DECREASING MULTISENSORY NUISANCE IN AN OPEN OFFICE: RESEARCHING AND DESIGN FOR THE EXPERIENCE OF OFFICE USERS

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Colophon

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TABLE OF CONTENTS

FOREWORD

I would like to start of this report by mentioning how much I enjoyed working on this project. The project focused on helping the Com&In team understand the experience of nuisance of co-workers within the office. This intruiged me, since it allowed me to create a better understanding between two groups of people who were both willing to communicate, but simply unable to due to the complexity of the dialogue. This pushed me to be constantly critical of my communication, which frustrated me but also allowed helped me grow a lot.

Within this project I engaged deeply with co-workers from the start. While this was difficult at first, I was surprised by their openness and willingness to help. Their effort helped me to create an insight for the Com&In team that helped to prioritse and better understand the issues to tackle. Following I researched how the perception of nuisance could be decreased. My scientific approach here shows how increasing the sense of control and material perception can be applied as tools to decrease the experience of nuisance. This shows that understanding perception can help to decrease nuisance, not only at IKEA, but in open offices in general.

This I could not have done withouth the positive attitude and willingness to help of the many co-workers and Com&In team. I'm still humbled by their trust and investment of effort and time, even when activities they were doubtfull about the outcomes and pushed them to do things they were unfamiliar with.

Next to this I want to thank Tomasz Jaskiewics & Sylvia Pont, for all your advice throughout this project. Your feedback always pushed me to be critical on my work. For me this hasn't been easy, especially since I always wanted to do more. Thank you for helping me to focus on quality and steering my into a realistic direction. Your ideas and enthusiasm and ideas, motivated me and helped me grow a lot as a designer and researcher.
Following I want to thank Annemarie van der Keur and Janine Jacobs, for guidance throughout this project. You both made me feel like a co-worker from the start and helped me find my way as a somewhat odd designer within the organisation.

Also I would like to thank Joop Geuze and Ayla Silos of the Com&In team, for the wonderful discussions and feedback about the many things

Furthermore I want to thank my family and friends, for their advice, good vibes, and time whenever I needed it

Finally I want to thank Bahareh Barati, Elif Ozcan Veiera & Elvin Karana, for paving the way for me. Their scientific work and help in connecting the dots, helped to make this project into a success.

EXECUTIVE SUMMARY

In the past few years, many companies have made the transition from an office with closed working spaces, towards open offices. The Dutch office of IKEA CBF made the transition to an open office in 2016, to support an activity-based way of working. This new way of working has to lead to an increase in complaints, about noise and distractions within the office. Co-workers commonly related this experience nuisance to auditory stimulation, however, visual or temporal stimuli could contribute to this as well.

The experience of the office was researched from a co-worker centered perspective, through interviews and contextmapping session. This revealed that co-workers mainly experience nuisance, when they are being distracted during individual focused work activities. Co-workers identified that they experience nuisance caused by six main sources, both relating to the behavior of co-workers and office facilities. Where most co-workers experienced nuisance from co-workers conversation and movement/foot traffic.

The amount of nuisance a co-workers experiences is mainly dependent on their role and the amount of individual work activities they perform. nuisance, than other co-workers. Next to this the individual experiences of co-workers are influenced by factors that influence the presence of specific sources and co-workers general ability to deal with nuisance. Co-workers here most frequently identified that individual needs and a low awareness about their own effect on their surroundings, to affect their general experience of nuisance. Finally co-workers all had an equal access to tools to protect themselves from nuisance. Consequently, co-workers' general experience of nuisance could most effectively be decreased through a design intervention that improves co-workers' ability to protect themselves from nuisance during individual work.

Next to this co-creation activities with the Com&In teamshowed that a physical design intervention, that could be applied as an individual solution to protect co-workers from nuisance, would most likely lead to valuable insights for the Com&In team.

Following I developed Fridfold, a stimulation barrier aimed at decreasing the amount of nuisance that co-workers experience from co-worker conversations and interruptions while working at their desks. This design aimed to make working at an individual deskspace feel 'fridfull' or serene, by having a calming effect on co-workers. To achieve this Fridfold was developed to both decrease the amount of stimulation and co-workers perception of stimulation. To achieve this, Fridfold aims to decrease co-workers perception of stimulation by increasing co-workers sense of control, through the interactivity of the design, and the perceived sound damping of materials, through the application of a three-dimensional textured screen.

The evaluation of the design with students and co-workers showed that the Fridfold influenced the amount of visual stimulation and improved co-workers sense of control, through the interactivity of the design. Furthermore co-workers envisioned that Fridfold could decrease the nuisance experienced from interruptions. While three dimensional-texture of the screen could not influence the perceived sound damping due to other characteristics of the screen. Therefore, Fridfold should be evaluated within the context of the office to identify how the design can influence coworkers' general experience of nuisance.

I:
NUISANCE IN THE OFFICE OF IKEA

About Open Offices

Open offices give employees the ability to use workspaces based on their personal needs during various tasks, giving them more authority over where and how they work best. This way of working causes employees to make more movement throughout the office space, which is envisioned to have two main effects. First of it should lead to more effective use of the space available within the office. Secondly, it should lead to more spontaneous and unexpected encounters between co-workers, leading to more collaboration and innovation within the organization.

Currently, research on open the flexibility of workspaces offices is not conclusive on the effects. Here a study on desk ownership showed that employees with a flexible workspace were generally more satisfied with their work environment than employees with a fixed workspace (Kim et al. 2016). While a review of multiple office environment studies showed that employees within an open office were less satisfied (Davis et al. 2011). This indicates that other factors besides the flexibility of the workspace influences employees' experience of an open office.

Organizations commonly make the transition to open offices to improve collaboration, they seem to have the opposite effect. Here employees in them actually experience less face to face encounters with their co-workers and show employees withdraw from officemates (Bernstein & Turban, 2018). While another study found that employees' perception of supervisory support decreased, within more flexible work environments (Morrison & Macky. 2017). This shows that instead, the openness of the space may create more social distance between employees.

Besides the social distance, working in open an office influences the productivity of employees. Employees in open offices generally had shorter attention spans and lower productivity (Davis et. al. 2011). This may be the result of disturbances and other distractions, that employees of an open office seem to experience more often and are shown to influence their productivity (Brennan et. al. 2002).

Definitions and abreviations

Throughout this report the terms and abreviations described here are commonly used, what they stand for is explained below.

IKEA CBF
The Core Business Franchise organisation within Inter IKEA systems B.V.

Com&In team
The Communication and Interior design team of the IKEA Core Business Franchise organisation

Co-workers
Employees working within the CBF Office of IKEA Delft

Multisensory nuisance
Nuisance that is caused by a combination of stimuli related to the different sensorial modalities.

MEV
The material experience vision for the design intervention (p.29)

IV
The interaction vision for the design intervention

Context of the project

The research throughout this project focuses on the context of the open office of the IKEA Core Business Franchise (CBF) organization in Delft. IKEA made the transition to an open office in 2016 and has been working in this way ever since. The office fits around 250 employees in seven different assignments, who all have on core tasks and consist of various specific teams.

The co-workers at IKEA CBF

The Co-workers within the CBF organization of Inter-IKEA Systems (IIS), are responsible for the development of IKEA as a franchising company. Their activities include guiding and evaluating store operations around the globe, providing training, determining the approach and strategy for expansion worldwide, and developing retail concepts and services of IKEA. Co-workers work across four different offices, three in Sweden and one in Delft, to achieve this. A team here consists of members from all four offices, which means that they may travel between offices for meetings. Which caused so much fluctuation in the composition of the workforce at each office, that it became logical to create open-plan offices.

Activity based working at the CBF IKEA Office

The different areas in the office are designed to support different types of office work activities. The goal of this is to achieve a more collaborative and personalized way of working, by stimulating co-workers to make use of multiple workspaces in the office, leading to more spontaneous encounters between co-workers To achieve this, co-workers are expected to move from one area to another when they switch tasks.

To facilitate this, IKEA created different spaces for four types of office activities (fig.1): Individual focus work, Collaborative work, Creative collaborative work, and relaxing social activities. An elaboration of the function of these spaces can be found in Appendix A2. Each of these spaces is designed to support the execution of a specific (set of) task(s) and has specific rules related to this space

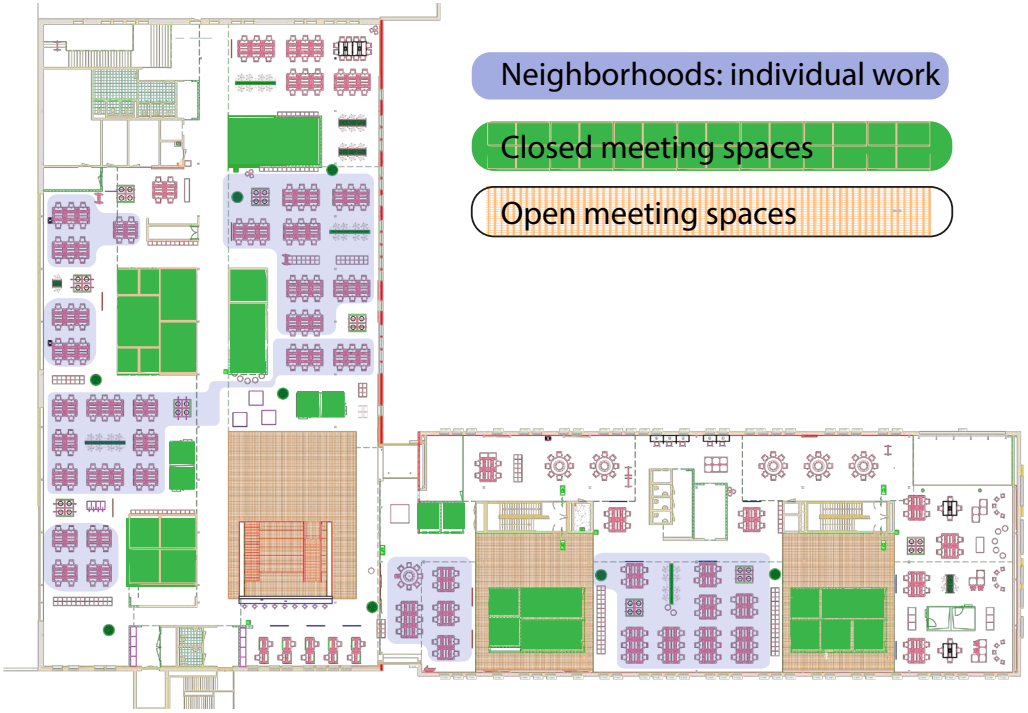


Fig.1: An overview of individual workspaces and meeting spaces, used for collaborative work and social activities, within the plan of the IKEA CBF Office in Delft

The role of the Com&In team

The client for this project is the Communication and Interior Design (Com&In) team at the Core Business Franchise (CBF) Office of IKEA Delft. They are responsible for improving the well being of their co-workers and creating a ‘fun’ and ‘inspiring’ place to work (fig.2). They achieve this by designing the layout and objects within the workspace, for both day-to-day use and events. For this they initiate and lead projects, that are commonly initiated by team managers, but also by co-workers also reach out to them directly. The goal of these projects is to improve the well being of co-workers within the workspace of IKEA.

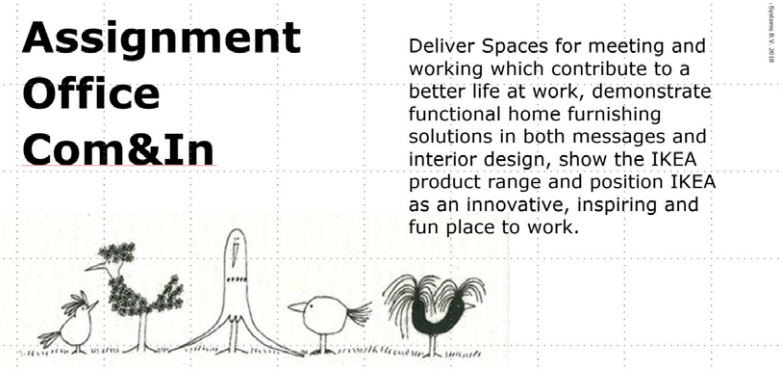


Fig. 2: The mission statement of the Com&In team

Nuisance within the open office of IKEA Delft

Co-workers expressed complaints about nuisance in the open office, since the transition to an open office and activity-based way of working in 2016. These complaints were initially viewed as a consequence of the transition, however, this turned out not to be the case. Where the number of complaints increased after the transition but did not disappear, after co-workers adjusted to the new way of working. This reveals that nuisance is still a structural problem within the open office of IKEA Delft.

The current way in which complaints are voiced, make it difficult for the Com&In team to address nuisance, for two main reasons. First off, the individuality of the cases makes it difficult and time-consuming to categorize and create an overview of the situation. Secondly, it’s difficult to assess the severity of issues, where they often receive complaints but rarely receive positive feedback regarding what works well. Because these cases are individual and the impact of these experiences is difficult to assess, it’s difficult for the Com&in team to understand and create an overview of the experience of the average co-worker. This project, will, therefore, focus on creating an overview of the various sources of nuisance, understand how they influence co-workers experience and how they can be addressed.

The Com&In team does not yet have a clear overview of these sources but do recognize some consistency. For instance co-workers in the Identity Range and Communication often voice complaints about other co-workers who converse next to the FIKA station, which is the coffee area. Next to they noticed that co-workers commonly claim a ‘Phonebooth’ for a whole day, instead of the 15minutes it is intended for. They use these spaces for individual work, which they could alternatively perform in the Neighborhoods or Library. Both examples suggest that co-workers experience nuisance in situations where different types of activities are performed within one space.

Multisensory Nuisance within the open office of IKEA Delft

Within the open office at IKEA Delft, the Com&In team receives complaints from co-workers concerning nuisance, that are difficult to grasp. There is no clear overview of what causes this nuisance and what type of stimulation and context factors play a role in this, which has lead to the initiation of this project.

Multisensory nuisance is a problem experienced in many open offices. However, there is conflicting evidence regarding its exact nature Auditive, visual, olfactory, and haptic stimuli may all affect how people perceive a space (Yanagawa, 2019), (Zuidhoek, 2005) (fig.3). The employees of the open office at the CBF department of IKEA express they experience nuisance as the result of sound. However, the perceived intensity of sound may be influenced by interactions with other sensory modalities(fig.3). These interactions, for instance, happen for visual perception, where visual stimulation can be both suppressed or enhanced by auditory stimuli(Vroomen, 2000) (Hidaka, 2015) and suppressed by tactile stimuli (Ide, 2013). This makes it difficult to determine which type of stimuli have the most influence on the experienced nuisance within an office. Especially because humans are incapable of perceiving all small changes in stimuli, while these can still have a physical effect, which has been shown for visual stimuli (Tsunetsugu. 2004). Finally, the meaning of a stimulus may also play a role, where for instance seeing the material can influence the perceived effectiveness of sound barriers (Joynt, 2010). As a result, I will focus this project on understanding the experience of multisensory nuisance within the office and the role that different sensory modalities and perception play in this.

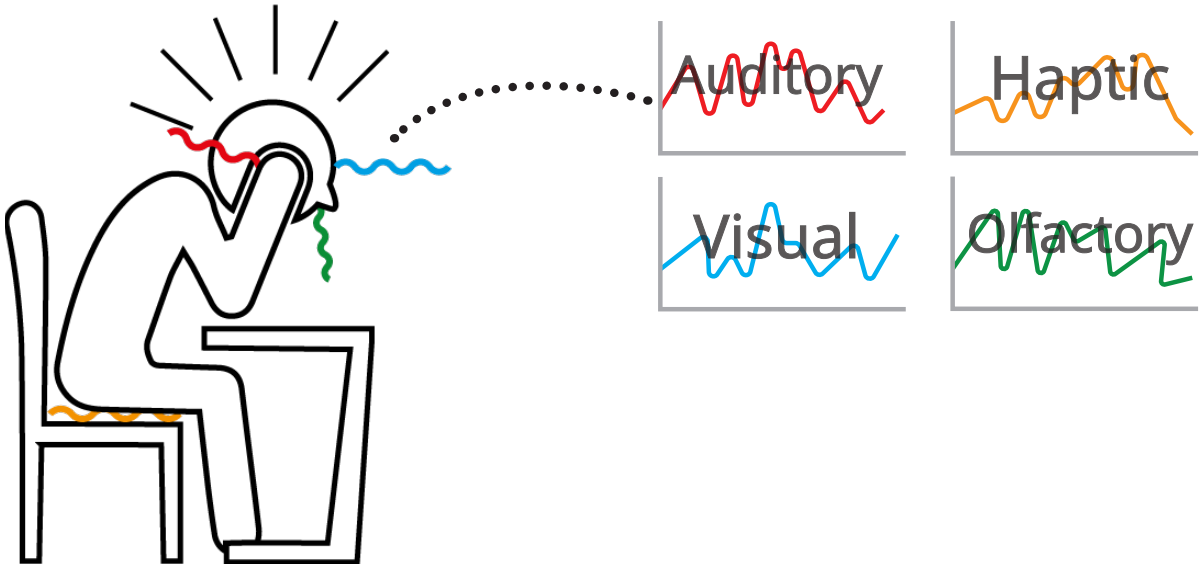


Fig. 3: Auditory, visual, olfactory and haptic stimuli all contribute to the perception of a space

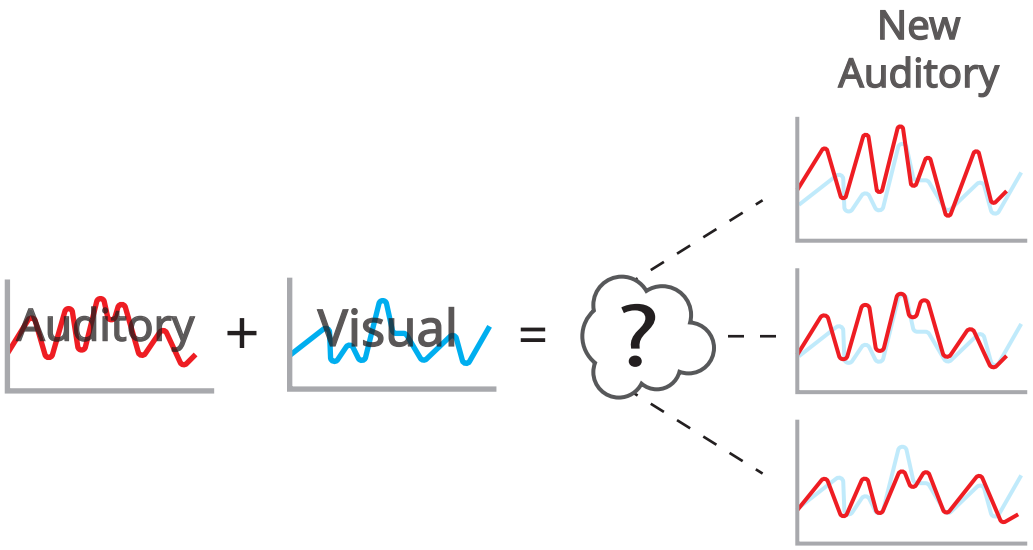


Fig. 3: Stimuli influenced each others presence across modaliteis the perception of each other intermodal

Understanding co-workers experience of multisensory nuisance

The aim of this project is to create an insight into co-workers' experience of nuisance, which is currently difficult for the Com&In team. Firstly, because nuisance is expressed by individual co-workers, which make it difficult to get an insight into the impact of the various sources and experience of the average co-worker. Secondly, because the experience of nuisance within the office is usually multisensory, which means that stimuli from different modalities, such for instance visual, auditory, and temporal, play a role in this. Co-workers, however, can not always identify these stimuli separately, which makes it hard to identify which source contributes most to the experience of nuisance. My insights should, therefore, provide the Com&In team of IKEA Delft with an overview of the main sources of multisensory nuisance, the sensory modalities that play a role in this, and insight into how many co-workers experience this.

To help the Com&in team tackle these sources of nuisance, they should also be able to understand when and why co-workers experience nuisance (fig.4). The anecdotes the Com&In team gave the impression, that nuisance is commonly experienced in situations, where co-workers perform individually and collaboratively activities in one space. Because of this, I decided to investigate if the nuisance is dependent on the amount of individual and collaborative work that co-workers perform. Next to this, co-workers work in different spaces throughout the day, to support the activity-based way of working. This shows that co-workers needs change throughout the day and depend on work activities. I, therefore, expect that it will be useful to create an overview of these needs during various work activities

To summarize, I will throughout my project create an overview of the main sources of multisensory nuisance and reveal the factors that influence co-workers individual experiences, with the goal to empower the Com&In team to address nuisance on their own.

fig.4: Co-workers working within this Neighborhood indicate that they experience nuisance from a variety of sources

II:

RESEARCHING EMPLOYEES IN AN OPEN OFFICE

a) Method

To gain an initial understanding of co-workers' experience of the office, I performed semi-structured interviews (fig.5). These focused on identifying the work activities that co-workers perform and how their experience of nuisance related to this. The set-up of these interviews can be found in Appendix A2.1. The interviews were conducted in a semi-structured way, using a fixed set of questions, where the order of questions depended on the conversation. Next to this I made use of laddering (Reynolds, T.J. 1988), which helped to gain an insight into co-workers experience of nuisance, without influencing the results. This helped to identify the needs that the different workspaces should fulfill for co-workers and during which tasks they experience nuisance. The outcomes of thes interviews should reveal the potential sources of nuisance, however, they did provide any tacit insights into the factors influencing co-workers' individual experiences.

Following, I created an overview of the main sources of nuisance and factors related to this, by conducting two context mapping sessions with co-workers (fig.6). These sessions focused on creating an overview of the main sources of nuisance that participants experience and factors that they related to this. The set-up of these sessions can be found in Appendix A3.1. To here immerse co-workers before the session and gather information on co-workers' activities, use of workspaces, and needs, I created a sensitizer for co-workers to fill in before the session. These sessions started off with an immersive activity, to make co-workers aware of the role that the individual sensory modalities that can play a role in the experience of nuisance. Following I organized two discussion rounds. Where the first focused on creating an overview of the sources of nuisance and the second focused on co-worker interruptions as a source of nuisance. I decided to investigate this source specifically, because during the interviews co-workers often mentioned interruptions as a specific source of nuisance. The session ended with a co-creation activity, where I asked co-workers to form groups of three to

fig.5: interview set-up and documentation

fig.6: Context mapping set-up and documentation

pick the source of nuisance they experience most and prototype a solution to tackle this. Following I asked them to present the impact of a solution, by roleplaying a specific situation where a co-worker experiences nuisance. This helped to further reveal how co-workers think nuisance can be addressed. As a result, these sessions provided me with both insights into the specific sources of nuisance and factors co-workers relate to them as well with information to further understand the link between co-workers' work activities, roles, and experience of nuisance.

In the interviews and context mapping, twenty-five co-workers of the IKEA CBF Office were involved. These participants were selected such that the results represent a sample of co-workers, with a variety of roles, working in different teams, and who perform individual work in neighborhoods all across the office (fig.7). The aim of this was to identify which work aspects, influenced co-workers' experience of nuisance. For the context mapping session, I already narrowed down this group. This was because co-workers with a manager or HR function during the context mapping session, consistently indicated to experience little nuisance. This meant that it was difficult for them to provide input that could contribute to a better understanding of nuisance in the office. Consequently, the majority of the co-workers involved had the role of project leader, topic specialist, team support, or simply co-worker.

