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Promoting Physical Wellbeing in the Workplace: Providing Working Adults with a Tool to Reduce their Sedentary Behavior

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ABSTRACT

This paper presents a user-centered design project examining how to reduce the long-term sedentary behavior of desk-based working adults by motivating them to utilize their sit-stand desks to make more transitions between sitting and standing. The project involved a range of design techniques and research methods to look deeper into the practices and habits of working adults and better understand why this lack of sit-stand desk use occurs and how it can be changed. Combining the findings of the different research techniques led to an innovative design strategy consisting of 5 key considerations to reduce the sedentary behavior of working adults: (1) reminders of when to alter between sitting & standing; (2) social support; (3) awareness of effects on body & mind; (4) education on sit-stand desk benefits & proper use; (5) control over sit/stand transitions The results of these considerations were applied in a final concept call BMDesk.

Keywords: Human factors, Workplace wellbeing, Sedentary behavior, Sit-stand desks, Behavior change

INTRODUCTION

This paper presents an overview of the user-centered design project examining how to reduce the long-term sedentary behavior (SB) of desk-based working adults by motivating them to utilize their Sit-Stand Desks (SSDs) to make more transitions between sitting and standing throughout the workday. The design research was conducted as part of a graduation thesis at the Delft University of Technology. The core goal of this paper is to examine and interpret insights gained from the research in this project. The final concept, BMDesk Application, and Controller, showcases an interactive digital platform aimed at reducing the SB of desk-based working adults by providing them with a tool in which they can set up their workday and sit/stand goals, check-in on how they are feeling with a step-by-step body and mind self-evaluation, receive personalized tips based on their self-evaluation, connect with colleagues to work towards developing their sit-stand behavior together, and track their progress to understand how their sit-stand transitions effects their mental and physical state.

Creating a healthy physical work environment is essential for both improving work performance as well as for the physical and mental wellbeing of employees. But as jobs are becoming less active, SB has become increasingly apparent among desk-based working-age adults in high-income countries with studies indicating that the average working adult sits about 8-9 hours per day, combing both work time and leisure time (Mantazari et al., 2016). To improve employee wellbeing and reduce the sedentary nature of the workplace, many companies have replaced the standard desk with sit-stand desks (SSDs). But research indicates that working adults often do not use the SSDs, remaining seated for most of the day. In a study done by Wilk et al. (2006), results indicated that 60% of men and women across the four companies, reported using the desks once a month or less. The primary reason for not adjusting the desk, cited by two-thirds of those studies, was that the individual 'could not be bothered,' with another third reporting that they already believe they had sufficient variation in posture (Straker et al., 2013), (Wilks et al., 2006). Often participants who were motivated to use the desks before the experiment, with a recurring reason of health, were the ones who more commonly continued to use the desks long-term (Chambers et al., (2019)). But even among these participants, studies indicated that despite their initial enthusiasm, employees often forgot or lacked the continuous motivation to switch to the standing position. In this paper, the research methods and techniques utilized to better understand working adults and why they may not use their SSDs are reviewed to present a design strategy that can be taken to promote the use of SSDs and reduce the SB of working adults. This design strategy was applied in a final design called the Body-Mind Desk (BMDesk).

Literature Review

A review of literature was done to analyze why this lack of SSD utilization occurs and to create an initial set of assumptions concerning the barriers desk-based working adults may face towards altering this behavior: (1) sitting is the norm and a static workplace culture results in static workplace behavior; (2) using SSDs in an environment where it is not common, causes an increased psychological discomfort and fear of disapproval; (3) people may be unaware how to properly use SSDs often resulting in an "all-or-nothing" mentality; (4) sitting is a subconscious habit and there is a general lack of motivation to alter this behavior; (5) people may be unaware of the negative impacts of SB or the physical and psychological benefits that correlate to properly using SSDs; (6) there is a perception of not being able to work effectively whilst reducing sitting. Literature sources: (Cole et al., 2015), (Niven & Hu, 2018), (Henderson et al., 2018), (Meyer et al., 2016), (Mansfield et al., 2018), (Hall et al., 2019), (Dutta et al., 2015), (Greenwood-Hickman, et al., 2016).

