Still at the Office - Designing for Physical Movement-Inclusion During Office Work

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ABSTRACT

In this paper we describe, analyse and reflect on experiences and knowledge generated from designing for physical movement integration during office work. Work in traditional modern office settings provides few physically demanding tasks. Evidence from research indicates that sedentary life styles are increasing our risk for developing a host of diseases and other medical complications.

Together with students and through user-centered design, concepts for inviting the body "back to work" were developed. The concepts inspired the design of three *physical movement probes* that were explored by office workers. The participants were encouraging to the attempt to transform the sedentary nature of office work into more physically sustainable work. They described their work environments as filled with stuff for enhancing physical activity but these were seldom used. Integrating physical movements in the design of future office work tools may have considerable positive effects on public health.

ACM Classification Keywords

D2.2 Design Tools and Techniques – User Interfaces

MOTIVATION

Who works in an office nowadays when mobile technology such as laptops, tablets and smart phones has made it possible to work almost everywhere? We can work from home, cafes, buses, the Metro, in waiting halls, in parks, at beaches and in mountains. Through cloud services, we can have access to the material we need for our work tasks as long as we are connected to the net. No matter where we are physically situated, if equipped with mobile technology we can go to work.

Why then do we write a paper about research in the mundane world of the office? Although we now have the potential to leave the office behind through mobile technology development, many of us are still mostly performing our work tasks seated for extended hours during a normal workday in the office or elsewhere. This manner of working is related to health issues such as metabolic syndrome, cardiovascular disease, obesity and cancer [30, 26]. It is hard to compensate for extended daily periods of being sedentary through regular physical training, in spite of the common belief that if we exercise regularly, let us say three times per week for an hour, then that ought to be more than plenty for maintaining physical fitness. If a person sits for more than six hours a day that person may still have an elevated risk of developing common diseases related to a sedentary life style.

Another perspective on why the office catches our interest is that many professions have been transformed into "office" work. The skill and craftsmanship and thereby the variety of physical movement during work has been moved into software and computer power. We can all marvel at how computer technology has gone from room-sized assemblies to embedded fabrics woven into our clothing. Our interfaces have evolved from command line to graphic, to touch and gesture. Engineers have transformed computing technology in unforeseen and remarkable ways, but the computing technology also seems to have transformed us. Many of us more or less leave our physical bodies behind as we step inside our modern offices—we work with our brains and leave the rest of our body at rest.

At many offices, there is an awareness of a physically undemanding work situation. Presently computing technology can be increasingly used in an effort to combat this sedentary life style. There are computer programs that alert you of prolonged sitting, there are also many sensor-based gadgets available that track pulse rates and movements. Sit-stand desks and office exercise equipment have been around for decades, yet *people are as sedentary as ever in the office*. How can this problem area be approached? How can we as interaction designers contribute?

Sedentary Work Postures

There has been a shift, a transformation in workload towards a less physically active and more sedentary work-style for many occupations and professions, Church et al., [4] have studied the situation in the U.S. from 1960 to 2010. They show that there has been a progressive decrease in the percentage of people having to use even moderately

intensive physical activity during their workday. This shift of everyday life in recent decades is partly related to technology development and work organizational development focusing on efficiency and safety [32]. Modern office work is often performed through interaction with computer technology. A person sitting in front of a computer doing office works spends insignificantly more energy than someone laying flat in a bed. Many daily hours seated leave us without adequate physical stimulation of our muscles and cardiovascular system. Dunstan et al., [7], conducted epidemiological and experimental studies that strongly indicate that too much sitting should now be considered an important stand-alone component of the physical activity and health equation, particularly in relation to diabetes and cardiovascular risk. Importantly, these detrimental indications remain even after accounting for time spent in leisure time physical activity. We sit at work, when transported, and when entertained. Our level of physical activity is often measured in MET hours where body mass neutral expenditure is calculated as 1 MET for resting, 8 METS for running and 3-4 METS for walking in average pace. Sitting comes to 1.5 MET and thus near total rest. Sitting includes almost no muscle contraction in the big muscles such as leg, gluteus and trunk [8].

RELATED WORK

Luff and Heath, [18], explored mobility in collaborative work-tasks. They generated three concepts for mobility, *micro, remote and local*. They discovered that technology developed to enhance collaboration over a distance kept these, locally situated, workers tied to the tools and the workstations that were used for distance collaboration. They discussed the risk of storing material in a digital environment from a perspective of flexibility for the workers. They also discussed the risk for undermining relaxed cooperation and collaboration. Still today we seem to be tied to our workstations in inactive postures, although the work tools have changed in size and become more mobile, portable and thereby more flexible. We find reason to approach the sedentary situation at the office environment of today inspired by these findings.