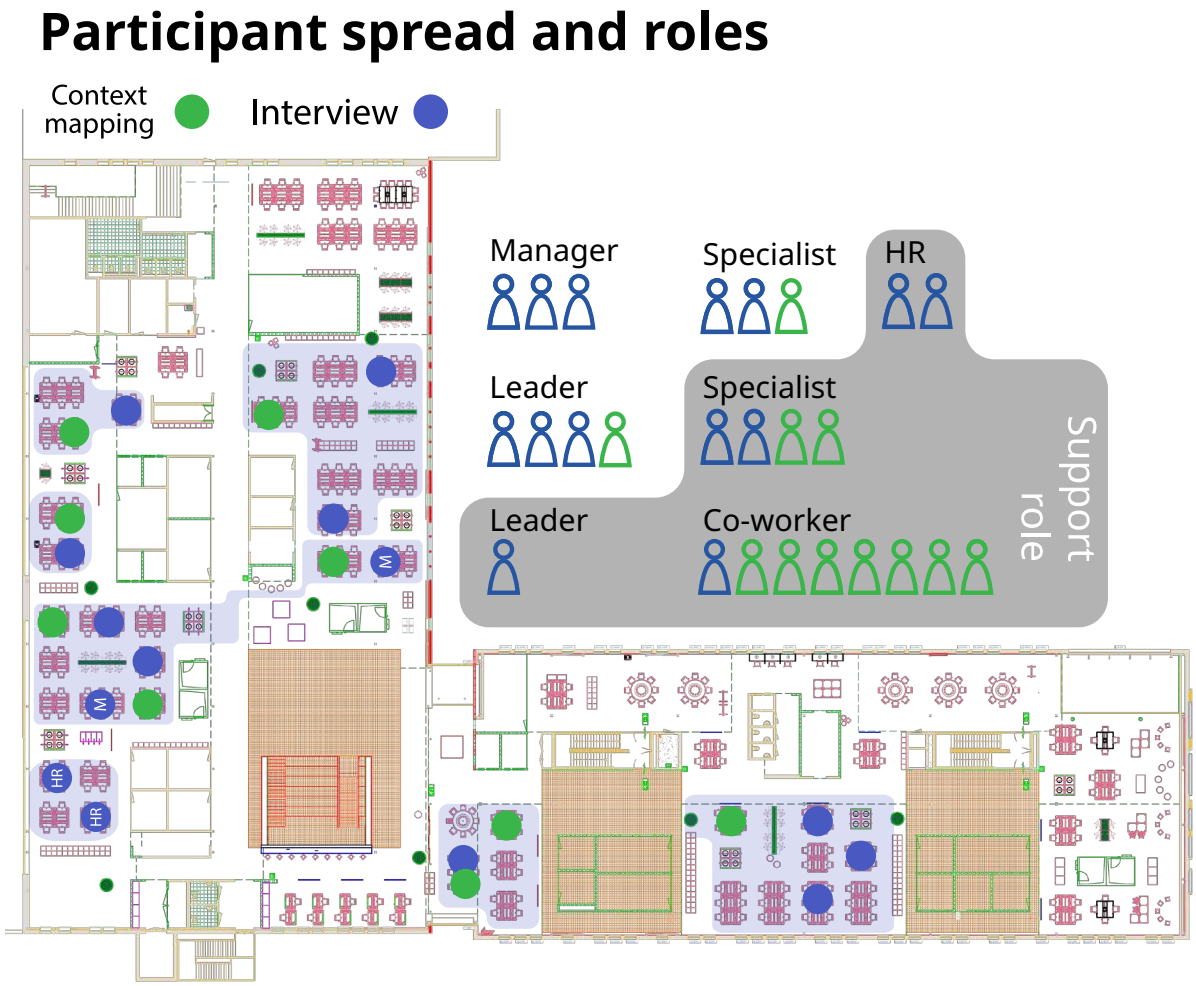


fig.7: Overview of the roles and neighborhood locations of the co-workers who participated in the interviews and contextmapping sessions

Analysis approach

I analyzed the data from both the interviews and context mapping sessions both quantitatively and qualitatively. To do this I made audio recordings of these activities and transcribed these into a set of quotes. I used these quotes to make an analysis on the wall (Sanders & Stappers, 2014) (fig.8). This helped me to create an overview of the individual and collaborative needs of co-workers, work activities, roles and gave an indication of how they experience and deal with nuisance. I analyzed the outcomes of the context mapping session by creating a matrix for analysis (Miles & Huberman, 1994) (fig.9). Within this matrix, I integrated quotes from the audio recording and sensitizers. To then understand the most important sources of nuisance and factors related to this, I performed a frequency analysis on both datasets. These lead to a quantified insight into which sources of nuisance are experienced by most co-workers. Finally, I created an overview of the roles of co-workers and their work activities, by integrating data from the sensitizer, into the wall analysis. This helped to understand the relation between co-workers' tasks and experience of nuisance. Besides this, it helped to determine if the participant sample is representative of the office as a whole. In summary, through this analysis, I was able to integrate the results of both the interviews and context mapping, which helped to present the analysis as a whole and present a more trustworthy overview of the sources of nuisance and context factors.

To communicate co-workers experience nuisance to the Com&In team, I created an visual overview of the individual sources of nuisance and how many co-workers experience these. Next to this I created a poster to show the factors that influence how co-workers ability to deal with nuisance. Finally I created posters to present the individual sources of nuisance and factors influencing the presence of this source. For this, I once again used the data from the frequency analysis of both sets in combination with representative quotes and photos to illustrate co-workers' experiences in the office.

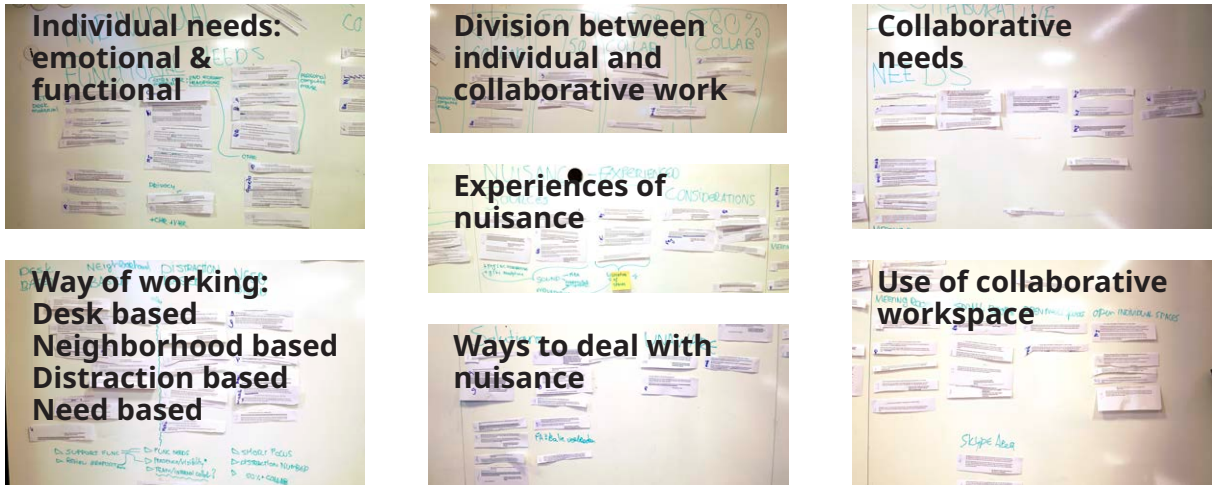


fig.8: the analysis on the wall resulted in a framework that shows how co-workers at IKEA work and their experiences of nuisance

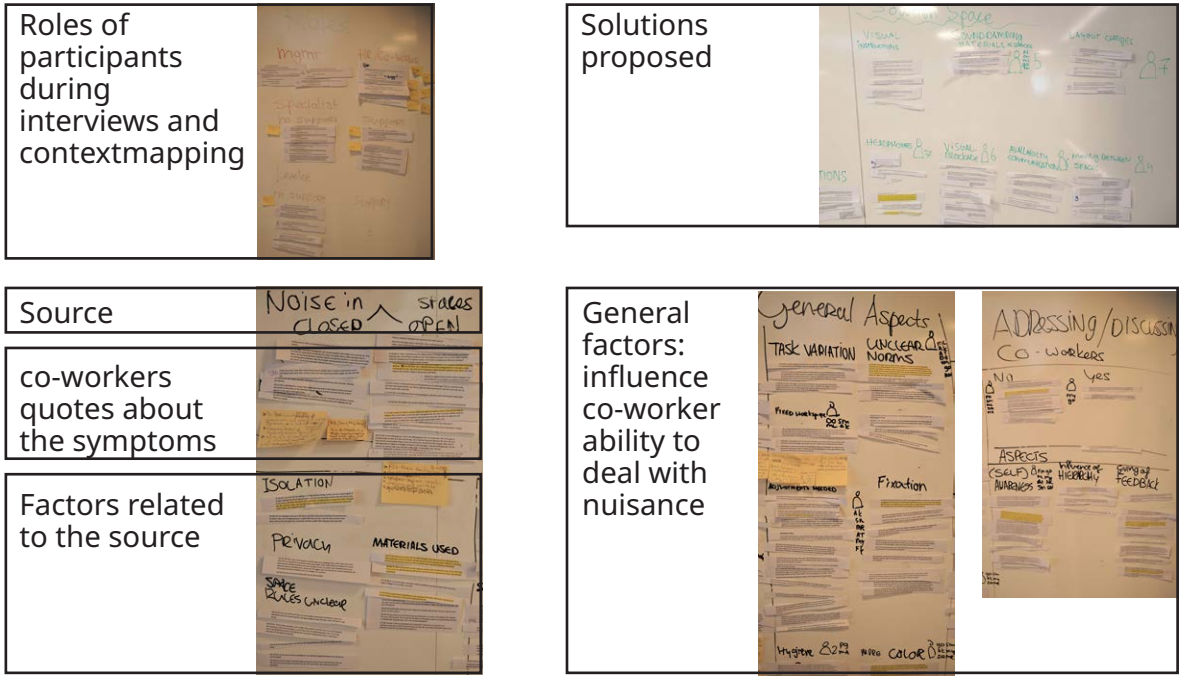


fig.9: the matrix for analysis is applied to create sources of quotes that identify which sources co-workers experience and the factors they relate to these sources. The right parts presents the factors that influence co-workers general experience of nuisance

b) Results

Co-workers' experiences of nuisance, within the open office of IKEA, are caused by six main sources. These sources can be seen in fig.10, which shows how many co-workers experienced nuisance from a source. This overview revels that nuisance is mainly related to the behavior of other co-workers, while the two other sources are related to the office lighting and climate system. Participants overall mentioned co-worker conversations as the most frequently experienced source of nuisance. While interruptions, movement and background noise were mentioned less often. The overview shows how many co-workers experience a source but does not reveal anything about the amount of nuisance they experience.

The amount of nuisance that a co-workers experiences from a source, depends on factors related to the way of working and design of workspaces. The individual source posters (fig.11), present the modality of the stimuli and the factors that co-workers found to influence the amount of nuisance. These posters and an elaboration on how these factors were determined, can be found in Appendix X. These factors are both related to behavior as well as the design of the space. Here the amount of factors and their relation to specific sources, mean that these factors were less frequently named by co-workers than other context factors. This means that they will only have a limited influence on co-workers experience of nuisance. However, these posters provides rich qualitative insights, through quotes of experiences and show symptoms of these sources that help to understand of each source. The insights from these posters, therefore, identify how the presence of a specific source of nuisance can be decreased.

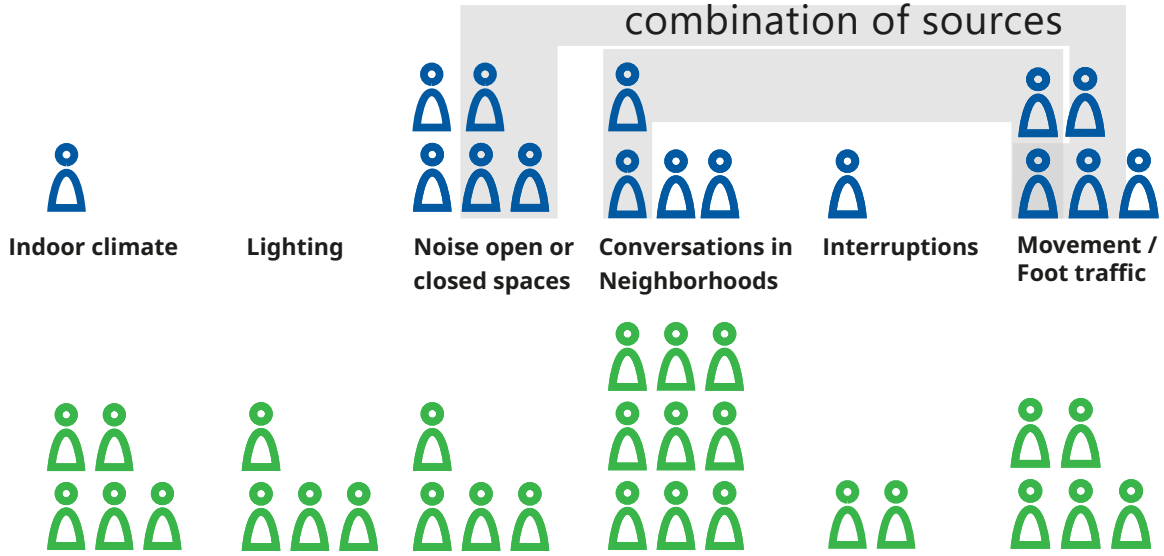


Fig.10: Overview of how often co-workers mentioned to experience as source of nuisance

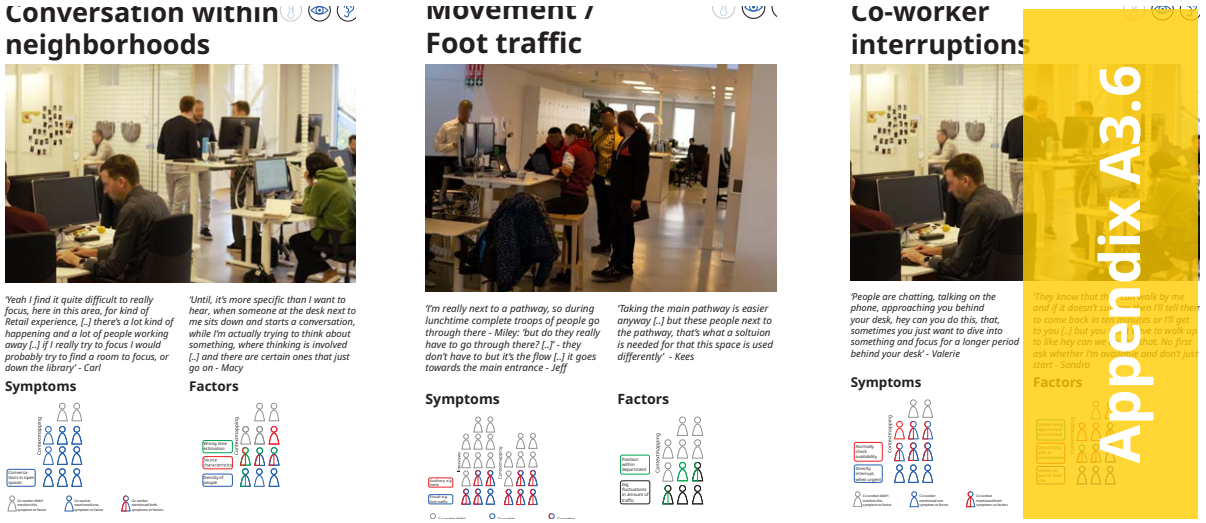


Fig.11: Co-worker conversations and movement are the sources of nuisance that most co-workers within the office experience. The individual source posters can be found in Appendix A3.6.

The amount of nuisance co-workers experience, in general, is dependent on their work activities and where they perform this. First of all, the amount of nuisance co-worker experiences depends on the number of individual tasks he or she performs. This is because, co-workers commonly identify nuisance, as stimulation that affects their ability to focus during individual work tasks. Here co-workers with a support role generally spend more time on these individual tasks and might, therefore, experience more nuisance than other co-workers (fig.12). This also indicates that co-workers with an HR or Manager role, are unlikely to experience nuisance. This is consistent with the interview findings, where these co-workers indicated to experience a little nuisance.

The amount of nuisance co-workers experience is also influenced by how activity-based co-workers work, which is presented in four categories (fig.13). This creation of these categories can be found in Appendix A2.2. Because the neighborhoods are not designed to facilitate focused work, co-workers who do work location-based are more likely to experience nuisance. This categorization in combination with the work time division shows that it's likely that co-workers with a support role and co-workers who perform review or report tasks experience more nuisance

Co-workers can generally deal with nuisance by protecting themselves from sources, by moving to another workspace, or by confronting other co-workers who are causing nuisance. Co-workers' ability to apply these approaches depends on internal factors, that relate to the social aspects of work, and external factors, that relate to the organization of work. The Experience overview presents these approaches and the factors that influence co-workers' ability to apply them (fig.14-16). The identification of these sources and factors is explained in depth in Appendix A3.4.

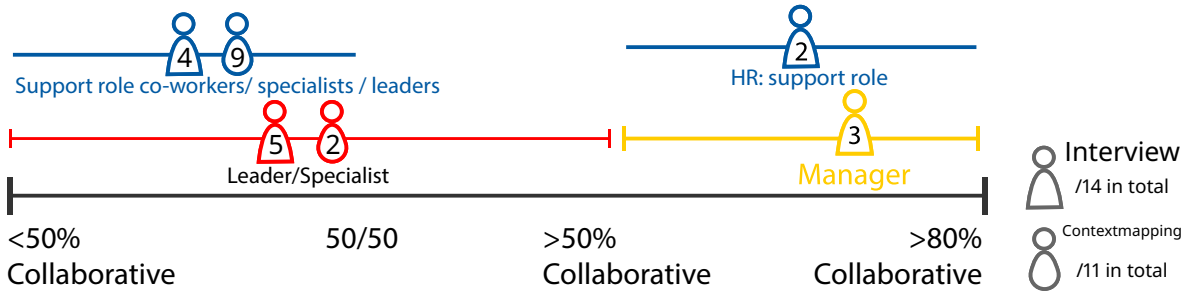


Fig.12: These lines show how much collaborative work co-workers with different roles commonly spend most of their time on

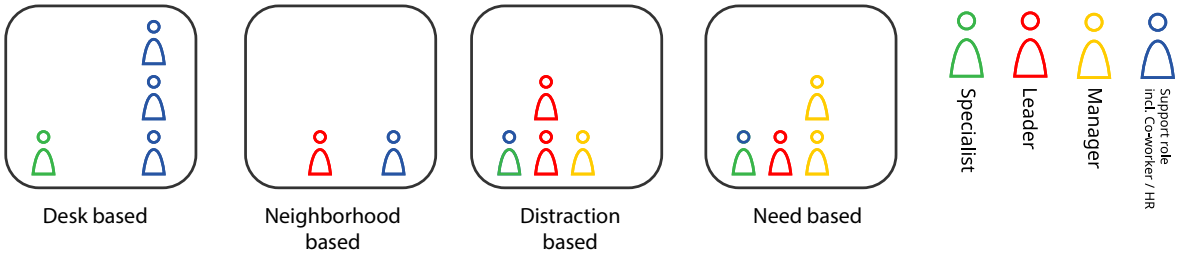


Fig.13: These lines show how much collaborative work co-workers with different roles commonly spend most of their time on

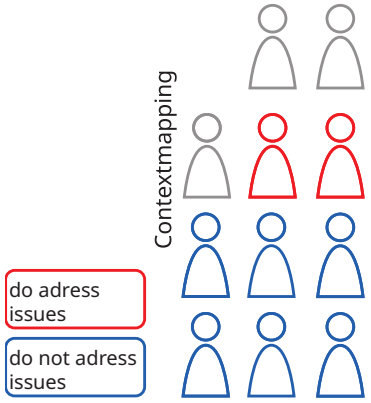


Fig.14: co-workers ability to confront other co-workers

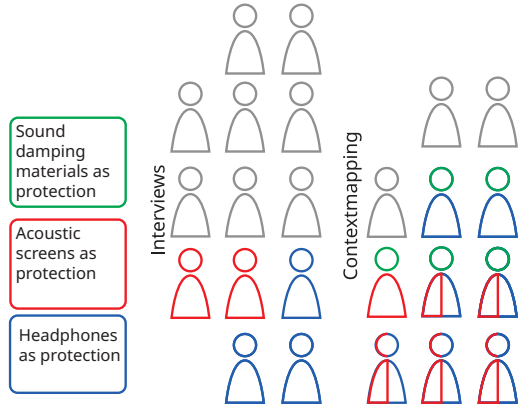


Fig.15: protective tools that are most often used or identified by co-workers as effective

The internal factors summarize the behavior and expectations of co-workers, which influence co-workers' ability to confront other co-workers. Co-workers, here, most often mentioned that they felt unaware of how their own behavior caused nuisance and had no clear understanding of the rules concerning space use. Co-workers as a consequence indicated feeling hypocritical or insecure, which prevented them from confronting other co-workers with their behavior.

The external factors related to the way of working and design the space, which influences co-workers' ability to move and protect themselves from nuisance. The insights already showed differences in co-workers ability to move. These differences turn out to be caused mainly by task-related factors, that require them to work more often at their deskspace. Here the need for specific equipment most often influences co-workers' ability to move. Next to this being approachable for other co-workers was named as an influence, which is common for co-workers with a support role. These factors may lead co-workers to work more often at their neighborhood desk space, which means that they perform focused tasks in an environment that is not always fit for this. Furthermore, all co-workers have an equal ability to protect themselves from nuisance, and tools to do this, such as noise-canceling headphones, can be requested if needed. Finally, co-workers indicated that traveling of sound contributes to the experience of nuisance. Here they indicated that elements of the space design, such as chosen materials and insufficient soundproofing of meeting spaces, contribute to the amount of auditory stimulation within open spaces. In summary, these factors show task-related needs, that influence co-workers' ability to move, cause co-workers to experience more nuisance. While improving co-workers' ability to confront other co-workers, can affect the overall experience of nuisance for most co-workers.

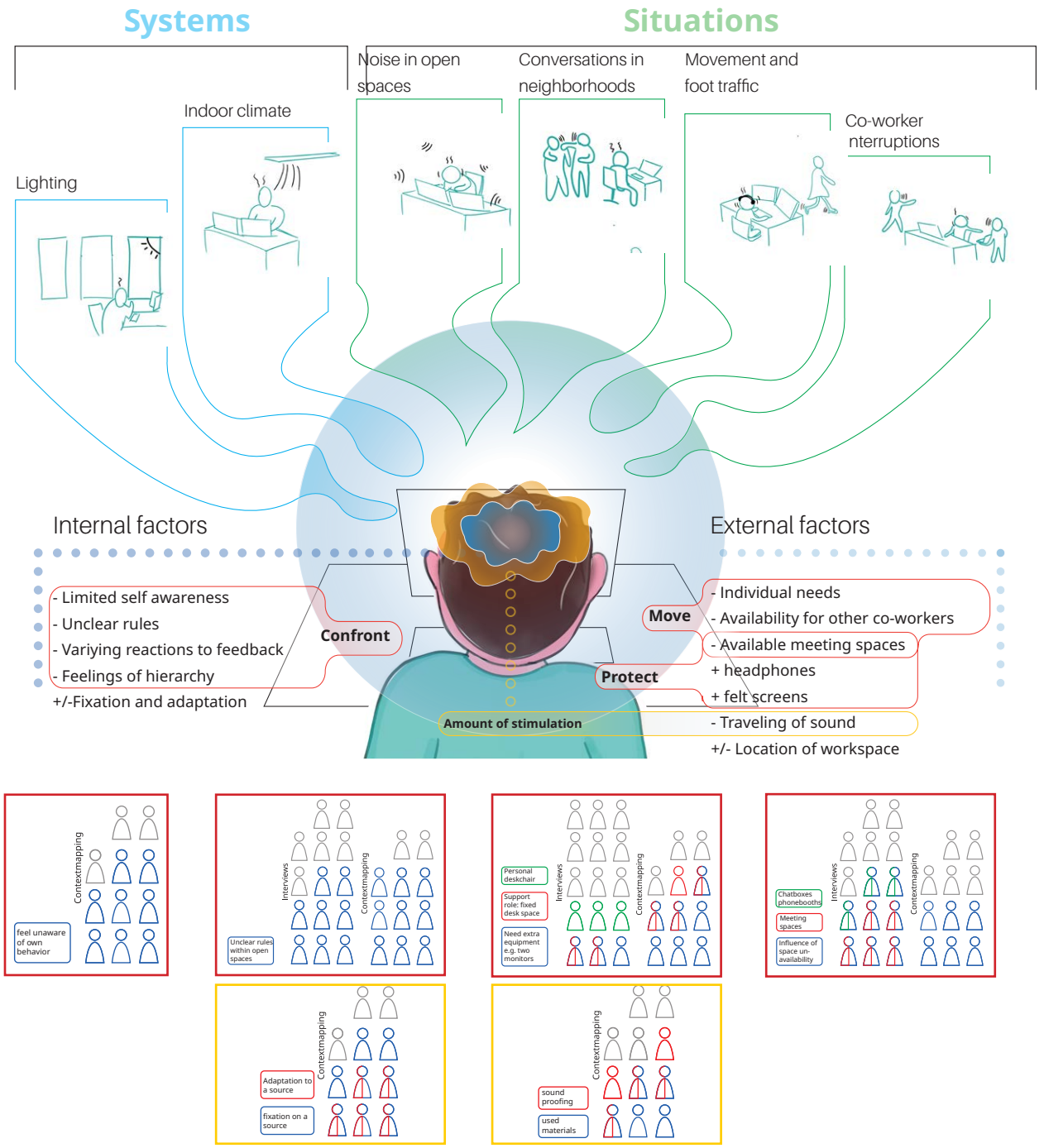


Fig.16: The experience overview showing the factors that influence co-workers ability to deal with nuisance

c) Conclusion

Participants indicated co-worker conversations as the main source of nuisance, which is similar to findings in other studies, where they also less often mentioned background noise. Here Haapakangas et. al. (2017) similarly found that 'distracting background speech largely explains the overall perception of noise'. These conversations seem to cause more nuisance, because co-workers can understand these stimuli easier. Participants mentioned that how well they could comprehend a source of nuisance, influenced how much distraction they experienced. Findings on the role of speech intelligibility support this, where a higher speech intelligibility has been shown to negatively influence the performance of specific individual tasks (Jahncke, 2013). Co-workers did not indicate specific tasks, however they did indicate that they experienced nuisance commonly during individual work activities.