METHOD

The development of BMDesk followed an Empirical Research through Design methodology (EDRM). The EDRM process started by formulating a hypothesis based on assumptions from the literature review, an autoethnographic study, and qualitative interviews. Next, several prototypes were

created, based on specified structured design principles, which were then tested based on the underlying hypothesis. These findings were fed into an itemized response and the most promising features of each prototype were combined to form a second iteration that improved upon the original design. This procedure was repeated several times until the final concept, the BMDesk Application & Controller, was developed (Keyson & Bruns, 2009).

Study 1: Auto-Ethnographic Research

The autoethnographic study consisted of a self-study occurring over nine days (Adams et al., 2015). The study involved documenting the designer's experiences while using a sit-stand desk to better empathize with the user and understand the barriers and facilitators they may face.

Study 2: Quantitative Interviews

Eleven participants, six inactive SSD users and five active SSD users, were selected for qualitative interviews. Four of the participants were female and seven were male, all within the age range of 22–44 years. Inactive participants were users who transitioned their SSD to the standing position once a week or less, and active SSD users transited their SSD to the standing position more than once a week and often several times per day. Both the active and inactive groups included participants who worked from home or the office and had daily access to manual or electric SSDs.

The interviews were divided into two parts, each consisting of open-ended questions. The first section concerned the barriers that may influence, or limit participants' use of their SSDs and the second section concerned the facilitators that promoted their SSD use. Since participants in the inactive group often did not utilize their SSDs, they were also asked to identify if there were any facilitators, they believed would motivate them to increase their SSD usage and enable them to develop the long-term sit-stand behavior

Generating Themes

A thematic analysis of the transcripts of the autoethnographic research and interviews was done. Clusters were generated, compared, and combined. Two overarching themes were used to depict the data: barriers to SSD use and facilitators to SSD use. These two themes were compared to determine the key factors that differ between and influence the SSD use of, active vs. inactive participants.

Barriers for SSD Use

Overall, seven barriers were most frequently mentioned: (1) **Sitting is a habit** and even though inactive participants often understood that their SB was bad for them, they lacked the motivation to change the habit and did not care to alter their behavior. (2) **Working in a static environment & social disapproval.** This often went together with participants' feelings of **psychological discomfort** when considering transitioning their SSD to the standing position. These participants worked in an environment where static sitting was the norm and going against this norm generally made participants feel

"weird" or "awkward." In addition, participants often stated that they worried they would disturb their colleagues when transitioning. (3) Participants often chose to remain seated as they believed that transitioning to the standing position would result in a **break in their workflow** and a **decrease in productivity**. (4) **Lack of awareness of sit-stand benefits**. Many participants were unaware of the benefits that altering their position could have both physically and mentally and instead focused on the potential discomforts that could occur. These participants also often had an optimistic bias believing that since they were not currently feeling pain, or associated the discomforts they felt as "normal," the long-term adverse effects of SB would not affect them. (5) **Lack of awareness of proper sit-stand practices**. There were mixed responses from participants about understanding how to best utilize SSDs and several of the participants had perceptions that the desks should be used in the standing position as much as possible. This idea deterred many participants as they were worried about the discomforts that would come from standing so much. (6) **Just forgetting to change position**: participants who were interested in forming the sit-stand habit but had a harder time maintaining the new behavior often stated that they just forgot to transition. (7) Inactive participants mentioned various **physical barriers** (e.g. too short cables, too long desk height transition). Although these barriers were also noted by active participants, they often found ways to overcome these barriers to ensure that they could continue transitioning to the standing position