Haller et al., [10], explored three different modalities of interrupting people to remind them to perform some training to prevent or to rehabilitate from bad posture. Feedback from graphical, physical or vibro-tactile cues was explored. Through a user study they found that physical feedback was rated less disruptive to the work tasks.

Zheng and Morell, [31], have added a system using force-sensitive resistors and vibro-tactile actuators to generate haptic feedback of sitting postures. Their findings suggest that vibro-tactile feedback can be effective in communicating musculoskeletal "messages" to the human sensory-motor system. The chair has been at focus for many attempts to improve sitting postures. Ergonomically following the movement of the user, providing support for the back, elbow and neck are among the improvements. Reeder et al., [24] developed Breakbot, a robot as a motivator for encouraging employees to take a break in order to remedy sedentary behaviour in office environments. They were encouraged by the initial positive responses to their design. Ryan et al., [25], explored if office workers follow the current recommendations of time seated. Through body worn accelerometers 83 office workers measured their sitting pattern during a workweek. *"No participants met the 20 or 30 min recommendations on every working day but seven (8%) participants met the 55 min recommendation."* Approaching the problem-area through designing different awareness-management systems and devices to remind and alert the individual of prolonged sedentary postures show promising results. We are exploring how an active physical movement-inclusive design perspective can contribute. Liu et al., [17] explored interaction qualities of IT supported activities in home and work-environment with special focus on Generation Y (first generation of "digital natives", born in the 1980s) office workers. They suggest that office design should cater for more playful, expressive, responsive and flexible interactions as Generation Y found this more accessible when working from home. Straker et al., [27], did a cross-sectional observational study of Swedish call centre workers. Investigating if their pattern of sedentary behaviour were associated with use of sit-stand desks and awareness of the importance of postural variation. Working with a sit-stand desk, as compared to a traditional desk, was correlated with less time seated but ergonomics awareness did not enhance the effect. Their result encouraged us to find ways to remedy the sedentary behaviour from a design-oriented perspective. A risk factor for poor health is long uninterrupted sedentary periods. Hutchinson and Wilson [12] did a meta-analysis of intervention studies aiming at improving nutrition and physical activity at the workplace. Their findings suggests that motivation enhancement was a successful approach and that if one area at the time (physical activity or diet) were at focus the effect became larger. This motivated us in our research to focus only on physical activity. Probst et al., [21], have engaged in designing something they define as the active office. They report that a main challenge is to identify office furniture feasible in supporting physical active office workflow and to combine these into an activity-promoting environment.

THEORETICAL AND METHODOLOGICAL APPROACH

The theoretical approach in this research is qualitative and explorative and the methodological approach is *user-centered design* [9]. Activities such as making, exploring, and experiencing are central components when approaching the area of inquiry. This research focuses on the complex societal challenges of inactivity in office environment. The aim of the research is to explore and generate knowledge of the social and cultural norms of sedentary behaviour in office environments through what we frame as physical movement-inclusive design perspective. The research was performed partly through field explorations, involving office workers in the inquiry. We developed *physical movement probes* as means to articulate and open up the

design space and collect user reflections. Hutchinson et al., [13] describe a technology probe in the following way: *A probe is an instrument that is deployed to find out about the unknown - to hopefully return with useful or interesting data. Technology probes are not primarily about usability in the HCI sense. They are not changed during the use period based on user feedback. In fact, a deliberate lack of certain functionality might be chosen in an effort to provoke the users* [13].

These probes are used as means to encourage discussion and collect user reflections as part of the design process. *"We become what we behold. We shape our tools and then our tools shape us."* is stated by Father John Culkin in his newspaper article about McLuhan [6].

We make things to make things happen. This is our rational for approaching the problem area through a design course and physical movement probes. We explore how we as researchers and designers within human-computer interaction and interaction design can provide alternative approaches to office-work. We are interested in the way computer technology allows us to exercise our physical movement potential or not. King et al., [14] and Perry et al., [20] argue for the relevance of integrating a *socio-ecological perspective* when aiming for augmented levels of physical activity. Promoting physical activity from a socio-ecological perspective through public means such as bike paths, walking trails and school curricula is on the agenda of public authorities and policy makers in many countries, [22, 19, 17]. Increasing the possibilities for becoming physically active through creating more choices, designed into the environment, is described in King et al. [14] as a *choice-persuasive or choice-enabling perspective.* We acknowledge the potential in this perspective for our attempt to re-design office-work.

METHOD

We have, through a physical-movement design perspective, explored ways to generate knowledge of the problem area and how to reduce sedentary work in office environments. So far we have explored our perspective in two ways:

(1) By involving 29 students (divided in eight groups) during a design course where they examined traditionally sedentary office work settings and developed design concepts. We evaluated the concepts according to their potential to remedy sedentary work. We conducted a thematic analysis on their individual reflections of participating in the course and on office work.