Co-workers experiences of nuisance vary from experiencing almost no nuisance, to continously. This is because co-workers experience of nuisance are influenced by many aspects of their work, such as their work activities, design of the office, organisation of work and many more. The results show three categories of aspects, work activities and roles, source related factors and general factors. These aspects influence the individual difference in experiences, where the work activites, roles and general factors have a larger effect than the source related factors.

The source related factors can help to tackle a specific source of nuisance, but are unlikely to have a considerable influence on the workforce's overall experience of nuisance. This is because these factors influence the presence of specific sources, where general factors influence the presence of multiple factors. This also meant that they were named less frequently than general factors. However, individual source posters, can help creates a rich insight into the experience of a source nuisance. Here the factors in combination with qualitative findings, reveal aspects of the sources that help to understand, how a source stimulation may cause a nuisance to co-workers and explains individual experiences. Because of this, the individual source posters can be applied to communicate specific issues to other teams and involve them in solving these issues.

The general factors influence the co-workes ability to deal with nuisance and are, therefore, more likely to have an effect on co-workers' overall experiences of nuisance within the office. These general factors indicate that co-workers who have task-related needs, that influence their ability to move, may cause co-workers to experience more nuisance. While improving co-workers' ability to confront other co-workers or protect themselves from nuisance, should be able to affect the overall experience of nuisance for all co-workers. Co-workers identified improving co-workers awareness of the surroundings or improving their protection towards visual and auditory stimulation as the main opportunities to decrease co-workers general experience of nuisance.

In summary, co-workers mostly experience nuisance at their individual workspaces, where co-workers often identified co-worker conversations as a source of nuisance. Consequently, co-workers that perform supporting tasks or work location-based within their role are more likely to experience nuisance. Co-workers' individual experiences of nuisance are influenced by source-specific factors, that influence the presence of a source, and co-workers' ability to deal with the nuisance. The variety of source-specific factors reveals the aspects that influence the presence of a specific source. These provide a deeper understanding of each source, but their presence is unlikely to influence the workforce's general experience of nuisance. The general factors influence the three defined ways in which co-workers can deal with nuisance, which means that they influence the presence of multiple sources. Here co-worker

d) Discussion

The context overview shows how the presence of nuisance can be decreased but does not reveal what type of design intervention can do this most effectively. This is due to variations in co-workers' individual experiences and no current insight into the abilities and responsibilities of the Com&In team. This means that it is unclear which source of nuisance should be addressed and what type of intervention can improve the experience of most co-workers. As a result, the current insight could not help me to determine a design approach, with a purposeful research goal.

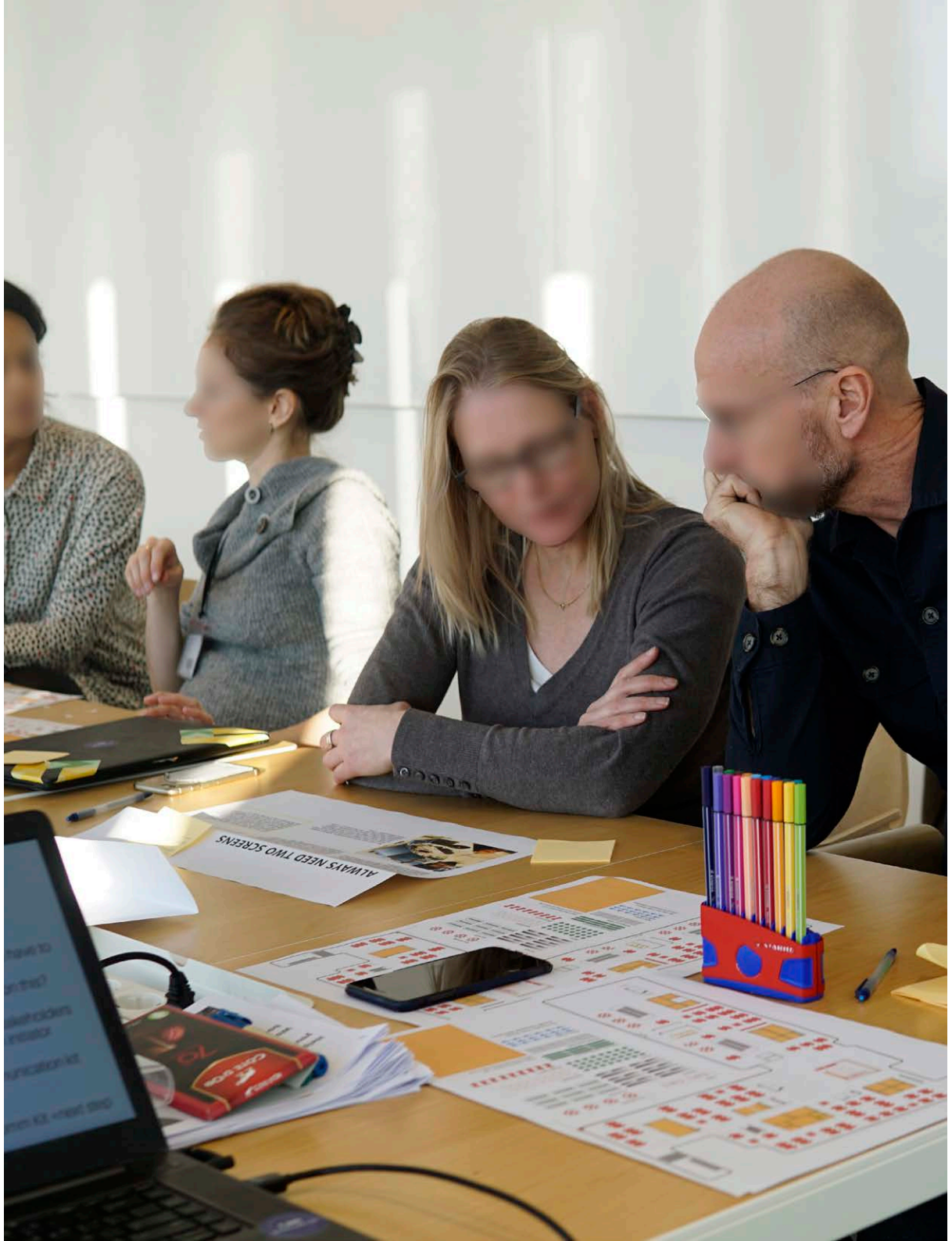
Co-workers primarily experience nuisance during individual work activities, still, there are multiple factors that cause big variations in individual experiences. This may be due to the diversity of teams and tasks within the office, however, I also noticed large differences between co-workers performing in similar teams or roles. This makes it difficult to foresee the effect of interventions on individual experiences. Here a better categorization of co-workers' work activities, based on a larger sample of the co-worker population, may help to reveal these insights. Within my project, this did not seem relevant, since it would not lead to a deeper understanding of multisensory nuisance.

The results reveal that Influencing the presence of these internal and external factors is the most effective way to decrease co-workers' general experience of nuisance. This is because they influence co-workers' ability to deal with nuisance, instead of the presence of specific sources. However, the number of factors show that there is a wide variety of individual experiences. Further, the influence of these factors on co-workers depends on their opinions and priorities, which often contradicted even for co-workers with comparable roles or work activities. This shows that it's difficult to foresee the impact of interventions, without thoroughly evaluating them.

Furthermore, I did not yet have a clear overview of the abilities and responsibilities of the Com&In and other office teams. This made it difficult to determine if the insights from the context overview could already help them to address certain sources of the nuisance. Understanding what sources of nuisance the Com&In team can not tackle yet based on these insights can help to determine a valuable design direction. This reveals that an insight into the solutions that the Com&In can already formulate, can determine what source of nuisance my intervention should help to further understand.

The current insights reveal, that to decrease the experience of nuisance for most co-workers a design intervention should allow co-workers to protect themselves from nuisance, during individual work tasks. This type of intervention should be able to decrease the experience of nuisance for most co-workers. This is because the effect of such an intervention is not influenced by context factors, which means that it can also decrease the experience of nuisance for co-workers that are unable to move away from nuisance due to their support role or task-related needs. This also means that this intervention should be applied as an individual solution at the desk spaces within the neighborhoods. To, finally, determine which source(s) of nuisance this design should address and help to investigate, a further understanding of the abilities and responsibilities of the Com&In team, before a design goal for the intervention is formulated.

III:
UNDERSTANDING AND TACKLING NUISANCE



a) Introduction

The nuisance co-workers' experience is categorized into six main sources: four related to the behavior of co-workers and two related to the lighting and climate within the spaces. Nuisance influences co-workers' ability to focus during individual work, which co-workers often related to distractions caused by co-worker conversations and movement or foot traffic as the two main sources. Co-workers' individual experiences are shaped by many factors, such as co-workers' role or location of desk space. However, these factors do not influence co-workers' ability to confront co-workers or protect themselves from nuisance. Co-workers identified This means that an intervention, that supports them in dealing with nuisance is more likely to affect the experience of most co-workers.

The goal of this project is to understand nuisance within the office of IKEA and empower the Com&In team to tackle this. This means that a design intervention should as well provide Com&In team with valuable insights on the sources of nuisance within the office. The current insights may already help the Com&In team to develop solutions. Consequently, the value of further insights is dependent on how these insights support the Com&In team in the development of solutions. To assess this the abilities and responsibilities of the Com&In team, should be better understood. Research into the abilities of the Com&In team should, therefore, reveal which sources of nuisance the Com&In team is able to tackle by applying their own and current insights. This helps to determine which sources of nuisance should be further researched.

Co-workers experience of these identified sources, will be further researcher through the creation and evaluation of a design intervention. To ensure that the insights from these evaluations can support the Com&In the development of design interventions, the intervention should have similar characteristics and fit the requirements of their own intervention. Furthermore I aimed to create an intervention that could be applied within the context of the open office of IKEA. This means that the design intervention should be accepted by co-workers within the office. This may be achieved by evaluating the design process of the Com&In team and by identifying the characteristics of solutions proposed by co-workers during the contextmapping sessions. The insights on these requirements, should support the creation of a design intervention that can be applied within IKEA's office context

In summary, the insights from the context analysis, can not identify a purposeful design goal, because it is unclear what insights can help to further empower the Com&In team. This means that I will identify the which source(s) of nuisance the Com&In team can not yet tackle, through the current insights. The identified sources of nuisance are further researched through a design intervention, that is also used to evaluate what design characteristics can help to decrease the current nuisance. This means that the intervention should have similar characteristics and fulfills the same requirements as the Com&In teams interventions. These characteristics, may be identified by reviewing the project approach of the Com&In team. Finally, to apply an intervention within the context of the office, the intervention should be accepted by co-workers. Here identifying the common characteristics of solutions proposed by co-workers, can support the design of a fitting intervention. The insights from these three research activities should help to identify which source of nuisance should be further researched and identify a set of requirements and characteristics to determine what design intervention can help to achieve this.

b) Method

The co-creation session helped to determine what sources of nuisance the Com&In team is yet unable to tackle (fig.17). Here I asked the Com&In team to formulate solutions for the six main sources of nuisance based on the insights from the context analysis. The approach and outcomes of this co-creation session can be found in Appendix A4. To guide them I provided them with insight posters (fig.18) a simple design approach (fig.19) and a Map toolkit (fig.20). Here the toolkit helped the Com&In team to divide the identified sources of nuisance into three groups. First sources that the Com&In team should and can decrease. Secondly, sources that the Com&In team is not responsible to decrease. Thirdly sources that the Com&In team should but is unable to address. Consequently, this grouping will show which source(s) of nuisance should be further understood, to help the Com&In team tackle these.

Following, I mapped the project approach of the Com&In team through a session. Here I focused on mapping the touchpoints and decisive moments in their process. The set-up of this session can be found in Appendix A5. Here I created an overview of the activities that different parties perform to gather and transfer information within the organization. This helped me to understand the requirements that a design intervention needs to meet in order to be applied within the office.

Finally, I identified, what type of design intervention would be accepted by co-workers as a way to decrease nuisance. For this, I reviewed the solutions and approaches to decrease nuisance that co-workers formulated during the interviews and context mapping sessions. Here I made use of the insights from the two previous activities, to determine the characteristics, upon which the design intervention is chosen. Through the insights from these activities, I finally determined which source of nuisance my design intervention should decrease and help to further understand and what type of design intervention could be applied to achieve this.

fig.17: The Com&In team at work during the co-creation session

fig.18: Example of one of the insight posters

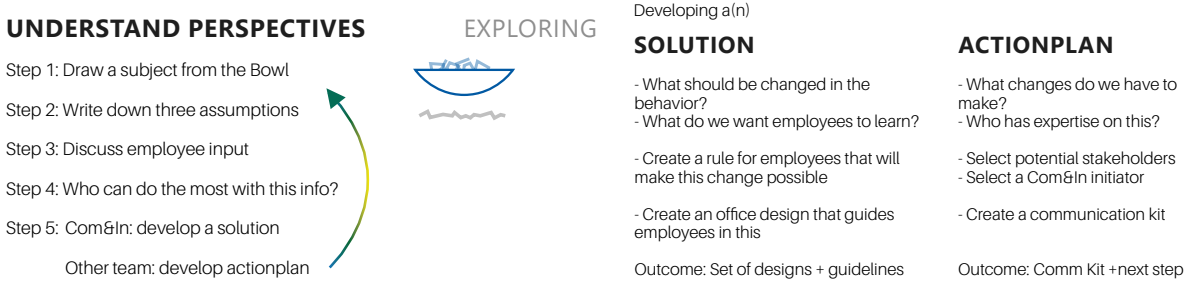


fig.19: The two steps of the design approach the Com&In team used during the co-creation session

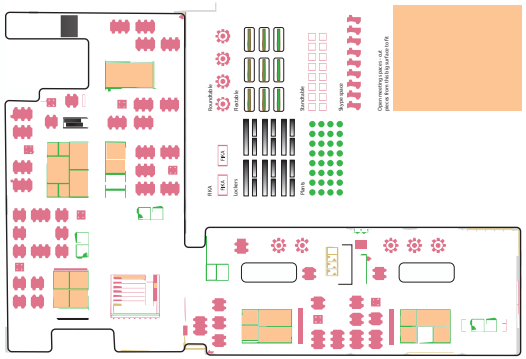


fig.20: The map toolkit

c) Results

The result from the Co-creation session showed that the Com&in team was able to deal with most of the identified causes of nuisance. The outcomes of this session can be found in Appendix A4.The Com&In team expressed that they were able to come up with potential solutions to decrease the nuisance caused by movement and foot traffic, as well as noise in open spaces. Next, they identified that nuisance related to lighting and indoor climate, would be the responsibility of other teams to address. Finally, the team indicated that the current insights could not help them to formulate solutions to decrease nuisance from interruptions and co-workers' conversations in neighborhoods. Here the Com&In proposed and discussed solutions to address these sources, but could not formulate a consensus on the general effectivity of these solutions and if co-workers would accept and use these. This reveals that nuisance caused by interruptions and co-worker conversations should be further researched, to empower the Com&In team's to tackle these sources

The outcomes of the Co-creation session also showed that the Com&In team could develop solutions to decrease the amount of stimulation, by decreasing the traveling of sound in spaces. While solutions to improve co-workers ability to move or confront other co-workers turned out to be difficult to implement, because these would changes in the defined way of working. However, the proposed solutions did indicate that solutions which helped co-workers to confront others could be developed if the insights would have provided a clearer understanding of how co-workers would like to use this type of solution. Finally the session did not review the team's ability to develop solutions for co-

workers to protect themselves, because examples in the office proved their ability to do this. This means that co-workers ability to deal with nuisance could be decreased through solutions focused on improving co-workers ability to confront other co-workers with the amount of nuisance they generate or by protecting co-workers

The process mapping (fig.21-22) with the Com&In team showed that solutions the Com&In team are all physical interventions that should comply with the IKEA way of working and the look and feel of the office. The insights from this mapping session can be found in Appendix A5. This showed that there were clear steps, but these were not executed in a fixed order, where the steps in the process and their duration change due to the big variety in projects and project owners that initiate these projects. For interventions applied at individual desk spaces, two main requirements should be applied to facilitate the IKEA way of working, the intervention should maintain the freedom in the use of workspaces and prevent an increased sense of desk ownership

The process mapping sessions also identified what made it difficult to address these sources of nuisance before. In summary, the insights show that the small teams at CBF, make it difficult for managers to identify nuisance as a problem. Here the individual differences between co-workers within a team, make it unlikely that team managers will initiate a project to investigate and solve a specific issue. This shows that an intervention that be applied as an individual solution, that all co-workers can use, is most likely to be applied within the current organization.

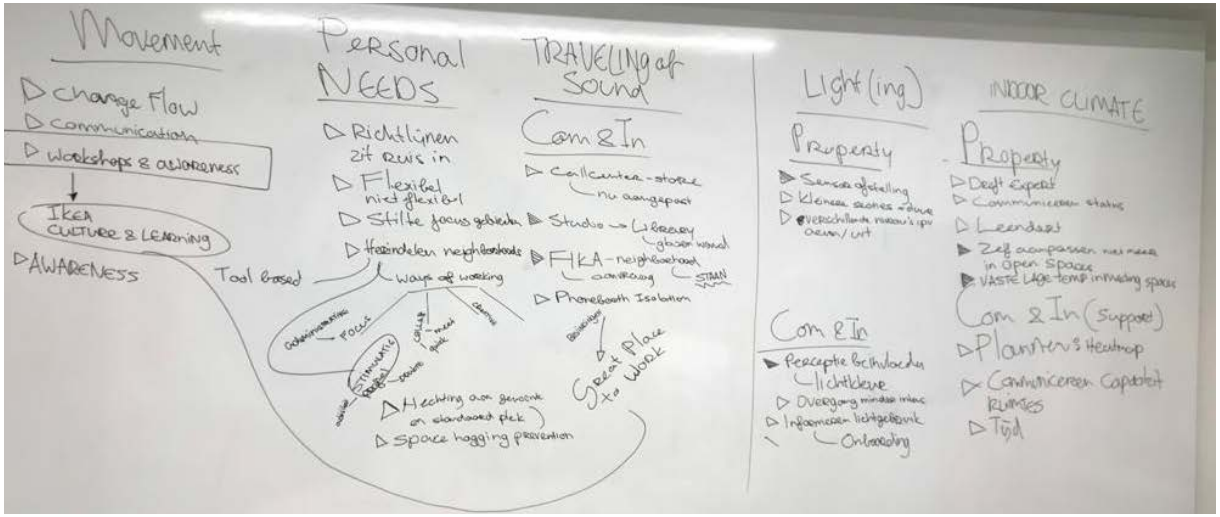


fig.21:Visual summary of the session in which we discussed solutions. Here the Com&In team was unable to develop solutions to address nuisance due to co-workrer conversations and interruptions. This which lead to a discussion on personal needs, without a clear outcome.

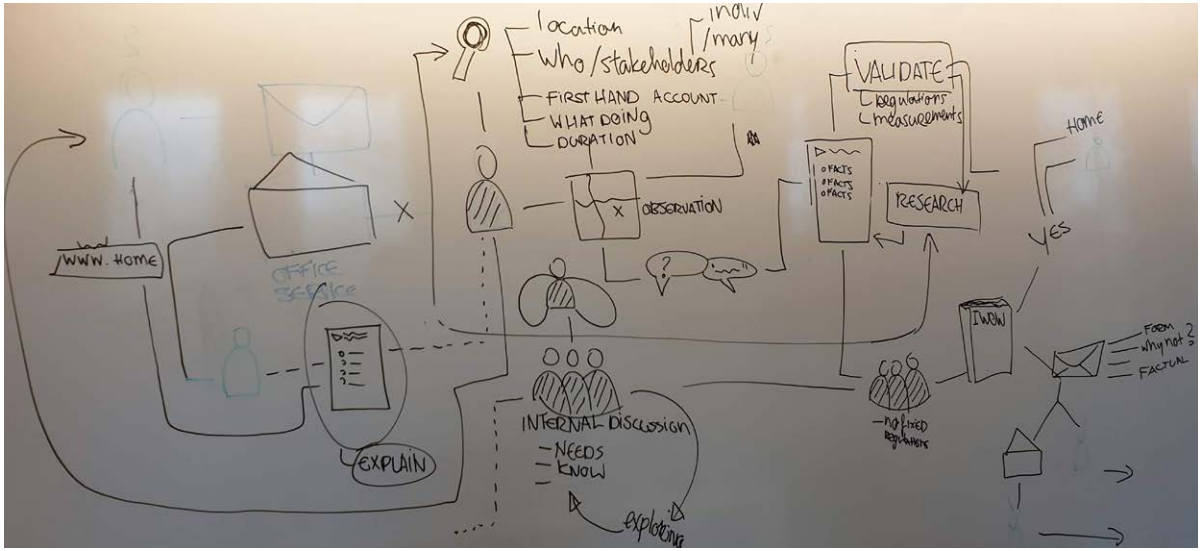


fig.22: project intitiation process map for the Com&In team

The solutions proposed by co-workers are characterized by their familiarity with currently applied solutions and were generally aimed at improving the sound damping within spaces or improving co-workers' awareness of their surroundings. An overview of these solutions can be found in fig.23, while the review of these can be found in Appendix A6. Within the group of commonly applied solutions, co-workers most often indicated that they believed in sound damping products, such as noise-canceling headphones and acoustic screens at IKEA to decrease nuisance. Sound damping materials were also mentioned earlier as a factor influencing materials as a way to decrease the presence of various sources of nuisance.
Co-workers most often mentioned increasing co-workers' awareness of their surroundings as an effective approach to decrease nuisance. Co-workers' low awareness of their surroundings was also often mentioned to limit co-workers' ability to confront others. This makes it likely that design intervention focused on empowering co-workers to improve this awareness can decrease co-workers' experience of nuisance. This makes both increasing co-workers' awareness of their surroundings and the application of sound damping materials, interesting design characteristics research through a design intervention.

