Ambient Clouds: Designing and Evaluating an Intervention for Noise Disturbance in a Shared Office Space

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ABSTRACT
Noise disturbance in the office environment might become problematic for working efficiency when the Industrial Design department moves to the open workspaces in the new Atlas building. To minimise the noise disturbance in this future situation, we designed an intervention that increases awareness about the working atmosphere in the open workspace for academic staff. Through applying the Theory of Planned Behaviour and the Self-Determination Theory, we analysed the current situation and looked at where issues might occur. A heuristics analysis was applied to this intervention, as well as change objective matrices and an ethical analysis.

Author Keywords
Noise Disturbance; Behavioural Change; Ambient Information Display.

DESIGN RATIONALE
This study analyses the problems regarding noise in the office space generated by the relocation of the Industrial Design staff working space to the new Atlas building and seeks a way to avoid or minimise it. The new area will be open and shared by the academic staff of TU/e. This research focuses on one of the major problems experienced in open workspace: noise disturbance. This space will be used by PhD students, graduate and non-graduate students, assistant professors, professors and the management team. As users have different status and tasks, the open office will be marked by various schedules and constraints brought by the diverse practices. Professors are out for teaching courses, students must be free to ask questions, fixed meetings are planned, etc. Therefore, users will not have the same schedules and needs.

The noise disturbance problem cannot be observed right now as the relocation has not happened yet. After some discussions about personal experiences, general behaviour and the users involved, we decided to focus on a specific situation that we all experienced before. When people leave the library, they tend to start talking before leaving the room. Their minds have already switched to a different task. The same kind of behaviour takes place when people leave a meeting room, beginning to chat about the reunion while their colleagues try to stay focussed on their work. This difference in mindset constitutes our main assumption: most noise disturbance takes place when people switch tasks. Thus, the current behaviour is « talking when transitioning », and the aim is to modify this behaviour and find a way to move it to an area made for conversation. Of course, the goal we want to achieve must fit the accepted noise level of the different users, helping everybody to work efficiently. We are not looking for a room that would be silent all day or ban any conversation with colleagues. The perfect noise level might change according to the people present in the working space and various moments of the day, it turns out to be a complex question.

To find a solution to this potential problem, we imagine an intervention based on two theories: The Theory of Planned Behaviour [11] and the Self-Determination Theory [7].

Theory of Planned Behaviour
We applied the Theory of Planned Behaviour [11], regarding the elements we knew, to find the intention to perform the expected behaviour. As we did not ask future users for their opinion and did not rate the beliefs, we imagined elements that could be relevant. The theory of planned behaviour explains that behavioural intention is made up of the attitude, the subjective norm and the perceived power of the individual over the situation.

Attitude is determined by behavioural beliefs and is weighted by evaluations of outcomes. Users could believe that moving to a different zone to talk does not make any difference in noise level, that the other room is less comfortable or that private conversations are good. These are behavioural beliefs we found about the outcomes. Users could think that moving to a different area takes too much time or that their conversations in the dedicated room would not be overheard. These are some outcome evaluations. Thus, hassle and time, privacy, responsibility towards the noise level and space comfort are elements that influence the attitude in our case.

Subjective norm is determined by normative beliefs and motivation to comply. Normative beliefs are beliefs users think their referents would approve or disapprove of. It is weighted by their motivation to comply with the referent's

opinion. Here, referents are represented by colleagues. People could think their colleagues would appreciate when they move and that they would be disturbed by the noise they make. Users could also believe their conversational partner would not appreciate it if they ask them to move. These are normative beliefs. We think that the users would comply to all of them. It is important for the users not to disturb others, to have good relationships with their colleagues and not bother them by asking them to move. These elements show that appreciation from colleagues, disturbance caused and relationships with colleagues matter for subjective norm.

Perceived control is determined by control beliefs of facilitators and barriers and weighted by the perceived power of these facilitators and barriers. Concerning control beliefs, users could believe that they would not know where to go, they would not have access to the talking area, they would not be able to book rooms soon enough or that their valuables might be stolen while they are away. At the same time, they might think they do not control who comes over to talk with them and at what time and that they do not control who enters the building. They could also be afraid of an insufficient amount of meeting rooms. These beliefs represent the individual's perceived power. Accessibility and availability of space, having no control of people approaching and the security of their stuff are facilitators and barriers that account for users' concerns about their perceived control.