(2) By developing, testing and evaluating three *physical movement probes* with 30 office workers (a mix of employees from administration, technical support and research). The three probes were an exercise bicycle with a custom-mounted tablet, a stair-climbing machine with a custom-mounted tablet and a treadmill at a desk with a laptop. The participants completed a web-based multiple-choice survey that was designed to capture their experience of using the probes. The Borg Rating scale of Perceived Exertion (RPE) [2] was used to capture how physically demanding they perceived using the probe was. We also included other questions such as about how they ranked the probes in order of personal preference and about their current work situations from a physical movement perspective.

The Design Course

In the design course *Human Product Interaction*, given at *The Royal Institute of Technology*, Stockholm, Sweden, 29 students were encouraged to discuss, reflect, examine and explore physical interaction between humans, products and the built environment. The course was a mixture of seminars, lectures and a design project. At the end of the course the students were asked to hand in a 3-4 pages long individual reflection of some themes such as *office work, movement and design.* They were also given the chance to share other reflections. During the design project the students were divided into eight groups and provided with a short design brief. A part of that brief is described here:

"Identify some different environments that can be defined as offices. Through user-centred-design methods such as participative observation, semi-structured interviews and/or questionnaires collect data and observe movements from users of that office environment. Analyse the data in order to find design issues or possible problem areas. Choose one of the identified offices for your design. Select together with the users the preferred design and develop a final concept aiming at enhancing physical movement at the office."

The Design Concepts

Among the eight groups final concept designs, four inspired our development of the physical movement probes. The development was initiated after and separately from the course. The four selected concept designs are described below.

Bank office - The bank is a large corporation and many of the work tasks at the department visited are individual and performed seated in front of a computer-screen. The users have keyboards that can be detached and plugged into another computer in order to access material if they need to discuss some matter with a colleague. They sit in a landscape. A majority of the users responded that not many did use the exercise facilities provided by the company. These were Pilates balls, flexible desks, break gymnastics, gym facilities and economical support for physical activity outside the workplace to promote physical activity. The reason was that it was not socially attractive to use the products. Motivating factors to get up from the office chair was the coffee machine, the water cooler, to discuss with a colleague, and go to the bathroom or to the printer. The student group discussed different solutions, to decide a day or at least part of the day for standing at work and provided something similar to The Lunchbeat, where people gather to dance disco and have a sandwich during lunch. http://www.lunchbeat.org

The final concept is a new workstation – an active desk. The aim is to arrange for a standing work position. Making

way for a change of state –upside-down perspective. Take a break and sit down but work actively through standing and changing your work environment. The desk can be individually adjusted to your preferences. It can host several individuals as forming a round table. See Figure 1 for the active desk concept.

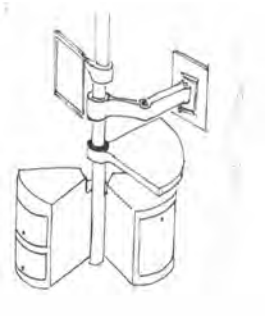

Figure 1: The Active desk

Architecture office – The students reported users sitting most of their time at work and often more than two hours without any break. They were not keen on changing computers since their own had personal adjustments and their software and settings. The most common work tools were computers and phones. Many of the participants felt pain and stiffness in neck and shoulder from a day at work. They did not use the Pilates balls or other training equipment provided. Nor did the messages or articles that management sent around to the employees change the situation. The students created a new layout of the office as a landscape, see Figure 2. They were inspired by the landscape in nature with variation in topography. The variation with different levels would hopefully be experienced as more lively and full of different places and spaces, both for collaborative and solo work tasks. Stairs between different levels were combined to keep the spaces open. A clear line between work and relaxation was drawn, by leaving the work level and go down to relax, to recharge.

IT consultancy office - The work environment was found not to support movements. Work tasks were performed sitting in front of a computer screen. Physical training equipment was placed in the office but was seldom used. At their office they had sit-stand desks, table tennis, soccer game, Pilates ball and a massage chair. The digital work environment has improved to such an extent that the workers are no longer forced to visit the client at their workplace, but can remotely solve the problems through shared screens. One of the participants said he took more breaks before when he smoked. Different approaches to support movement were discussed such as a self-adjustable or irritating chair, "foot-mouse", robot colleague or robot dog walking around and remind you to take a break and go for a walk. They also discussed why people go to the coffee machine even though they do not take a cup. Maybe the answer is that they hope for some social interaction or that their bodies communicate in a non-conscious way that they need a change in posture and movement. In figure 3 the students' final design concepts, the foot-mouse and the irritating chair with sharp spikes rising after too long period of sitting are illustrated.

