

SitFit

FINAL MASTER PROJECT REPORT



By Linda Schellenberg

Abstract

Introduction

Sit stand desks (SSD) have been proven to reduce prolonged sitting [1]. At the same time, another study [2] concluded that office workers rarely change their desk positions creating an opportunity to research supporting functions for the usage of SSD.

Purpose

This work is to study a design intervention that allows the user to set a time for planned standing and/or sitting. This is to see which can promote healthier behaviour actions such as more changes of position and which function was less interruptive throughout the workday.

Method

This research was done in the workplace vitality hub with people that work there. A total of 8 participants participated for 6 workdays each. The User test was split into two sections. In the first part 3 working days of each participant were recorded about their sit stand behaviour throughout their workday. In the second part a device was deployed with a simple timer function that after the timer goes off automatically changes the desk position from its original position to the opposite. In the last three days the participants were asked to test for one day just the planned sitting function, one just the planned

standing function and one using both at the same time. After each test they were asked to fill in a questionnaire.

Results

The results showed no definitive indication that the automatic desk change was interfering with work. Further there was also no preference for one of the two functions. Planned standing and sitting had only an increase of 5% standing time compared to the baseline. The main difference in results between those two functions was the proportion of long term sitting and standing time which was reduced in with the use of the planned sitting function. The planned standing function had also a reduction of long term sitting but not a significant change on anything else. In comparison the mixed intervention created an increase of 25% standing time almost equalling the amount of standing and sitting time.

Conclusion

There is an indication for a direction with this functionality, that it could increase changes of position. However since this was a short term study with a small amount of participants it is inconclusive, if this trend can be seen over a longer time period. More research needs to be done for concrete statements.



Introduction

Over the years the amount of sedentary jobs increased. For example in the US sedentary jobs increased by 83% since 1950 and with 48% of jobs in the US being highly sedentary [3]. In the past office environments were created with the thought of workers spending most of their time sitting behind a desk, creating cubicle farms[4]. This is now changing with a stronger focus on workers' health and comfort in mind, seen by the innovations created by leading office furniture and solution creators [4], [5]. As well as guidelines created by the European government in order to secure workers health and safety[6]. A popular solution to fix this issue is the implementation of SSD where the user can change their working position as well as adjust it to their own height requirements for comfort. Research showed that in the beginning stages of the usage sitting time is substituted by standing time[1], [2], [2], [7], [8]. Over time however the usage decreases slightly and the changes of position stagnate around two times per day[1], [2], [9]. Even though it is still more than without the implementation of SSD's it still is less than at the beginning. This of course can have many reasons which opens up the opportunity to research and design additional features to support the usage of the desk.

One common solution is the use of prompts such as light or computer based[10]–[12]. With some even having an automated desk changing function. However what was found in research were preset times in which the desk change would occur or complicated programs that allowed for a lot of personalization, but less accessibility for an open office [11], [12]. For example in the office vitality hub there are many people working regularly but also irregularly such as students. These students wouldn't have the access to the benefits of a personalized program as introduced by Bakker Elkhuisen [13]. In addition there is already a device in place that should remind workers to change their desk positions, the Zens pug. This Pug starts blinking after an hour, if the position was not changed. This time was set for all tables and does not allow for personalization on an individual level. So the idea came to create a personalised timer that changes the desk position automatically.

This resulted in two different functions planned standing, to set a timer for how long one wants to stand and planned sitting, to time for how long one wants to sit. Creating the following questions:

- Can the intervention design promote more vital behaviour actions in comparison to the existing design?

- Planned sitting or planned standing which is less interruptive throughout the workday?
- Which intervention creates more standing time/more change of position?

Literature review

The literature referenced in this part was collected over the course of the Proposal period and during the timeframe of this research.

Prolonged sitting and standing

Prolonged sitting and standing is a serious issue as it is not only associated with health problems, but also higher mortality rates [6], [14]–[16]. At the same time substituting sitting with standing can also lead to health risks [17], [18]. This leads to another research that proves physical activity in combination with reduced sedentary behaviour results in reduced mortality rates [15]. The activity itself does not have to be high intensity as reducing inactivity by walking or standing is already being more effective than an hour of physical exercise [19]. These recommendations can also be found in the European Guidelines [6].

European guidelines

According to the European Agency for Safety and Health at Work [6] it is advised to avoid to spend more than 50% of the work day in a sitting position, as well as taking micro breaks after every 20-30 minutes and to get up for at least 10 minutes after sitting for 2 hours. Further they also advice against standing for more than an hour at the same spot and to avoid standing for more than 4 hours of the workday. The main focus

being to reduce static working conditions and increase movement and exercise. Various recommendations were advised and one common tool suggested was the sit stand desk.

Sit stand desks

SSD are a known and common tool to increase standing and decrease sitting time over the day [4]–[9]. However the effect was measured to be decreasing over the time of a year [1], [9], [20], even though it is not a drastic change it is still lower than at the beginning of the usage. Creating a need of supporting designs for the SSD.

Interventions

Current interventions in the vitality hub are the implementation of the Zens plug, which has a LED ring on top [see Figure1]. This plug can be programmed via a central system allowing the office manager to set certain colours to represent certain actions. One of which is that after measuring the user of the desk sitting or standing in one position for more than an hour, the light on top starts to flash indicating to the user that they need to move or change their position. Concluding the current design interventions directed specifically at the SSD in the Hub.

The next find was the use of computer based prompts [11]. This was a centralized system where participants received prompts on their computer notifying the user to change their desk

position. The results of this 4 ½ month study concluded that computer based prompts increased the daily standing transitions and supporting the effectiveness of said prompts. This intervention is currently on the market and was further developed by Bakker Elkhuisen [13]. In their design it is possible to adjust the desk via the computer screen and to personalize the notifications on the screen.

Another intervention was a semi-automated desk which prompted on the computer screen the user to stand for 10min after sitting for 50min [12]. The users had the options to agree, refuse or postpone the change of the desk. Showing results in a reduction of sitting time over a period of 2 months and no issues with the intervention interrupting their work. Additionally participants reported this being a positive contribution to their personal health and wellbeing.

The intervention by Zens and the semi-automated desk have centralized settings for when to create a prompt, while Bakker Elkhuisen used personalized settings. Those settings however are extensive and require a learning curve as well as it collecting a vast amount of personalized data. Creating an opportunity for a design that allows personalization, but also anonymity. Giving control to the user over their position needs with a design as simple as possible.

Design

The design evolved through an existing product the Zens Plug [Figure 1]. This Plug is an additional feature that can be included in products from Ahrend[10]. It is a wireless charger with a led ring that allows the facility manager to program the colours via a central system to indicate certain events. Examples are: blue for when the table needs to be cleaned, green when it is available for use or flashing when the position of the user has not changed in a certain amount of time. However it does not have a personalized function besides being able to charge phones. Inspired by the possibilities this can offer I wanted to explore the personalization of this function using the LED lights.

Idea

Since the main focus is to create more changes of position, the idea was to make it easier to implement more changes of position and create a function that was not only simple to use, but also allowed the user to set their own goals. Making it a personalized experience for each user on their personal needs for how long they want to stand or to sit. Automizing the change of position for the user to make it easier for them to follow through with their goal. Allowing the creation of a healthier office behaviour.

At the end a different, but similar design was created. With the simple function of a timer that changes the desks original position upon completion. From either sitting to standing or standing to sitting. This idea of the implementation of a desk that changes the position automatically was already something considered in some designs [11], [12] as well as indicators for the need to change the position [10]–[12]. However these products are not personalized for each user, but have a set repeated pattern. So the idea was to research the effect of automating the change of the desk with personalized control. Meaning the desk does not change on its own the position according to a set pattern, but only after a personally set time set by the user. Giving the user personalized control of their healthy behaviour and making it easy for them to keep track of the time spend in a position.

The user can plan their sitting or standing time according to their own needs and around their schedule. Changing the way for them to track their standing or sitting time as well as using it to track other activities, if wanted.

Development

In the beginning the initial design was meant to be more restrictive. Only allowing the change of the desk after setting a timer and then unlocking the desk to be adjusted to a different position.

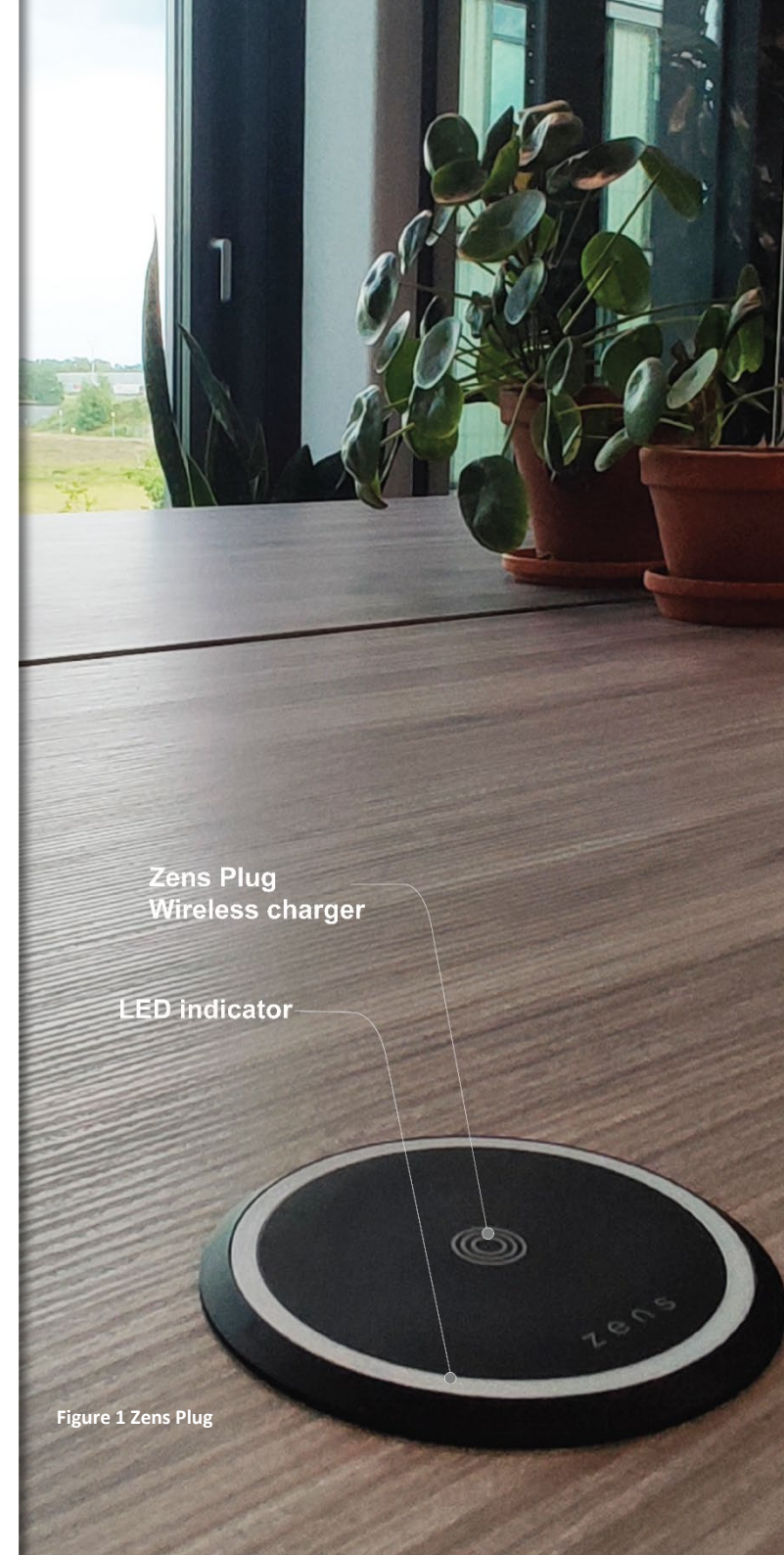


Figure 1 Zens Plug

However this was found to be too restrictive and it was chosen against this approach focusing on a more personalized and flexible approach.

For the final design of the functions it was chosen to implement three different usages. The first being *planned sitting* where the user can set a timer for how long they plan to spend sitting at their desk till the desk changes its position to a standing desk. The next function was the *planned standing* function where the user planned how long they wanted to spend their time at a standing desk. Making the last implementation the *mixed* function a combination of both

function where the user can freely choose any type of combinations that suit their schedule.

In addition a snooze function was added to allow the user when needed to extend the time by one interval twice or at the third press to turn it off. This allows the user to have even more control of the atomization

and have the possibility to disrupt the timer for a more flexible approach.