Finally, we focused on the following elements to design another intervention: the comfort of space, the appreciation from colleagues and the importance of a good relationship with them as well as the accessibility and availability of space.

Self-Determination Theory

The Self-Determination Theory [7] explains different kinds of motivation people can have. They differentiate them into six types: amotivation, external regulation, introjected regulation, identified regulation, integrated regulation and intrinsic motivation. We found examples for each sort of motivation within the given context and provided potential interventions that fit this behaviour:

- *Amotivation* represents a complete lack of self-motivation. We imagine these people do not care whether other people want a quiet area or not. Maybe they do not care if it is quiet either.
- People in *external regulation* act only because of an external reward, punishment or cue. Without it, they do not perform the desired behaviour. In our case, people could stay quiet only because others asked them to be silent. They could also be quiet to receive a reward, as the quietest employee of the month. A physical reminder could be a stimulus to help them change their behaviour.
- *Introjected regulation* concerns people who understand the reasons of the regulation and accept them. They still need external elements to act. People in this category could stop talking when they notice people around them are bothered. It could be helpful for them to visualise the sound level and define its acceptable limit or provide a reminder to perform the desired behaviour.
- People in the *identified regulation* category are motivated because the goal of the expected behaviour fits their identity and values to some extent. Thus, they feel more free to act. In our case, they know they work more productively when the area is quiet and therefore understand that their colleagues appreciate silence too. To involve identified regulated people, we could create awareness about benefits and consequence of the behaviour change.
- *Integrated regulation* is related to people who are interested by the goals of the behaviour. Even if they do not enjoy the activity itself, the behaviour is a part of their identity and fits their personal goals. Users in this category of motivation believe a quiet working space benefits their productivity and well-being, which is really important for them. We could teach them to appreciate and enjoy the behaviour itself and not only its result, to promote the behaviour even more strongly.
- *Intrinsically motivated* people want to perform the behaviour by themselves. They are interested in the behaviour and enjoy performing it. They would move to a quiet area by themselves to concentrate or because they like to move around and have private discussions. No intervention is needed for them as they already have the expected behaviour and appreciate it.

Because we believe intrinsic motivation is not feasible for the aimed behaviour, the aim of our proposed intervention is to stimulate introjected and/or identified regulation.

CONCEPT

Based on the application of the theories to the design case, we developed a first iteration of the concept. The focus of this first iteration was based on the assumption that people in a shared workspace are constantly transitioning between different stages of focus, ranging from coffee breaks, to prototyping, to focussed reading and writing. We were especially interested in the extent to which individuals are aware of their personal influence on the working atmosphere. We assumed that one of the main issues in causing disturbance to others is when meetings or social gatherings happen in the shared working environment. For the first iteration we envisioned a device that indicates which meeting room is available whenever people have a spontaneous meeting. However, as we realised that meeting in a shared working environment is not always a problem

and it depends largely on the atmosphere, we started looking for ways to get information about the atmosphere in the room.

In the second iteration, the focus shifted towards a peripheral display of the atmosphere in the working space. Drawing inspiration from work by Bruns Alonso et al. [1] that indicates that tangible interfaces can offer a way to interpret and reduce stress, the second iteration involved a tangible interface that users could fiddle with when feeling frustrated. Through gathering data about the amount of people in the room who are fiddling and the intensity of the fiddling, the system can analyse the general atmosphere in the shared workspace. Additionally, building on research by Eggen et al. [4], peripheral audio feedback was introduced. To make the system more appealing, it was themed based on walking through nature. The temperature of the light in the working space changes according to the amount of stress that is measured. The sound of birds is used to provide information about the noise level in relation to the frustration level, as well as guide talking individuals to a place where it is more appropriate to make noise.