Figure 3: "Foot-Mouse" and "Irritating Chair."

University administration office - The students reported that the office workers were seated in front of a computer screen most of the time at work. The movements were small: tapping on keyboard and clicking on the mouse. Walking was performed when getting a coffee, walking for lunch and getting documents from the printer. They had sit-stand desks but those were seldom used. Some of the participants that used the sit-stand desk reported problems with pain in the feet. Standing for a long period of time can be stressful for structures in the feet if no good floor support is available. The group discussed concepts such as sit and stand clock, automation in desk height (when leaving the room the desk rises so when getting back into the room you get to work by a standing desk). A prototype, see figure 4, of a standing carpet with different layers of material was tested, aiming at supporting the feet during standing posture. The top layer was a piece of reindeer fur. Some comments from the office workers are here shared: "Nice to take off the shoes and stand on this smooth and warm material". "A little worried about foot sweat". "I feel that the heels are less stressed and I get good support for the arch of the foot".

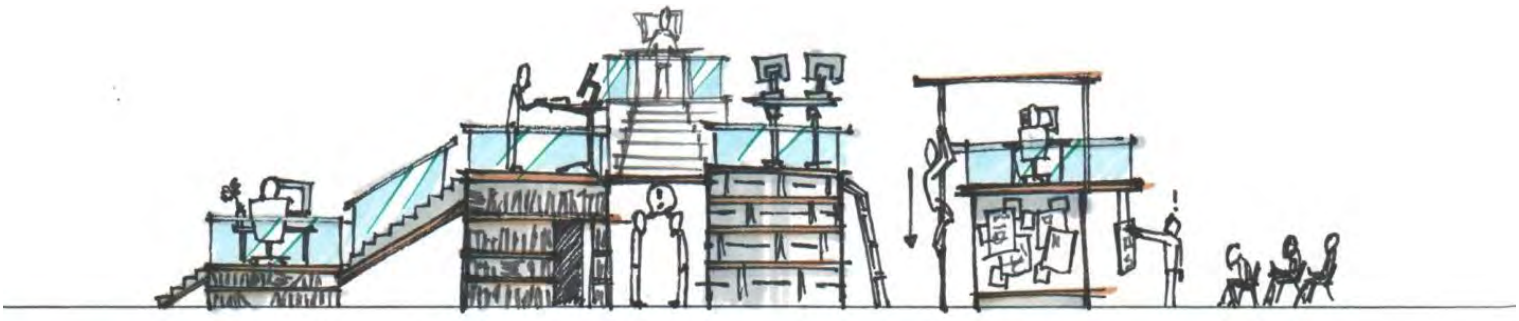

Figure 2: Topographic Office Landscape

Figure 4: Testing the prototype and an illustration of the different layers

Analysis of the Selected Design-Concepts

In the students' design brief there were no constraints on the outcome of the design concepts. They were asked to follow a user-centred method and try to remedy the sedentary situation. Not an easy task, including many perspectives and obstacles to overcome as described in the texts in many of the design concepts. At almost every office they could identify and find products already placed there aiming at supporting physical activity. These four design concepts show a participant sensitive design approach in that they tried to stay close in their design to what their participants described as an obstacle for being physically active. This is part of the outcome of the design project – the discovery of obstacles in the office setting. Obstacles in these settings are, among others, that physical activity is not socially attractive, that the layout and furniture do not support variation in movement. The design of the settings has not been "critical" to the extent that motivators and activators are sufficient to change the "normal" attitude. In our evaluation and analysis of the design concepts we as designers looked for approaches that use our knowledge of the problem area.

RESULTS OF STUDENTS' REFLECTIONS ON THEMES

At the end of the course the students were asked to write (3-4 pages) individual reflections on four themes, see below. They were also invited to share any other thoughts on the theme of the course in "free" reflections. The first part was mandatory and the second part was optional.

The first part of the collected data was analysed through conducting a thematic analysis where the themes to reflect upon were decided on beforehand [5]. The themes or areas were: *Office, Movement, Work and Design*. The aim with the task and the analysis was to find out what reflection they triggered and how this could inform and support research within the defined problem area.

Office From the analysis it became visible that the students had managed to identity some of the problems inherited in the paradox of leisure interactive design of computer technology and props in the environment to be physical active, that are not part of the direct work-tasks.

"Office work is often referred to as done by someone working with information, administration, paperwork, with a laptop or a desktop computer. Sitting in front of a computer performing light flickering with the mouse and tapping on keyboards."

"Equipment at the office is not so easily changed – a computer a phone and a printer does not really urge you to be physically active."

Movement The students' reflections of the notion of movement were quite disparate. They identified in their explorations issues of regulations and policies, concerning many parameters at the office but during discussion they did not think that regulations would help to remedy the sedentary situation. They described perspectives of movements in everyday actions as being on the looser side towards efficiency.