In summary, reviewing the current insights with the Com&In team showed that that the current insights can nog help the Com&In team to tackle nuisance related to co-worker conversations and interruptions. This will be further researched through the creation and evaluation of a design intervention, which should have similar characteristics as interventions created by the Com&In team. Their project approach showed that they create physical design interventions, which should increase desk ownership or limit co-workers' freedoms. Next to this, a solution for individual co-workers is more likely to be applied as a solution within the current organization. Co-workers proposed solutions, also showed that they would be more likely to accept a design intervention, that is similar to already familiar objects within the current office. Finally, co-workers identified both increasing co-workers' awareness and the application of sound-damping materials as effective approaches to decrease nuisance. Through these insights, I determined that nuisance caused by co-worker conversations and interruptions should be further researched, through a physical design intervention, that can be applied as an individual solution for co-workers, while maintaining the freedom in the use of workspaces and prevent an increased sense of desk ownership

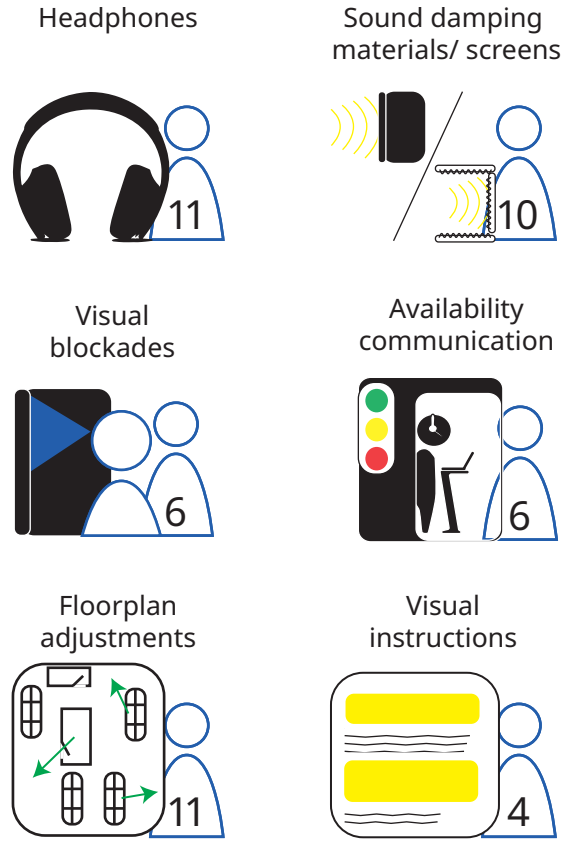


fig.23: the solutions proposed by co-workers during the interviews and contextmapping sessions

d) Design goal

The design intervention should be applied as an individual solution at co-workers' desk spaces To achieve this, I decided to base this design intervention on the acoustic IKEA screens, that are currently applied at specific departments (fig.24). These screens were frequently named by co-workers as a seemingly effective intervention to decrease nuisance, which should make it more likely that co-workers will trust the effect of the design intervention. Furthermore, this helps to research the effect of the intervention as if it would be an already existing solution, instead of as an unknown object.
The current design of these screens, however, focuses purely on decreasing auditory stimulation, while I aim to create a design to also address visual stimulation. Consequently, I will design a stimulation barrier that will focus on decreasing the nuisance experienced from co-worker conversations and interruptions during individual work tasks.

The goal of the intervention is to investigate how design characteristics can help to the nuisance caused by co-worker conversations and interruptions. Since nuisance influences co-workers' ability to focus during individual work, the design should make co-workers' desk space come across as an environment that supports individual-focused tasks. These tasks are commonly performed in calmer environments, such as the library. However, the context analysis showed that co-workers ability to move is dependent on task-related factors (See II, c) results). This means that the design intervention should make co-workers feel as a calm workspace, which translates into the Swedish word 'fridfull' (fig.x25). As a result, the design goal for this design intervention will be to:

Create a 'fridfull' or serene individual workspace for employees, by decreasing the amount of nuisance co-workers experience from co-worker conversations.

fig.24: The currently IKEA Bekant desk screens

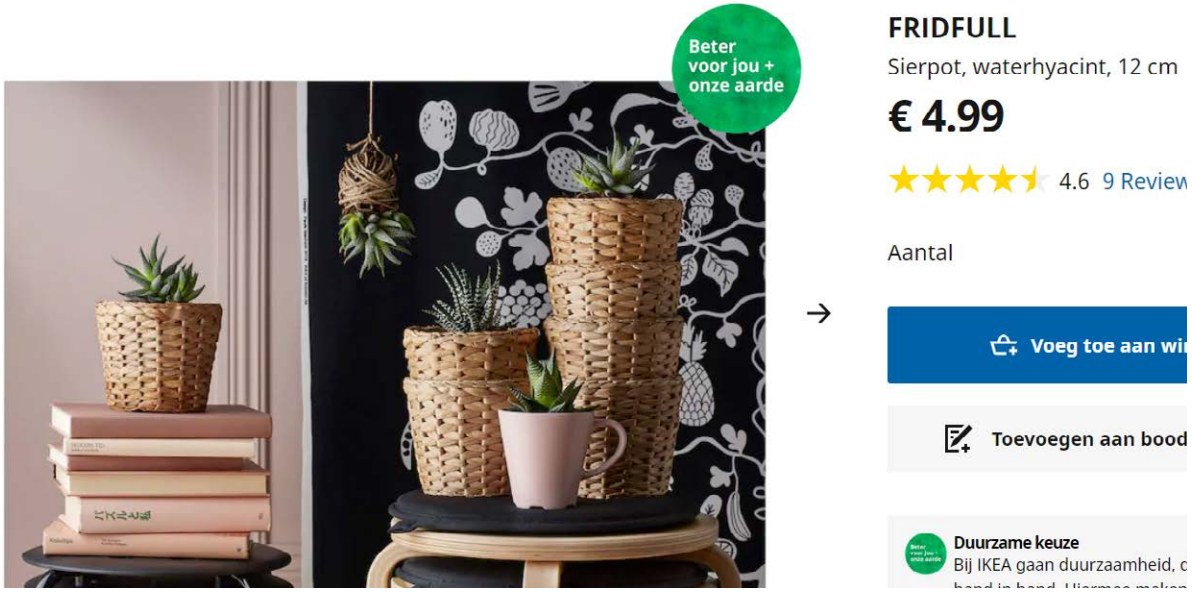


fig.25: Fridfull is also a product within the current IKEA range

e) Discussion

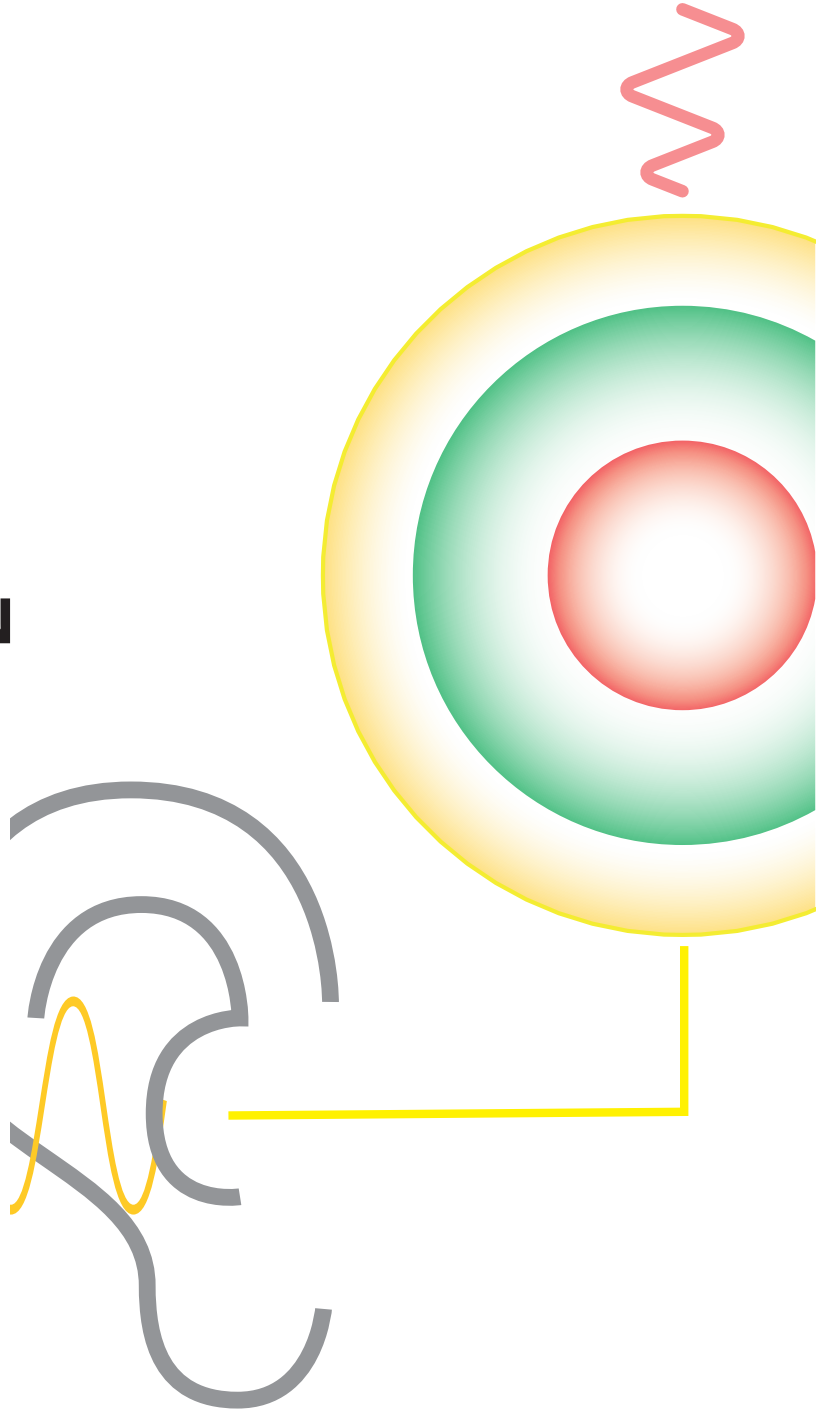
The outcomes of the Co-creation session showed that nuisance caused by co-worker conversations and interruptions, should be further researched. This is because the current insights could not help the Com&In team to formulate solutions to address these sources of nuisance. It could be argued that this may be because the toolkit used during the session only facilitated the creation of physical interventions, however, as a facilitator I also tried to inspire new ideas beyond physical interventions. Besides this, the process mapping of the Com&In team showed that their focus lies on the creation of physical interventions. This means that researching into how a physical intervention could influence the experience of nuisance caused by co-worker conversations and interruptions, would provide valuable insights for the Com&In team.

Co-workers suggested solutions both identify both sound damping materials and improving co-workers' ability to confront other co-workers about nuisance, as an effective approach to decrease nuisance. Next to this co-workers identified the lack of co-workers' awareness about the stimulation they cause as one of the main factors that influence the current experience of nuisance. To achieve this the intervention should allow co-workers to communicate his experience of nuisance towards co-workers who cause nuisance.

One way to achieve this is through direct confrontations, such as feedback discussions. These have been identified as a successful tool to motivate a change in behavior (Kok, 2011). The main reason I did not apply this approach, is that this approach can also do a lot of damage to the organization. Where if these discussions are not supported by a clear and user validated protocol, they result in conflicts between co-workers. Within my project, it did not seem feasible to develop and validate such a tool, within a few design iterations. Next to this co-workers at IKEA, generally, found it difficult to initiate confrontations, for various reasons. Therefore, I would recommend developing an intervention to facilitate confrontations between co-workers, within in a follow-up project and develop a validated tool outside the current IKEA organization.

The application of sound damping products and materials was also commonly proposed by co-workers. Here co-workers trusted the effectivity of noise-canceling headphones and the currently applied sound barriers. Next to this, co-workers identified the current use of materials as a factor that contributed to the amount of noise within open spaces. The perception of materials has already been shown to influence the of sound damping people to experience from a sound barrier(Joynt, Kang. 2010), which makes it interesting to research what effect of the use of materials for the design intervention, can have on the amount of nuisance co-workers experience.

IV:
DECREASING NUISANCE, THROUGH ALTERING CO-WORKERS PERCEPTION AND SENSE OF CONTROL



I formulated a design approach, to design a sound barrier, that both aims to decrease the objective amount of stimulation co-workers receive and subjective stimulation co-workers perceive

a) Introduction

The aim of the design intervention is to protect co-workers from nuisance of co-worker conversations and interruptions, during individual work activities. To achieve this the intervention should make working at an individual deskspace feel ‘fridfull’ or serene, by having a calming effect on co-workers. This may both be done by decreasing the amount of stimulation, but might also might also have an emotional effect, that alters co-workers perception of nuisance. Therefore, I formulated a design approach, which both aims to decrease the objective amount of stimulation co-workers receive and subjective stimulation co-workers perceive.

Perceptual effects

Sound barriers are commonly applied to lower the amount of stimulation co-workers experience within an open workspaces. These barriers rarely take into account co-workers perception of stimuli, while I found that both co-workers’ perception of the material and their sense of control, can influence the amount of nuisance they experience. Besides this, attention can also play a role in decreasing the amount of stimulation. Therefore I aim to develop a stimulation barrier, that decreases co-workers perception of stimuli, through the influence of material perception and a sense of control, as well as the amount of stimulation

The material qualities of sound barriers can influence how co-workers perceive the amount of sound they damp (Hong, 2014). For this it’s important that the material’s surface is opaque (Maffei, 2013), and that the material is preconceived as sound damping (Joynt & Kang, 2010). Reviewing other sound damping products, shows that sound damping products often have surfaces that consist of three-dimensional textures, while desk screens are rarely textured (fig.26). Consequently, my design intervention will investigate, if three dimensional textures can contribute to the perceived sound damping of desk screens.

fig. 26: The difference between the textured used in professional sound damping applications and acoustic desk dividers, where little examples are known that have three-dimensional textures

Furthermore, co-workers susceptibility to distraction, is influenced by the sense of control they feel within their surroundings (Lee&Brand. 2010). / Increasing this sense of control and enabling them to adapt the amount of stimulation at their workspace to their preference (Booij, 2012), should decrease the amount of nuisance they experience. This can be achieved by creating an interactive design, that allows co-workers to influence the amount of visual and auditory stimulation co-workers receive, throughout the day (fig.27).

Besides decreasing co-workers perception of nuisance, the amount of stimulation from sources of nuisance may be decreased through steering co-workers attention. Here behavior related to this, such as hovering around a workspace, may cause more distraction, than interruptions themselves. This becomes clear when integrating my research insights on the sources of nuisance, with literature on attention in visual and auditory perception. This is further explained in Appendix B1. The screen should therefore aim to make co-workers invisible for the user of the screen, but allow other co-workers to still see them from afar. This may help co-workers to assess if they can interrupt a co-worker.

To summarize, I will design an intervention that utilizes of the material qualities of the barrier, co workers sense of control and ability to focus their attention, with the aim to decrease co-workers experience of nuisance (fig.28).

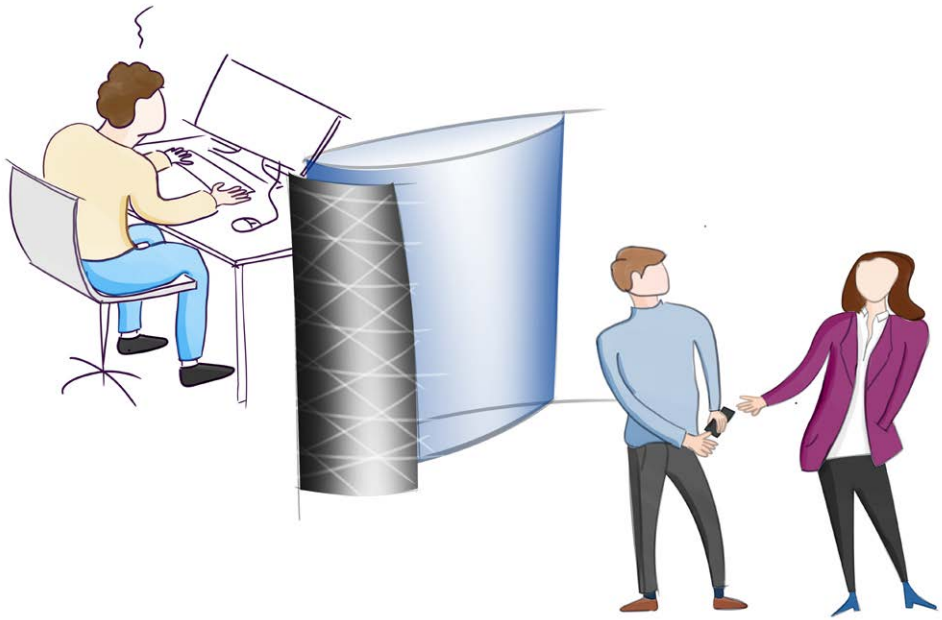


fig. 27: A short conversation can unknowingly quickly form a source of nuisance for a co-worker doing individual work within the same space. The design intervention aims to decrease the presence of these situations.

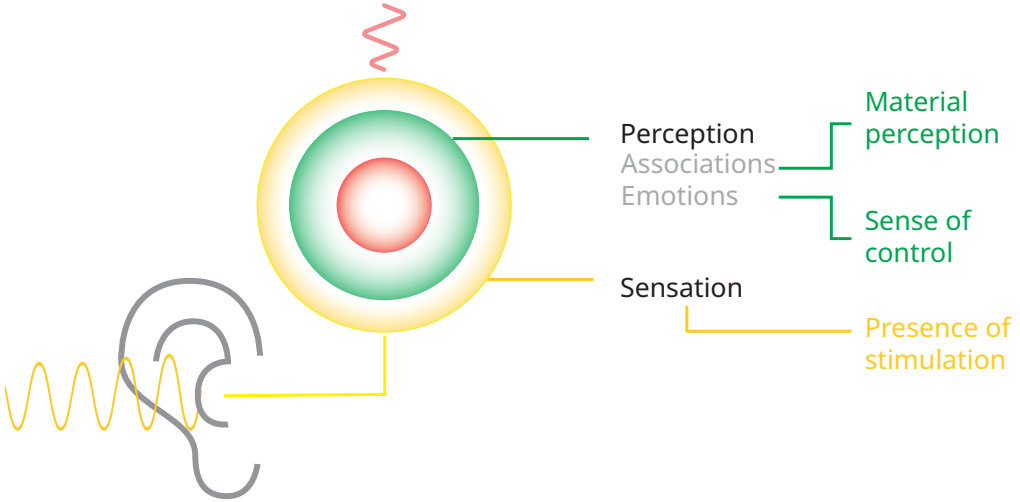


fig. 28: The design intervention should decrease the sensation and perception of stimuli, to decrease the experience of nuisance

b) Method

The perception of employees is altered in two ways, through both increasing their sense of control and the perceived sound damping of the materials. I approached this by first creating vision on how co-workers should experience the design. Following I created a design that embodies these visions, by evaluating ideas and concepts with users.

Vision for the design
I develop the a design intervention that would influence co-workers perception of nuisance, through its interaction and perception of materials. To achieve this the interaction should give co-workers a higher sense of control. While a three-dimensionally textured screen and the other materials, should increase co-worker perception of the sound damping ability of the screen. I created a vision for the interaction and material experience of the design and interaction with the product and interpret the sensorial information of the applied materials. This lead to an interaction vision and material experience vision, that are explained in detail in Appendix X. These two visions provide a guideline for my design decisions, that helped to achieve the desired effect of the intervention.

Selecting a three-dimensional texture
Through these visions I first determined a three-dimensional texture for the screen, since this texture is determining for both the folding movement and perceived sound damping of the screen. Here I investigated various textures and folding movements through paper prototypes, that I evaluated through spontaneous discussions with co-workers. I created these paper prototypes, based on folding techniques from Paul Jackson's handbook folding for Designers (2011) and displayed these in the office to evoke spontaneous discussions. Within these I focused on understanding what form aspects, could communicate the desired characteristics and thus contribute to the perceived sound damping of the barrier. This lead to the formulation of three damping characteristics, that reveal which aspects of a texture can contribute to their perceived sound damping and motivate co-workers to interact with it.

Following I developed four visual concepts, based on these characteristics. These concepts present four textures and their folding movements, that I discussed with the Com&In team and my TU Delft team. I used these discussions to determine which texture both teams preferred and to identify any concerns with regards to the placement of the screens. I communicated these concept to the teams, using a combination of drawings and paper prototypes.Based on these insights I determined the applied texture for the design interaction.

Evaluating interactions and folding movements
Co-workers interact with the screen to perform three operations, during it's use. First they unfold the the three-dimensional texture of the screen, following they attach the screen to the frame and finally they fold it compactly again. To identify the needs and concerns this folding system should fulfill, I held discussion with both Com&In team and co-workers. The set-up of this evaluation can be found in Appendix X For this I chose to sketch a variety of mechanisms to present to both groups (fig.x - xx), without defining the construction. The aim of this was to create a discussion on needs and concerns. Based on this I formulated requirements and factors that influence the perceived reliability of the folding systems.

The insights from these activities are integrated in a set of guidelines that helped me to created a three-dimensional texture, interaction and materials for a design intervention that are consistent with the vision of the design. These guidelines can, therefore, also be applied as a general approach to design a physical design intervention, with an experience that should that should co-workers in an open office, should perceive as sound damping.

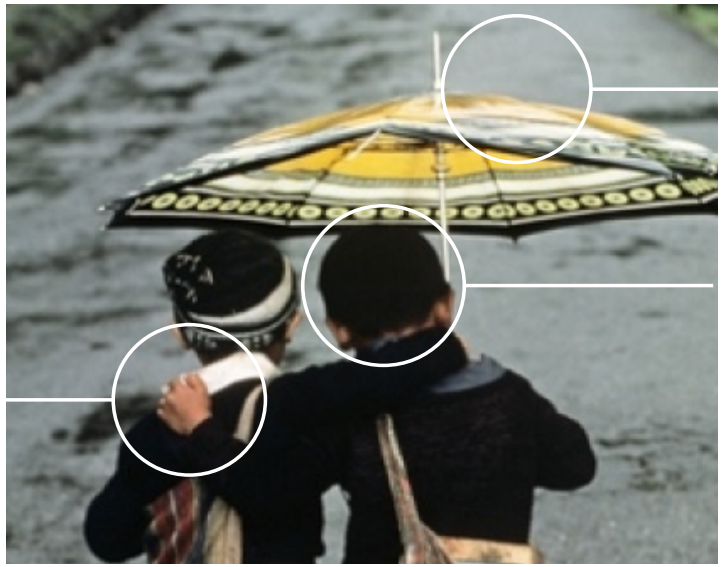
c) Vision: A sense of control through interactivity and materials

The perception of employees is altered in two ways, through both increasing their sense of control and the perceived sound damping of the materials. To achieve this, I created an interaction vision and materials experience vision. Appendix 3.1 & 3.2 explain how the these visions and their visual representations were developed.

The following paragraphs explain the two visions and their role within the design process. In short, these visions provide the guidelines on how co-workers should experience the interaction with the product and interpret the sensorial information of the applied materials.

The interaction vision describes how the screen increases co-workers sense of control, through the interaction between them. This vision (fig.29) that makes use of a metaphor of two brothers. Here the big brother, representing the design intervention, shades his little brother, the co-worker, from the rain. Like the big brother, the interaction with the design should have a calming effect on co-workers, that makes them feel at ease at their desk space.

When your big brother puts up and shares his umbrella with you



Protective
He will keep you dry and safe

Reliable
You know you can count on him!

Caring
Putting his hand on your shoulder

fig.29: The interaction vision presents a metaphor for how co-workers should feel during the interaction with the product. In this case the product is represented by the 'big brother'. Image from: https://stevemccurry.files.wordpress.com/2010/11/india-11102.jpg

The material experience vision (fig.30) describes the visual and haptic information that co-workers should gain from the materials and textures of the information, when using it. This vision is translates the four types of material qualities, described in Karana's Material Driven Design method (2014) into a framework. Here co-workers should feel a sense of 'relief', that is elicited through the materials emotive quality of the materials. The collage (fig.x) finally express the sensorial and performative qualities of the materials, upon which the materials for the design are selected.