Figure 3 Side view

Form

The Form was meant to be prominent on the table. This form sticks out and changes the position of the light. Directing it towards the user instead of up. It is meant to be as simple looking and easy to use as possible.

Further it has a slight tilt to make it more visually pleasing and give an indication on which side the front of the device is [Figure 3]. The round edges and mushroom inspired shape was meant to make it look Friendly and inviting.

Materials

The whole design was 3D printed. While the top and bottom were printed with standard white ABS, the mid-section was printed in Veroclear, a semi transparent material. Letting light pass through but also hiding the electronics from direct view.

3D Design

The top has indents for the pressure sensors and a smaller hole for the cables to pass through. As well as a bigger hole for the button. The top lies

on a ledge of the middle section. With a small nub on the middle section, the top aligns to the right direction [Figure 4].

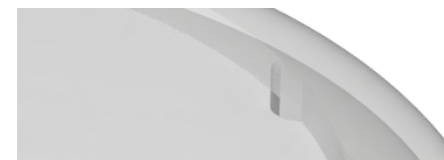


Figure 2 Closeup Nub

The middle section went through multiple changes throughout the design process. In the initial design the LED's were supposed to be separate, which needed different design solutions and created a greater challenge for the assembly as well as the programming. In the end a LED strip created the best solution for this problem. It can be braided through the mid-section [Figure 2] this fixates it in the right position and is easy to install.

The bottom section has small nubs made to hold the middle section in place so that it would not move around and stay in position [Figure 2]. In addition a lip and groove on the outside keeps both parts in position. Further it has a platform and an opening. The platform is meant for the installation of the button. While all the wiring passes through the opening into a cable box underneath the table. The design itself can be installed in the same opening as the Zens plug. The circular extrusion is meant to guide the Puk and fixate it in position.

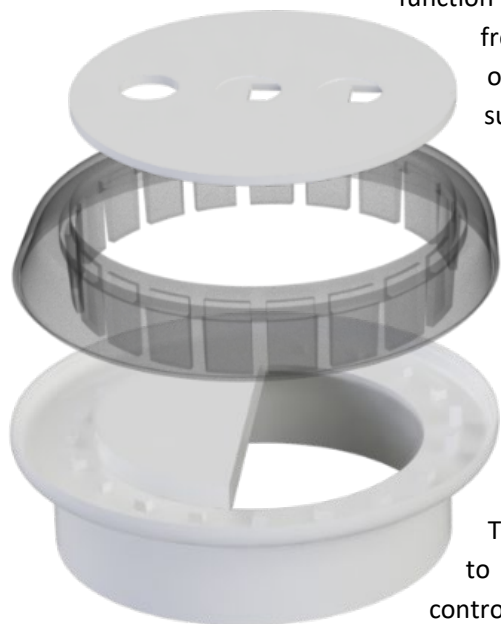


Figure 2 Assembly

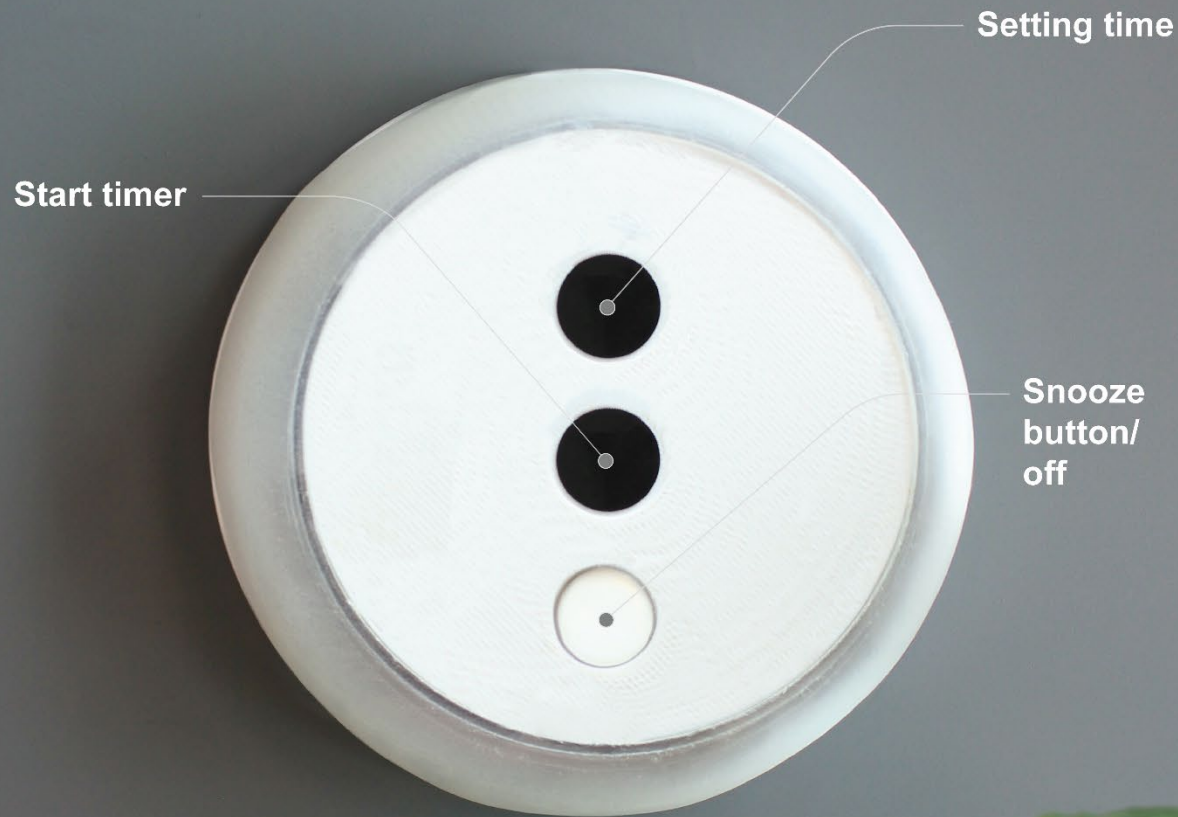


Figure 5 SitFit Puk

Function

In order to make the usage as simple as possible the device would automatically detect, if it is in a sitting or standing height so that the user has no additional actions. Further the device only has three “buttons” [Figure 5]. Two black force sensors and one standard button.

Since the target group was of varying age groups and could have different understandings of technology, it was a priority to make it simple enough to be explained without overloading the user with too much information. This led to the first two buttons. Two pressure sensors were used to separate the setting of the timer and the start of it. The first button allows the user to set the time for the timer. Each press lights up one of the 10 LED's on the side of the timer [Figure 6] with each of them representing 15 minutes. Meaning that if someone presses the button 3 times they set the timer for 45 minutes. In order to start the timer the button the middle button



Figure 6 setting timer

needs to be pressed. That way there was a failsafe preventing the table starting a timer on its own as well as allowing for the user to correct their mistakes. So that if the user gets distracted while setting a timer or any reason leaves the table after turning on some lights the timer will not start automatically. Further it allows the user to click through the lights to turn them off and only having to use one button. After turning on the 10th light the next press turns off the lights and allows to start from the beginning. Starting the timer turns off all the LED's but one and changes the colour of the light from blue to purple [Figure 6 & 7]. This signals that the timer is ongoing. Now the rest of the lights turn on in the percentage of the set time passing. Making it easy for the user to estimate on how long they sit or stand. The white button is specifically different from the others to make it easier for the user to distinguish that it has a different function from the other two. This button is the snooze/turn off button. By pushing it once it increases the timer by 15 minutes while running, the same happens with the second push and the third one turns off the timer. Allowing the user to have even more control and flexibility in their usage.

Technology

Creating the technology to test this design proved to be a challenge, but with some recommendations by other professionals, it was made possible.

Electronics

This device consists of three parts. Part 1 being the data visualization and interaction. This is the main part of the design as it involves the most interaction for the user in this research.

The buttons on the top are two force sensors chosen to be used since they are flat and simple to integrate into a flat surface. The third button is a standard push button. As mentioned previously the initial idea was to use separate LED lights for the visualization, but the suggestion to use a LED strip had more advantages. That way the same LED can be used for the different light colours as well as simplifying the coding of this design. To detect the height of the desk a distance sensor was attached. The whole design was controlled by an Arduino Nano [for reference see Figure 8].

The second part is the automatic desk change. By opening up the controls used to adjust the desk height and adding some cables to the buttons it was possible to control the table via the design. To make it save for the user relays were used to control the buttons and the whole construction as put on a separate power supply working on 5V.



Figure 7 Timer running

The last part was the Data collection. Initially an SD card was used to save the height and time data. But over the time of the user test the SD card failed multiple times changing the method to using a Wemos D1 mini that sends the data to Adafruit IO instead. The only data send is the height of the table and the platform shows the time when the data was received. In addition some participants were asked to self-report their standing and sitting time on paper.

This was to ensure the data collection worked properly and reducing lost data creating a mixed methods approach. In Figure 8 a simplified version of the circuit is visualized. Showing how the main parts of the circuit and how it was possible to control the table with the device.

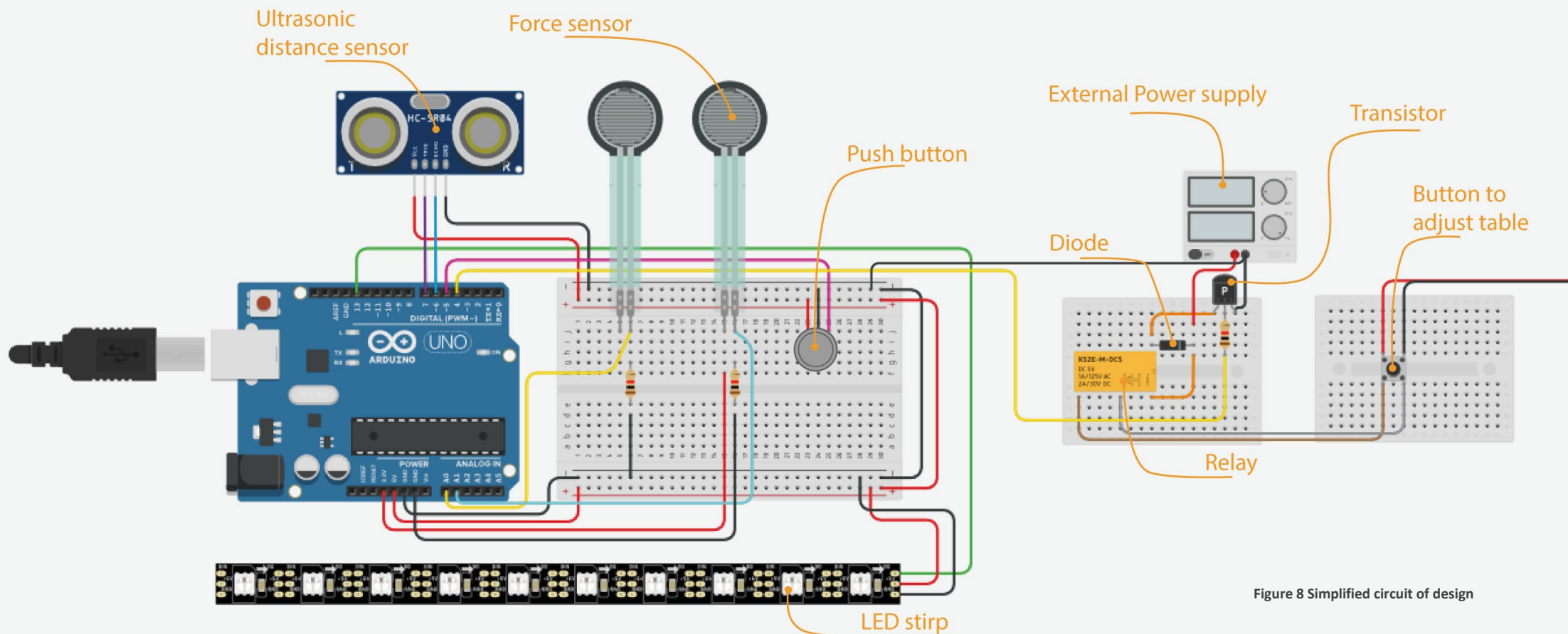


Figure 8 Simplified circuit of design



Methodology

For this research a research object will be deployed with users to gain more data about the realistic usage of the design and how it effects their behaviours.

Users

Participants consisted of various workers in the Office Vitality Hub on the High Tech Campus in Eindhoven. All of them are adult participants of varying ages and professions. In total an amount of 8 people participated after signing the consent form. The requirements for the participation were that they work at a sit stand desk and that each workday lasted for at least 3 hours.