"There are regulations for ventilation, noise, lightning space etc. and we get opportunities to be physically active during office-hour but the job as such does not demand physical movements to any grater extent."

"Through development aiming at efficiency our movements seems to have become smaller, lighter and less spontaneous."

Work From the reflections on the notion of work we identified tensions in the their descriptions when it came to how work-tasks are performed and to a certain extent a critical perspective on what is done: If the movements are not *included in the actual work activities* they seem superficial.

"It is a paradox and a stress factor that management put pressure on their employees to be physically active and yet more effective – if the work-place design and the work-pace does not support physical activity, why talk about it?"

Design In the reflections on the notion of *design* the students rely on design as a powerful tool enabling change and thereby to increase or decrease opportunities to be physically active in everyday interactions.

"I see our university from a different perspective now after the course – the entire school is designed for sitting. I have started to stand, but by doing so I stand out."

"Design can be used to form our everyday environment – it is something that is not just there. We are responsible for the sedentary stressful work climate that is present."

"Different aims at trying to get people more physically active has been focused on information – it is time to design the environment to support physical activity in a non-intrusive way."

RESULTS OF THE STUDENTS' "FREE" REFLECTIONS

In the analysis of the "free" reflections we did a thematic analysis with no themes provided beforehand [1]. This method was used in support of identifying, organizing and understanding the collected material. It "*interprets various aspects of the research topic*" [3]. Within HCI thematic analysis has been used and described as being valuable for evaluation and/or informing design, [23, 28, 29]. Words or descriptions that had similarities were highlighted by colour in the text. Continuing with this way of working eventually three themes evolved: *Discovering habits, describing postures and changing behaviour.*

Citations exemplifying the themes are all from different students. During the work with the thematic analysis we were surprised to find out that the theme that evolved matched a behavioural change pattern. This was not the focus for the course. The result came as a surprise. The results can be related to *theories of behavioural change.* Having confidence in one's ability to perform a given action is a construct in behavioural science that has been labelled *self-efficacy*. *Self-efficacy* and *social support* are important factors for behavioural change. To be fully acknowledged as a successful change of behaviour the results have to stand the pressure of time. We have not evaluated the students' initiation and attempt for behavioural change. Therefore our results are only pointing towards similarities with the theory at this early stage after the initiated change. The way the students seem to change behaviour can also be described as going through a *design process*. In this setting it becomes quite visible how the *design of the environment* is playing a part in the sedentary behaviour.

Discovering habits A pattern, a theme, evolves when exploring and investigating everyday interactions. Although the students themselves were not at focus for the enquiry they started to "see" and discover their own habits, a first step in the process of actively *changing behaviour.*

"Before starting up my studies at KTH I worked as a ski instructor in Canada. I had a lot more energy after the workdays then. I know that I am all too sedentary in my everyday life but I do not find ways to change the situation. It is affecting my sleeping pattern and I often have pain in neck/shoulder and back-pain."

"I think that it may be easier to change habits now that we are young and before we have become adjusted to the sitting postures at work. We realize that many of us will end up in an office-environment. If we have been used to a variation in physical movements during our education it might be easier to take that habit into work life."

"Sitting is very much fundamental and integrated in my way of living my life – it is comfortable to sit. Nothing is really stopping me from going for a walk for a shorter period of time but I have never done that. Maybe in my next apartment and in future work-situations I might change the habit or routine that I now live by – seated for most of my awake hours."

Describing postures Under the theme of *describing postures* the students shared how they explored the discovered habits and they *described the problems* in more detail. They identify when the problematic postures occur. They relate the postures to situations and contexts, narrowing down the design space.

"I have friends that have been working for some years after university studies and they say that the work situation is much less flexible and much more seated than what was the situation during education. They are much more desk and screen bound now."

"I think that as a student not many activities are designed for movement. We are sitting down during lectures, we sit down during exam, we sit down during studies and we are expected to study a lot on our own after school. So, when can we find opportunities for physical activity in everyday life?"

"I sit during my studies, I shop on the net sitting in front of my computer screen, I entertain myself through TV games etc. in front of a screen or I do all these things at the same time multitasking but through the exact same physical movements."

Changing behaviour The students describe *realizing* as the driving force for the *change of behaviour.* This seems to be inherent as a motivation factor, to see a way out of the described problem area. Discovering possibilities and alternative ways of behaving is connected to *self-efficacy, design solutions and theories of behavioural change.* The students were also concerned with the sustainability of these new habits. How much can they (the students) rely on continuing these changes of behaviour, when the context, the environment, the social cues are not enhancing this kind of change of behaviour?