These two visions communicate similar characteristics but are applied in a different way. The interaction vision helps to support decisions on the folding interaction and assembly system, where the material experience vision helps to define what materials should be applied within the design. Both are used in combination to decide on the applied texture and it's folding mechanisms since this influences both the interaction with the product and perceived qualities of the materials. These visions helped me to design a product, that makes co-workers feel at ease, by expressing reliability, protection and care, through both the interaction and the use of materials

Material experience vision

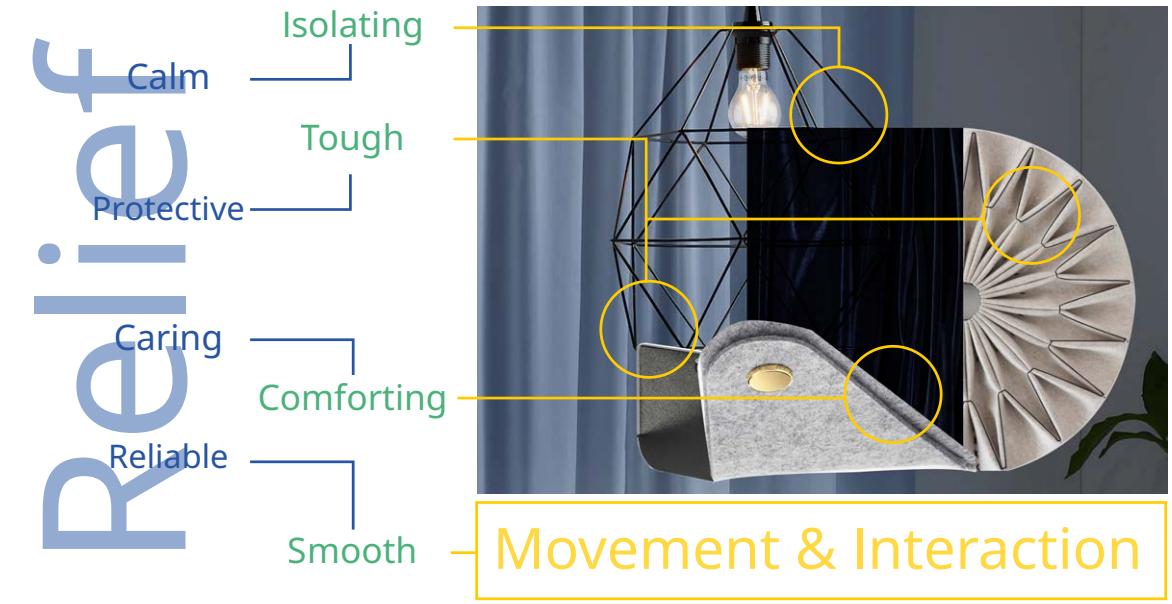


fig.30: The material experience vision translates the qualities of the material on four levels, towards various materials, shapes and details, to provide a guideline for the material selection of the design intervention. Images from: https://www.ikea.com/nl/nl/images/products/brunsta-hemma-pendant-lamp-black__0880954_PE656656_S5.JPG?f=g, https://www.ikea.com/nl/nl/images/products/pudda-basket__0909115_PE638398_S5.JPG?f=g, https://www.buzzi.space/products/buzzipleat, https://www.muralswallpaper.com/app/uploads/Dark-Blue-Velvet-WEBSITE-SWATCH-820x532.jpg

Ideating a three-dimensional texture concept

Co-workers, during the discussions of the paper prototypes, showed a preference towards more complex textures, that fold bi-directionally. Their responses to these paper textures can be found in Appendix B4. Here co-workers showed a preference for textures that fold in a vertical direction, over horizontal folding ones. Next to this it co-workers more often picked up prototypes with bi-directional folds, which makes it more likely that they would interact with such a texture. Finally, none of the folding mechanisms was able to evoke a sense of care. This should, therefore, be communicated through other elements of the design, such as the haptic feedback of the materials or the interaction of attaching the screen. From these insights, I created a set of damping-characteristics, that helped me to select textures, that are suitable for the design intervention.

I selected the textures for my concepts, based on three damping-characteristics, that I formulated. The formulation of these characteristics is described in Appendix B4 and takes into account the input of co-workers, as well as the analysed qualities of textures applied in sound damping products. First, these textures should have a constant rhythm. Secondly they should consist of geometric elements, that change orientation throughouth the textures. Thirdly these lines should be long and allow for a diagonal or bi-direction folding direction. This gives the design a more elegant aesthetic and makes the textures more interesting to observe during folding. This may motivate co-workers to keep interacting with the screen. These three damping-characteristics can be applied as guidelines to select textures that should be perceived as sound damping.

fig. 31: I displayed paper prototypes within an open space of the IKEA CBF office, to provoke spontaneous discussions.

Selecting a three dimensional texture

Following I created four sketch concepts and presented these together with the paper prototypes to my team at IKEA and the TU Delft (fig.31-34). These sketches can also be found in Appendix B5. The discussion of these concept sketches and paper prototypes focused on identifying their preferences and concerns for the execution of these textures in the design intervention.

My team at IKEA and the TU Delft both had a preference towards the diagonal folding Zig-zag V-pleat texture (fig.33). Both teams were concerned about the size and shape of the forward folding cupola concept (fig.x). Where a horizontal bi-directional folding concept (fig.x), simply did not evoke any enthusiasm. This showed that the application of a zig-zag V-pleat texture in the intervention is supported by both the IKEA and TU Delft team.

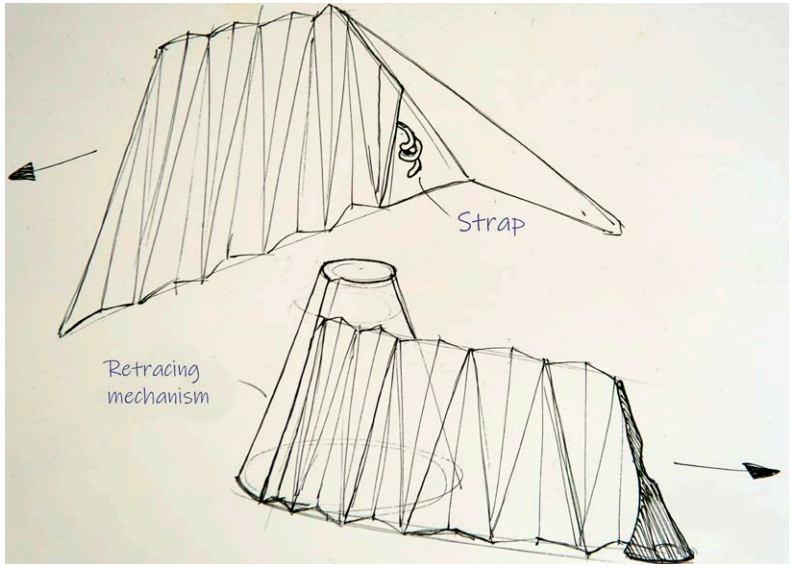


fig.31: Two bi-directional folding concept with a horizontal direction

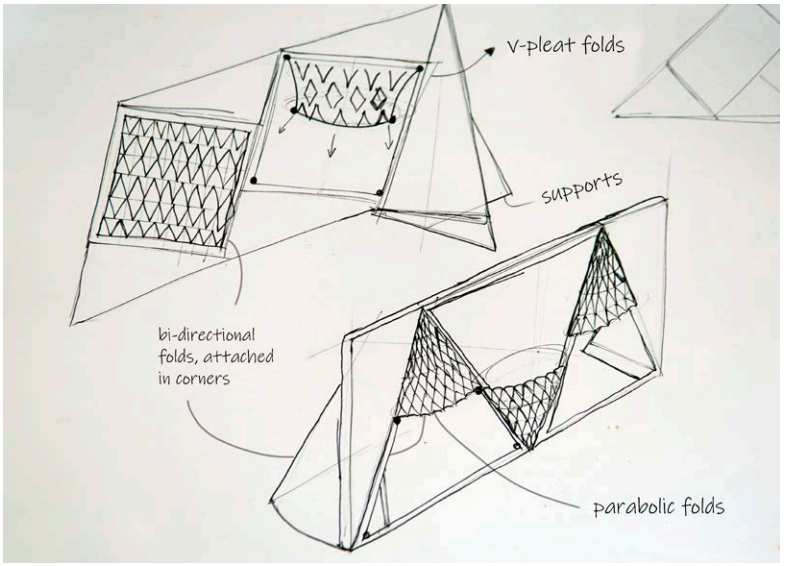


fig.32: Two bi-directional folding concepts with a vertical folding direction. These were preferred by both the Com&In and TU Delft team

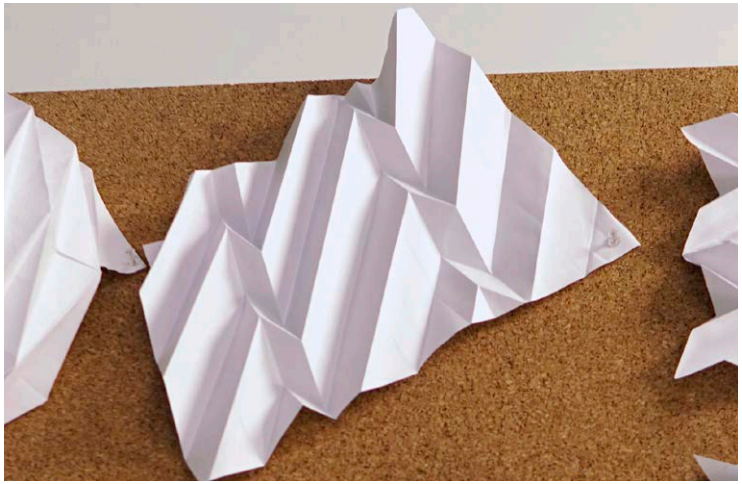


fig.33: The zig-zag v-pleat texture, preferred by the Com&In and TU Delft team

fig.34: The cupola texture, that lead to concerns about the co-workers ability to move at their desk

Evaluating interactions and folding movements

The video interviews I had with the Com&In team and co-workers showed that they have similar underlying concerns, although they express this in a different way. This can be seen in Appendix B6. In general, the Com&In team prefers a string system, because this guides co-workers in the use and storage of the design, while Co-workers preferred the strap system, because it looked just simpler to operate and more fitting for the office space. Here co-workers viewed the string systems as less reliable and more difficult to repair. Next to this they were not interested in folding the screens halfway, but only fold or unfold This shows that the attachment system for the intervention, should guide co-workers to unfold and store the felt screen in one action without in between configurations, through a system that looks simple,and feels reliable.

fig.35: The four proposals. Top Left: strap system. Top right: vertical pully system. Bottem Left: diagonal string system. Bottom right: combined system with straps and diagonal string system

fig.36: an example of a visual storyboard for a system

Design guidelines

To decrease co-workers' experience of nuisance, I have developed a sound barrier that aims to influence co-workers' perception of their workspace. For this the design makes use of a three-dimensional texture, that aims to increase the perceived sound damping of the barrier, and interaction with the screen, which should increase co-workers' sense of control (fig.37). Both the texture, the materials, and interaction are then designed based on three qualities, that are expressed within the interaction vision (IV) and material experience vision (MEV). This should result in a design that is interpreted as 'protective' 'reliable' and 'caring', which should have a calming effect on co-workers.

The three-dimensional texture forms the basis of the design since this determines how co-workers experience the material and the folding movement during the interaction. I selected this texture, by first evaluating the characteristics of other sound damping products. Following I created and discussed a set of paper prototypes with co-workers. Based on these activities, I formulated three damping characteristics, that support the selection of a texture that is 'reliable' and 'protective'. First, the texture folds bi-directional or vertically. Secondly, the texture has straight edges. Thirdly it is geometric with constant repetitions. I also found that that none of the textures, were able to provoke a sense of care, as a result this should be provided by the material of the textured screen. Based on these guidelines, I discussed four concepts with the Com&In and graduation team, to identify their preferences. This lead to the selection of a Zig-zag V-pleat texture (fig.38), which meets all these damping characteristics and was preferred by both teams.

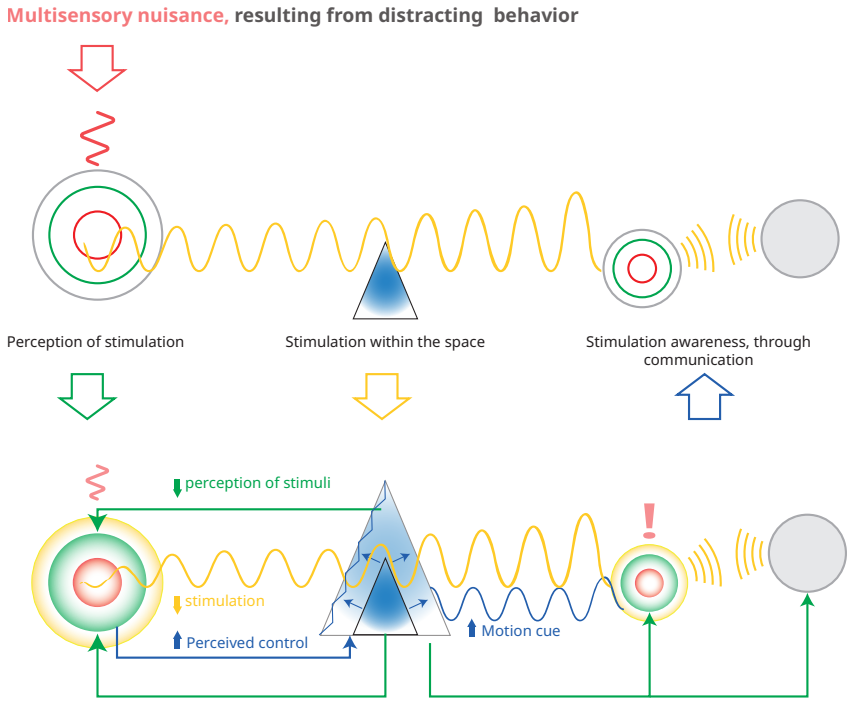


fig.37: The envisioned effect of the design intervention, here the blue lines represent the effect of the interaction with the intervention, which is supported by the perceived and actual stimuli damping of the materials of the screen.

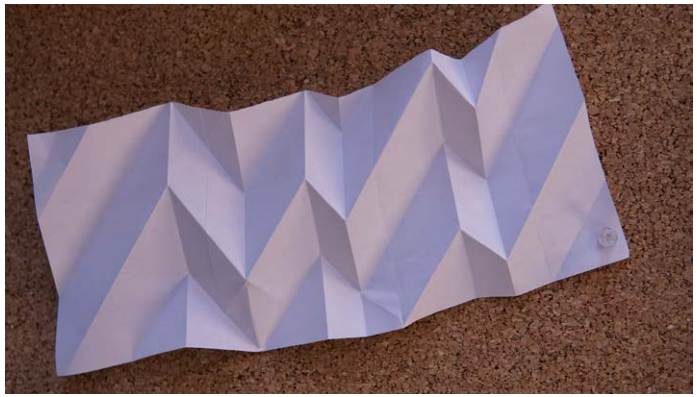


fig.38: The selected texture, a Zig-zag V-pleat fold

Following I developed the folding system, which allows co-workers to unfold and attach the textured screen to a frame and allows them to compactly fold and store the screen when they don't use it. To identify the needs and concerns that this folding system should fulfill, I held a discussion with the Com&In team and interviewed co-workers, based on a set of simple storyboards. Here, co-workers preferred a system that looks simple to operate and is reliable or easy to repair, while the Com&In team a system, that is attached to the frame since it could help co-workers to store the screen neatly. Since no concept was clearly preferred, I developed a new combined proposal based on these insights during prototyping.

The insights from these user evaluations form a set of guidelines (fig.39), that I form the foundation of my design intervention. An overview of these guidelines, that shows the research activity they are derived from, can be found in fig.x. The application of these guidelines, helped me to select the texture, materials for the design and develop the interaction, such that these design aspects consistently communicate the intervention its qualities. In short, these guidelines should help to create a design that communicates that it's 'reliable', 'protective' , and 'caring', which should have a calming effect on co-workers.

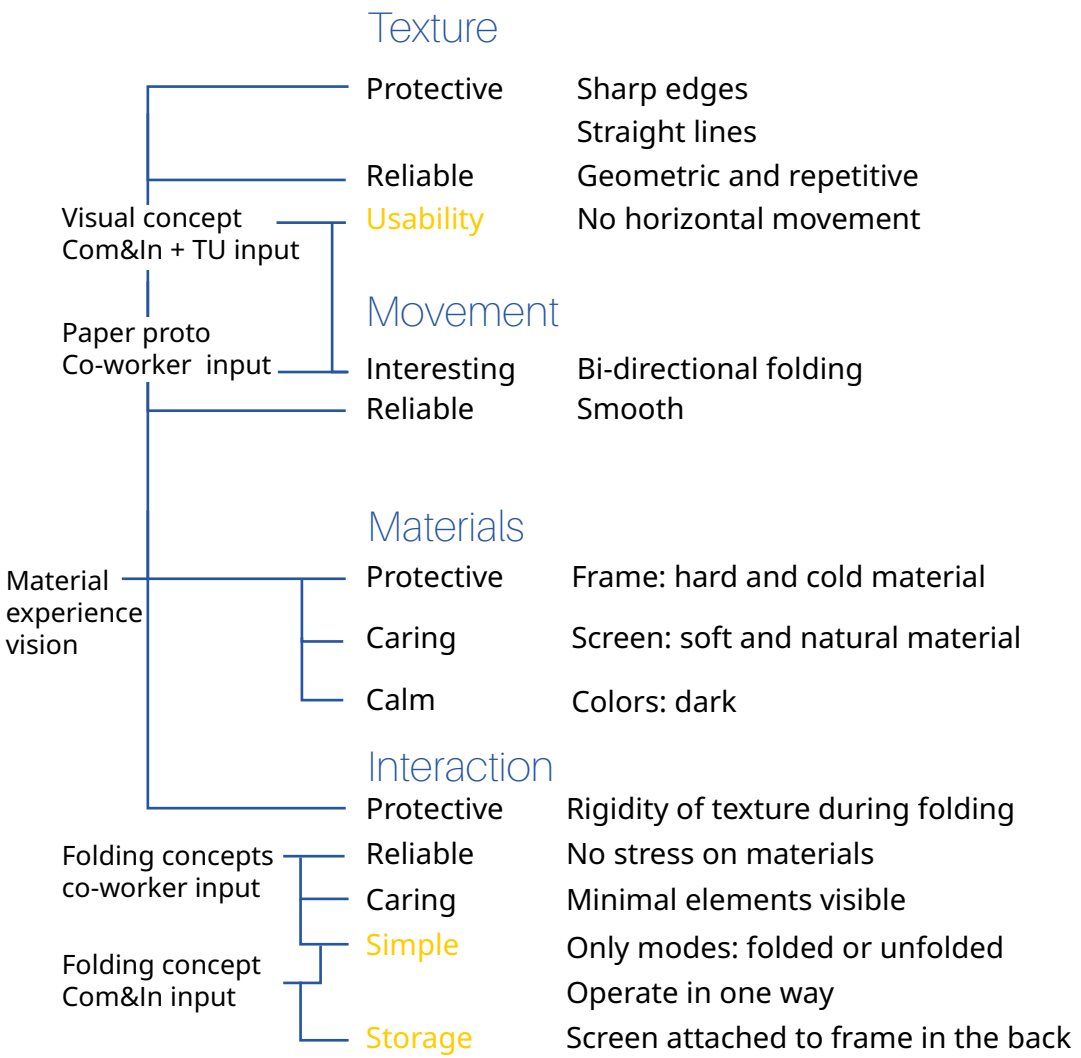


fig.38: Overview of the design guidelines and which activities helped to establish them

e) Prototyping: Full-scale and small-scale prototypes for user testing

To make sure that the design intervention could be implemented in the office and could be evaluated with co-workers, I created two working prototypes. These prototypes iterations revealed how the three-dimensional screen and a reliable folding system present folding system could actually be produced. Following I created the embodiments of these prototypes to express the experience of the design and help me measure the effect of the design intervention on co-workers' experience of nuisance.

Creating three-dimensional textures with felt

To embody the screen for my design intervention, I experimented with various materials and constructions. Here my prototyping approach builds on the work of Bahareh Barati (fig.39), who laser cut polypropylene sheets to create a V-pleat texture. While these sheets were quite stiff and therefore difficult to fold (fig.x), they did reveal CNC cutting techniques as production methods to create textures with this complexity. Following this I CNC knife and laser cut various materials, to create a screen with desirable material attributes.

Through my prototyping iterations, I aimed to create a screen that could be repeatedly and compactly folded, while maintaining its desired texture when standing on its own and feel soft to touch. To achieve this I did various prototyping iterations, which are described in Appendix B7. From these iterations I learned that it was not feasible to create a sandwich construction, because I could not find a material for the core, that could be folded repeatedly and compactly (fig.40-41). Following I laser cut thick sheets of felt in various ways, where I learned that cutting it with dashed lines and cutouts at each end, created sheets that were both able to carry their own weight and compactly foldable(fig.42-42). Following I created the sharp edges, by flat ironing the edges of the folded sections of the screen. These iterations show the potential of felt and other natural soft materials, to form small rigid structures.

fig.39: A repeating v-pleat texture, such as the one made by Barati (2019). Image from Jackson, 2011, 'Folding For Designers', p.125

fig.40: This texture, that was cut into cardboard, could not fold compactly or repeatedbly without ripping.

fig.41 Here I lasercut an EVACast sheet of 1.2mm, to create a texture, however this sheet was way to stiff to fold compactly.

fig.42: Side and front screen, are created to facilitate user testing at a corner desk within a neighborhood.

fig.43: Side and front screen, are created to facilitate user testing at a corner desk within a neighborhood.

Purpose of the small- and full-scale prototypes

I created a functioning full scale and small scale prototype to test the both prove the feasibility of the design and assess the design through two different user tests. The full scale prototypes is used during user testing in a controlled set-up and aims to measure the effect of the interaction and three dimensional texture on co-workers experience of nuisance (fig.44). The small scale prototype is used during remote testing and should help co-workes to understand and evaluate the use and impression of the deisng.

The full scale prototype presents the interaction and material experience of the design of Fridfold as closely as possible. This is done to evaluate the effect of Fridfold during user testing and to evaluate the feasibility of the design. To achieve this, the prototype presents the interaction, material qualities and size of the final design. Next to this it consists of two screens, that are placed at the side and at the front of the desk, which is similar to how it would be set-up in the office context. Appendix B8 shows the development and construction of this prototype,. The development of the interactive elements is further described in the next section. The effect of this prototype is assessed used during the Effect assessment user test (p.55). Consequently, I kept the frame of the protype simple to emphasize the texture of the screen and the interaction. This emphasis on the screen and interaction with the product should then makes it easier to measure the effect of the three-dimensional texture and interaction on co-workers experience of nusiance during user testing

fig.44: The full scale prototype, that shows the screen like it would be applied within the office and the let's users experience the interaction and material qualities of the design. This prototype is used during the Effect assessment user test (see section V , part b) method

The small scale prototype is used to show the three dimensional texture and folding interaction with the sound screen to co-workers during the remote user tests. Appendix X, also elaborates on the design decisions and how this prototype was made. I, here, aimed to replicate the screen's original ratio, texture and maintain as much ability to damp visual stimuli as possible. For this I scaled the screen's width to fit the maximum postable size and asked test participants to compensate the height to the normal ratio. Also, I decreased the texture size to that of earlier small prototypes. I then replicated the folding interaction of the straps, that were preferred by co-workers (p.41), by using paper clamps to attach the edge of the screen to the frame. Here I replicated and scaled the original features of the design, with the aim to have co-workers experience the design as realistic as possible.

Both prototypes aim to convey a similar experience of the design to co-workers, however they serve different purposes. Through the full scale prototype, I aim to measure how the interaction and texture of the material influence co-workers experience at a deskspace. To measure this the design is evaluated within a controlled set-up. While the small scale prototype lets co-workers experience these elements, to further understand and improve the experience of the intervention. As a result, the combination these prototypes should give an insight into the effect of the current design and on how it could be further improved in terms of use, interaction and material experience.

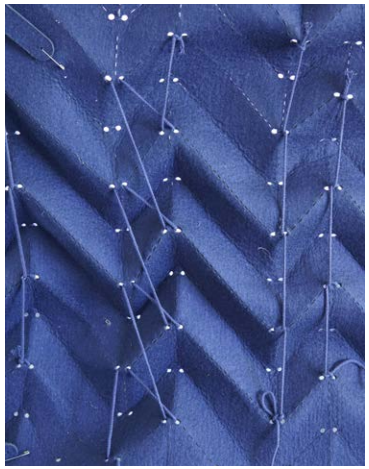
fig.45 Small scale prototype, placed on top of a book to compensate the height and replicate the ratio of the full scale screen.

Developing the screen folding mechanism for the full-scale prototype

The interaction with Fridfold should allow users to unfold and attach the screen to the frame and after using it allow them to compactly fold the screen onto the back of the frame. For this I tested the screen with folding systems, using strings and straps. The strap system allow that make the screen fold like a curtain, and straps, that allow co-workers to attach the screen to the frame at it's edges. The outcomes of this can be found in Appendix B8. These reveal that a system using strings could not achieve the desired textural qualities, while systems using strings to pull and fold the screen, caused stress on the screen.

Combining this with the insights from the prototypes, suggested that a system using straps to attach the frame and strings to aid in the neat folding, could make sure the interaction was still simple and made it easy to fold and stor the screen neatly.