Procedure

For the user test the participants needed to participate for 6 work days in total. The user test was split into two parts part 1 was the baseline test (3 days) and part 2 the deployment (3 days).

In the first part the participants were asked to work as usual as their sit and standing times were recorded. While collecting the data some participants were asked to self-report their sit and standing behaviour due to sensor malfunctions and availability of sensors, as well as for the case that the data collection via the sensor failed.

In the second part the design was deployed. This was again split into three parts where each day was used to test one of the different functions, planned sitting, planned standing and the mixed version. After each day the participants were asked to fill in a questionnaires [see Table 4-6 for questions] about their usage of the device.

Data analysis

After all the data was collected the questionnaire data was coded and thematically analysed. The sit stand data was split into baseline and deployment data as well as separating the deployment data by function. Creating a mixed method approach for the best results.

Results

The result section is divided into data collected from the sensor/self-report about the sit stand desk usage and the questionnaire part.

Sit Stand Desk Data

After collecting all the data and heights the data was simplified to sitting and standing time. Each interval was split into 30 minutes or less and 30 minutes or more. This was done to categorize it into short term sitting/standing. By categorizing the time to short and long term it is possible to see which interaction created shorter intervals to support mobility in the office. Allowing for a better comparison between each intervention

since the participation times varied for each day making it harder to compare the effects. This also relates to the guidelines which suggest to take a micro break after 20-30 minutes of sitting and to at least stand for 10 minutes after sitting for 2 hours[6]. Further the amounts of those were counted and how often they occur in a day as well as the average length of each interval was measured.

Pilot

The pilot was done by participant B234. Their data is included in the baseline and mixed intervention. The baseline was generated the same way as in the main test, the only difference being that they used only the mixed intervention in the second part and having a day in the baseline that was less than 3 hours due to malfunctions. Generating 3 days of mixed intervention data. In the pilot it was determined to switch to transferring the desk height to an online database.

The data showed an increase of 7% of standing time and increased the change of position by one on average.

Baseline

To create a baseline as mentioned above 3 days of working data was analysed [see Attachment A].

As a result an average participation of 5:27 hours (h) per day was determined of which 78% was spend sitting and 22% standing [see Table 1]. As well as an average of 2.5 changes of position changes.

The average duration spend in short term sitting being 6 Minutes (min) with 0.3 counts and 4:09h with 1.8 counts of long term sitting. For standing the short term was on average 13min with 0.6 counts and for the long term 58min with 0.9 counts. Meaning that people changed positions more often after sitting for a long time.

Planned Standing

For the planned standing an average of 5:13h, spending 73% sitting and 27% standing [see Table 1]. Showing a slight increase of +5% standing time in comparison to the baseline. On average 3.3 position changes were measured, 0.8 more than the baseline.

Short term sitting lasted on average 8min and long term sitting for 2:24h, with 0.4 appearances for short term and 1.9 for long term. Compared to the baseline short term sitting increased by 2 min and 0.1 counts and long term decreased by about 1:30h and increasing by 0.1 counts.

Short term standing lasting for 13min with 1 count on average and long term standing for 38 min with a count of 1.1 on average. In comparison

short term and long term standing stayed almost the same time wise, but the count increased for short term by 0.4 and for long term by 0.1.

The average use of the device was 3 times.

Planned Sitting

Participants participated on average 5:34h with this intervention. Spending 73% sitting and 27% standing [see Table 2]. This intervention showed the same difference in results as the planned standing intervention. However the amount of changes of position differed from the planned standing intervention being 3.3 to 4.3 for planned sitting. Overall increasing the position changes by 1.8 times compared to the baseline. Showing that the planned sitting intervention created more changes of position.

For the short term sitting the time on average was 9min with 0.6 counts and long term 1:34h and 2.4 counts.

Short term standing averaging 14min with 1.1 counts and long term standing with 38min and 1.4 counts too.

The device was used 3 times on average.

Mixed

This data includes the results of the pilot test. The data of the pilot test was averaged from 3 days mixed data to 1 average day [see Attachment A].

Type	Total time of test	Sitting	Standing	Change of position	percentile of day sitting	percentile of day standing	sitting <30min	sitting <30min times	sitting >30min	sitting >30min times	standing <30min	standing <30min times	standing >30min	standing >30min times	Device usage
Base per Day	05:27:28	04:15:33	01:11:55	2.46	78.04%	21.96%	00:06:05	0.25	04:09:27	1.79	00:13:20	0.63	00:58:35	0.88	
Standing intervention Average	05:13:00	03:50:09	01:22:51	3.29	72.66%	27.34%	00:08:26	0.43	02:24:13	1.86	00:13:26	1.00	00:58:39	1.00	2.71
	00:14:27	00:25:24	00:10:56	0.83	5.38%	5.38%	00:02:21	0.18	01:45:15	0.07	00:00:06	0.38	00:00:04	0.13	

Table 1 Base in comparison to standing intervention (green increase compared to base, red decrease and yellow neutral)

Type	Total time of test	Sitting	Standing	Change of position	percentile of day sitting	percentile of day standing	sitting <30min	sitting <30min times	sitting >30min	sitting >30min times	standing <30min	standing <30min times	standing >30min	standing >30min times	Device usage
Base per Day	05:27:28	04:15:33	01:11:55	2.46	78.04%	21.96%	00:06:05	0.25	04:09:27	1.79	00:13:20	0.63	00:58:35	0.88	
Sitting intervention Average	05:34:51	03:58:43	01:36:09	4.29	72.71%	27.29%	00:09:21	0.57	01:34:29	2.43	00:14:13	1.14	00:38:30	1.14	3.00
	00:07:24	00:16:50	00:24:14	1.83	5.33%	5.33%	00:03:16	0.32	02:34:59	0.64	00:00:53	0.52	00:20:05	0.27	

Table 2 Base in comparison to sitting intervention (green increase compared to base, red decrease and yellow neutral)

Type	Total time of test	Sitting	Standing	Change of position	percentile of day sitting	percentile of day standing	sitting <30min	sitting <30min times	sitting >30min	sitting >30min times	standing <30min	standing <30min times	standing >30min	standing >30min times	Device usage
Base per Day	05:27:28	04:15:33	01:11:55	2.46	78.04%	21.96%	00:06:05	0.25	04:09:27	1.79	00:13:20	0.63	00:58:35	0.88	
Mixed intervention Average	06:49:02	03:30:03	03:19:00	5.42	52.57%	47.43%	00:15:00	0.75	01:21:52	2.63	00:08:56	1.25	01:37:52	1.79	5.17
	01:21:35	00:45:30	02:07:05	2.96	25.46%	25.46%	00:08:55	0.50	02:47:35	0.83	00:04:24	0.63	00:39:17	0.92	

Table 3 Base in comparison to mixed intervention (green increase compared to base, red decrease and yellow neutral)

The mixed intervention lasted on average 6:49h and showed a proportion of 53% sitting and 47% standing [see Table 3]. Changing the proportions to almost equal amounts. Increasing the standing time by 25% compared to the baseline. At the same time it more than doubled the changes of position from 2.5 baseline to 5.4 with the intervention. Short term sitting increased from 6min base to 15min with 0.8 counts. Long term sitting decreased by 2:34h to 1:34h with the intervention as well as increasing the count by 0.8 to 2.6.

Short term standing reduced by 4min to 8min, but increased in counts by 0.6 to 1.3. At the same time long term standing increased by 39min to 1:37h as well as a doubling the count of the baseline to 1.8.

Questionnaire

For each day the intervention was used the participant was asked to fill in a questionnaire[see Attachment B for all answers]. Overall the questions were the same with slight adjustments fitting for each intervention [see Table 4-6].

Planned Standing

Q2

For 2 out of 7 participants there were no issues when using the device. 5 had troubles with the desk not going down, buttons not working for

Type	Question
Planned Standing	1. How often did you use the timer in the stand function (after the timer goes off the desk goes down)? (approximately)
	2. Did something not work? If yes please elaborate what.
	3. Was the intervention interrupting your workday? If so how?
	4. Do you think that you stood/sat more than before using the device? If so, please indicate how much more and why you think one or the other was more prominent.
	Standing more
	Sitting more
	5. Did you avoid using the device? Please elaborate why or why not?
6. For what purpose did you use the device? (For example time standing/sitting time, duration of a meeting, scheduling a break)	
7. Additional comments about the usage:	

Table 4 Questions Planned Standing

Type	Question
Planned Sitting	1. How often did you use the timer in the sit function (after the timer goes off the desk goes up)? (approximately)
	2. Did something not work? If yes please elaborate what.
	3. Was the intervention interrupting your workday? If so how?
	4. Do you think that you stood/sat more than before using the device? If so, please indicate how much more and why you think one or the other was more prominent.
	Standing more
	Sitting more
	5. Did you avoid using the device? Please elaborate why or why not?
6. For what purpose did you use the device? (For example time standing/sitting time, duration of a meeting, scheduling a break)	
7. Additional comments about the usage:	

Table 5 Questions Planned Sitting

changing the desk height and the table going further up instead of down.

Q3

None of the 7 participants thought of the device as interrupting. One participant mentioned that it did not feel like an intervention. While others thought of it as useful and a reminder to change position. Another participant thought of it as helpful to realize the passage of time, while another got used to it so well that they were able to time themselves to the change.

Q4

4 participants estimated that they stood more two that they sat more and one said that it was the same as usual. Compared to the baseline 3 out of the 4 that mentioned they stood more, but they sat more by a difference ranging from 6% to 26%. Only one assessed themselves right with an increase of 23%. For those that thought they sat more both actually stood more compared to their baseline from 27% to 41%. To mention here is that the participant with 41% had one extreme baseline day where they sat for 13 hours which could be the reason for the wrong assessment, since the other two days had less sitting time. The one reporting no changes actually sat more by 22%.

Type	Question
Mixed intervention	1. How often did you use the timer in the sit function (after the timer goes off the desk goes up)? (approximately)
	2. How often did you use the timer in the stand function (after the timer goes off the desk goes down)? (approximately)
	3. Did something not work? If yes please elaborate what.
	4. Was the intervention interrupting your workday? If so how?
	5. Did you perceive one function more interruptive than the other? If so which and why?
	6. Do you think that you stood/sat more than before using the device? If so, please indicate how much more and why you think one or the other was more prominent.
	Standing more
	Sitting more
	7. Did you avoid using the device? Please elaborate why or why not?
	8. For what purpose did you use the device? (For example time standing/sitting time, duration of a meeting, scheduling a break)
	9. Additional comments about the usage:

Table 6 Questions Mixed

Reasons for why participants thought one way or another besides the malfunctions were that one participant got motivated to stand more through the participation as well as another one mentioning the use of the device being a reason. While someone else chose after two malfunctions to set the timer for shorter time periods since they didn't feel like working standing up.

Q5

When asked if they avoided using the device 5 participants said no and two yes. Reasons to avoid using were that they didn't want to work standing up in the morning or that it was not natural to time their sitting and preferred to sit down when needed. Another mentioned that they forgot to use the device once they sat down.

Q6

The main purpose to use this device was to time standing (5 responses). Some used it to do a quick

ideation session as well as to do administrative work and one chose to use it to time when they wanted to sit.

Q7 and other comments throughout

For additional comments people mentioned that they thought it was easier to schedule since the period was personalized, easy to use and that it was surprisingly supporting and not interfering. Another comment was that it was useful, natural to use, that they liked using the device and that it made them more aware of standing being a good thing as well as making it easier for them to do so by creating a deadline.

Also one participant preferred the planned sitting function over the standing one. While another mentioned a lack of explanation that the desk would go up automatically and in which position the desk needs to be in. An interesting comment was that the device was not quite 'friendly' to have around.

Planned Sitting

Q2

For the planned sitting everything worked for 5 out of the 7 participants. One of the other two was not sure if something didn't work since they were not always sure if the timer was running. The other participant had a malfunction where the desk didn't go up.

Q3

6 participants did not experience the intervention as interrupting. One was not feeling like standing and thus preferred to have planned standing instead. Another comment was that one participant was surprised about the desk going up due to them not noticing the timer going off.

Q4

Again when asked if participants stood or sat more 4 answered stood more and 1 that they sat more. In comparison to the baseline only one actually stood more by 38% while the other 3 sat more, but only between 1% to 4% compared to their baseline. The participant answering that they sat more actually stood more by 5%. The other two chose neither out of those one stood 5% more while the other sat more by 7%.

Reasons for those assessments were that one normally had no access to a SSD and that they without the device would forget to change, if not actively encouraged/stimulated. One participant noted that when standing got uncomfortable, it was nice to be able to set a timer that would remind them to stand up so that they would not forget when they are focused.