A possible scenario of use of the system is as follows (see also Figure 1): *Eight colleagues are working in a shared working environment, most of them are doing individual computer work (1). One of them wants to discuss his work with his neighbour and they start talking to each other about their work (2). The person across the desk is trying to read and gets irritated by the conversation. However, he finds it hard to correct his colleagues, since it is a meaningful conversation which probably will not take long. While his irritation and internal dilemma grows he starts squeezing the fiddle which is located at the right side of his desk (3). Slowly, the overall light atmosphere in the room changes to a more blue light (4). While his colleagues keep talking, other people across the room, who are trying to focus to meet a deadline, are getting frustrated as well. Since more people are fiddling the light change becomes less subtle. Based on the amount of sound produced, in combination with the cold-light colour the sound of a bird colony flying from a tree is activated (5). The sound is designed in such a way that it imitates a colony of birds flying off to the coffee room. One of the talking colleagues notices the sound and suggests to continue the conversation in the coffee room (6). The other colleague agrees and together they walk to the high table located in the coffee room to continue their conversation. While the noise disappears, the level of annoyance decreases as well (7). The remaining colleagues can focus on their work again and because they stop fiddling the light slowly turns back to yellow.. Meanwhile, the collaborating colleagues continue their conversation in the coffee room (8).*

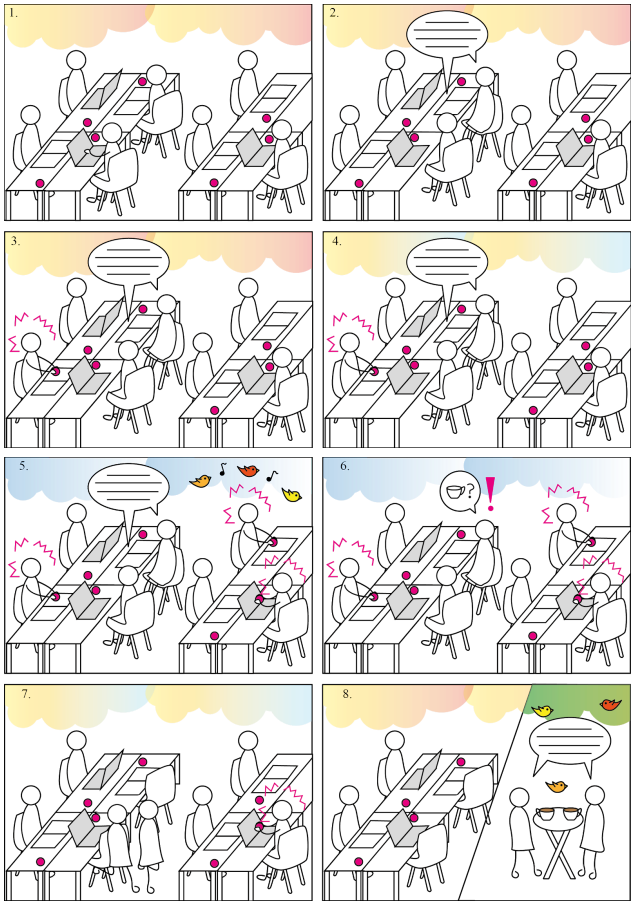

Figure 1. Office space scenario.

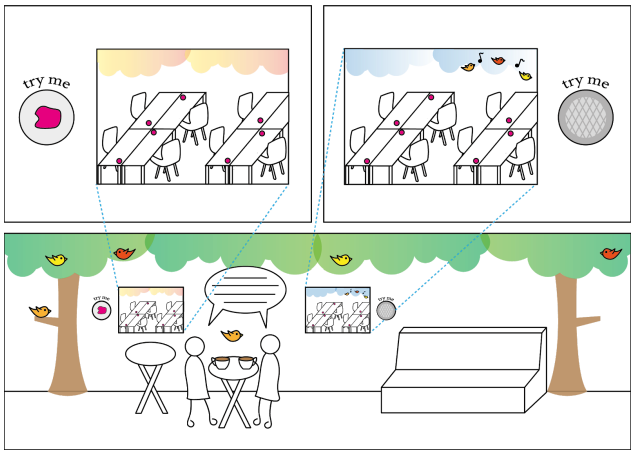

Figure 2. Coffee room scenario.

In the coffee room, users can try out the interaction with the system through two miniature representations of the working area and two ways to interact with these miniatures. The first shows the changes in light, and can be manipulated by squeezing a fiddle that has been attached to the wall. The second shows the flock of birds flying away

whenever someone talks or shouts into the microphone next to it. Doing so will trigger physical birds in the miniature and also the sound that would be heard in the working space (see Figure 2).