Facilitators for SSD Use

Four of the key facilitators mentioned included: (1) **Social support or influence**, such as seeing a coworker or supervisor using their own SSDs, was often the initial factor that influenced participants to try using their SSDs in the standing position. This factor was also reinforced by having an **active environment** where using the SSDs was normalized and psychological discomfort less apparent. (2) **Immediate relief and body and mind cues for transition.** A commonly mentioned facilitator was that upon initial use of SSDs participants often became more aware of the physical discomforts they felt from prolong periods of static sitting or standing and noticed how altering between the two positions could relieve them of these discomforts. They also noticed that working in different positions affected their mental state, often improving their mood and energy levels. This increase in consciousness of their physical and mental state allowed them to be able to use physical and mental cues, e.g. feelings of discomfort or fatigue, as indications for when it was time to transition their position. (3) **Task-based transitions:** although this was a facilitator not mentioned by the active SSD participants, it was a common recommendation by the inactive SSD participants. Since the break in workflow appeared to be a significant barrier, many participants believe that they would be able to alter their desk height if it correlated to the start or end of a task. (4) The need for **reminders** is an important aspect for all participants who have not yet fully developed the sit-stand habit. Many participants mentioned that they often just forgot to make the transition and having reminders would help them.

Key Considerations for Final Concept

These findings led to the hypothesis that to reduce the SB of desk-based working adults, the use of SSDs in the workplace should be normalized by ensuring that working adults understand the benefits and proper use of SSDs while also offering the key tools: (1) reminders of when to transiting between sitting & standing; (2) social support; (3) awareness of effects on body & mind; (4) task-based transitions.

Study 3: ERDM

To test the different facilitating tools, three rapid prototypes were created, each utilizing a different key tool or combination of tools (social support, body & mind awareness plus reminder, and task-based transitions). The study was conducted in a laboratory setting over four hours. Nine participants, five female and four males all between the ages of 20 – 27 years, were involved in the study. Each participant was provided with one of the three prototypes and an electric SSD. All the participants were inactive SSD users and typically remained seated at their desks for a minimum of 6 hours per day. The goal of this study was to determine whether the hypothesized measure to increase SSD use would in practice be confirmed.

Procedure

Participants were divided into three even groups with each group testing one of the three prototypes. Each group was provided with an explanation about the study and was instructed on how and when to alter between sitting and standing based on their prototype's corresponding tool. The study lasted three hours and at the end of the testing period, a discussion was held, and each group was asked to fill out a questionnaire evaluating their experience with the tool.

Data Analysis

An itemized response method (van Boeijen et al., 2013) was used to indicate important findings from the experiment and identify the positive and negative experiences felt by the participants for each tool. In the case of this experiment, these findings were used to compare the three tools and combine the most promising features for further development in the final concept.

Results

Table 1 presents the findings of this experiment. As shown in the figure, participants experienced the prototype that used a reminder to promote body & mind awareness the most positively. Several participants stated that after a few transitions, they became more conscious of how their bodies were feeling and were then able to transition between the two positions without the aid of the prototype. This autonomous transition was not noted with participants who were evaluating the alternative key tools: social support and task-based transitions. These participants felt as if they had less control over deciding when to sit or stand. This factor was significant in participants' belief in whether they would be able to maintain the behavior long term or

Table 1. The positive and negative features of each prototype.

Social Support Tool	Body & Mind Awareness + Reminder	Task-Based Tool
+ Doing it together helped with motivation	+ Increased awareness of discomforts in body	+ Promotes time management
+ Reduces social barrier	+ Noticed immediate physical relief	+ Limited concentrat ion break from current task
+ Prompted interaction between coworkers	+ Taking time to scan how they were feeling	
+ Pressure from others to stand	+ Recieving infonnation about effects of sitting/standing	
+ Colleagues to remind eachother	+ Feelings of autonomy/control over transitions	
+ Working together made it fun	+ After time, participants began to transition on their own, with out light reminder	
+ Challenges worked for more competative participants	+ Personalized experience	
+ Util ize social aspects to support and not force	+ Physica l reminder (Light)	
– Felt like being monitored	– Self-eval moments tended to break concentration	– Lost a sense of autonomy
– Limited autonomous transitions if transitioning at same time	– Sl ight psychological di scomfort at altering position in the beginning (felt alone)	– Too long of an inital set-up
– Could be distract ing from work		– Participants remained in a position longer than what was comfortable to them if a task was not finished
– Question as what would happen if working alone		– Led to part ic ipants ignoring how their body was feeling
– Participants fe lt that behavior change should be more personal		– Felt like it added another task 10 their workday
		– Did not believe ii would work long-term

not. Participants also experience the personalized tips on how to lessen any discomforts positively. With the notion that they could choose to follow the tip or not, the participants who took part in the body & mind awareness tool enjoyed transitioning between sitting and standing more and noted the immediate relief they felt when they altered their position.