Q5

6 out of 7 did not avoid using the device while one stated that when the desk was supposed to go up

and it didn't they just ignored it and continued to work sitting down.

Q6

As for the purpose the participants used it to plan when to stand up, for how long they wanted to sit or to not sit for too long and scheduling it as a signal for other events such as meetings or breaks. One participant did not like working standing up and went for walks instead.

Q7 and other comments throughout

Additional comments were that one participant felt more tired that day and thus did not stand as much. Mentioning that they preferred the planned standing to the planned sitting since they consider sitting their default working state. Another participant noted the same comment as for planned standing that it was very easy to use and that again that it was not a very friendly device to have around, but also that it was surprisingly not interfering and rather supportive. The next comment was that it was good to use, but scared them out of their concentration sometimes. However it was not too bad.

Other thoughts were that it was a nice reminder to stand and that they wouldn't have to think of standing up again. This was also confirmed by another participant thinking that it helped them to stay more vital with little issues and getting satisfaction of standing up every now and then.

Further comments were that it was motivating, another mentioned curiosity about the influence of the device on their day, further it was mentioned that it helped to keep up with their healthy routines as well as to stand up more and that it was easy to use.

Mixed

Q3

Out of 10 days in deployment 5 times there were no issues with the device. The other 5 times there were technical issues such as the desk not changing the position, the desk not changing to the correct height and the expectation that the timer would repeat itself after being set once as well as it being not clear if the timer was started or not.

Q4

For 5 participants the intervention was not interrupting their workday. The other 3 thought of it as a bit surprising/not noticing the lights flashing and that they now used the timer instead of the adjustment buttons creating a learning curve. Further comments were that it made their workday more pleasant or that it added to their workday. Comments about the flashing lights also included that even though they didn't notice them the change of the desk was slow enough to allow to adjust their position. Another one commented that even though it surprised them

sometimes this made them content and made them feel like they stood enough throughout the day as well as the interruptions creating inspiration.

Q5

As for which intervention (planned sitting or standing) was preferred, 4 participants had no preference, one thought the planned standing one was more interruptive, another thought that it was overall interruptive that the timer didn't set automatically and someone turned off the timer before it changed positions so they didn't experience any of them as an interruption and had no preference.

Q6

Overall 9 out of 10 days were perceived to have stood more than usual. The one that thought they sat more had actually a difference of less than 1% from their baseline, with it leaning more towards standing. Out of the 9 other days 3 of those were from the pilot test of which only two were on average longer standing times compared to the base with a total average of 7% more standing time. The rest of the 6 days were separate participants of which two were found to have stood less than compared to their baseline, this being less than 1% up to 2% while the others had a longer standing time of 20% to 79% compared to their baseline.

Comments included that the device acted as a reminder to stand with the desk moving up automatically, that the research itself motivated the participant to stand more and another noted that they prefer walking as a break instead of working standing up. Someone also noted that they think they stood more, but not in comparison to the use of the separate planned sitting and standing days. Interestingly they stood more compared to the other intervention days not significantly with the highest difference being 7%.

Q7

Out of the 10 reference days 6 were when participants did not avoid using the device. The other 4 had one which forgot to set a timer, while the other three had reasons such as the device not working properly, lack of attendance due to being away from desk and avoiding using it due to the pending interruption.

Q8

As for the usage participants commented with it being for planning sitting and standing time, with two focusing on standing time, another used it to refocus and not to sit for too long and one also used it to schedule breaks.

Q9 and other comments throughout

Additional comments included that it made it easier for participants to stand more due to the

deadline setting, that it is easy to use and that it added quality to the work life by reminding them to sit and stand.

A comment was made that the lights as an indicator for a set value were perceived as less overwhelming than setting a digital timer with numbers and having to make a specific decision on a specific number, making it according to them more accessible.

Criticism was mentioned about the brightness of the lights and that it was hard to notice when they start flashing indicating a position change. With one participant suggesting the implementation of a vibration in the desk.

Other comments repeated the deadline setting, it being a reminder to stand up, it being easy to handle, as well as repeating some previous statements and that adjusting the timing it to their preferences made it fine.

Thematic analysis

Here the comments of each questionnaire were analysed and categorized by topic [see Attachment B for the topics].

Topics Planned standing

From the positive comments about the device 4 topics were identified topic 1 being the useful category with words such as helpful, easy to use and supportive. Topic 2 was the reminder

category with words such as awareness and deadline. The next topic was motivation and the last topic being general with liking the device.

Negative comments had the topic of dislike and not handy. Not handy including comments about them preferring a different intervention for that day and not experiencing it as natural.

Topics Planned sitting

The positive topics in the planned sitting intervention were reminder, motivation, useful and general. Overall the reminder had the most comments with comments directed at pain relief through the reminder and less mental load. Motivation usefulness and general had mainly the same points as planned standing.

Negative topics were Unclear, where participants noted that they were not sure, if the timer was working or about the general functionality. Further the not handy topic had similar comments to before and a new topic the forgetting to set the timer was created

Topics Mixed

The mixed positive topics included reminder and motivation as well as useful with people adding it being pleasant inspiring and mentioning that the research was motivating to stand more. Other new comments mentioned conscious usage, the automatism and improving the quality of work.

Negative topics were again unclear, forgetting to set a timer and not handy. New comments were about the confusion that the timer didn't repeat itself automatically, pending interruption, less usage due to absence, the lights being too dim and the positioning of the start of the light being not in a handy spot.

Discussion

At the beginning of this research three questions were defined:

- Can the intervention design promote more vital behaviour actions in comparison to the existing design?
- Planned sitting or planned standing which is less interruptive throughout the workday?
- Which intervention creates more standing time/more change of position?

In the context of this research the answer for the first question would be yes compared to the baseline working at desks with the Zens pug there are more changes of position and a decrease of sitting time with an increase of standing time. However it was noted multiple times that the participation and the design itself motivated participants to get up more. Indicating a novelty effect which needs to be studied over a longer

time period for more stable results and clearer indications.

The next question did not have a definitive answer as both functions were perceived as equal and only one having a preference for the planned sitting intervention.

As for which intervention created more standing time and change of position it was surprising that the planned sitting and standing interventions created similar results. With the surprise of the Mixed intervention working the best. Again this is in the context of this study and needs to be tested long term to have definitive answers.

The baseline showed an average of 2.46 changes of position per day which is slightly elevated to a statement of a different study[2]. With a proportion of 77% sitting and 23% standing proportion.

To summarise the results, overall the biggest difference in results between sitting and standing time was achieved by the mixed intervention. Creating an average of 53% sitting and 47% standing time as well as 5.4 changes of position per day.

Further there was also no clear preference for one of the two functions as well as no definite indication that any function, was more interrupting than the other.

Interestingly both functions separately had the same distribution between sitting and standing time. The main difference being that there were more changes of position as well as a different distribution of the sitting and standing intervals with planned sitting.

The Sitting intervention reduced long term sitting significantly on average by 2:34h to just 1:34h as well as long term standing by 20 min to 38min. In comparison the planned standing intervention did not have an effect on anything besides long term sitting which was reduced by 1:45h to 2:24h.

This shows that planned sitting in the context of this experiment encourages shorter instances spend prolonged sitting or standing. While planned standing also reduces the sitting time, it does not have a significant difference compared to the other values in comparison to planned sitting. Resulting in the question why is it that in combination the effect is so strong? Various reasons could have led to this effect.

A theory would be that some participants overall reacted more to one intervention than the other and that when it was possible to use both functions it improved the overall data. Another possible reason could be timing as some reported to prefer one function over another for a certain day. As well as forgetting to use the function when doing the planned sitting and standing

interventions since the in between time needs to be monitored by the participant. In reverse the participant could exchange their responsibility to remember the change by setting a timer for both intervals in the mixed intervention and thus reducing their mental load.

The main topics found in the data were: Useful, Reminder, General, Motivation, Dislike, Not handy, Unclear and Forgot to set timer. Overall the main feedback was positive about how it is useful by reminding the user as well as motivating them to change positions more. The Dislike and not handy topics main points were about the device being not 'friendly' to have and about the preference for a different function for the planned sitting and standing Questionnaires. Further it also included comments about the lights being not bright enough making user not notice the flashing and the lights starting at the back making it hard to see, if the timer was started or how many lights were on.

Another special comment was that a participant thought that having the lights with fixed intervals a better solution than choosing and setting a number by themselves. Making the choice less overwhelming and more accessible.

Thus for the future evolution of this design it is important to reconsider these comments with special focus on the position of the lights as well

as the prompt informing the user about the future desk change. A suggestion by a user was the implementation of vibrations in the desk when the desk is about to change. This could be a great solution since it does not require the participant to look up and pay attention to something outside of their visual field.

Further the usage of the intervention varied from wanting to stand more, to using it to time administrative work, using it for an ideation session and to plan it around breaks and meetings. Opening up the possibility to further research possible application implementations. Since this study only included 3 days with each being a different type of intervention there is room to speculate that there could be more possible functionalities. The intervention by Bakker Elkhuisen [13] already suggest different usages and interventions in combination with the personalization. However, since their design is extremely personalized it hinders the anonymous personalized functionality. This is where this design has its strong points in being personalized easily accessible and anonymous. Further in the research used as a base for their design the interventions were

Conclusion

In general all interventions were perceived positively with it being perceived as motivating and useful as well as a good reminder to stand up or for how long one would sit down.

The data showed no differences in the sitting and standing time between the two functions on their own. But does show differences in the time proportion of the sitting and standing bouts as well as the counts of position changes. In addition, the mixed intervention where both functions could be used at the same time did show a significant change in sitting and standing behaviour. Opening room for speculation and research as to why the combination created such a big difference.

Further the automatic change of the desk was not perceived as interrupting by the majority of participants. There was also no conclusive answer on a preference rather that people perceived both as equal.

Overall the experiment was limited in time and needs longer time intervals of testing to make definitive conclusions. For now this is just an indication on how this function could be perceived in the future.

Bibliography

- [1] L. R. Renaud, M. A. Huysmans, H. P. van der Ploeg, E. M. Speklé, and A. J. van der Beek, 'Natural Patterns of Sitting, Standing and Stepping During and Outside Work-Differences between Habitual Users and Non-Users of Sit-Stand Workstations', *Int J Environ Res Public Health*, vol. 17, no. 11, p. 4075, Jun. 2020, doi: 10.3390/ijerph17114075.
- [2] M. A. Mazzotta, K. Ferrar, F. Fraysse, L. K. Lewis, and M. McEvoy, 'Usage of Sit-Stand Workstations and Associations Between Work and Nonwork Sitting Time: An Observational Study', *J Occup Environ Med*, vol. 60, no. 5, pp. e268–e272, May 2018, doi: 10.1097/JOM.0000000000001252.
- [3] A. L. Gremaud *et al.*, 'Gamifying Accelerometer Use Increases Physical Activity Levels of Sedentary Office Workers', *JAHA*, vol. 7, no. 13, p. e007735, Jul. 2018, doi: 10.1161/JAHA.117.007735.
- [4] 'History of Office Design | From the 1700's to Today | K2 Space', *K2space*, May 10, 2017. <https://k2space.co.uk/knowledge/history-of-office-design/> (accessed Jun. 28, 2023).
- [5] 'Ahrend. Vitalisierung von Arbeitsbereichen'. <https://www.ahrend.com/de/> (accessed Jun. 28, 2023).
- [6] N. de Langen, 'Promoting moving and exercise at work to avoid prolonged standing and sitting - OSHwiki | European Agency for Safety and Health at Work', Apr. 28, 2020. <https://oshwiki.osha.europa.eu/en/theme/s/promoting-moving-and-exercise-work-avoid-prolonged-standing-and-sitting> (accessed Jun. 07, 2023).
- [7] T. Torbeyns, S. Bailey, I. Bos, and R. Meeusen, 'Active workstations to fight sedentary behaviour', *Sports Med*, vol. 44, no. 9, pp. 1261–1273, Sep. 2014, doi: 10.1007/s40279-014-0202-x.
- [8] A. J. Chambers, M. M. Robertson, and N. A. Baker, 'The effect of sit-stand desks on office worker behavioral and health outcomes: A scoping review', *Applied Ergonomics*, vol. 78, pp. 37–53, Jul. 2019, doi: 10.1016/j.apergo.2019.01.015.
- [9] E. Nelson-Wong *et al.*, 'Office-workers maintain decreased workplace sitting time long-term following participation in a sit-stand desk intervention study', *Ergonomics*, vol. 65, no. 6, pp. 857–865, Jun. 2022, doi: 10.1080/00140139.2021.1998647.
- [10] 'Silence Meet | Bringt Stille zurück an Ihren Arbeitsplatz'. <https://www.ahrend.com/de/produkte/space-in-space-losungen/silence-collection2/silence-meet/> (accessed Jun. 28, 2023).
- [11] G. Garrett *et al.*, 'Computer-based Prompt's impact on postural variability and sit-stand desk usage behavior; a cluster randomized control trial', *Applied Ergonomics*, vol. 79, pp. 17–24, Sep. 2019, doi: 10.1016/j.apergo.2019.04.003.
- [12] D. F. Barbieri *et al.*, 'Sit-Stand Tables With Semi-Automated Position Changes: A New Interactive Approach for Reducing Sitting in Office Work', *IIEE Transactions on Occupational Ergonomics and Human Factors*, vol. 5, no. 1, pp. 39–46, Jan. 2017, doi: 10.1080/24725838.2016.1259191.
- [13] 'BakkerElkhuizen | High-quality workspace solutions'. <https://www.bakkerelkhuizen.nl/> (accessed Jul. 04, 2023).
- [14] H. Daneshmandi, A. Choobineh, H. Ghaem, and M. Karimi, 'Adverse Effects of Prolonged Sitting Behavior on the General Health of Office Workers', *J Lifestyle Med*, vol. 7, no. 2, pp. 69–75, Jul. 2017, doi: 10.15280/jlm.2017.7.2.69.
- [15] U. Ekelund *et al.*, 'Dose-response associations between accelerometry measured physical activity and sedentary time and all cause mortality: systematic review and harmonised meta-analysis', *BMJ*, vol. 366, Aug. 2019, doi: 10.1136/bmj.l4570.
- [16] A. J. Pinto *et al.*, 'The Physiology of Sedentary Behavior', *Physiol Rev*, Jun. 2023, doi: 10.1152/physrev.00022.2022.
- [17] N. de Langen and K. Peereboom, 'Musculoskeletal disorders and prolonged static standing', *OSHWIKI Networking Knowledge*, May 04, 2020. <https://oshwiki.osha.europa.eu/en/theme/s/musculoskeletal-disorders-and-prolonged-static-standing> (accessed Jun. 26, 2023).