"I realize that the course has made me change my behaviour when it comes to how I travel to school. I used to take the bus or the metro but now I try to walk as much as I can. As we discussed during the course I wonder for how long I will be able to maintain this change. I feel that the risk is high that I slide into bus and metro again after a while."

"I started to walk to the university instead of taking the bus. I realize that the design for students are sitting postures and that we tend to focus on the tasks and thereby forget to include physical variation – I feel my body hurts a lot after studying for exams but I do not experience it until the exams are done."

Probing Office work

After the design course we developed and collected data of user-experience from three movement probes. The results from the evaluation of the design concepts developed by the student group, the analysis of their reflecting texts and research findings from literature about the negative effects of prolonged sedentary postures were guiding our design and development of the movement probes. There are a broad variety of products and systems monitoring individual levels of physical activity and as such aiming at providing motivational support, among others there are; FitBit, Jawbone, LUMOback and iPosture. Monitoring products do not as such provide means for being physically active and less sedentary during office work. Moreover, efforts such as providing products for physical activity placed at the office environment do not seem have a major impact on patterns of sedentary work. We have developed three movement probes combining equipment such as a treadmill, step-machine and exercise bicycle with tablets and laptops, see figure 5:

Figure 5: From left to wright; movement probes A, B and C

A: a bike and a tablet. A combination of using the bike and reading a text on the tablet. The selected text, the same for all to read, was news from the department.

B: a step-machine and a tablet: A combination of using the step-machine and watching a video having the sound through Bluetooth headphones.

C: a treadmill and a laptop. A combination of walking on the treadmill while answering a web-based survey with multiple-choice questions and two free-text questions about the experience of testing the Maker Office probes.

In a pilot study 30 participants explored these different concepts. We recruited the participants by sending out a mail to employees at a big university department with a high degree of office work. The aim was to collect *"experience"*, data of how the participants describe the use of these concepts and to get a *deeper understanding* of these systems in a similar way as described in [15]. To build knowledge on how future design of work activities in office environments can cater for a more movement-inclusive situation. The empirical material collected from the participants of the three design probes was a web-based survey. It consisted of 3 Borg Rating of Perceived Exertion ratings (one for each probe), 19 evaluations on Likert scales of experience, interest to use the probes in their work, and of their work situation with physical activities, and finally 2 open, free text, questions for comments and thoughts. The Borg Rating of Perceived Exertion (RPE) scale, [2], is a way of measuring intensity level of physical activity. Perceived exertion is how hard you feel that your body is working. We used this scale for the rating of the probes. The scale spans from 6-20 where 9 corresponds to "very light" exercise. For a healthy person, it is like walking slowly at his or her own pace for some minutes. 13 on the scale correspond to "somewhat hard" exercise, but it still feels Ok to continue. 19 on the scale correspond to an extremely strenuous exercise level. The 30 participants were aged from 25 to 69, 14 women and 16 men. They tested the three probes for about 5 minutes on each probe. In total the test took about 25-30 minutes or more depending on how much comments the participants wanted to share with us as designers and researchers. They came one at the time and they were all provided with the same material to interact with. They answered the survey (in digital form) while exploring station C. The questions collected data for example of perceived exertion, order of preference and open questions of what they liked and did not like about the probes. After the exploration they were invited to share any other thoughts on the tests or experience of the problem area from their perspective.

RESULTS FROM THE SURVEY

How hard the participants experienced the physical activity on the three different probes, A (blue), B (red) and C (green) are illustrated in Figure 6, 7 and 8.

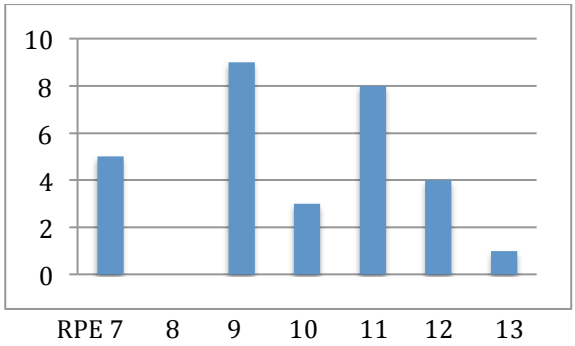

Figure 6: Probe A - Rates of perceived exertion

A: the ratings span from 7 (very, very light) to 13 (somewhat hard). The mean value is 9.8.

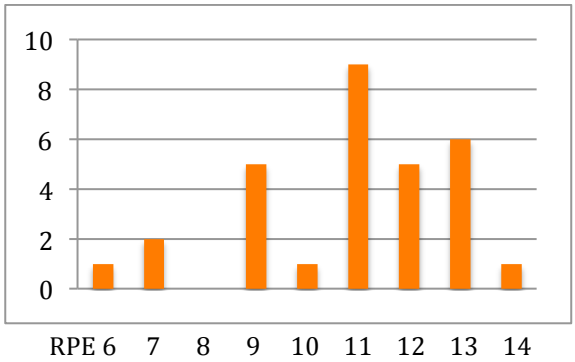

Figure 7: Probe B - Rates of perceived exertion

B: the ratings span from 6 (just below very, very light) to 14 (just above somewhat hard). The mean value is 10.9.