HEURISTIC EVALUATION

As part of the peer evaluation, we analysed the intervention designed by team 5 for the same design rationale as our intervention. The evaluated intervention is called Social Map, and is an illuminated floor that gives users feedback on their noise level. It does so by changing the light on the tiles whenever a set noise threshold is breached (see Appendix 1). The evaluation was done according to the persuasive health technology heuristics [9]:

1. **Appropriate Functionality:** Users do not really use the system. They cannot control it, except by the global noise level. The lights are automatic. Thus, as the system is automatic, it is easy to use but could be irritating in some situations. Users do not have the possibility to adapt it.
2. **Not Irritating or Embarrassing:** The system should be really well adjusted, otherwise it could be perceived as annoying. For example, if an area is louder due to the work itself (e.g. a team meeting) and the threshold is not adapted. The system is not embarrassing except if a social pressure related with the system exists.
3. **Protect Users' Privacy:** The information is immediately public for the people that are around, but cannot be linked to the person after that moment in time. Users have no control over whether they make this public or not, however, their noise is already public information anyway.
4. **Use of Positive Motivation Strategies:** The feedback from the system is rather negative, there is no positive reinforcement other than the lack of light being on.
5. **Usable and Aesthetically Appealing Design:** The visual design is attractive. The users will not really interact or use the system as it is automatic. The illuminated area must be big enough to be seen from the desks since the ground is hidden by desks.
6. **Accuracy of Information:** The information is rather simple, it shows whether there is noise or not in a certain location. This requires highly sensitive sensors throughout the room to be very accurate. Additionally, it would be great if the system could make a distinction between different kinds of noise (e.g. the noise of someone's heels might be less annoying than two colleagues talking about their weekends).
7. **Appropriate Time and Place:** The system communicates information about the noise level, however it does not take into account what the acceptable noise level at a certain moment might be. At one moment, noise might be more acceptable than at other moments, for instance during a drink at work or a group meeting. The feedback is offered real-time, which is good and which means that users can also get immediate feedback on whether they have changed their behaviour accordingly. Arguably, it might be necessary to communicate something about the appropriate noise level before people start making noise so it becomes possible to prevent rather than cure. The intervention is very location-oriented, which means that people will immediately know that it concerns them.
8. **Visibility of User's Status:** The entire system seems easy to understand. However, people don't always have feedback about the progress. They only see light when the sound threshold is passed. Moreover, it informs only about the group progress.
9. **Customizability:** The technology is not customizable as it is a public interface (doesn't react on specific people).
10. **Educate Users:** Not applicable, or at least not apparent from the scenario.

Additionally, our intervention design was evaluated by team 3 (see Appendix 2). This led to several insights about the functionalities of the system which we used to evaluate and improve (the description of) the envisioned intervention.

The main heuristic issues within our design were with 'Not Irritating or Embarrassing', 'Visibility of User's Status', 'Customizability' and 'Educate Users'. As our design incorporates both changes in light and in sound in a working environment, the system could be perceived as annoying by its users. This highly depends on the subtlety of the changes. We envision the light change to be very gradual, much like the light outside changes due to the weather. The sound of the birds would need to have several variations in the duration, the pattern and possibly the volume to make sure that the sound does not feel like a constant repetition but that instead it feels natural. The embarrassment is a little harder to tackle, as it is also hard to imagine exactly how different people will react to the feedback from the system. We imagine that embarrassment might be caused when users feel uncomfortable with the fact that others can see that they are fiddling, as this might be perceived as very direct negative feedback on whoever is talking in the room. At the same time, it might be embarrassing for people when it becomes obvious that they have scared away the birds, depending on the situation.

The second issue with the heuristics is that it is hard for users to see their personal status within the system. The system is designed to be able to react to anonymized input to make it adaptable for shared working spaces where different desks are used by different people throughout the week. Additionally, when considering user ethics, making it personalised would require consent to process personal data, whereas in this case no personal data is saved. In the

scenario, the sound of the birds is located where the noise is made, however the sound will always spread through the room to some extent. In a situation where multiple people are being noisy in different parts of the space, the individuals addressed by the system might not feel like the system is referring to them. A possible solution might be to repeat the sound until the noise is resolved. However, this will increase the annoyance the system causes and would make less sense thematically as well. This issue would have to be carefully analysed during the intervention, to see whether this behaviour occurs and how problematic it is.

The third issue with the heuristics of the system is that it is not customizable by its users. The main reason for this is that it was assumed that the system would be used by different individuals each day. Therefore, enabling those individuals to change parts of the system could result in a different interaction with the system every day. To stimulate the learning curve of working with the system, we therefore decided to have one coherent way to communicate with the system. A possibility to have some influence on the system would be to customize it with the entire team when it is first implemented. In that way, it can incorporate different people's preferences but still be coherent throughout.