- [18] P. M. King, 'A comparison of the effects of floor mats and shoe in-soles on standing fatigue', *Applied Ergonomics*, vol. 33, no. 5, pp. 477–484, Sep. 2002, doi: 10.1016/S0003-6870(02)00027-3.
- [19] B. M. F. M. Duvivier *et al.*, 'Minimal Intensity Physical Activity (Standing and Walking) of Longer Duration Improves Insulin Action and Plasma Lipids More than Shorter Periods of Moderate to Vigorous Exercise (Cycling) in Sedentary Subjects When Energy Expenditure Is Comparable', *PLOS ONE*, vol. 8, no. 2, p. e55542, Feb. 2013, doi: 10.1371/journal.pone.0055542.
- [20] N. Shrestha, K. T. Kukkonen-Harjula, J. H. Verbeek, S. Ijaz, V. Hermans, and Z. Pedisic, 'Workplace interventions for reducing sitting at work', *Cochrane Database of Systematic Reviews*, Jun. 2018, doi: 10.1002/14651858.CD010912.pub4.
- [21] J. Y. Chau *et al.*, 'The effectiveness of sit-stand workstations for changing office workers' sitting time: results from the Stand@Work randomized controlled trial pilot', *Int J Behav Nutr Phys Act*, vol. 11, p. 127, Oct. 2014, doi: 10.1186/s12966-014-0127-7.

Attachment A

Tables:

Table 7 Baseline Total times and amounts by participant

Participant	Total time of test	Sitting	Standing	Change of position	percentile of day sitting	percentile of day standing	sitting <30min	sitting <30min times	sitting >30min	sitting >30min times	standing <30min	standing <30min times	standing >30min	standing >30min times
A1234	18:57:00	14:30:00	04:27:00	18.00	76.52%	23.48%	00:19:00	1.00	14:11:00	11.00	01:52:00	5.00	02:35:00	4.00
B2345	11:18:00	08:30:00	02:48:00	4.00	75.22%	24.78%	00:00:00	0.00	08:30:00	4.00	00:30:00	1.00	02:18:00	2.00
C3456	17:38:00	17:38:00	00:00:00	0.00	100.00%	0.00%	00:00:00	0.00	17:38:00	3.00	00:00:00	0.00	00:00:00	0.00
D4567	18:09:00	09:10:00	08:59:00	10.00	50.51%	49.49%	00:30:00	1.00	08:40:00	6.00	00:55:00	2.00	08:04:00	5.00
F6789	15:08:00	11:32:00	03:36:00	8.00	76.21%	23.79%	00:00:00	0.00	11:32:00	8.00	00:20:00	1.00	03:16:00	3.00
G1235	02:00:00	00:00:00	02:00:00	2.00	92.31%	7.69%	00:00:00	0.00	00:00:00	3.00	00:30:00	1.00	01:30:00	1.00
H2346	11:41:00	06:41:00	05:00:00	8.00	57.20%	42.80%	00:41:00	2.00	06:00:00	3.00	00:32:00	2.00	04:28:00	4.00
J3457	12:08:00	10:12:00	01:56:00	9.00	84.07%	15.93%	00:56:00	2.00	09:16:00	5.00	00:41:00	3.00	01:15:00	2.00
Total	10:59:00	06:13:00	04:46:00	59.00	78.04%	21.96%	02:26:00	6.00	03:47:00	43.00	05:20:00	15.00	23:26:00	21.00
Average	16:22:23	12:46:37	03:35:45	7.38	76.50%	23.50%	00:18:15	0.75	12:28:23	5.38	00:29:43	1.88	02:55:45	2.63
Per Day	05:27:28	04:15:33	01:11:55	2.46	78.04%	21.96%	00:06:05	0.25	04:09:27	1.79	00:13:20	0.63	00:58:35	0.88

Table 8 Standing intervention total times and amounts

Participant	Total time of test	Sitting	Standing	Change of position	percentile of day sitting	percentile of day standing	sitting <30min	sitting <30min times	sitting >30min	sitting >30min times	standing <30min	standing <30min times	standing >30min	standing >30min times	Device usage
A1234	07:20:00	06:10:00	01:10:00	6.00	84.09%	15.91%	00:00:00	0.00	01:32:30	4.00	00:18:00	2.00	00:34:00	1.00	4.00
C3456	05:40:00	04:07:00	01:33:00	3.00	72.65%	27.35%	00:08:00	1.00	03:59:00	1.00	00:20:00	1.00	01:13:00	1.00	3.00
D4567	05:45:00	04:28:00	01:17:00	3.00	77.68%	22.32%	00:00:00	0.00	02:14:00	2.00	00:00:00	0.00	00:38:30	2.00	2.00
F6789	04:00:00	03:22:00	00:38:00	4.00	84.17%	15.83%	00:30:00	1.00	01:26:00	2.00	00:19:00	2.00	00:00:00	0.00	2.00
G1235	05:29:00	02:34:00	02:55:00	1.00	46.81%	53.19%	00:00:00	0.00	02:34:00	1.00	00:00:00	0.00	02:55:00	1.00	2.00
H2346	05:15:00	04:19:00	00:56:00	2.00	82.22%	17.78%	00:00:00	0.00	04:19:00	1.00	00:11:00	1.00	00:45:00	1.00	3.00
J3457	03:02:00	01:51:00	01:11:00	4.00	60.99%	39.01%	00:21:00	1.00	00:45:00	2.00	00:26:00	1.00	00:45:00	1.00	3.00
Total	12:31:00	02:51:00	09:40:00	23.00	73.53%	26.47%	00:59:00	3.00	16:49:30	13.00	01:34:00	7.00	06:50:30	7.00	19.00
Average	05:13:00	03:50:09	01:22:51	3.29	72.66%	27.34%	00:08:26	0.43	02:24:13	1.86	00:13:26	1.00	00:58:39	1.00	2.71

Table 9 Sitting intervention total times and amounts

Participant	Total time of test	Sitting	Standing	Change of position	percentile of day sitting	percentile of day standing	sitting <30min	sitting <30min times	sitting >30min	sitting >30min times	standing <30min	standing <30min times	standing >30min	standing >30min times	Device usage
A1234	04:00:00	03:12:00	00:48:00	4.00	80.00%	20.00%	00:00:00	0.00	01:04:00	3.00	00:24:00	2.00	00:00:00	0.00	2.00
C3456	06:27:00	04:00:00	02:27:00	4.00	62.02%	37.98%	00:00:00	0.00	01:20:00	3.00	00:00:00	0.00	01:13:30	2.00	2.50
D4567	03:42:00	01:51:00	01:51:00	5.00	50.00%	50.00%	00:16:00	1.00	00:47:30	2.00	00:10:00	1.00	00:50:30	2.00	3.00
F6789	07:10:00	05:40:00	01:30:00	5.00	79.07%	20.93%	00:00:00	0.00	01:53:20	3.00	00:01:00	1.00	00:44:30	2.00	3.00
G1235	05:49:00	05:23:00	00:26:00	2.00	92.55%	7.45%	00:00:00	0.00	02:41:30	2.00	00:26:00	1.00	00:00:00	0.00	3.00
H2346	08:52:00	05:02:00	03:50:00	6.00	56.77%	43.23%	00:25:30	2.00	02:05:30	2.00	00:28:00	1.00	01:41:00	2.00	3.50
J3457	03:04:00	02:43:00	00:21:00	4.00	88.59%	11.41%	00:24:00	1.00	01:09:30	2.00	00:10:30	2.00	00:00:00	0.00	4.00
Total	15:04:00	03:51:00	11:13:00	30.00	71.29%	28.71%	01:05:30	4.00	11:01:20	17.00	01:39:30	8.00	04:29:30	8.00	21.00
Average	05:34:51	03:58:43	01:36:09	4.29	72.71%	27.29%	00:09:21	0.57	01:34:29	2.43	00:14:13	1.14	00:38:30	1.14	3.00

Table 10 Mixed intervention total times and amounts (B2345 divided by 3 since they only used the mixed function for 3 days)

Participant	Total time of test	Sitting	Standing	Change of position	percentile of day sitting	percentile of day standing	sitting <30min	sitting <30min times	sitting >30min	sitting >30min times	standing <30min	standing <30min times	standing >30min	standing >30min times	Device usage
A1234	09:05:00	07:07:00	01:58:00	9.00	78.35%	21.65%	00:00:00	0.00	01:25:24	5.00	00:19:30	4.00	00:40:00	1.00	8.00
B2345	03:53:20	02:49:20	01:04:00	2.33	72.57%	27.43%	00:00:00	0.00	02:49:20	2.00	00:00:00	0.00	01:04:00	1.33	2.67
C3456	06:27:00	03:01:00	03:26:00	7.00	46.77%	53.23%	00:06:00	1.00	00:58:20	3.00	00:08:00	3.00	03:02:00	1.00	5.00
D4567	06:30:00	03:35:00	02:55:00	4.00	55.13%	44.87%	00:25:00	1.00	01:35:00	2.00	00:00:00	0.00	01:27:30	2.00	3.00
F6789	07:30:00	05:46:00	01:44:00	6.00	76.89%	23.11%	00:26:00	1.00	01:46:40	3.00	00:29:00	2.00	00:46:00	1.00	3.50
G1235	08:01:00	00:41:00	07:20:00	3.00	8.52%	91.48%	00:09:00	1.00	00:32:00	1.00	00:00:00	0.00	03:40:00	2.00	8.00
H2346	09:50:00	03:29:00	06:21:00	9.00	35.42%	64.58%	00:24:00	1.00	00:46:15	4.00	00:15:00	1.00	01:31:30	4.00	?
J3457	03:16:00	01:32:00	01:44:00	3.00	46.94%	53.06%	00:30:00	1.00	01:02:00	1.00	00:00:00	0.00	00:52:00	2.00	6.00
Total	06:32:20	04:00:20	02:32:00	43.33	51.35%	48.65%	02:00:00	6.00	10:54:59	21.00	01:11:30	10.00	13:03:00	14.33	36.17
Average	06:49:02	03:30:03	03:19:00	5.42	52.57%	47.43%	00:15:00	0.75	01:21:52	2.63	00:08:56	1.25	01:37:52	1.79	5.17