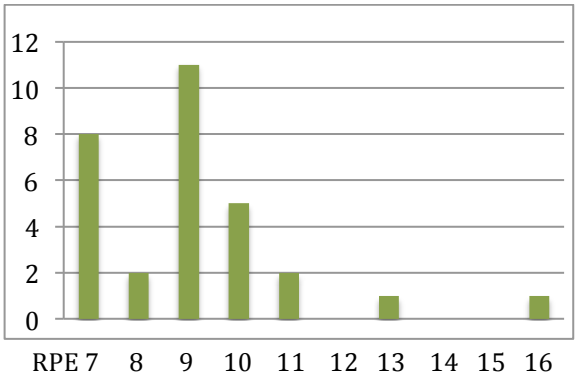

Figure 8: Probe C - Rates of perceived exertion

C: The ratings span from 7 (very, very light) to 16 (just above hard). The mean value is 9.1.

The ratings reveal that the physical activity is within the range of what people are normally being able to withstand for a longer period of time. The participants were also asked to grade their preferences with respect to the movement probes A, B and C on a scale from 1 (lowest) to 5 (highest), the result is illustrated in Figure 9.

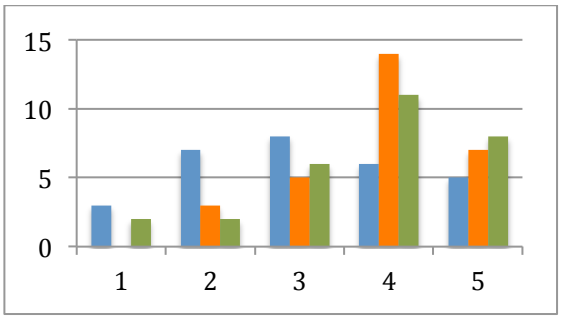

Figure 9: Preferences of probes A, B and C

Probe A was the most evenly ranked, with mean value 3.1, but compared to probe B and C it was ranked the lowest among the participants. Probe B was selected as the most preferable probes with 73% ranking 4 or 5, mean value 3.9. Probe C was ranked 4 or 5 from 64% of the participants, mean value 3.7.

There is something notable about the RPE ratings and the preferences, (Table 1) as seen from the mean values:

Mean values	Probe A	Probe B	Probe C
RPE rating	9.8	10.9	9.1
Preference	3.1	3.9	3.7

Table 1: Mean values of RPE ratings and preferences

Even if station B was experienced as the most strenuous, it was the one preferred by the participants.

We asked the participants if they would use the probes or similar ones if these were available at their workplace. Possible answers on a six level Likert scale were: no, not likely, maybe, somewhat likely, most likely to definitively. **Station A**: responses were almost even on the more likely side as on the more unlikely side. **Station B**: responses on the more likely side were double compared to the more unlikely side. **Station C**: responses on the more likely side were more than double compared to the more unlikely side.

In the free-text questions the participants were asked to describe what they liked and did not like about the movement probes (A, B and C). We share part of the results by quoting some of the participants:

A: *"It made me aware of the biking and that made it somewhat difficult to focus on the reading." "Cycling comes naturally and not is something you need to concentrate on. That is why it was easy to read and bike."*

B: *"After a while I started to focus more on the video and almost forgot about the room around me – that was really great". "Stepping was so hard that I started to sweat, not so nice in Office work".*

C: *"It was very flow-like to walk and write". "I tended to lean a bit on the table with one of the hands – to stabilize for the writing. This made me tense in the shoulders".*

We used Likert scales from 0 (never or not at all) to 10 and to 5 on the last question (always or extremely) when asking about the participants' work-situation.

- How often are you using a computer at work?
  90% answered ≥ 8 of 10
- How often are you sitting at work?
  73% answered ≥ 7 of 10
- How monotonous are your work tasks?
  70% answered ≥ 7 of 10
- How physically demanding are your work?
  87% answered ≤4 of 10
- Would you like to make use of your physical movement abilities to a greater extent during your workday? 80% answered ≥4 of 5

DISCUSSION

The findings from the field study and material collected through the student design projects describe some of the obstacles within the defined problem area: It is not socially attractive to use the products for physical activity already there at the office. People are sedentary and the level of physical activity is low during many of their work tasks. The student groups' approach to turn the sedentary situation upside down by designing for "sit-relax – stand-work", by making the landscape similar to landscape in nature with its variety in level and material under the feet as in the design concept for floor-support inspired us to further explore physical inactivity in office settings through the development of three movement probes. Our approach to probe office work may serve as a method to generate knowledge of what to focus on in the design of movement-inclusive office work tools.