EVALUATING INTERACTION & INTERVENTION LEVEL

In order to predict whether our design will persuade people to perform the intended behaviour we have conducted a small evaluation on both macro and micro level. Macro level relates to the effectiveness of the intervention, micro level relates to the interaction [3]. For both evaluations we used a change objective matrix to analyze the relation between performance objectives and change objectives based on determinants from different theories (see Tables 1 and 2).

Performance objective	Determinants (theory)	Change objective
Move to coffee room when talking.	Habits, behaviourism [5]	Automatically move when talking, without decision making.
Is aware of personal role in work atmosphere	Identified Regulation [7]	Values silent atmosphere, understands that others do too, wants to commit.
Is aware that colleagues can be disturbed by noise/sound.	Social norm, planned behaviour [11]	Believes colleagues want it to be quiet and is motivated to comply to this.

Table 1. Change objective matrix for intervention.

Performance objective	Determinants (theory)	Change objective
Fiddle when frustrated (give info to the system).	Fiddling can reduce stress [1]	Expressing frustration by fiddling to influence lights.
Developing a relationship with the system. (Listen to birds and register light changes).	The media equation [8]	Understand the meaning of the light colours and birds noise and how to respond to it.
Connect own behaviour to system's interactions.	Medium, Fogg's functional Triad [6]	Understand how behaviour is connected to the lights and birds.

Table 2. Change objective matrix for interaction.

Based on the defined change objectives we formulated different strategies, which are applied in the concept described earlier. On an intervention level these strategies are based on techniques from the 'Behaviour Change Design Cards' as proposed by Chrysanthi Konstanti (see Table 3). The techniques from these cards are based on the behaviour change wheel [10] and the transtheoretical model (TTM) [12]. Within our case we focused mainly on the techniques from the behaviour change wheel, rather than on the different stages from TTM. Based on the selected techniques we can conclude that our strategies would be mainly effective for people in the action/maintenance stages, according to Chrysanthi's methodology.

Change objective	Behaviour change technique (theory)	Strategy
Automatically move when talking, without decision making.	Prompts/cues (Behaviour Change Design Cards)	Bird sounds to trigger the behaviour (move away)
Values silent atmosphere, understands that others do too, wants to commit.	Feedback on behaviour (Behaviour Change Design Cards)	System changes light to stimulate reflection on own noise.
Beliefs colleagues want it to be quiet and is motivated to comply to this.	Social support (Behaviour Change Design Cards)	Via the system others can show that they are disturbed.

Table 3. Objective to strategy on intervention level.

On an interaction level the earlier described heuristics are used as theoretical basis to determine strategies (Table 4).

Change objective	Change technique (theory)	Strategy
Expressing frustration by fiddling to influence lights.	Visibility of user's status; Privacy; Appropriate functionality [9].	Light is changed for the entire office; Fiddles are available on every desk.
Understand the meaning of the light colours and birds noise and how to respond to it.	Not irritating or embarrassing; Appropriate time and place [9].	Light changes gradually, birds not too loud; Birds are where the sound is.
Understand how behaviour is connected to the lights and birds.	Educate users [9].	Put explanation of system's behaviour in the coffee room.

Table 4. Objective to strategy on intervention level.

EMPIRICAL EVALUATION PLAN

In order to evaluate our design on an intervention level we need to determine whether our user:

- Moves to the coffee room when talking.
- Is aware of their personal role in the work atmosphere.
- Is aware that colleagues can be disturbed by noise.

If we would implement this design we would conduct a within-subject-analysis over a one-month period. In order to do so we select one floor of the new Atlas building and assume that the people on this floor are representative for the Industrial Design part of the building. We plan to log data (via the system) for a period of six weeks and plan several observations during this period. Next to this we will conduct a survey among all academic staff working on this floor before we place the intervention and one when we remove the intervention. The goal of this survey is to gain insights on the self-perceived experiences of our participants related to our performance objectives. For a visual overview of the different evaluation methods distributed on a six week timeline, see Figure 3.