Following I applied the vertical strings as a separate system to provide the support for the screen and keep the texture intact. This sytems, however could not maintain the structure when the screen was folded multiple times. Therefore I prototyped various combination of strings, which can be seen in fig.46. Here it became clear that knotting the wire to the screen helped to maintain the texture when folding is multiple times. Furthermore the diagonal connections , seen on the second row on the left, could help to maintain the structure well without curving the screen to much. To then further prevent curving I also added a string at the front of the screen (fig.). This made the screen close at the bottom, which contributed to the quality of the prototoype. This diagonal string system may not be feasible to apply in the final design, due to the complexity of manufacturing this, however functioned well for the prototype.



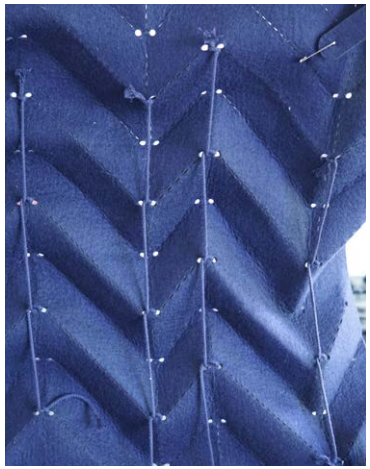


fig.46: The diagonally linked strings (left), caused less curving of the screen and maintained the texture better, than the vertical strings (right)

fig.47: The string at the front to prevent curving of the screen (fleft) and pattern of the knotted strings in the back (right)

Following I attached buttons at the front and back of the screen. The front buttons (fig.x) attach the straps to the screen and are consistent with the material experience vision. While the buttons at the back are used to attach the screen to the frame. Here I chose to use buttons that could be attached using thread and needle, which meant that they were not visible at the front (fig.48).

Evaluating the interaction with theses straps, I found that the current straps were unable to facilitate the compact folding of the screen due to their top and bottom positioning (fig.49). Therefore I added a wrapping strap, that could wrap around the screen and facilitate the compact folding (fig.50-51). For this I applied a hook, instead of the buttons, applied for the other straps, to highlight the alternative functionality of this strap

This resulting system can facilitate the envisioned folding interaction of the design and provides the desired textural quality for the screen. Here the knotted strings can maintain the texture of the screen after multiple folding operations. The straps help users to attach the screen to the frame in a simple and easy way. While the wrapping strap could facilitate the compact folding of the screen (fig.52).

This same system was replicated in a simpler way for the small-scale prototype, to still give co-workers an idea of the interaction (fig.53). This is further elaborated in Appendix B9. Next to this storyboards and other visual material is used to help co-workers further understand the design.

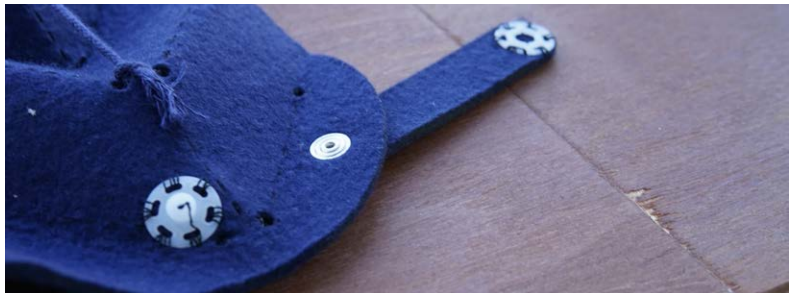


fig.48: The metal front buttons and plastic back buttons could be attached, without showing at the front of the screen

Fig.49: The buttons were unable to fold the screen compactly

fig.50: The wrapping strap could be attached to create more tension on the screen

fig.51: The strapping strap, folded around both screens as seen from the back (left) and front of the screen (right)

Trough these prototyping iterations, I have developed a design that is feasible to produce and can be tested with users to measure the effect of the interaction and texture on co-workers experience of nuisance. Where I could rely on the design guidelines from the earlier user evaluations, throughout my prototyping iterations. This finally lead to an executable design, that through evaluations and experiments, that is consistent with the material experience vision and takes into account the preferences and concerns of the stakeholders with regards to the interaction with the screen.

fig.52: The full scale prototype in the unfolded (left) and compactly folded (right) conditions

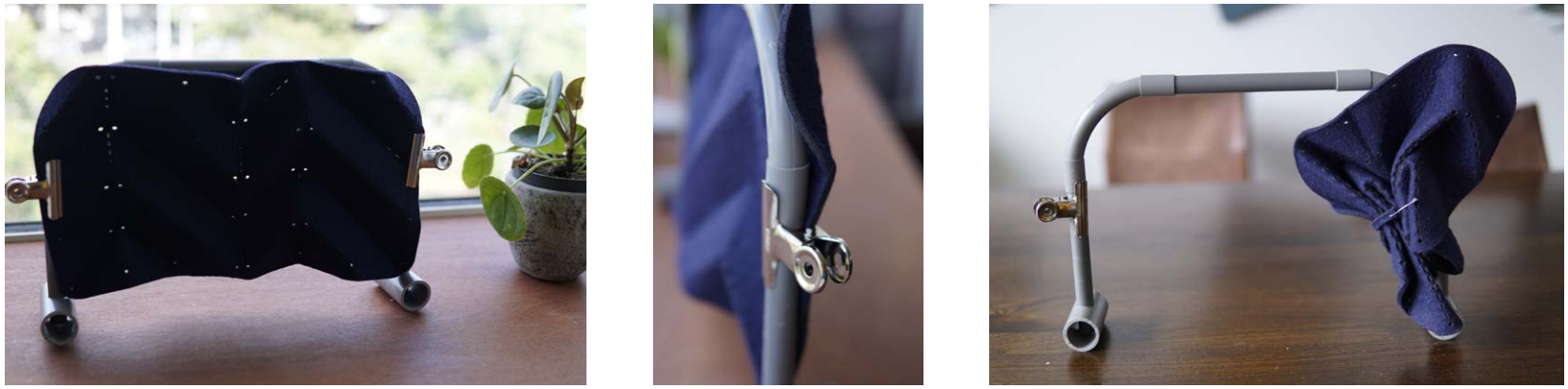


fig.53: The small-scale prototype. Left: unfolded. Middle: the paper clamps applied to attach the screen to the frame. Right: the screen in folded position

f) Design: Fridfold

FrifFold is a stimulation barrier, that is created to alter the perception of employees, such that they experience less nuisance. This is done through the application of a three-dimensional surface texture and by giving employees the ability to control the amount of stimulation, through interaction. The name Fridfold is a conjunction of ‘Fridfull’, the feeling described in the design goal and folding, the interaction with the intervention.

A sound screen to decrease objective and subjective nuisance

Fridfold is an interactive stimulation barrier that helps co-workers to decrease the amount of nuisance they experience (fig.54). The design aims to do this by decreasing the amount of stimulation and the perception of this stimulation. This is supported by the experience of the design, that should come across as ‘caring; ‘protective’, and ‘reliable’.I designed the three-dimensional texture, materials and interaction with the design, all focused on communicating these three characteristics, where the materials should also communicate ‘calmness’ as a result after the interaction. The role that the design elements play in is further elaborated in the following section.

I selected the materials and three-dimensional texture, based on specific haptic and visual characteristics, to communicate the qualities of the design (fig.55). Here the sharp edges of the texture and cold and hard touch of the steel frame, aim to communicate the protective quality of the screen, where the soft touch of the felt communicates a sense of care. Next to this I applied dark colors aim to make the environment feel calmer for co-workers. Finally the folding movement of the three-dimensional texture aims to feel smooth, which should make the design feel ‘reliable’. The combination of these qualities should make co-workers feel ‘relief’ when they work at their desk with the screen.

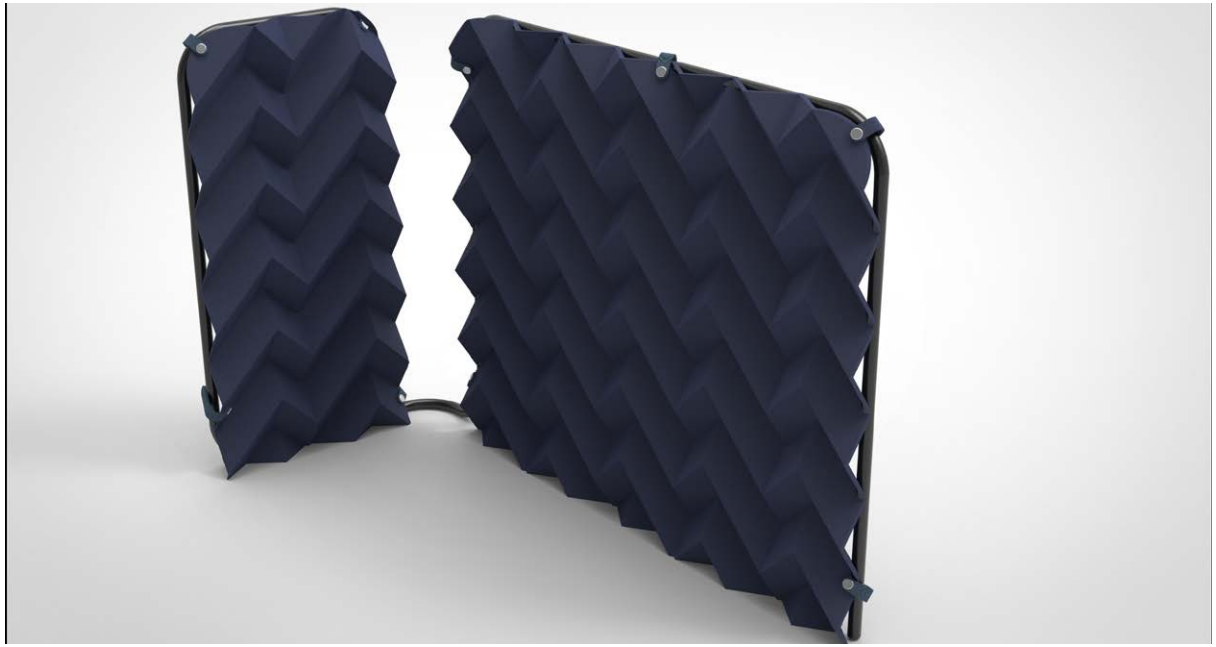


fig.54 Fridfold, stimulation barrier to decrease the sensation and perception of visual and auditory stimulation

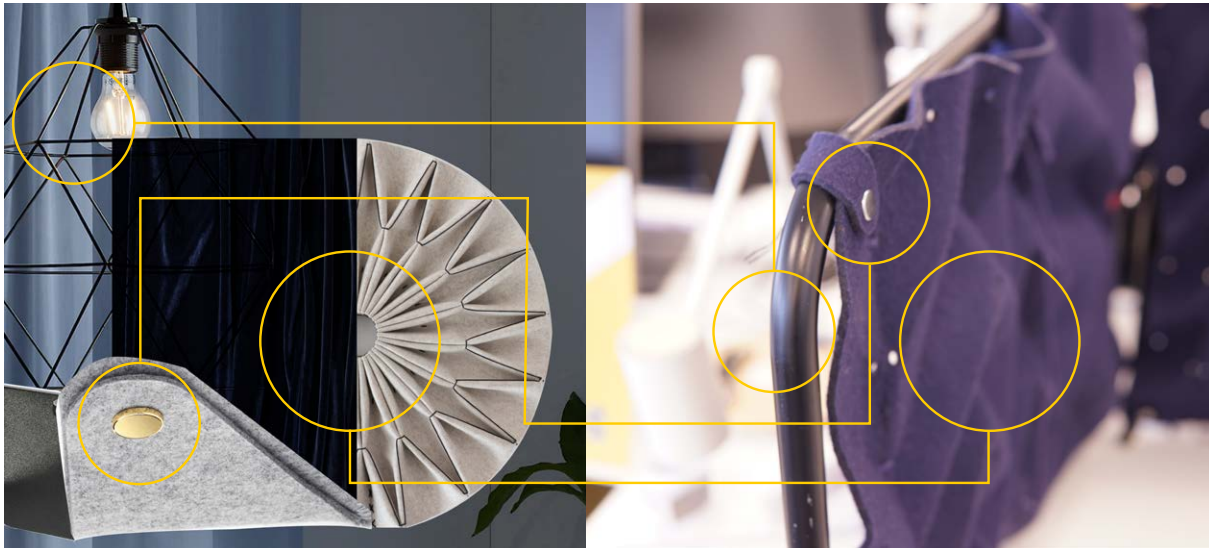


fig.55 The link between the final design and the Material experience Vision (p.38)

Co-workers interact with the screen by unfolding its texture and attaching it to the frame. Based on co-workers' input, I designed five straps, that co-workers use to unfold an attach or compactly fold and store the screen in a neat way, at the back of the screen. Allowing co-workers to interact with the screen should enhance the sound damping of the screen, by making co-workers feel more control over their surroundings, which aims to decrease their perception of stimulation (fig.54-55).

The design of the screen aims to both lower the amount of stimulation co-workers receive and their perception of stimulation. The amount of stimulation is decreased through the acoustic and visual qualities of the felt screen. Here the 3mm thick felt should be able to decrease the sound level significantly, while it's dark-colored opaque surface blocks light from the outside and reflects little light from the inside, which helps to draw attention away from anything beyond their desk. Next to this the three-dimensional texture has characteristics similar to textures applied in sound damping products (see fig.x for reference). This means that co-workers' preconceptions about this material should lead them to perceive a higher sound damping from the screen. Combining these should lead them to experience less nuiance, where the actual damping is enhanced by a lower susceptibility to these distractions.

fig.56 The buttons that are used to fold the screen of Fridfold

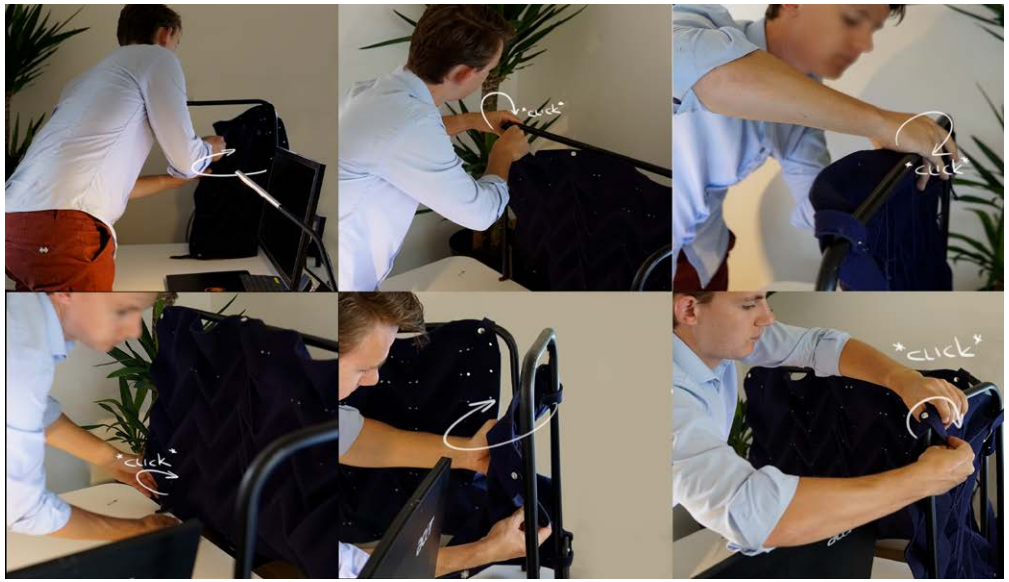


fig.55 Storyboard to explain the interaction with Fridfold

Within the context of the IKEA CBF office this screen can be applied as an individual solution that can be placed on the desks of co-workers. Where the current design can applied at the side where co-workers experience most nuisance, such as along a pathway (fig.58).

I developed the embodiment of the frame, by integrating user insights, with ergonomic data and by evaluating sketched concepts. The sizing of Friddold can be seen in fig.59, while the process behind this can be found in Appendix B9. In short the current sizing should block stimulation on and below eye level for a co-worker using the screen, while keeping him visible to other co-workers this can make sure that co-workers can still see if they are present from far. Where the presence of the screen should give the signal that co-workers is performing a focused task and doesn't wan't to be interrupted.

fig.58: Fridfold within the context of the CBF Office

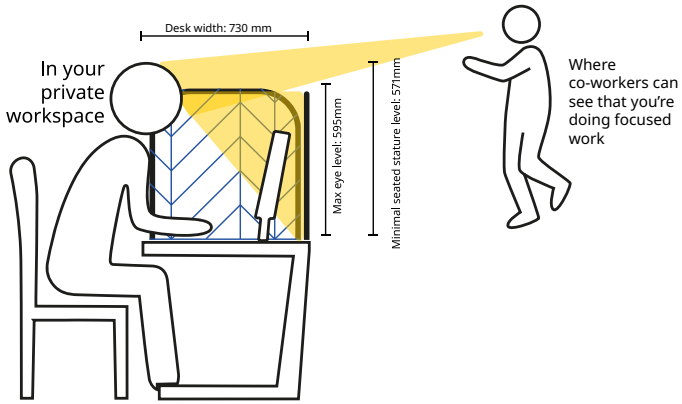


Fig.59: The height of the screen is created such that all visual stimulation on eye level or below this is blocked. At this height the

For the frame I first evaluated whether this could be applied as a structure between desks (fig.60), however this turned out not be practical. Instead I chose a shape that I immediately associated with an embracing movement (fig.62). This curving part of the frame is placed near the back of the desk and contributes to the ‘protective’ quality of the design, without limiting co-workers’ freedom to move.

The resulting design, should be able to decrease both the amount of stimulation co-workers receive and their perception of these sources of nuisance. Where the products experience, should further convince co-workers the product is ‘reliable’, ‘caring’ and ‘protective’ and ‘calm’. This should help co-workers to create a desk space for themselves, where they can feel relieved. This shows that the design should be able to fulfill it’s design goal of creating a ‘fridfull’ or serene individual workspace for co-workers.

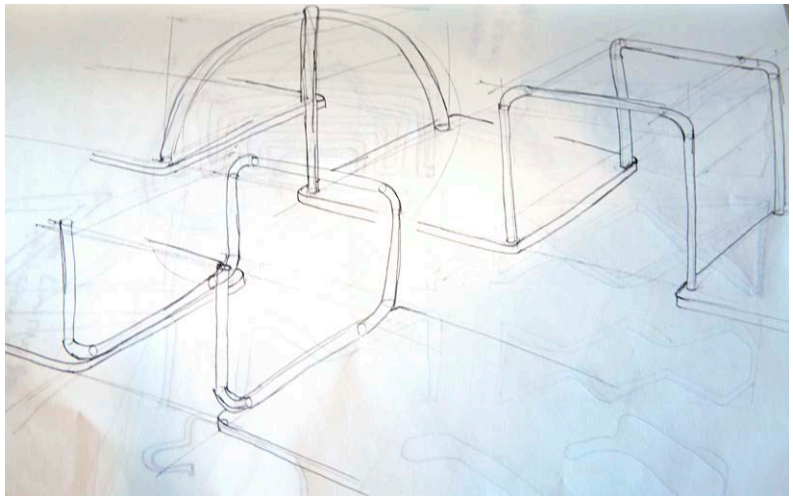


fig.60: Creating an overarching structure between desks seemed interesting, but difficult to impelemt on desks with adjustable height or would constrain the pathways between desks

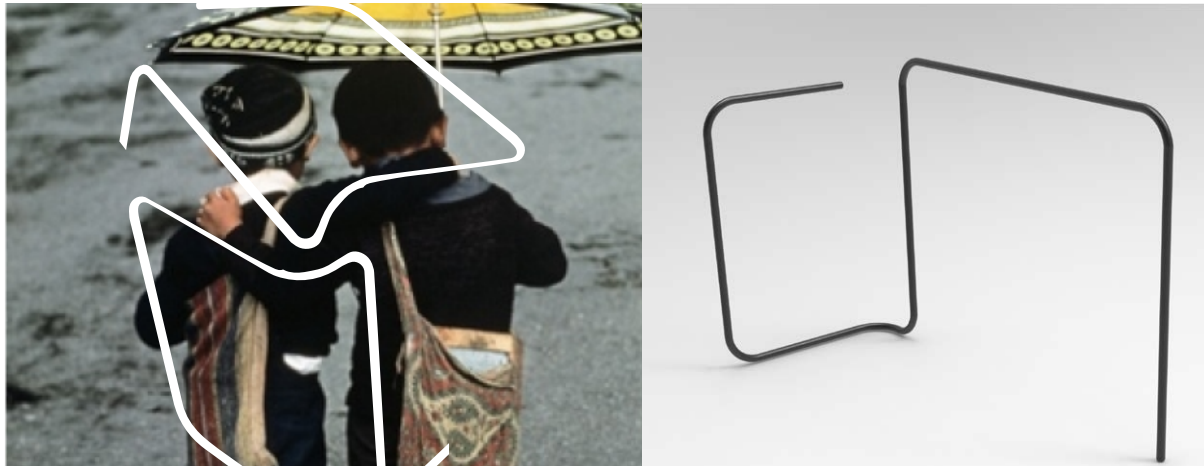


fig.61: The final design of the frame

V:

VALIDATING THE EFFECT OF CONTROL AND MATERIAL PERCEPTION ON THE EXPERIENCE OF NUISANCE

a) Introduction

The effect and design of Fridfold are evaluated, through two separate user test. These tests were initially combined into one test, however, as a consequence of the COVID-19 crisis, I could no longer evaluate the design of Fridfold within the context of the IKEA CBF Office. Therefore, I created one test to measure how Fridfold may affect people their experience of nuisance in an open individual workspace and a second test to evaluate the impression of the design on co-workers and identify how the design could be further improved (fig.62).

The first test, called the Effect assessment, investigates how the current design of Fridfold could influence the experience of a nuisance during individual work activities in an open office context. To achieve this, I created a comparative user test in a set-up, that stimulates the experience of working on an individual task in an open office. Participants here assess their experience on a number of factors, both in a condition with and without using a full-scale prototype of Fridfold. This should give reveal how Fridfold influences several aspects of their experience and determine if co-workers' sense of control influences their experience of nuisance.

The second test is the Remote experience evaluation, which is used to evaluate the impression of the design on co-workers and identify how the design could be further improved. For this received a package at home to perform these tests, which included a set of assignments and small-scale prototype and other materials to give them a rich impression of the design of Fridfold. The outcomes of these tests should help to assess if Fridfold has the envisioned 'calming' effect on co-workers and identify how the design could be further improved

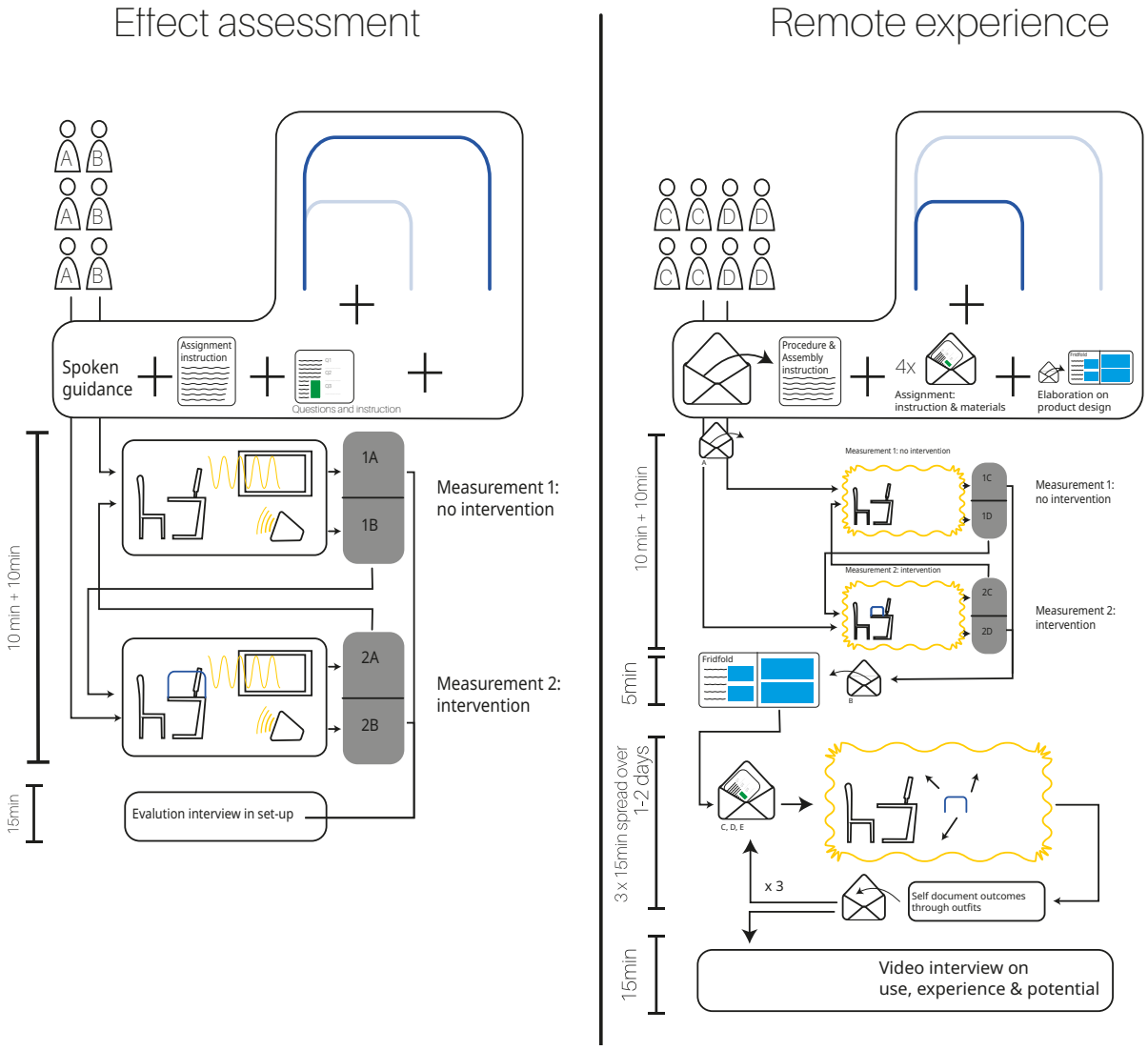


fig.62: The process charts of both user evaluations

b) Method

The Effect assessment and Remote experience evaluation are used to measure the effect quantitatively and assess the experience of the design qualitatively. In combination, these evaluations should reveal how the current design influences the experience of nuisance and identify opportunities to further improve the design.