Base

Participant	Type	Kind	Total time of test			Change of position	percentile of day		sitting <30min
			Sitting	Standing			sitting	standing	
A1234	Base	Total	18:57:00	14:30:00	04:27:00	18.00	76.52%	23.48%	00:19:00
B2345	Base	Total	11:18:00	08:30:00	02:48:00	4.00	75.22%	24.78%	00:00:00
C3456	Base	Total	17:38:00	17:38:00	00:00:00	0.00	100.00%	0.00%	00:00:00
D4567	Base	Total	18:09:00	09:10:00	08:59:00	10.00	50.51%	49.49%	00:30:00
F6789	Base	Total	15:08:00	11:32:00	03:36:00	8.00	76.21%	23.79%	00:00:00
G1235	Base	Total	02:00:00	00:00:00	02:00:00	2.00	92.31%	7.69%	00:00:00
H2346	Base	Total	11:41:00	06:41:00	05:00:00	8.00	57.20%	42.80%	00:41:00
J3457	Base	Total	12:08:00	10:12:00	01:56:00	9.00	84.07%	15.93%	00:56:00
		Total	10:59:00	06:13:00	04:46:00	59.00	78.04%	21.96%	02:26:00
		Average	16:22:23	12:46:37	03:35:45	7.38	77%	23%	00:18:15
		Per Day	05:27:28	04:15:33	01:11:55	2.46	78.04%	21.96%	00:06:05

Intervention

Participant	Type	Kind	Total time of test			Change of position	percentile of day		sitting <30min
			Sitting	Standing			sitting	standing	
A1234	Standing intervention	Total	07:20:00	06:10:00	01:10:00	6.00	84.09%	15.91%	00:00:00
C3456	Standing intervention	Total	05:40:00	04:07:00	01:33:00	3.00	72.65%	27.35%	00:08:00
D4567	Standing intervention	Total	05:45:00	04:28:00	01:17:00	3.00	77.68%	22.32%	00:00:00
F6789	Standing intervention	Total	04:00:00	03:22:00	00:38:00	4.00	84.17%	15.83%	00:30:00
G1235	Standing intervention	Total	05:29:00	02:34:00	02:55:00	1.00	46.81%	53.19%	00:00:00
H2346	Standing intervention	Total	05:15:00	04:19:00	00:56:00	2.00	82.22%	17.78%	00:00:00
J3457	Standing intervention	Total	03:02:00	01:51:00	01:11:00	4.00	60.99%	39.01%	00:21:00
		Total	12:31:00	02:51:00	09:40:00	23.00	73.53%	26.47%	00:59:00
		Average	05:13:00	03:50:09	01:22:51	3.29	72.66%	27.34%	00:08:26

Standing intervention in comparrison with base

Type	Total time of test	Sitting	Standing	Change of position	percentile of day sitting	percentile of day standing	sitting <30min	sitting <30min times	sitting >30min
Per Day	05:27:28	04:15:33	01:11:55	2.46	78.04%	21.96%	00:06:05	0.25	04:09:27
Average	05:13:00	03:50:09	01:22:51	3.29	72.66%	27.34%	00:08:26	0.43	02:24:13
	00:14:27	00:25:24	00:10:56	0.83	5.38%	5.38%	00:02:21	0.18	01:45:15

Participant	Type	Kind	Total time of test			Change of position	percentile of day		sitting <30min
			Sitting	Standing			sitting	standing	
A1234	Sitting Intervention	Total	04:00:00	03:12:00	00:48:00	4.00	80.00%	20.00%	00:00:00
C3456	Sitting Intervention	Total	06:27:00	04:00:00	02:27:00	4.00	62.02%	37.98%	00:00:00
D4567	Sitting Intervention	Total	03:42:00	01:51:00	01:51:00	5.00	50.00%	50.00%	00:16:00
F6789	Sitting Intervention	Total	07:10:00	05:40:00	01:30:00	5.00	79.07%	20.93%	00:00:00
G1235	Sitting Intervention	Total	05:49:00	05:23:00	00:26:00	2.00	92.55%	7.45%	00:00:00
H2346	Sitting Intervention	Total	08:52:00	05:02:00	03:50:00	6.00	56.77%	43.23%	00:25:30
J3457	Sitting Intervention	Total	03:04:00	02:43:00	00:21:00	4.00	88.59%	11.41%	00:24:00
		Total	15:04:00	03:51:00	11:13:00	30.00	71.29%	28.71%	01:05:30
		Average	05:34:51	03:58:43	01:36:09	4.29	72.71%	27.29%	00:09:21

Sittng intervention in comparrison with base

Type	Total time of test	Sitting	Standing	Change of position	percentile of day sitting	percentile of day standing	sitting <30min	sitting <30min times	sitting >30min
Per Day	05:27:28	04:15:33	01:11:55	2.46	78.04%	21.96%	00:06:05	0.25	04:09:27
Average	05:34:51	03:58:43	01:36:09	4.29	72.71%	27.29%	00:09:21	0.57	01:34:29
	00:07:24	00:16:50	00:24:14	1.83	5.33%	5.33%	00:03:16	0.32	02:34:59

Participant	Type	Kind	Total time of test			Change of position	percentile of day		sitting <30min
			Sitting	Standing	Change of position		sitting	standing	
A1234	Mixed Intervention	Total	09:05:00	07:07:00	01:58:00	9.00	78.35%	21.65%	00:00:00
B2345	Mixed Intervention	Total/3	03:53:20	02:49:20	01:04:00	2.33	72.57%	27.43%	00:00:00
C3456	Mixed Intervention	Total	06:27:00	03:01:00	03:26:00	7.00	46.77%	53.23%	00:06:00
D4567	Mixed Intervention	Total	06:30:00	03:35:00	02:55:00	4.00	55.13%	44.87%	00:25:00
F6789	Mixed Intervention	Total	07:30:00	05:46:00	01:44:00	6.00	76.89%	23.11%	00:26:00
G1235	Mixed Intervention	Total	08:01:00	00:41:00	07:20:00	3.00	8.52%	91.48%	00:09:00
H2346	Mixed Intervention	Total	09:50:00	03:29:00	06:21:00	9.00	35.42%	64.58%	00:24:00
J3457	Mixed Intervention	Total	03:16:00	01:32:00	01:44:00	3.00	46.94%	53.06%	00:30:00
Total			06:32:20	04:00:20	02:32:00	43.33	51.35%	48.65%	02:00:00
Average			06:49:02	03:30:03	03:19:00	5.42	52.57%	47.43%	00:15:00

Mixed intervention in comparrison with base

Type	Total time of test	Sitting	Standing	Change of position	percentile of day sitting	percentile of day standing	sitting <30min	sitting <30min times	sitting >30min
Per Day	05:27:28	04:15:33	01:11:55	2.46	78.04%	21.96%	00:06:05	0.25	04:09:27
Average	06:49:02	03:30:03	03:19:00	5.42	52.57%	47.43%	00:15:00	0.75	01:21:52
	01:21:35	00:45:30	02:07:05	2.96	25.46%	25.46%	00:08:55	0.50	02:47:35

sitting <30min times	sitting >30min	sitting >30min times	standing <30min	standing <30min times	standing >30min	standing >30min times
1.00	14:11:00	11.00	01:52:00	5.00	02:35:00	4.00
0.00	08:30:00	4.00	00:30:00	1.00	02:18:00	2.00
0.00	17:38:00	3.00	00:00:00	0.00	00:00:00	0.00
1.00	08:40:00	6.00	00:55:00	2.00	08:04:00	5.00
0.00	11:32:00	8.00	00:20:00	1.00	03:16:00	3.00
0.00	00:00:00	3.00	00:30:00	1.00	01:30:00	1.00
2.00	06:00:00	3.00	00:32:00	2.00	04:28:00	4.00
2.00	09:16:00	5.00	00:41:00	3.00	01:15:00	2.00
6.00	03:47:00	43.00	05:20:00	15.00	23:26:00	21.00
0.75	12:28:23	5.38	00:29:43	1.88	02:55:45	2.63
0.25	04:09:27	1.79	00:13:20	0.63	00:58:35	0.88

sitting <30min times	sitting >30min	sitting >30min times	standing <30min	standing <30min times	standing >30min	standing >30min times	Device uage
0.00	01:32:30	4.00	00:18:00	2.00	00:34:00	1.00	4.00
1.00	03:59:00	1.00	00:20:00	1.00	01:13:00	1.00	3.00
0.00	02:14:00	2.00	00:00:00	0.00	00:38:30	2.00	2.00
1.00	01:26:00	2.00	00:19:00	2.00	00:00:00	0.00	2.00
0.00	02:34:00	1.00	00:00:00	0.00	02:55:00	1.00	2.00
0.00	04:19:00	1.00	00:11:00	1.00	00:45:00	1.00	3.00
1.00	00:45:00	2.00	00:26:00	1.00	00:45:00	1.00	3.00
3.00	16:49:30	13.00	01:34:00	7.00	06:50:30	7.00	19.00
0.43	02:24:13	1.86	00:13:26	1.00	00:58:39	1.00	2.71

sitting >30min times	standing <30min	standing <30min times	standing >30min	standing >30min times	Device uage
1.79	00:13:20	0.63	00:58:35	0.88	
1.86	00:13:26	1.00	00:58:39	1.00	2.71
0.07	00:00:06	0.38	00:00:04	0.13	

sitting <30min times	sitting >30min	sitting >30min times	standing <30min	standing <30min times	standing >30min	standing >30min times	Device uage
0.00	01:04:00	3.00	00:24:00	2.00	00:00:00	0.00	2.00
0.00	01:20:00	3.00	00:00:00	0.00	01:13:30	2.00	2.50
1.00	00:47:30	2.00	00:10:00	1.00	00:50:30	2.00	3.00
0.00	01:53:20	3.00	00:01:00	1.00	00:44:30	2.00	3.00
0.00	02:41:30	2.00	00:26:00	1.00	00:00:00	0.00	3.00
2.00	02:05:30	2.00	00:28:00	1.00	01:41:00	2.00	3.50
1.00	01:09:30	2.00	00:10:30	2.00	00:00:00	0.00	4.00
4.00	11:01:20	17.00	01:39:30	8.00	04:29:30	8.00	21.00
0.57	01:34:29	2.43	00:14:13	1.14	00:38:30	1.14	3.00

sitting >30min times	standing <30min	standing <30min times	standing >30min	standing >30min times	Device uage
1.79	00:13:20	0.63	00:58:35	0.88	
2.43	00:14:13	1.14	00:38:30	1.14	3.00
0.64	00:00:53	0.52	00:20:05	0.27	

sitting <30min times	sitting >30min	sitting >30min times	standing <30min	standing <30min times	standing >30min	standing >30min times	Devicce uage
0.00	01:25:24	5.00	00:19:30	4.00	00:40:00	1.00	8.00
0.00	02:49:20	2.00	00:00:00	0.00	01:04:00	1.33	2.67
1.00	00:58:20	3.00	00:08:00	3.00	03:02:00	1.00	5.00
1.00	01:35:00	2.00	00:00:00	0.00	01:27:30	2.00	3.00
1.00	01:46:40	3.00	00:29:00	2.00	00:46:00	1.00	3.50
1.00	00:32:00	1.00	00:00:00	0.00	03:40:00	2.00	8.00
1.00	00:46:15	4.00	00:15:00	1.00	01:31:30	4.00 ?	
1.00	01:02:00	1.00	00:00:00	0.00	00:52:00	2.00	6.00
6.00	10:54:59	21.00	01:11:30	10.00	13:03:00	14.33	36.17
0.75	01:21:52	2.63	00:08:56	1.25	01:37:52	1.79	5.17

sitting >30min times	standing <30min	standing <30min times	standing >30min	standing >30min times	Devicce uage
1.79	00:13:20	0.63	00:58:35	0.88	
2.63	00:08:56	1.25	01:37:52	1.79	5.17
0.83	00:04:24	0.63	00:39:17	0.92	

Attachment B

Questionnaire data

Planned Standing

"1. How often did you use the timer in the stand function (after the timer goes off the desk goes down)? (approximately)"

4 times

3 (?)

2 times

Twice within a ~4 hour workday. The first time for 30 minutes and the second time for 15 minutes. (2)

stood all day (2)

3x

3 times

Total	19
-------	----

"2. Did something not work? If yes please elaborate what. "

The first time I used the timer, the desk did not go down. There was a problem with the sensor.

The last 2 times I used the timer, the desk didn't go down

No it worked

The up and down button did not work for a moment because I pressed the down button myself (before the desk went automatically down).

Everything worked

The table went up instead of down when it was time to sit

First time it went up two centimetres since it was already up, while it was supposed to go down.

Did not work	5
Everything Worked	2
Desk did not go down	2
Button didn't work	1
Table went up instead	2

"3. Was the intervention interrupting your workday? If so how? "

No, I was controlling the timer myself so it did not feel like an intervention.

No, because it didn't go down 🤔

No

It was not interrupting my workday.

Did not interrupt

It was very useful to be reminded to change position, it helped me to realize that time has lapsed.

Not really, this far in I was getting used to it and almost timed it as to when it would almost go down.