Data logging

In order to determine to what extent our design reaches the set goals in relation to noise disturbance we plan to log four different types of data. For a period of six week we will measure the overall sound level using a decibel meter. The intervention period will start after one week and take place over the course of four weeks. This data can give us insights in the absolute sound level, but in order to evaluate whether we reach the set goals, more data is needed. During the four week intervention period we will log the following system interactions:

- Light changes, start and end time per light temperature.
- Fiddle use, amount of squeezes per day per physical fiddle.
- Movement based on birds sound, detect movement via a sensor in the door of the coffee room, log time and map this to the start and end time of the birds sounds.

By constantly logging data we will be able to gather large amounts of data. However, the data can be interpreted in multiple ways. For instance, if the sound level is low does it mean everybody is working in silence or that it is silent because there are not many people? Or if the amount of fiddle squeezes is low, does it mean the frustration level is low or that people forget/refuse to fiddle?

Observations

To be able to interpret the logged data we will conduct a combination of structured and semi-structured observations. These observations will take place on Monday 08:30-11:30, Wednesday 11:30-14:30 and Friday 14:30-17:30 during the first two and the last two weeks of the six week research period. By choosing different time slots on different days before, during and after the intervention period we expect to get a complete image of the behaviour of our participants during the research period. On all time slots two researchers will simultaneously observe the same group of people. By comparing their observations afterwards we can increase the reliability. The structured observations will be count-based and registered via pre-defined tables. The first table registers the amount of people in the office space and in the coffee room. Notes are event-based and hold the amount of people in the room (n) and the time stamp (the first moment that amount of people is present) for every change. The second table registers the type of noise and the duration (start- & end time) per event.

The possible types are: phone call, one-on-one conversations, group meetings, shout-outs, people walking by while talking and environmental sounds. On top of these two tables both researchers will conduct some semi-structured observations which they register through

Figure 3. Timeline Empirical Evaluation (6 weeks)

making notes. Notes will be gathered about the followings themes: other noise causes (e.g. prototyping, music, doors, machines), signs of frustration (e.g. sighing, facial expressions, putting on headphones), people correcting each other and 'others, namely'. This combination of structured and semi-structured information can be used to interpret all the logged data in relation the the set intervention goals.

Surveys

The first part of the survey will be conducted both before and after the intervention period. Answers can be given on a five-point-likert-scale where 1 is 'not at all' and 5 is 'all the time'. Questions can be along the lines of "To what extent are you..

- ..frustrated by your colleagues?"
- ..annoyed by noise in the office space?"
- ..able to express your frustrations about noise?"
- ..talking with others in the office space?"
- ..likely to move to a different room to meet?"
- ..satisfied about the overall noise level?"
- ..aware of your own responsibility?"
- ..actively considering others when talking?"
- ..attached to having a quiet office space?"
- ..able to work more efficiently if it is quiet?"

The second part of the survey will only be conducted after the intervention period and is used to gain more insights in how people experienced the system. This part of the survey will have the same answers (1 is 'not at all' and 5 is 'all the time') and questions such as "To what extent..

- ..did you register the light changes in the room?"
- ..did you register the bird sounds in the room?"
- ..did the light changes frustrate/irritate you?"
- ..did the bird noises frustrate/irritate you?"
- ..were you too embarrassed to use the fiddle?"
- ..were you embarrassed by the light changes?"
- ..were you embarrassed by the bird sounds?"

On top of this, both surveys will hold some open questions to get more qualitative insights on how people experienced the system. These open questions that will be asked both before and after the intervervention period:

- Could you shortly explain how you experience working in this shared office space?
- Please explain how you experience your relationship with your colleagues during the day?

ETHICAL GUIDELINES

To analyse the ethical aspect of our intervention, we used the Heuristic principles of Berdichevsky [2], did a value and user analysis and finally picked some relevant critical questions [13] to consider.

Heuristic principles

The equivalency principle

Asking people to reduce the noise level in order to work more efficiently is moral, in our opinion. Actually, stimulating people to move to a specific place to talk does not seem like a punishment. In other situations, this behaviour is already requested. For example, silence is mandatory in the library, and trains have dedicated locations for phone calls.

The reciprocal principle

No one in our group would refuse to follow the rules outlined in our suggested intervention and we would even prefer it that way. We are aware that this principle is not sufficient to assess our design as ethical but represents an important requirement.

The big brother vs little sister principle

The entire process and data must stay anonymous and be used for research only. We will not communicate it to their chief or anyone else. The only public information is that anyone can see who fiddles or not and which people are pointed out by the birds. In our opinion, it would be a good thing to see who is fiddling to avoid building a suspicious environment. Moreover, the system reacts to the number of fiddles and not to one person in particular.

