noise is considered. A value of 0% stands for a very bad intelligibility of the speech and a value of 100% stands for a very good intelligibility of the speech.

For an office area STI data like > 0,60 (red to yellow) show a good speech intelligibility, < 0,45 (blue) stand for a bad speech intelligibility.

In the STI scale the numbers mean:
- 0-0,3 incomprehensible
- -0,45 weak
- -0,6 adequate
- -0,75 good
- -1,0 excellent

Figure 9 – Speech intelligibility
From the color distribution you could see that in the direct neighborhood of the speaker a very good speech intelligibility exists. That is for individual discussions at the workspace reasonable and desirable.

The arrangements in variation 1 and 2, the change of the carpet (Variante 1) and the absorption surface on the shelf (Variante 2), are not very effective.

Adjacent workstations, which shouldn’t be affected by these kind of talks, need an acoustic screen to reduce the speech intelligibility under 0.45 STI. As shown in Figure 9, you only get those blue colored areas if you have structural or furniture solutions with a height of at least 1.40 meters to reduce the sound dispersal of the sitting persons. (Variante 3) All other areas without shielding – the group workspaces – show a sound distribution with a corresponding high speech intelligibility at the neighboring workspaces.

3. CONCLUSIONS

There are some general means you could keep in mind to achieve good working conditions in open plan offices. An improvement of performance and speech privacy can be achieved by reducing STI at large distances from the speaker. With the “ABCD” principle – absorb, block, cover and distance – it is possible to damp speech and add background noise with helps to get overall better sound conditions in the office. (8)

• Absorb on ceiling, walls, furniture
• Block using screens between desks
• Cover the speech by sound masking
• Distance between desks should be at least 2.5 m

Sound masking can mean individual systems, like using headphones. The noise level should be at most 45 dB to enable conversations at normal speech effort. Normally it is better to have natural sounds, these are more comfortable than brown noise, also music is not recommended.

![Diagram](image)

Figure 10 – The ABC of acoustic design (9)

It is important to start very early in the project to work with all people involved on good solutions for the office environment. Qualified change management is absolutely necessary for the involvement of the user very early on. This participation in the design of the environment always increases satisfaction with the final solution. Staff awareness is increased and the purpose of open space offices is understood and the user gets information on how to behave to reduce annoyance.

You also should have the ABCD principle in mind and add enough support spaces, like small (tele)meeting rooms and additional rooms for concentration in demanding work periods. Think about isolating the office zones from coffee areas, aisle, etc. and to think of phone booths i.e for private calls. Always consider the culture of the organization, already in the planning process and develop an office etiquette, where you develop “Spielregeln” (office rules), decide if you want to wear headsets and plan...
dedicated areas for intensive concentration (silence) and interactive work (free conversation).

There is a need for complementary parameters for the acoustic evaluation of open plan offices. Ordinary room acoustic parameters such as reverberation time are not sufficient for a relevant characterization of the acoustic environment in open plan areas. The influence of interior design on sound propagation over distance is a crucial factor for the overall impression of the acoustic environment and its suitability as an effective workplace.

In Europe, the purpose of using an open plan structure is often to create flexible solutions that support communication between employees and working teams, but such a structure also permits concentrated work. In these environments, the creation of a high level of speech privacy is normally not a realistic goal or even an intention. Instead, the organization of work stations should support communication between members of the same team but depress speech sound from neighboring groups working on other projects. This implies that the prevention of sound propagation over long distances is important. (9)

Besides it is important to take into account the multidimensional character of people’s perception of sound, as well as the character of the room (shape, volume and distribution of absorption) and the activity that is planned for the room. These three factors interact and have to be considered in the acoustic design in order to secure an appropriate acoustic environment.

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