Effect assessment

The Effect assessment consists of a comparative user test, which aims to reveal how Fridfold influences participants' experience of a shared workspace while performing an individual focused task. During this test, participants perform a reading comprehension assignment, followed by a questionnaire, both in a condition with and without Fridfold. This comparative design helps to understand the effect of Fridfold on the space and allows for the elimination of most of the interpersonal differences.

Participants performed the Effect assessment within a controlled set-up in my living room (fig.63-64). Details on the set-up and materials used can be found in Appendix B10. Within this set-up, I presented participants with intense auditory and visual stimuli, in order to have participants experience a nuisance within the short time span of the experiment. The design of Fridfold is represented through a full-scale prototype, where participants are instructed to unfold the screen of Fridfold at the start of the round during which they experience the workspace with it (fig.65). The combination of the intense stimuli (fig.66)and interaction aims to recreate the experience of nuisance of a co-worker, who has been working in a shared deskspace for a longer period of time and identify if the interaction with and presence of Fridfold influence this experience.

The Effect assessment was performed by six participants. Each of these participants was male and between 25-30 years old. Here due to the COVID-19 pandemic, these participants were directly related to the researcher or indirectly related through roommates. All of them had previous experience working in an open office or shared workspace.

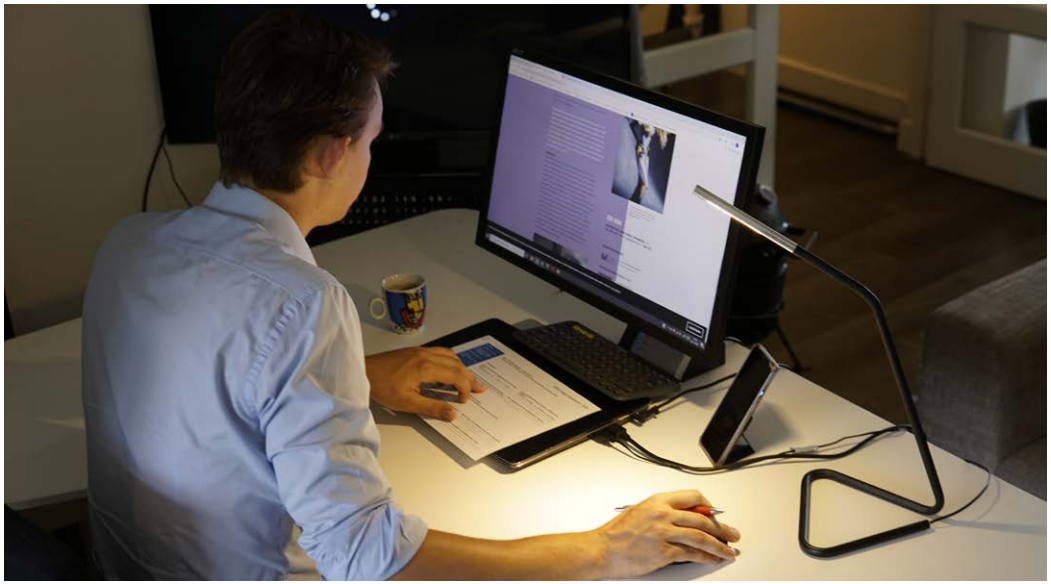


fig.63: one of the participants performing the Effect assessment, reading text on the external monitor

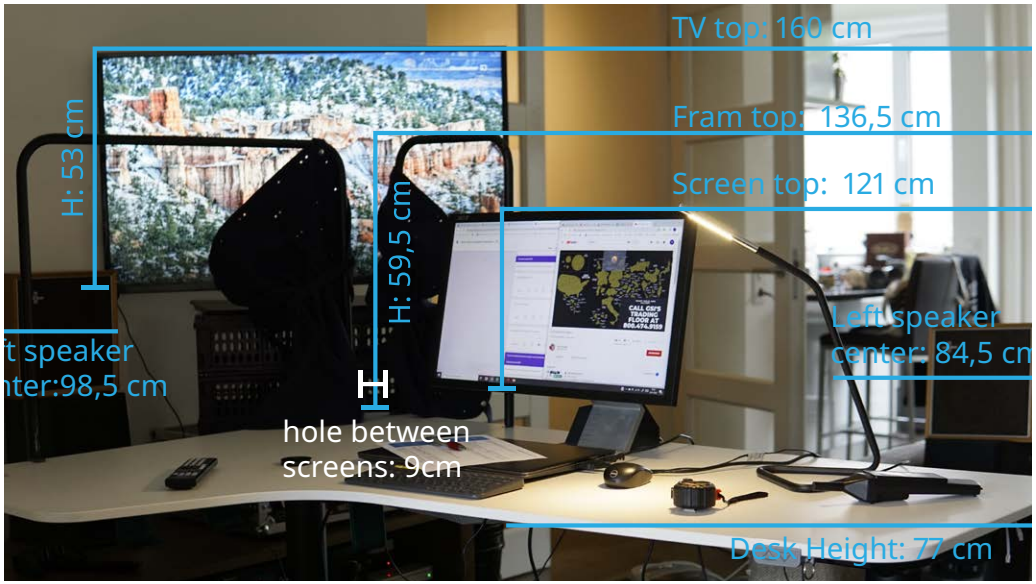


fig.64: The controlled set-up, where visual stimulation is presented is present in both the central and peripheral field of vision and remains present above eye level even when placing the screen.

The influence of Fridfold on the experience of participants is recorded, through a questionnaire, sound measurements (fig.67), and an interview. The questionnaire is used to create a quantitative account of the influence of Fridfold on participants' experience and is filled in after each round of the test (fig68). This questionnaire aims to reveal the influence of the intervention on the visual, auditory, and general perception of stimulation. Next to this, it reviews how the influence of the design intervention on their ability to focus, pleasantness of the workspace, and perceived sense of control. To achieve this, the questionnaire consists of seven questions, that ask participants to assess their experience for each of these aspects. The measured effect of Fridfold is interpreted through an analysis of the sound recording within the test set-up and a semi-structured interview is performed after each test. These sound measurements help to indicate the role of the decrease in stimulation, while the interviews, help to identify the role the sensation and perception in the experience of participants. The combination of these measurements and the qualitative account is used to assess the effect of the design intervention on the amount of auditory stimulation and indicate if the interaction and texture contribute to the perceived effect.

In summary, the Effect assessment should indicate if the application of Fridfold can influence the experience of nuisance during individual work in an open workspace. Further, it should indicate if this effect relates to the amount of stimulation participants experience or other aspects, such as their sense of control and ability to focus.

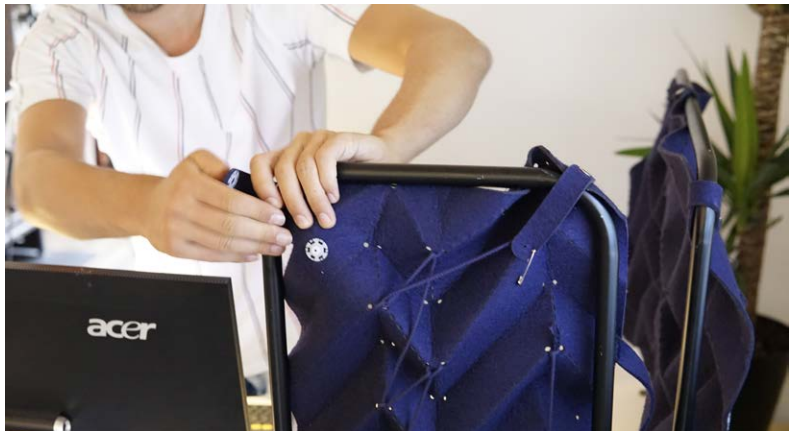


fig.65: A participants interacting with the full-scale prototype during the the comparative test

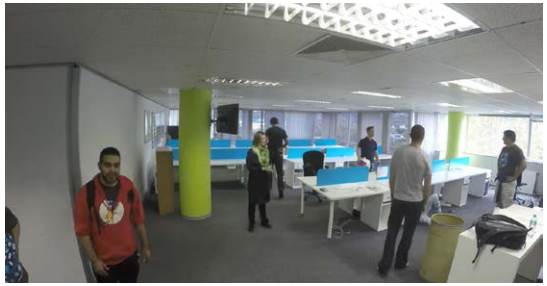


fig.66: A screenshot of the time-lapse video that represents the visual stimulation in the set-up

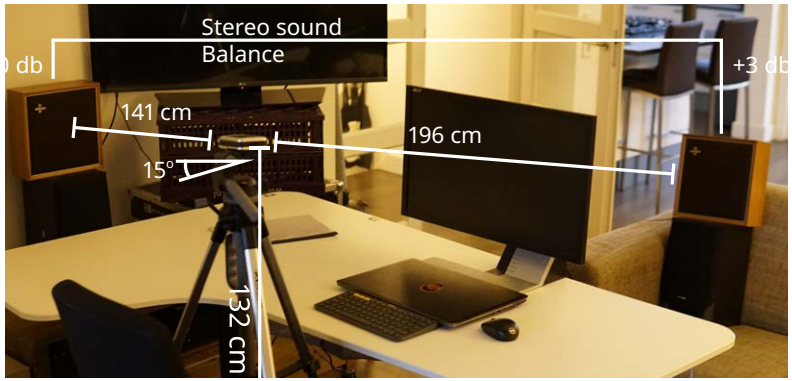


fig.67: Set-up of the sound measurements. For the test auditory stimulation is set-up to give participants an omnidirectional experience of the sound source

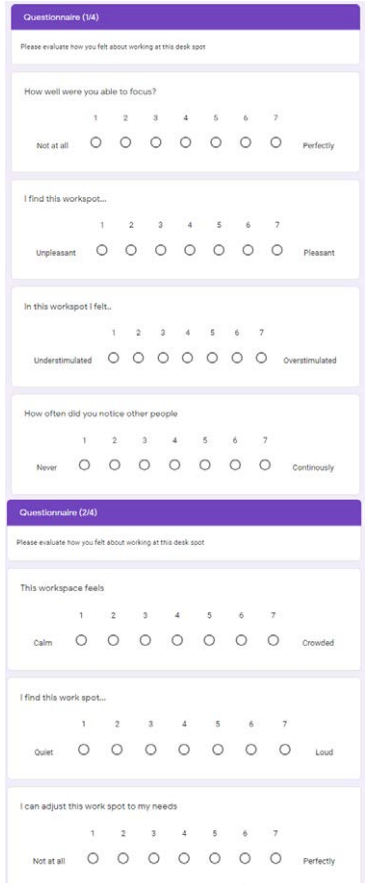


fig.68: The seven questions of the questionnaire, that are assessed using a 7 point likert scale

The Remote experience evaluation

This user test is used to the impression of the current design on co-workers and how the design could be further improved. For this, they received a package with materials to help them understand the final design and three assignments to perform on their own (fig.69). To help co-workers understand the design of Fridfold, they receive a small-scale prototype, an assignment during which they use this prototype, and a written presentation of the final design. The three assignments evaluate the emotional effect of Fridfold on co-workers, how co-workers would use and improve the design, explore if the design could be used as a communication tool. These measurements should help to evaluate if Fridfold can have a calming effect on co-workers and identify how the design can be further improved.

To give co-workers an impression of the design of Fridfold, they received a small-scale prototype (fig.70), an immersive assignment, and an explanation of the final design (fig.71). The small-scale prototypes allow co-workers to experience the material and texture of the screen, interact with the design, and gives an indication of the size of the full design. A further explanation of how the choices made in creating this prototype can be found in Appendix B8. The immersive assignment is identical to the comparative user test from the Effect assessment. This means that it requires co-workers to interact and experience the effect of the small scale prototype and compare this with a condition without the design. While the explanation of the final design helps co-workers to understand the embodiment, functions, and interactions of the final design. Together these package contents should help co-workers to understand the materials, use, and functions of Fridfold.

Co-workers will perform three assignments, evaluating the emotional effect the design has on them (fig.72), the use of Fridfold (fig.73), and identify if Fridfold could also serve a tool to better structure interruptions (fig.74). The first assignment assesses the impression of the design on co-workers, by asking them to visualize the character of the design and

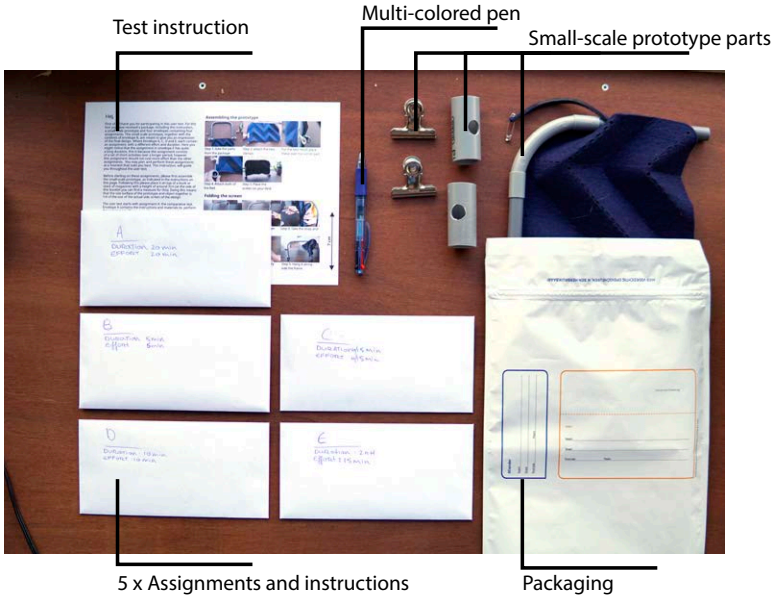


fig.69 : Remote testing materials

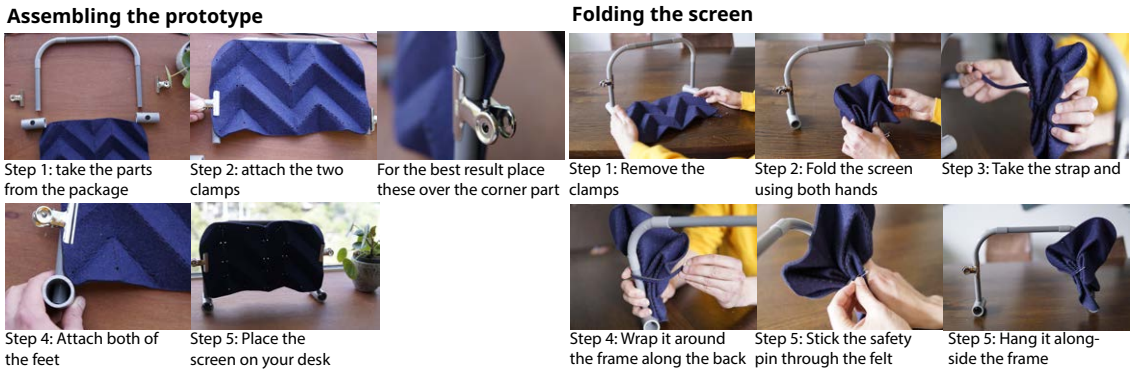


fig.70 : Assembly and folding instruction for the small-scale prototype

identify what they feel as a result. Here they take on both the perspective of using Fridfold themselves as well as seeing another co-worker use it. Co-workers for this make use of a toolkit, containing examples of common facial expressions and hand signals, which can reveal the intent of the design (Rozendaal, 2020). To indicate how they feel as a result of this, I used the PreMo toolkit (Desmet, 2014). Within the second assignment, co-workers reflected on how they would use Fridfold to decrease the nuisance of sources they experience and to indicate how this could be improved. Finally, the third assignment asks co-workers to use the small-scale prototype as a communication tool with their family members. This should identify if, in combination with rules, the design can help to structure interruptions throughout the day. After completing this test, participants are interviewed via a video call, giving the researcher the opportunity to gain a deeper understanding of the answers participants formulated. This opportunity helps to increase the quality of the insights, by making sure that the questions are answered on an equal level by each participant. Next to this, co-workers will discuss and are asked to give suggestions to improve the use and functionalities of the current design. Consequently, the Remote experience evaluation should help to evaluate if Fridfold has a calming effect on co-workers, reveal what needs the current design fulfills, and may reveal further needs of co-workers and opportunities to improve the design.

In short, the Remote Effect assessment evaluates if the design has a calming effect on co-workers, through its impression, evaluate the use of the design, and identify what further needs co-workers would like the design to address. As a result, the combined outcomes of the Effect assessment and Remote experience evaluation, should indicate how the current design of Fridfold influences the experience of nuisance during individual work tasks in an open office space and how the design can be further improved.

fig.71 : The Explanation of the final design, that participants found in envelope B

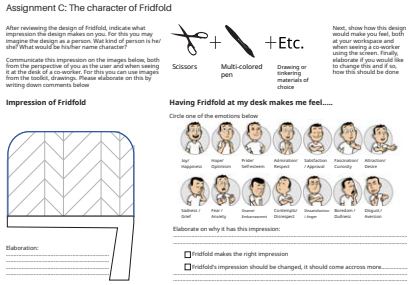


fig.72 : Assignment C,. Here co-workers made drawings and used the tookit to visualize the character of Fridfold, while using PreMo to indicate how they feel when using/seeing Fridfold

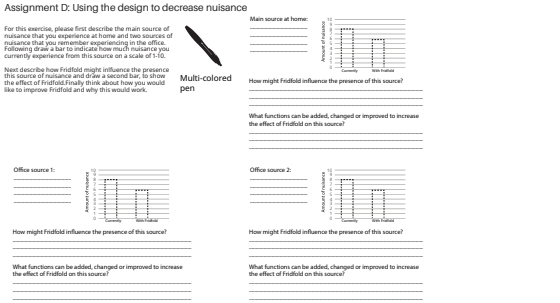


fig.73 : Assignment D,. Co-workers indicated the three main sources of nuisance and identified how the current design should help and could be improve to tackle this

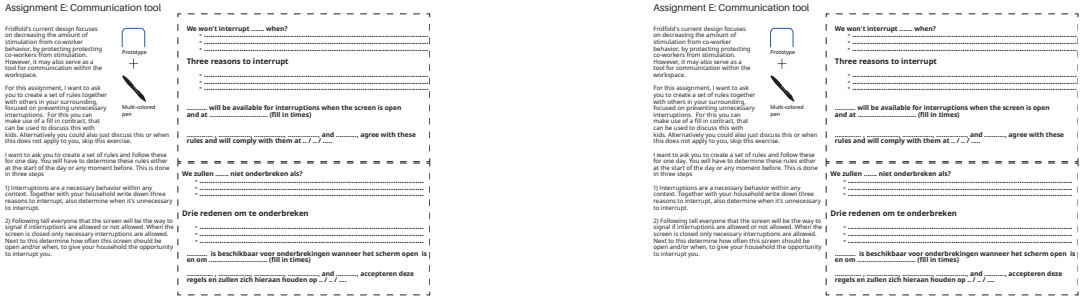


fig.74 : Assignment E, where co-workers used the small-scale prototype to manage interruptions, by discussing a set of rules

Effect assessment results

The comparison of the mean scores from the Effect assessment questionnaire in both conditions shows that the presence of Fridfold in the workspace influences participants' experience of the test on each aspect. This can be seen from the comparison of mean scores for each measurement in fig.x. Here the blue bars, represent variables for which the scores are hypothesized to increase in the condition where Fridfold is applied. While the variables that were hypothesized to decrease in this condition are indicated in yellow. This graph presents the adjusted mean score of each measurement in the condition without (1) and with (2) the presence of Fridfold, where the error bars represent the adjusted variability in scores (fig.75). These measurements were adjusted with a factor for each measurement, to account for the variability in means between subjects. This could be done because the test was set-up using a repetitive measures design, which means that each participant assessed their experience in both conditions (Field, A. 2014). More information on how these adjusted measurements were created can be found in Appendix B11.

The measurements seem to be normally distributed, which is assessed by comparing the mean and medians of each variable. This was done because the small sample size made it difficult to do this through These are presented in fig.76, which shows the mean, median, maximum and minimum score for each variable. Here differences between the median and mean scores quite small compared to the size of the measured effects.

This mean comparison revealed that participants, globally perceived the presence of Fridfold to influence the amount of visual stimulation, noticeability of others, and sense of control over their workspace. On average participants sense of control in the NoScreen condition (M=3.5, SE=0,247) was lower than in the Screen condition (M=4,833, SE=0.247). While the amount of visual stimulation participants experienced in the NoScreen condition (M=4,83,SE=0.167), decreased in the Screen condition ((M=2,5,SE=0.167).

fig.75: Comparing the mean scores of each measurement. Blue bars are the measurements for which the value is predicted to increase in the Screen condition (2), while the measurements presented in yellow bars are expected to decrease

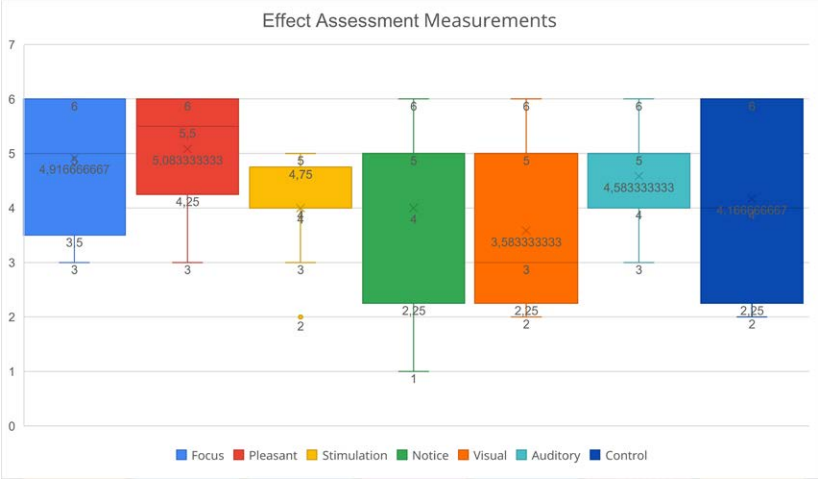


fig.76: Comparing the mean and median score of the measurements for each variable

Participants also noticed more co-workers in the No Screen (M=4.6667, SE=0,211) than in the Screen Condition (M=3.33, SE=0.211). The measurements also show trends in the predicted direction for the measurements on ability to focus, the pleasantness of the workspace, the amount of auditory stimulation, and stimulation in general.