The disclosure principle

To be sure everybody is aware of the new design, an info meeting should be organized to explain the system and its motivation before the installation. To explain the system, the coffee room is equipped with a playful device demonstrating the birds and cloud operation. Furthermore, the intervention and its motives should be mentioned on the intranet to be sure that everybody has access to the information.

The reasonably predictable principle

Our design could imply social embarrassment caused by the system and users confronting each other. As social relations are complex, the risk of making people uncomfortable when pointed at exists. However, considering the maturity of users and the professional context, we think the risk is small. Moreover, the system reacts only to the number of fiddlers. It is not possible to point or denounce someone directly through the system. Finally, we argue that the risk of social embarrassment is always present is society whether this system is used or not.

Value and user analysis

The different people concerned by the intervention are PhD students, graduate and non-graduate students, assistant professors, professors and the management team. We suppose that students might be less free to ask questions to others once the system would be installed. They would be the ones that lose the most. On the contrary, the

management team needs silence to work. While working more efficiently, they would benefit from the intervention the most.

Critical questions

To deepen our reflection, we choose some critical questions from the critical heuristics of F. Yetim [13]. This set of heuristics focuses on ethics for persuasive systems and is design-centered. These questions are pragmatic and help to take concrete elements of the intervention into account.

To answer the questions, we define the following elements:
Circumstances R: chatting in the open working space
Action A: move to the coffee room
Circumstances S: having a good working atmosphere
Goal G: work efficiently
Value V: consideration

Will the action A bring the about the desired goal G?

The action would improve the likelihood of it by keeping the noise away of the working space. In more, people would still be allowed to chat but should move to a different area if their colleagues are bothered. It is supposed to maintain a healthy working space.

Are there alternative ways of realising the same consequences?

Yes, such as forbidding noise or using noise-canceling headphones. We know that many other solutions exist. We think our intervention might help people to work efficiently thanks to a quiet area. Of course, right settings must be found and the intervention must be evaluate.

Are there alternative ways of realising the same goal?

Yes, we could for example use closed working spaces. Other solutions also exist to work more efficiently. We focused only on the noise level in a shared working space. Other factors might influence the main goal as well.

Is it possible to do the action A?

As long as people are physically able to move, they can do the action. This action might be annoying to repeat too often but is not always needed and depends on the general acceptance of noise level.

Are the believed circumstances R possible?

We believe that they are. It is the heart of the problem. Of course, as we could not observe the situation, these circumstances are based on an assumption and should be checked.

Are the particular aspects of situation S represented by G possible?

Yes, they are. A good working atmosphere helps to work efficiently. This good working atmosphere is supposed to fit the general noise acceptance

Is the value proposed indeed a legitimate value?

Yes, it is. Considering others and being considered by others is important for healthy social relations. It also helps to feel competent which is especially important in a working environment.

In summary, other interventions could be applied but we do not see any major ethical reasons to cancel our intervention. The circumstances are possible, and the action can be applied by everybody (it could only be annoying for people with reduced mobility). No specific user seems discriminated by the design. All users will be well informed of the goal of the intervention and observations. We also want to respect people's privacy by keeping all data anonymous and use them for research only. This also allows people to trust us and promote the use of the system without suspicion or fear. The most important risks concern social embarrassment and unintentional outcomes, as mentioned in the evaluation made by the other team. The work atmosphere could be a little deteriorated, some groups or person could be stigmatized and finally the system outlines could be judged unpleasant. Although, the consequences would not be excessive, at first glance, considering the context and users. These risks could also appear independently of any intervention and are not more prone to happen in ours. Anyway, if some negative outcomes would be realized as a result of the system, we would take entire responsibility for them.

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APPENDICES

Appendix 1: Recieved design intervention team 5

Social Map

From contemplation to preparation we have self-reevaluation, which states that realizing that the behaviour change is an important part of one's identity as a person. When you go from preparation to action you have self-liberation; making a firm commitment to change. Social liberation is also a part of the social map. In social liberation is realizing that social norms are changing in the direction of supporting healthy behaviour change. SDT postulates that when people experience the satisfaction of the needs for relatedness and competence with respect to a behaviour, they will tend to internalize its value and regulation.

What is the illuminated floor map?