Participants who assessed the Social Support Tool felt more inclined to alter to the standing position since their colleagues were standing. As they were doing it together there were fewer feelings of psychological discomfort and they felt that they could rely on each other to remember to alter positions. They also noted that this tool could work long term if it felt more supportive rather than controlling. Participants who assessed the Body & Mind Awareness Tool initially felt psychological discomfort when altering position, but over time it lessened. Participants who assessed the Task-Based Tool experienced the transitions most negatively. Even though they felt that they were able to remain concentrated on a task, they also felt that they lost control

and had to remain in one position if a task was incomplete, even if they were feeling discomfort. Participants in this group felt that this was just another task to add to their day and they would not keep up with it long term.

BMDESK CONCEPT DEVELOPMENT

Combining the findings of the literature review, autoethnographic research, qualitative interviews, and ERDM study led to an innovative design strategy for altering the SB of desk-based working adults which was applied in a final design called the Body-Mind Desk (BMDesk). This innovative strategy partly confirmed the hypothesis and theorized that to reduce the SB of desk-based working adults and increase their long-term SSD use, the BMDesk should include elements that provide users with: (1) reminders of when to transition between sitting & standing; (2) social support; (3) awareness of effects on body & mind ; (4) education on SSD benefits & proper use; (5) control over sit/stand transitions. Based on findings from the research it was decided to focus on the development of a digital tool and interactive controller. The main elements of the design concept can be observed by scanning the QR codes in Figure 1.

Figure 1: QR1: The BMDesk digital application prototype found on Figma. QR2: The controller and corresponding elements. By forcing the user to take their hand off their mouse to turn off the reminder, they take a microbreak and it is more difficult to ignore. QR3: A storyboard presenting the BMDesk use scenario.

The BMDesk provides users with an interactive tool that (1) gives them control over setting up their workday and defining how many sit-stand transitions they want to make and how long they want to remain in each position; (2) triggers a light reminder indicating to the user when it is time to check in and (3) provides a step-by-step body and mind self-evaluation included in the digital application; (4) based on the self-evaluation, the application provides a personalized tip and option to "learn more" about how the user can alter their position to relieve them of any physical or mental pain they are experiencing; (5) allows the user to choose if they actually want to change position and provides an additional reminder after a preset amount of time in the case they do not switch; (6) uses a two-way LED infrared sensor to automatically track the number of transitions and how long the user is in each position; and (7) allows the user to connect with the coworkers or friends to setup challenges or select times to standup together.

CONCLUSION

The work presented in this paper highlights a need to reduce the sedentary nature of desk-based working adults through increased utilization of their

sit-stand desks and improvements to their workplace practices. Providing working adults with the ability to recognize how prolonged periods of static sitting can adversely affect both their body and mind and the knowledge and tools to alter this behavior presents a novel design direction. This project followed an ERDM process that utilized various research techniques such as a literature review, autoethnographic research, qualitative interviews, rapid prototyping, and in-person user testing, to provide key insights and design iterations resulting in the final BMDesk concept. This process put the user at the center and involved them at almost every stage of the design process. Altering a behavior and forming a new habit does not happen instantaneously. Although many promising insights were gained from all the user interviews and evaluations, it is difficult to understand how the BMDesk will evolve over a longer period and whether it will be enough to encourage desk-based working adults to utilize their sit-stand desks more often.

Limitations

This project and the research studies involved occurred during a time of global social distancing due to the COVID-19 pandemic, therefor research methods were adapted due to given limitations of the pandemic. For the EDRM, there were restrictions on who could enter the laboratory site for testing. For this reason, nine master students from the Industrial Design faculty and the Delft University of Technology were used as test participants. These students did not fall into the target group of desk-based working adults, but due to the nature of their study and the fact they are accustomed to prolonged periods of desk-based work, they provided an optimal alternative to working adults.

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