Following I reviewed if these measured effects are consistent among the sample, through an paired-samples T-test for each measured variable. (Field, 2014). The outcomes of these T-tests are presented in fig.77, while the data used and methods used to process this data can be found in Appendix X. The results of these T-tests show that the effects seen for Visual (t(5)=7.00, p=0.001), Control (t(5)=-2,697,p=0.043), and Notice (t(5)=3,162, p=0,025),were significant. While these effects for Focus, (t(5)= , p=), Pleasant (t(5)= , p=), Stimulation (t(5)= , p=), and Auditory (t(5)= , p=), were not significant. This means that participants consistently noticed a decrease in the amount of visual stimulation and the amount of 'people', they noticed. While they experience an increased sense of control over the workspace.

To determine the influence of Fridfold on the auditory stimulation participants receive within the test set-up, I compared the recordings of the audio signal as received by the participants within the test set-up in both conditions. The set-up used and processing of this data using is further elaborated in Appendix B11. Comparing the output of the decibel meter showed that in the condition with Fridfold the maximum intensity of the sound decreased by 2.2 dB, compared to the control condition, which co-workers are unlikely to notice. Comparing the sprectrums and spectograms (fig.77) shows that Fridfold mainly influences the intesity of frequencies above the 125-5000Hz range that is associated with speech intelligibility.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Focus1 - Focus2	-,83333	1,32916	,54263	-2,22820	,56153	-1,536	5	,185
Pair 2	Pleasant1 - Pleasant2	-1,16667	1,32916	,54263	-2,56153	,22820	-2,150	5	,084
Pair 3	Stimulation1 - Stimulation2	,66667	1,36626	,55777	-,76714	2,10047	1,195	5	,286
Pair 4	Notice1 - Notice2	1,33333	1,03280	,42164	,24948	2,41719	3,162	5	,025
Pair 5	Visual1 - Visual2	2,33333	,81650	,33333	1,47647	3,19019	7,000	5	,001
Pair 6	Auditory1 - Auditory2	,50000	,83666	,34157	-,37802	1,37802	1,464	5	,203
Pair 7	Control1 - Control2	-1,33333	1,21106	,49441	-2,60426	-,06240	-2,697	5	,043

fig.77: Results of the Paired sample T-test

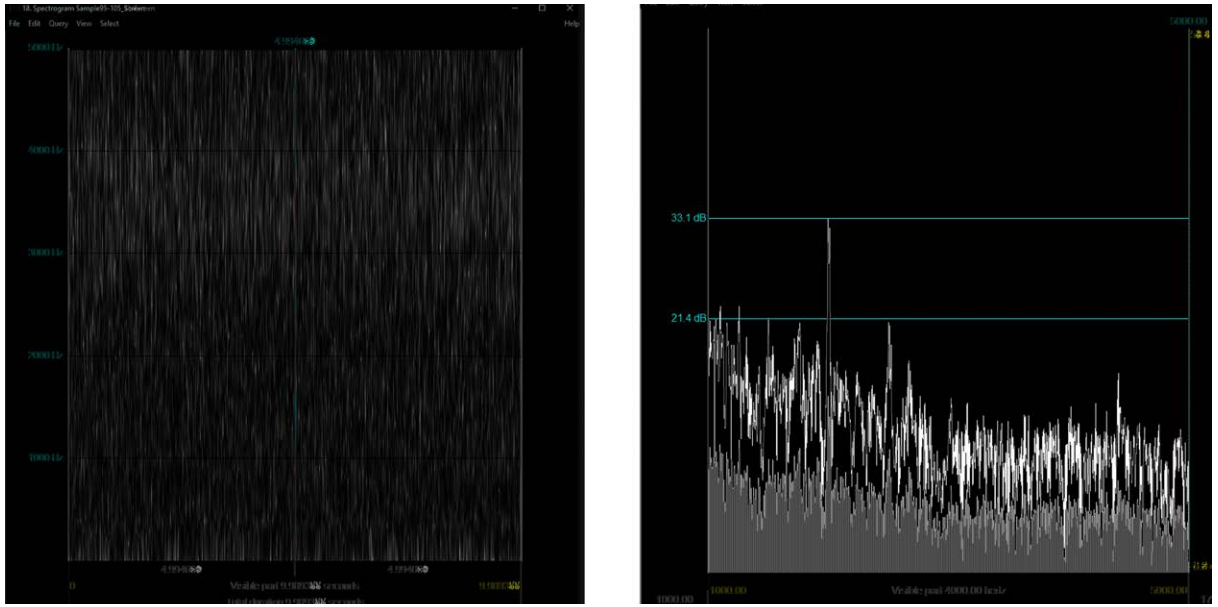
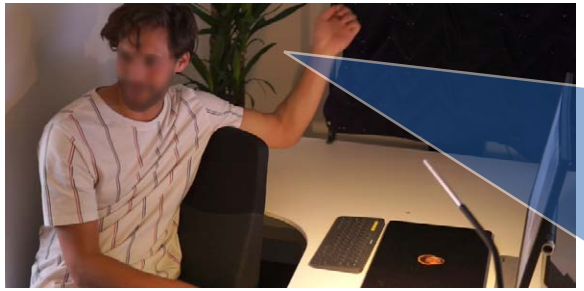


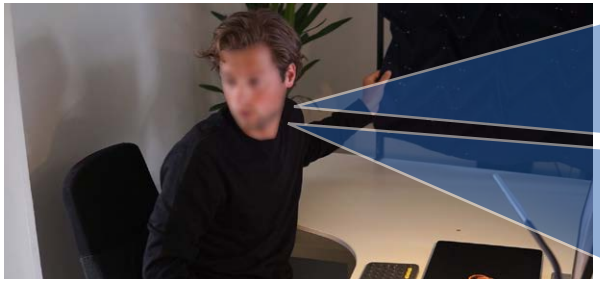
fig.77 using the difference layer function in photoshop, I showed the differences between the two audio samples. Here the grey values indicate the differences between the two signals, where white indicates complete absence

The outcomes of the interviews indicate that Fridfold influences participants' sense of control and the amount of visual stimulation they receive (fig.78). The outcomes of these interviews can be found in appendix B12. Here five participants indicated that they noticed a decrease in visual stimulation in the condition where Fridfold was present. While one of them also noticed a decrease in auditory stimulation. Next to this, four participants indicated that they felt the presence of Fridfold contributed to their ownership over their desk. Finally, three participants indicated that they felt they performed the task better, in the condition where they used Fridfold. In Summary, this means that participants relate the presence of Fridfold to increased performance, experience less visual stimulation and feel more control.

Participants of the effect assessment also gave an insight into how they would use Fridfold. Here all participants indicated that they would only fold the screen occasionally and would only do this if needed to perform short collaborative tasks. Next to this four participants indicated that they would not interact with the front screen, where they could not think of a situation where this was needed and the placement on the desk made it more difficult to operate. Finally, four participants indicated that they preferred this over other desk screens or cubicles because of its flexibility.



Ja als je echt voor jezelf bezig bent in die zin en dan plus de vrijheid dat als je iets wil doen met iemand iets wil doensamen, dat je dat nog kan.



Misschien dat [...]ik hem gewoon zo laats staan, ik weet niet in hoeverre ik hem nou zo steeds weer netjes opklap uitklap

Ik heb niet het diee dat het qua geluid heel veel verschil uitmaakt, maar dat is meer mijn perceptie van stof dat ik dat niet gelijk denk dat dat helpt qua geluid

Waar het handig voor is, is voor als je met je collega ofso gaat meeten en die zit aan de andere kant van jou bureau, of wat dan ook, zoiets moet modulair zijn natuurlijk

fig.78: quotes of participants, who performed the Effect assessment test

Remote Experience Evaluation Results

The Remote experience evaluation indicated that the design of Fridfold at the individual workspaces made two co-workers feel satisfaction/approval, while one other co-worker felt felt hope/optimism, but gave a similar explanation. One participant felt boredome/dullness, as a consequence, which she related to concern about the sound damping ability of the screen. Furthermore they imagined that seeing other co-workers using Fridfold would make them feel respect. While only one participant indicated this in the booklet, the others indicated this when elaborating on the answers they gave here. Participants found it hard to attribute a character to Fridfold and did not relate this to the materials used. Although they did all indicate that Fridfold made the right impression.

Furthermore all participants indicated that they would like to use Fridfold to decrease the presence of auditory sources of nuisance, but found it difficult to assess if the screen could achieve this. Where they had similar concerns about the size and thickness, as participants during the Effect assessment. Three out of four Participants also all indicated that they would like to use Fridfold to decrease the presence of a source of visual nuisance. When discussing this, all participants indicated that they trusted Fridfold be effective in decreasing the effect of these distractions.

Furthermore, participants reflections on the use of the deisgn showed that they liked the ability to place and remove the screen and thought the screen could help them to do focused work more effectively at their desk. Where two participants indicated that they thought Fridfold might help them to focused work at their desk.

Finally co-workers indicated that within the open office of IKEA, Fridfold could help to decrease nuisance from interruptions. They indicated this throughout the test during the reflection on the exercise concerning interruptions, While only one participant actually performed this exercise at home, each of them indicated this somewhere throughout the interview and during the discussion of the exercise on interruptions. For this they did stretch the importance of clear communication about the purpose of the design, where they otherwise did not expect the screen to work effectively

d) Conclusion

The results of the effect measurement indicate that it's likely that Fridfold can generally affect the amount of visual stimulation, the notice-ability of co-workers and the sense of control for employees performing individual tasks within a simulated individual workspace. Here the quantitative measurements of these aspects showed that the presence of Fridfold decreased the visual stimulation and notice-ability of co-workers. These three effects were found to be consistent among the sample, where T-testing showed that these effects were significant. Furthermore the qualitative data from the Effect assessment interviews confirm that co-workers noticed these effects. Next to this participants of the Remote experience evaluation also expressed that they imagined Fridfold to be effective to decrease nuisance related to visual stimulation, which one of them already experienced when placing the small-scale prototype on a higher surface. This makes it clear that Fridfold can decrease the amount of nuisance from visual stimulation within an open office context, altthough the extent of this effect is unclear.

The results also indicate that the increased sense of control co-workers experienced is related to the interactivity of Fridfold. Here co-workers during the Effect assesment interviews and Remote experience test often indicated that they liked the ability of the screen to be used flexibly and that the screen made them feel more ownership over their workspace. However, the results did not clearly indicate if this affected co-workers experience of nuisance. While they did not relate the increased sense of control to a decrease in nuisance, co-workers during the remote test all envisioned Fridfold as a way to manage the amount of interruptions they currently experience. This shows that interactivity can be used as a design element to improve the sense of control co-workers have over their workspace, which benefits he well being of co-workers in the office and could potentially decrease nuisance from interruptions.

The presence of Fridfold had little influence on co-workers general experience of stimulation and amount of auditory stimulation. Co-workers also indicated that they did not experience a difference in the amount of auditory stimulation, with the exception of one participant. This is supported by the objective sound measurements, that show that Fridfold decreases the intensity of the sound by 2 dB. Furthermore the signal intenty for frequencies between 1000 - 500 Hz have been shown to influence the intelligibility of speech (DPA Microphones. 2016). Comparing the spectrums of the recordings in both conditions, however shows that Fridfold has a larger influence on frequencies above this 5000Hz threshold. This means that the current design of Fridfold in unable to decrease the presence of the auditory nuisance caused by co-workers.

This also means that the material characteristics of the screen, were also unable to influence the perceived sound damping of the material. Here two out of six the participants did associate the three-dimensional texture with other sound damping products. However participants from both the Effect assessment and Remote experience evaluation expressed concern about both to the thickness and size of the screen, during the Effect assessment and the remote test. This means that that three-dimensional textures as a separate design characteristic can not influence the perceived sound damping of users, but that this ability also relies on other design characteristics of a sound barrier.

Finally, the measurements suggest that Fridfold might be able influence co-workers ability to focus and may improve the pleas pleasantness of working at a deskspace. Here the measurements on these aspects showed trends, while some participants during the interviews of the Effect assessment suggested that the presence of the screen influenced their ability to focus. Participants during the remote experience evaluation also expected the screen to have this effect and expressed the need to do this at their desk. Half of the participants from this test also indicated that they would feel satisfaction/approval when working with Fridfold at their desk. Therefore, it would be useful to evaluate this aspect of the current design of Fridfold within the context of the IKEA CBF office.

In summary, the test results show that Fridfold should be able to decrease the amount of visual stimulation co-workers experience at a desk space in an open office. Next to this interactivity as a design elements has been shown to influence co-workers sense of control over their environment. Where participants during both tests indicated they liked to have the ability to place and remove the screen based on their work activities and participants during the Remote experience evaluation imagined this would decrease nuisance from interruptions. The evaluation also showed that Fridfold could not influence the experience of auditory stimulation and the three dimensional textures as a design characteristic, could not separately give the impression of sound damping, but for this also relies on other characteristics of the screen, such as the size and thickness. This means that the current design of Fridfold can decrease nuisance from visual stimulation within the office and increases cow-workers sense of control over their workspace, which benefits the well being of co-workers within the office.

e) Discussion

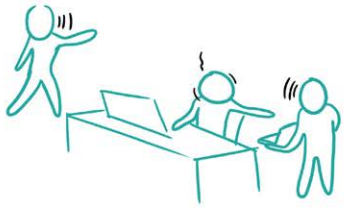
The findings of the Effect assessment, indicate that Fridfold can influence the experience of co-workers in an open workspace, however the reliability of these results is limited due to the small sample size (n=6). This means that the normality of these measurements could not be effectively assessed through resampling, which makes it difficult to assess if the measured significance of these results is influenced by outliers. This means that the current measurements do not identify an exact effect, but rather indicate which aspects of employees experience the design is likely to have a significant influence on.

Next to this the measured effect of Fridfold on the amount of visual stimulation measured during the Effect assessment would likely be smaller within the context of an office. This means that it's still unclear Fridfold may affect co-workers experience within an open office. This is because the Effect assessment was performed in a controlled set-up, instead of the open-plan office of IKEA Delft. This was due to consequences of the COVID-19 pandemic, which resulted in a large majority of the co-workers working from home. As a consequence, participants were exposed to simulated stimuli as opposed to the stimulation within the open office. While the experience of auditory stimulation, was should be comparable to that in an open office, this could not be achieved for the visual stimuli, due to limited resources. Here the auditory stimuli were presented as omnidirectional, which compares to the experience of the office. The visual stimuli during the Effect assessment were presented using a screen, which meant stimuli could mimic the effect of movement on a fixed distance, but could not simulate approaching movements, which are also present within the office. Furthermore the stimulation was only displayed in the the left peripheral and central field of participants vision. Therefore, the effect or Fridfold should be evaluated within the context of an open-plan office, in order to identify it's actual influence on co-workers experience of nuisance.

It could also be argued that controlled setup could provide a more objective account of the effect of Fridfold on the experience of nuisance. This is primarily due to the controlled stimuli, that are consistent for each participant, which would have been more difficult to achieve within the context of the office. Next to this I could increase the intensity of the stimuli to a level that made it more likely that participants would experience nuisance within the short duration of the experiment, while the fluctuations in stimulation within the office could not guarantee this. Participants statements reflected this, where each of them noticed the presence of visual and auditory stimuli, while the extent of this effect varied between participants. Furthermore measurements done within the office context could be influenced by individual's opinions of their own work spot and opinion on the organisation as a whole. For instance a participants that often experiences nuisance might react stronger to an intervention, in an attempt to promote it's implementation. This means that testing within the context of the office, would make it more difficult to measure and effect and prove the validity of the outcomes. Therefore, I recommend to repeat these measurements with a larger participant sample, to prove the effects of the current design of Fridfold and to combine this with long term testing with various co-workers within the context of the office to identify how this effect may change within the context of the open office of IKEA Delft

However before further testing is done, it might be interesting to re-evaluate the role of visual stimulation in the experience of nuisance. This is because the the results suggests that the experience of nuisance is largely dependent on the amount of auditory stimulation. Here the presence of Fridfold influences the mean amount of visual stimulation significantly more than the amount of stimulation in general. While the deviation in means for auditory and general stimulation are of a similar order. This may be related to the differences between auditory and visual distractions. Here cognitive research has shown that visual stimuli may not elicit a RON process in the brain (Berti & Schröger, 2001). Where RON, 'probably reflects processes in the context of reorienting towards task-relevant aspects of stimulation following distraction' (Shröger & Wolf, 1998). However, this may also be due to the used stimuli visual stimuli within the eThe absence of this process could mean that humans process visual stimuli less consciously and process nuisance from a visual stimulus less consciously.

VI: CONCLUSIONS



Project Outcomes

The outcomes of this project reveal that co-workers within the open office of IKEA experience nuisance when stimulation influences their ability to focus during individual work activities. This nuisance is commonly caused by sources related to the behavior of other co-workers. Co-workers' experiences of nuisance are generally shaped by their roles, work activities, and the ability to deal with nuisance. Their stories also revealed that there were many other factors that create a large diversity in experiences, even between co-workers with similar roles and work activities. This diversity in experiences means that a design intervention that is aimed at decreasing the presence of a specific source is unlikely to decrease co-workers' general experience of nuisance.

Instead, co-workers' general experience of nuisance could more effectively be decreased by a design intervention that improves co-workers' ability to deal with the nuisance that they experience. This could be done by improving co-workers' ability to move to other workspaces or to confront other co-workers about the nuisance they cause. Co-workers' ability to apply these approaches for instance individual needs, that require them to work at a designated desk, or unawareness about their own behavior, which made them feel hypocritical when confronting other co-workers. The influence of these factors could only be influenced by making changes in the design of the organization. For the CBF office of IKEA Delft, these changes could simply not be achieved within the duration of this project, which is likely also the case for other larger organizations. This means that interventions focused on helping co-workers protect themselves from nuisance will have a more effective short term impact on co-workers' experience of nuisance within a larger organization.

The evaluation of Fridfold identified that co-workers' sense of control could help to improve the effectiveness of interventions that protect co-workers from nuisance. Here the results of the Effect assessment indicated that the interactivity of the design enhanced users' sense of control. Although it's unclear how this relates to the experience of nuisance, the interview and remote testing statements revealed that the ability to place and remove the screen positively influenced the experience of the desk space. This means that adding interactivity to design interventions can contribute to employees well being in open-plan offices.

Next to this Fridfold the evaluation showed that Fridfold could decrease the amount of visual stimulation experienced during work tasks and help to manage interruptions from co-workers. Here the measurements of the Effect assessment indicated that the presence of Frdfold decreases the amount of visual stimulation and notice-ability of co-workers, within a controlled set-up. While participants of the Remote experience evaluation indicated that Fridfold could help to decrease the nuisance from interruptions and would not interrupt another co-worker working with Fridfold at their desk. They did also stretch that clear communication about the design would help to achieve this. However, the results from these evaluations show that This shows that further evaluation of Fridfold within the office of IKEA is needed to

Finally, the evaluation indicated that the sense of control and perceived sound damping of materials could influence the perception of stimulation, however, this could not be proven through the current evaluation. This is because the correlation between these design characteristics and the experience of stimulation could not be proven with the current research approach. Furthermore, participants' statements indicated that a three-dimensional texture could not separately influence the perception of auditory stimulation, but indicated other aspects that play a role in this as well. Consequently, further evaluation of the design of Fridfold is needed to determine if users' sense of control and the perceived sound damping of materials could influence the experience of nuisance in open offices.

Relevance for the Com&In team

The outcomes of this project provide the Com&In team with a set of insights, that can support them in tackling the various sources of nuisance within the office. These insights show an overview of these sources and reveal that the amount of nuisance co-workers experience depends on their roles, work activities, and various other factors. Here the quantified insights on these sources of nuisance could help to prioritize which sources of nuisance should be addressed, while the factors identify opportunities to address these. Here the individual presentation can help other teams within the CBF organization to understand the outcomes of the research and involve them in projects to address these sources of nuisance. Finally, the quotes from co-workers help to empathize with these experiences and can provide further inspiration for solutions.

The outcomes also show that the effect of an intervention focused on addressing a specific source of nuisance, is unlikely to decrease the general experience of nuisance within the open office of IKEA. This is because the context analysis showed that co-workers' individual experiences of nuisance are dependent on multiple factors and are not always related to a co-worker's role, but also to personal interpretations and attitudes. While the effectivity of a design intervention that allows co-workers to protect themselves from nuisance, is unlikely to be affected by these factors. This indicates that a design intervention focused on improving co-workers' ability to deal with nuisance will be more effective within the context of the IKEA CBF office.

Next to this, the evaluation of Fridfold shows that the design can be used to protect co-workers from visual distractions at a desk space and to increase co-workers' sense of control over their workspace. Here exact effect of Fridfold on the experience of visual distractions should be assessed within the context of the open-plan office of the IKEA CBF organisation. This is becaus the Remote effect assessment made use of visual stimuli that were not able to replicate the experience of visual stimulation within the. However, the size of the measured effect, makes it unlikely that this effect can not be measured within the context of the IKEA CBF office. Furthermore, the evaluations showed that interactivity as a design element can be applied in other design interventions that are applied at workspaces to increase co-workers' sense of control over this space. Where co-workers indicated that they liked to have the ability to create a closed office space whenever they needed it. They also envisioned that the screen could help to decrease nuisance from interruptions when the design of Fridfold would be combined with communication about the purpose of the design.

The current design of Fridfold is still unable to influence the amount of auditory stimulation co-workers experience at their desks. Participants during the Effect Assessment interviews did relate the three-dimensional texture to sound damping materials, however thickness and size of the screen were not able to convince them of the sound damping ability of the screen. While the objective sound measurements done within the test set-up of the Remote Assessment also confirmed that the material was unable to damp sufficient sound to have a perceivable effect. Because increasing the thickness of the screen would make it difficult to fold this, a new improved three-dimensional should be made out of a different material with a larger sound damping ability. Consequently, the design of the screen should be further developed in order to decrease nuisance from auditory stimulation at co-workers' deskspace.

Tackling nuisance in open-plan offices in the future

The current public opinion on open offices is shaped by researchers and journalists, who plead that the concept of the open office does not work and that these offices have a negative impact on the wellbeing of employees. The findings on nuisance within the IKEA office shows that the design of space and work environment is more complex research provides an insight into should show that the concept of the open office is not the problem, but that the design of these offices is simply much more difficult than the design of an office with separate individual workspaces.

Here the design approach used within this project indicates that user-centered design research methods, such as context mapping, co-creation and user evaluations could provide value for the field of office interior design. Here contextmapping was effective to create a deep understanding of the experiences and behavior of employees in general. Where co-creation helped to make sure that a design intervention would be accepted by the users. These insights, could help to create a clearer design brief, which can decrease the amount of needed design iterations, before a design can be implemented. Furthermore the tacit insights, that were found during user evaluations and contextmapping, could be used to understand what co-workers found important when using a product and what elements of a space they related to the experience of this space. These insights may also be of value in the creation of other designs, because they are commonly related to the feeling and impressions of people. In short, these user-centered design research methods could help an office interior design team to create better design briefs and provide insights that could also be used in later projects, building a library of knowledge over time.

Furthermore the project reveals that the experiences of nuisance of co-workers are so diverse, that a design intervention focused on decreasing a specific source of nuisance is unlikely to decrease the general experience of nuisance in an open office. Instead, these solutions should focus on improving co-workers ability to decrease the nuisance they experience. Another benefit of this approach, as shown by Fridfold, is that these interventions may improve co-workers sense of control, which has been shown to influence the experience of nuisance they experience (Lee&Brand. 2010). A drawback of these interventions, however is that their effect likely fades over time. While an intervention focused on improving co-workers awareness about the influence of their behavior on the experience of other co-workers is more likely lead to long lasting changes (Kok,2011). This indicates co-workers general experience of nuisance in an open office could most effectively be decreased by design intervention, that allows co-workers to discuss and change the behaviors that cause nuisance.

Reflection on the current design approach to decrease nuisance in open offices

The current public opinion on open offices is shaped by researchers and journalists, who plead that the concept of the open office does not work and that these offices have a negative impact on the wellbeing of employees. The findings on nuisance within the IKEA office shows that the design of space and work environment is more complex research provides an insight into should show that the concept of the open office is not the problem, but that the design of these offices is simply much more difficult than the design of an office with separate individual workspaces.

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