Concept of floor lighting underneath people - closest image to our concept.

It is an illuminating notification system that alerts users they have passed the accepted social threshold for noise. Every clusters floor will light up when they pass this threshold. The illuminated floor map is part of a signal as a trigger. ‘’It will make people more aware, it is not trying to motivate but it simply indicates when the behaviour is inappropriate’’. When a cluster is too loud, the floor illuminates. This implementation is based on social liberation, where it hopes to keep people accountable to the adjusted social policy.

Scenario

Person 1 walks to their desk where everyone else in the cluster is sitting. Good morning and hellos are exchanged between everyone. As person 1 unpacks their bag to set up their desk, person 2 asks ‘how are you’? Into which person, one replies; ‘Well, I had a really strange dream last night’. To which the attention from other people is sparked. Now everybody is involved in the conversation, person 1 continues his story. The outrageous nature of the dream starts to get people in a light-hearted mood and joking around. This accelerates fast and now jokes are being exchanges, stories of other people dreams are being told. Now their floor comes illuminated which makes the talkers and the funny guys aware. They have passed the accepted social threshold for noise. Because they are in the action phase, they only needed a small signal as a trigger to remind them they acted outside the social norm.

Appendix 2: Heuristics evaluation by team 3

1. Appropriate Functionality: The design is easy to use, since squeezing is the only interaction that takes place. We assumed that the fiddle is wireless, making it a mobile device that you can take along through the office. However, do you need to charge the ‘fiddle’? How do you communicate when the battery runs low? Feedback is given in an open and clear visible and audible way for the whole environment.

2. Not Irritating or Embarrassing: The swarm of birds can be perceived to be irritating to all users, both in proximity of the noise makers but also for the whole floor. Also continuous change of light colour might be perceived as annoying and/or distracting. Also, it might be embarrassing when (a part of) the colleagues in the workspace are

fiddling, looking intensely at the noisemakers, waiting for the birds to blast off and fly the bad guys to the coffee corner.

3. Protect Users' Privacy: Not really applicable to this case. However, the user can notify the system anonymously so that is a plus.

4. Use of Positive Motivation Strategies: The design does not really recognize positive behaviour and therefore positive reinforcements strategies are also not implemented within the design to promote continuous process. In our opinion, the system punishes users in a way by changing the lights and using bird sounds. This might cause awkward situations, resulting in deflection of the target behaviour (having conversations in the coffee corner automatically) into an unwanted behaviour: having no conversation at all.

5. Usable and Aesthetically Appealing Design: The 'fiddle' seems easy to use. However, it is not clear if it comes in different sizes for different hands. The design of the fiddle might also induce unwanted use of it (random fiddling). Maybe it would be good if you could design it so, that misuse does not lead to any unwanted light change or bird sounds. No further information could be drawn from the rest of the sketch since it is basic in its design.

6. Accuracy of Information: The information flow in this design is very instantaneous: Users act upon a situation, fiddle, data is send to the system, and the systems acts in the way it should. If the fiddling stops, so does the data flow, and the system acts again. There is not much that can go wrong, since all data flow is triggered physically. The only inaccuracy of data can occur by 'random fiddling', as described in the point above.

7. Appropriate Time and Place: The feedback (light and sound) are given on the appropriate time (when multiple people are irritated by the behaviour). The feedback is given in an effective way, since the feedback is directly given after a certain threshold (amount of total fiddling) is past.

8. Visibility of User's Status: Feedback is given for the behaviour directly, producing irritating vocal noise. However, progress is a bit more difficult to see. If different users in the space produce irritating noise it might not be clear where the irritating noise comes from. For example, some users might not experience vocal noise as irritating while across the room, where another group is sitting and members of that group are chatting, the people that produce non irritating vocal noise might think it is their conversation that is causing irritation.

9. Customizability: Not applicable for this design. It might be interesting to make the light- and soundscape adaptable, so that the output of the system can be created by the users itself, maybe creating a more impactful effect.

10. Educate Users: The target behaviour (having conversations in the coffee corner) is promoted by the behaviour of fiddling when you get agitated by the noise level. This process appears to be rather passive, users should remember that they can fiddle if they are annoyed by people talking. Skills and goals are not really clearly stated within the design. There is no feedback on the fiddle device which shows the progress towards the end goal. Also the sound- and light feedback that appears in the room when there is too much noise goes away when the noise stops.