No	7
Did not feel like an intervention	1
Malfunction	1
Useful	1
Reminder	1
Passage of time	1
Helpful	1
Got used to it	1

"4. Do you think that you stood/sat more than before using the device? If so, please indicate how much more and why you think one or the other was more prominent. "

Sat more: even though the desk didn't automatically go down the last two times, I sat more than the last time. I now set the timer for standing pretty low, because I wasn't feeling like working standing up.

same as normal

I stood more than I do generally, but I am not sure if I stood more than the 3 reference days. I think I was motivated to stand more by the participation in the experiment.

Sat more before using the device, mostly all day

It made me sit for shorter periods.

	Standing more	Sitting more
Total	4	2

Desk didn't go down two times still sat more	1
Was not feeling like working standing up because of timer malfunction making them stand more before	1
No difference to before	1
Motivated probably to stand more by participation	1
Sat for shorter periods of time	1

"5. Did you avoid using the device? Please elaborate why or why not? "

No, I liked using it. It made me aware of the fact that standing is good and made it easier to do so. You can create sort of a deadline for standing which I like.

Yes, because in the morning I wanted to do my work sitting. So I didn't use the product that much

Yes for me it was not natural to use it, for timing my sitting. Normally when I have enough of the standing I go sitting. And I don't time my sitting time

No

Did not avoid using the device since i find it useful

No, but I caught myself out forgetting about it once I sat down.

No, it came rather naturally to use.

No	5
Yes	2
Liked the device	1
More aware	1
Made it easier to stand more	1
Deadline	1
Wanted to work sitting in the morning	1
Used the device less	1
Not natural to use for timing sitting	1
Normally don't time sitting time	1
When enough of standing then sitting (against planned standing)	1
Useful	1
Forgetting to use device when sitting	1
Natural to use	1

"6. For what purpose did you use the device? (For example time standing/sitting time, duration of a meeting, scheduling a break)"

Time standing

To do a quick ideation session of 15-30 minutes

Timing of sitting

To schedule standing time.

Used the device for standing more

It was planned standing while doing administrative work on the computer

I wanted to stand more often.

Time standing	5
Ideation session	1
Timing of sitting	1
While doing administrative work	1

"7. Additional comments about the usage: "

Using the device makes me aware of the fact that standing is possible and by scheduling it it also becomes easier to do so, because the period is set for you

I reaaaaally liked the device when it was working the other way around :D

I didn't fully understand how to use the device. The 3 buttons were clear, but it wasn't clear for me if I need to put the desk at sitting/standing position myself or if that would happen automatically.

Very easy to use and not quite a 'friendly' device to have around. Surprisingly not interfering at all, rather supportive.

More aware of standing	1
Scheduling standing is making it easier	1
Personalized	1
Liked the device in planned sitting	1
Did not understand how to use in which position the desk needs to be & that it would change automatically	1
Easy to use	1
Not 'friendly'	1
Not interfering	1
Supportive	1

Planned Sitting

"1. How often did you use the timer in the sit function (after the timer goes off the desk goes up)? (approximately)"

2 times

2-3 times? ←marked as 2.5 times

3 times

I think I used it 3 times but with relatively long sitting durations (1-2 hours).

all day (3)

I did not count, but I did use it every time I decided to sit. At least 3 times, maybe 4.
←marked as 3.5 times

4 times

Total	21
-------	----

"2. Did something not work? If yes please elaborate what. "

Everything worked fine

It worked perfectly

Everything worked

Yes. Twice the timer finished but the desk did not go up.

Everything worked just fine

I am not sure if I always pressed the 'start' button correctly, but I think it is quite sensitive – I was scared that I may have done something wrong

when I pressed it twice if I was not sure, it was not always clear to me that the timer has started. I am not sure if it went up by itself – it definitely did at least once, but I didn't notice the other times, I just went on with my work.

Everything worked

Everything worked	5
something didn't work	1
Desk didn't change	1
Usage not always clear	1
Not sure if change happened on its own	1

"3. Was the intervention interrupting your workday? If so how? "

No

Not really, but in none of the situations I was aware that the led light timer went off. So every time I was surprised when the desk went up

No not at all

Maybe yes. I was not feeling too much like standing today and I would prefer I had the planned standing instead of the planned sitting (because I mostly wanted to sit).

It did not interrupt my workday

Not really, it was nice to know that I have put down a reminder to stand up and that I don't have to think about it again.

No it helped me to stay more vital with little issue. It felt satisfying that I was actually standing every now and then.

No	6
Yes	1
Not noticing timer going off	1
Surprised	1
Not feeling like standing	1
Preferred planned standing instead	1
Reminded to stand up	1
Nice	1
Not having to think about it	1

"4. Do you think that you stood/sat more than before using the device? If so, please indicate how much more and why you think one or the other was more prominent. "

Normally I do not have a sitting/standing desk and here I like to use it

Stood more! Because I forget to change when I'm not actively encouraged/ stimulated to do so

I think I sat and stood same as normal

I think neither

Sat more before using the device, mostly all day

I definitely changed more than I would have. Once standing became uncomfortable it was nice to know that I can sit for 15minutes. I would probably have remained sitting for longer once I am focussed as I don't get such strong indications from my body to change than I do once standing.

I was really tired so the standing was a nice change but I really had to sit down every now and then.

	Standing more	Sitting more
Total	4	1

Likes to use sit stand desks	1
Normally no access to sit stand desks	1
Stood more	2
Forgot to change	1
Same as usual	2
Sat more before device	1
More changes of position	1
Change of desk when discomfort from standing	1
Else would have sat more when focused, because no body discomfort compared to standing	1

"5. Did you avoid using the device? Please elaborate why or why not? "

No, but on another day I would use it more. I was not feeling completely fine so preferred to sit

No I did not. I'm motivated to adapt to a healthier working routine and I know I'll need an external reminder to stick to it.

No

Yes. The one time that the desk should automatically go up but it didn't work I decided to continue sitting.

Did not avoid the device because i got curious how it would affect my day

No – I was just not sure if it was always working or not.

No, it's easy to use and it helped me stand up more

No	6
Yes	1
Preferred another day would than use it more	1
Motivated	1
Needs external reminders for healthier routines	1
Desk didn't go up so stayed sitting	1
Curiosity	1
Not sure if it was working	1
Easy to use	1
Helped to stand up more	1

"6. For what purpose did you use the device? (For example time standing/sitting time, duration of a meeting, scheduling a break)"

Used it to plan when I wanted to stand

I tried to sit for less than 1.5 straight. When setting the timer, I kept in mind if the lunch break or a standing meeting was near, so sometimes when the timer went off, I went on a walk instead of working standing up

Reduce sitting time

Planning sitting time.

I used it while working on my computer and mostly not to sit for too long.

I wanted to stand up some more and be vital.

To plan when to stand	2
Reduce sitting	1
Planning for how long to sit	2
Scheduling it around events	1
Went for a walk when desk went up instead of continuing to work	1
While working on computer	1

"7. Additional comments about the usage: "

I was feeling physically tired today and standing was not my preference. If I compare the planned standing with the planned sitting day, I think I

preferred the first. I think that is because I consider sitting as my default working state.

Very easy to use and not quite a 'friendly' device to have around. Surprisingly not interfering at all, rather supportive.

Was good to use, sometimes scared me out of my concentration but it wasn't too bad.

Standing was that day not the preference	1
Prefers the planned standing	1
Sitting being a default working mode	1
Easy to use	1
Not 'friendly' device	1
Not interfering	1
Supporting device	1

MIXED

"1. How often did you use the timer in the sit function (after the timer goes off the desk goes up)? (approximately)"

4

B2345 3 times Mixed = 1. I used it 1 time, it did go up after the timer. 2.I used it 2 times 3. 2 times

approx. 3 times

2 times

One or two times. But I also used the desk at sitting positions without setting the timer.

← marked as 1.5 times

3 times (or approx.. 2 hours)

I used this function the most but was not good at counting due to regular interruptions. Apart from being interrupted, I would probably use this function every-time I sit down in order to remind me to not sit too long.

4 times

Total	17.5
-------	------

(B2345 = 5/3)

"2. How often did you use the timer in the stand function (after the timer goes off the desk goes down)? (approximately)"

4

B2345 3 times Mixed = 1. 1 time, it didn't go down after the timer. 2. 1 time 3. 1 time

approx. 2 times

1 time

Two times.

5 times (5.5 hours)

I used this deliberately as it was part of the project. I would probably use it less as I get enough cues from my body that it is time to sit. But should I know that I have to spend a long day at the desk, I would find this function really good as a cue to structure my tasks and not to get too 'lost' in particular activities.

2

Total	16
-------	----

(B2345 = 3/3=1)

"3. Did something not work? If yes please elaborate what. "

Everything worked

B2345 3 times Mixed = 1. Yes, I installed the timer and it didn't go down by itself after the timer. 2. Everything worked this time 3. Everything worked

It did work, so this one's completely on me, but I expected the timer to start again automatically when it had gone off. This is why I often forgot to set the timer again immediately.

Yes the height was not correct for sitting and standing (had to adjust)

Yes. The desk was at standing position, but I manually lowered it a few centimetres from its automatic setting (to be more comfortable). When the timer finished and it needed to go down, it went up instead (maybe because I manually adjusted its height a bit?).

Everything worked

I didn't realize how hard I need to press the 'go' button and as the 'first' light was to the back of the circle I initially couldn't see that the device has started. It was not clear whether the back soft light or first specific light meant 15 minutes.

Everything worked fine

Everything worked	4	2
Something didn't work	2	1
Expected the timer to repeat after setting once	1	
Forgot to set timer	1	
Not the correct height	2	
Unsure about the device usage	1	
Table malfunction		1

"4. Was the intervention interrupting your workday? If so how? "

No, it made my workday more pleasant

B2345 3 times Mixed = 1. No, the lights of where not too bright in the background. I however didn't

notice the flickering "warning" lights when the desk goes up. 2. No, this time I once again didn't notice the warning lights, but that's fine, the desk doesn't go up very fast so you have time to get up or go down in time. 3. No

3 times I didn't notice the flickering lights, so the table went up/down abruptly while I was typing.

A bit because I had to think about the timer. Normally I use the adjustment buttons quite often.

No

No interruptions

Not at all, in fact it felt like it was adding to my work day – however, I can imagine that when it is too busy with going back and forth and not being at my desk that I might at times not think about it.

It sometimes surprised me, but I also felt content, since I was standing enough on a day. Plus the sudden interruptions helped me find new inspiration.

No interruption	4	3
Interrupting	3	
Pleasant	2	
Lights to dim	1	2
Surprised by change	2	1
Timer in the way	1	

Speed was not too fast		1
Inspiring	1	

"5. Did you perceive one function more interruptive than the other? If so which and why? "

No

B2345 3 times Mixed = 1. No 2. No 3. No

I don't completely understand what you mean by function. But I perceived it as interruptive that I had to set the timer back on, after I realized too late that this was expected of me. In this scenario I was distracted from the task I was doing.

Didn't use the 'uitstel' function

I didn't experience neither being interruptive.

Nothing interrupted due to the device being turned off in both standing and sitting

I find them both great.

The standing, because I actually had to get up which felt like more of a bother than sitting down.

No difference between each other	4	3
Standing more interruptive	1	
Turning off before it went off	1	

Timer not repeating automatically after setting once	1	
--	---	--

"6. Do you think that you stood/sat more than before using the device? If so, please indicate how much more and why you think one or the other was more prominent. "

Normally I work at the university where there are no sit/stand desks and here I use the stand function so I significantly stand more due to the possibility of standing

B2345 3 times Mixed = 3. I think I stood more because of the timer on the device worked as a kind of reminder to stand. Normally you are not very conscious about how many minutes or hours you sit down. Now, you can set a goal for yourself to sit an hour, and then the table goes automatically up which helps you remind to stand.

I normally don't choose to work standing up at a desk. I prefer walking as a break from sitting. This device and the fact that I was joining a research, motivated me to challenge myself! :D

I think I stood more compared to my reference, but not more compared to the planned sitting or planned standing.

Stood more due to more time spent standing

	Standing more	Sitting more
Total	6	1

(B2345 = 3x stood more)

Stood more	1	1
More conscious	1	1
Goal	1	1
Reminder		1
Automatism		1
Motivation	1	
Because of research more standing	1	
Prefers walks to interrupt sitting	1	

"7. Did you avoid using the device? Please elaborate why or why not? "

No I did the opposite. The device helped me to think about standing up and made it easier because there was a 'deadline' to it.