For HCI researchers approaching sedentary behaviour the best proof of success would be sustainable long-term positive behavioural change. To validate such changes would in turn require large-scale longitudinal studies. But as, discussed by Klasnja et al., [15] these kinds of studies are seldom within the scope of HCI and interaction designers in their early design and development of interactive systems. Our contribution is to develop physical movement-inclusive designs (as the movement probes) to reveal, discuss and share user experiences of office-work. We sought to generate knowledge of the defined problem area, evoke a reflection process for the participants and a learning process for us as researchers. The design of the environment instructs or tells us how to behave. To visualise these behavioural patterns is a good starting point for change.

The design brief did not explicitly ask the design students to focus on the work tools. None of the groups focused on a new design or a re-design of the most common work tool that is puts people in seated positions – the computers. Nor did we as researchers when developing the three movement

probes. We wanted to involve artefacts that were familiar to our participants at this stage of our explorations.

One of the problems when aiming to remedy the situation with sedentary behaviour at the office is that the body does not to go off with an alarm similar to signalling hunger or sleep. When we need food the stomach tells us that in a quite clear manner. When we are in need for sleep, the body is "telling us" through yawning, not being able to focus, difficulty to keep our eyes open, being slow in motion, hard to stand upright etc. But when in need for physical activity, the signals are not that obvious or direct. At least not until later on when, partly due to the lack of physical activity we may get health problems. There are signals but we seem not be that sensitive to acknowledge the way our bodies try to communicate that it is being "under-used". Although this is the focus of awareness management devices, our participants expressed the desire to make use of movement capacities *during* the work tasks. As sitting is close to resting measured in METS, aiming for higher levels of energy expenditure during work tasks may result in health benefits.

When exploring the physical movement-inclusive design probes many of the participants expressed both in the survey and directly after the explorations that they enjoyed the probes. The probes were more appreciated than we had anticipated. From the analysis of the survey they seem to welcome harder exercise while working or, at least, say that if you exercise while working it should be challenging. This was expressed through their RPE and rating of preferences (as illustrated in Table 1). Time might be correlated to this result since the explorations only took about 15-20 minutes. The probes were not designed as the final solutions, but as means for further discussion. In the given office context they provided *design hypotheses* to inspire and be explored by other researchers as described in [11]. We have gained knowledge through these explorations that will form the basis for further research design. From the free text answers we also see the importance of designing for flow if aiming at remedying situations of excessively physically inactive computer work. The physical movement interaction should provide possibilities for flow and the level of physical activity should not be too tiresome.

An unexpected result from the design course was found in the analysis of the students' reflections. It seems as if many of them did initiate a change in their own behaviour when it comes to everyday physical activity. Changing means of local travel was the most common way that they approached the situation. This may be related to the fact that the choices of how to transport themselves to and from school are more obvious than to alter behaviour while at school, where the choices are less obvious. For transport there are buses, metro, bikes, cars and feet to mention a few. Our focus of research was never intended to include behavioural changes aiming at the students themselves (the focus was on office work). The students' impetus for change may have been related to the physical movement focus during the design course and also (as shown in the thematic analysis of the students' reflections) to the students discussing among themselves how sedentary they found their lives to be. As social support is a great potential for behavioural change this may have triggered them to go ahead.

CONCLUSIONS

This paper has explored how a physical-movement design approach might contribute to remedy traditional sedentary work practices in an office environment. Sedentary life styles increase the risk for developing a host of diseases and other medical complications as described in the literature. Methods to approach this problem area seem to focus on awareness management and devices for encouraging physical activity. The results from our explorative field-studies with students show that the office settings they observed were equipped with artefacts to promote physical activity that were left unused. It was found to be "not socially attractive" to go beyond the established postures of working in many of the settings observed. Moreover, there was no need to be physically active in order to do the work.

The results from having the 30 office workers explore the physical movement probes indicate that if the physical activity is performed as integrated with the work tasks it may become self-sustaining. Interestingly, the participants preferred activities that were strenuous. They described their current work situation as overwhelmingly computer bound, sedentary and monotonous and they expressed a desire to be more physically active. The results from this explorative study contribute to the HCI research domain by providing design hypothesis for redesigning work situations along the lines of a movement inclusive design approach. The key is to find a baseline level of physical activity that allows us to work at an office even if the office is not a specific place for physical activity (such as a gym or other recreational facility). What we have today is a default office design that keeps us sedentary in front of a computer screen. A physical-movement inclusive approach may further physically sustainable work practises.

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