B2345 3 times Mixed = 1. At the end yes, because it didn't work the time before and I had to go in 30 minutes so I didn't feel like switching the table again to standing in that period of time. 2. No, it's easy to handle 3. No, it's easy to handle

No, I actively made myself use the device. The reason is written in my previous answer above :)

A bit but that was also because I was not constantly at my desk

I wouldn't say I avoided it, but I kept sitting without setting the timer at some point.

Avoided using the device due to the pending interruption

See my answer to question 4.[Not at all, in fact it felt like it was adding to my work day – however, I can imagine that when it is too busy with going back and forth and not being at my desk that I might at times not think about it]

No, I just timed it to my preferences which made it fine.

Not avoiding	4	2
Conscious usage	2	
Reminder	1	
Deadline	1	
Yes Avoid using	2	1
Pending interruption	1	
Frustration		1
Easy to use		2
Absence	1	
Forgetting to set timer	1	
Timed it to preferences	1	

"8. For what purpose did you use the device? (For example time standing/sitting time,

duration of a meeting, scheduling a break)"

Time standing and sitting

Plan standing time.

For making sure I don't sit too long. When it worked while I was standing, this also helped me to re-focus again

I wanted to improve standing time and schedule breaks.

Planned standing and sitting	1
Planned standing	2
Not sitting too long	1
Refocusing	1
Schedule breaks	1

"9. Additional comments about the usage: "

I really liked using it, because it made it easier for me to stand and it is sort of fun to set the time for it yourself with a real deadline

B2345 3 times Mixed = 1. You have to look really good how many lights are on when you instal the lights because they can start at the back of the device so you have to stand to see how many you put on. Other than that it works easy and fine. 3. I really don't notice the warning lights when going

up or down, maybe build in a vibration also to warn you if the table is about to move.

I would like it to inform me more clearly when it's almost going up/down. Because when I'm hyper focusing on a task, I don't notice a flickering light in the corner of my eye when working in a well-lit working environment.

The lights indicating the timer progress are not easy to see because when the timer starts and when it is close to the end they are at the back of the device.

I really like that the 'timer' is set with 'lights' and in 15min blocks. It makes it very easily accessible. I think if I had to digitally 'print' a specific time, I might just feel overwhelmed with having to make a decision and probably not do the effort. Choosing the little lights by just pressing is very user friendly and no effort at all.

I great innovation which will definitely add quality to my work life if I don't have to think to remind myself of when to stand and sit 😊

The flickering lights are nice however in deep focus I don't notice it anymore.

Liked using it	1	
Easier to stand	1	
Fun	1	
Deadline	1	

Lights hard to tell		1
Bad position because it starts in the back	1	1
Have to stand to set timer		1
Worked fine		1
Not noticing warning lights/better feedback for position change	3	1
Integrate vibration feedback		1
Hyperfocus / deep focus in the way of noticing	2	
Lights not strong enough in a well lit environment	1	
Improve quality of work	1	
Hard to see progress when timer is running	1	

Thematic analysis

Planned standing

Useful:

Useful², helpful, made it easier to stand more², , natural to use, easy to use, not interfering, supportive,

Reminder:

reminder, passage of time, more aware², deadline

General:

got used to it, liked the device,

Motivation:

motivated by participation, personalized,

Dislike:

not 'friendly',

Not handy:

wanted to sit in the morning, used the device less, when standing becomes uncomfortable than switching to sitting, not natural to use.

Planned sitting

Unclear

Usage not always clear , Not sure if change happened on its own, Not noticing timer going off , Not sure if it was working, Not 'friendly' device

Forgot to set timer

Not handy:

Not feeling like standing, Preferred planned standing instead, Preferred another day would than use it more, Standing was that day not the preference , Sitting being a default working mode,

General

Nice

Reminder

Reminded to stand up, Change of desk when discomfort from standing, Else would have sat more when focused, because no body discomfort compared to standing , Needs external reminders for healthier routines, Not having to think about it

Motivation

Motivated, Helped to stand up more, Surprised , Curiosity

Useful

Easy to use², Supporting device, Not interfering

Mixed

Unclear

, Expected the timer to repeat after setting once, Unsure about the device usage, pending interruption, frustration, Absence,

Forgot to set timer²

Not handy

Not the correct height², Lights to dim⁴, Surprised by change, Timer in the way, Bad position because it starts in the back³, Have to stand to set timer ,

Motivation

Motivation, Pleasant, Inspiring, Because of
research more standing, easier to stand, fun

Reminder

Reminder2, Deadline2, goal,

Useful

Conscious usage, easy to use, timed it to
preferences, , liked using it, Speed was not too
fast, Automatism, improve quality of work,
refocusing

Attachment C

Consent Form

Information sheet for research project “SitFit”

1. Introduction

You have been invited to take part in research project SitFit! Participation in this research project is voluntary: the decision to take part is up to you. Before you decide to participate we would like to ask you to read the following information, so that you know what the research project is about, what we expect from you and how we deal with processing your personal data. Based on this information you can indicate via the consent declaration whether you consent to take part in this research project and the processing of your personal data.

You may of course always contact the researcher Linda Schellenberg via l.schellenberg@student.tue.nl if you have any questions, or you can discuss this information with people you know.

2. Purpose of the research

This research project will be managed by Linda Schellenberg.

The purpose of this research project is to find out more about the usage and functions a sit/stand desk can provide. By participating in this research you provide insights into future development of the sit/stand desk and how certain functions can provide a more active working environment. This research data will be used in the Final Master Project report and may be published. Any identifying data will be removed from the publication keeping your data anonymous.

3. Controller in the sense of the GDPR

TU/e is responsible for processing your personal data within the scope of the research. The contact details of TU/e are:

Technische Universiteit Eindhoven
De Groene Loper 3
5612 AE Eindhoven

4. What will taking part in the research project involve?

You will be taking part in a research project in which we will gather information by: collecting the distance your desk changes throughout your working day, implementing device functions and

questionnaires. The research consists of two parts over a total of 6 working days. (One Working day is a minimum of 3 hours)

Part 1 – Establishing a Baseline (3 Working Days)

- A device will be attached to your sit/stand desk measuring the change of the distance of your desk throughout your workday
- Information needed to be provided by you is the sitting and standing height you use/feel comfortable at. As well as your working hours.
- No other information will be needed and you can continue working normally.

Part 2 – Device inclusion (3 Working Days)

- Device will be installed on your sit/stand desk and you will be asked to use it as you please while working normally.
- You will be given an explanation on the usage and can ask questions about the functions.
- Each day you will be asked to fill in a questionnaire about the functions and usage of the device.
- You'll need to again provide your working hours, your preferred sit and standing height will be used from the data provided at the beginning and the height of your desk will also be measured again throughout your working day.

For your participation in this research project you will not be compensated.

5. Potential risks and inconveniences

Possible inconveniences are that the desk will change automatically the position after the device timer has ended. Please take that into account when using the device. You will be again informed about this risk at the beginning of part 2.

Your participation in this research project does not involve any physical, legal or economic risks. You do not have to answer questions which you do not wish to answer. Your participation is voluntary. This means that you may end your participation at any moment you choose by letting the researcher know this. You do not have to explain why you decided to end your participation in the research project.

6. Withdrawing your consent and contact details

Participation in this research project is entirely voluntary. You may end your participation in the research project at any moment, or withdraw your consent to using your data for the research, without specifying any reason. Ending your participation will have no disadvantageous consequences for you.

If you decide to end your participation during the research, the data which you already provided up

to the moment of withdrawal of your consent will be used in the research. Do you wish to end the research, or do you have any questions and/or complaints? Then please contact the Linda Schellenberg via l.schellenberg@student.tue.nl. If you have specific questions about the handling of personal data you can direct these to the data protection officer of TU/e by sending a mail to functionarisgegevensbescherming@tue.nl. Furthermore, you have the right to file a complaint with the Dutch data protection authority: the Autoriteit Persoonsgegevens.

Finally, you have the right to request access, rectification, erasure or adaptation of your data. Submit your request via privacy@tue.nl.

7. Legal ground for processing your personal data

The legal basis upon which we process your data is consent.

8. What personal data from you do we gather and process?

Within the framework of the research project we process the following personal data:

- Working hours and days
- Preferred sit/standing height
- Desk changed during the working day

9. Confidentiality of data

We will do everything we can to protect your privacy as best as possible. The research results that will be published will not in any way contain confidential information or personal data from or about you through which anyone can recognize you, unless in our consent form you have explicitly given your consent for mentioning your name, for example in a quote.

The personal data that were gathered via sensors and other documents within the framework of this research project, will be stored on password protected computers and the OneDrive of the TU/e.

The raw and processed research data will be retained for a period of 1 year. Ultimately after expiration of this time period the data will be either deleted or anonymized so that it can no longer be connected to an individual person. The

research data will, if necessary (e.g. for a check on scientific integrity) and only in anonymous form be made available to persons outside the research group.

This research project was assessed and approved on 10/05/2023 by the ethical review committee of Eindhoven University of Technology.

Consent form for adult participation

By signing this consent form I acknowledge the following:

1. I am sufficiently informed about the research project through a separate information sheet. I have read the information sheet and have had the opportunity to ask questions. These questions have been answered satisfactorily.
2. I take part in this research project voluntarily. There is no explicit or implicit pressure for me to take part in this research project. It is clear to me that I can end participation in this research project at any moment, without giving any reason. I do not have to answer a question if I do not wish to do so.

Furthermore, I consent to the following parts of the research project:

3. I consent to processing my personal data gathered during the research in the way described in the information sheet.

YES NO

4. I consent to using my answers for quotes in the research publications – without my name being published in these.

YES NO

5. I consent to retaining research data gathered from me and using this for future research in the field of Industrial Design in which recognized ethical standards for scientific research are respected, and for education purposes.

YES NO

6. I consent to making research data gathered from me available via a repository, namely Office Vitality domain, for the purpose of retaining the data and using it for future research as described above.

YES NO

Name of Participant:

Signature:

Date:

Name of researcher:

Signature:

Date:

Attachment D

CODE

```
#include <Adafruit_NeoPixel.h>
#ifdef __AVR__
#include <avr/power.h> // Required for 16
MHz Adafruit Trinket
#endif
// Which pin on the Arduino is connected
to the NeoPixels?
#define PIN 4 // On Trinket or Gemma,
suggest changing this to 1
// How many NeoPixels are attached to the
Arduino?
#define NUMPIXELS 10 // Popular NeoPixel
ring size
Adafruit_NeoPixel pixels(NUMPIXELS, PIN,
NEO_GRB + NEO_KHZ800);
long PeriodInterval = 900000;
int sensorPin = A0;
int sensorPin2 = A2;
int sensorValue = 0;
int sensorValue2 = 0;
int press_count = 0;
int prev_state = 0;
int state = 0;
unsigned long prevTime = 0;
unsigned long currentTime = 0;
int Button = 2;
int press_count1 = 0;
int lastButtonState;
```

```
int currentButtonState;
const int TRIG_PIN = 5;
const int ECHO_PIN = 3;
// Anything over 400 cm (23200 us pulse)
is "out of range"
const unsigned int MAX_DIST = 23200;
int cm;
unsigned long startMillis;
unsigned long startMillis1;
unsigned long currentMillis;
unsigned long currentMillis1;
unsigned long sitMillis;
unsigned long standMillis;
unsigned long countMillis;
unsigned long countMillisA;
unsigned long countMillisB = 0;
long g = 0;
long h = 0;
long m = 0;
long t = 0;
bool runTimer = false;
bool runTimer2 = false;
unsigned long lastMillis = 0;
int sit = 62;
int stand = 94;
int mid = 75;
void setup() {
  Serial.begin(115200);
  pixels.begin(); // INITIALIZE NeoPixel
strip object (REQUIRED)
  pinMode(sensorPin, INPUT);
```

```
  pinMode(sensorPin2, INPUT);
  pinMode(Button, INPUT_PULLUP);
  // The Trigger pin will tell the sensor
to range find
  pinMode(TRIG_PIN, OUTPUT);
  digitalWrite(TRIG_PIN, LOW);
  //Set Echo pin as input to measure the
duration of
  //pulses coming back from the distance
sensor
  pinMode(ECHO_PIN, INPUT);
}
void loop() {
  currentTime = millis();
  sensorValue = analogRead(A0);
  sensorValue2 = analogRead(A2);
  sensor();
  showTouch();
  distance();
  Serial.print(currentTime);
  Serial.print(" ");
  Serial.print(sensorValue);
  Serial.print(" ");
  Serial.print(sensorValue2);
  Serial.print(" ");
  Serial.print(cm);
  Serial.print(" ");
  Serial.print(press_count1);
  Serial.print(" ");
  Serial.println(press_count);
```

```

// timer starter
if (press_count > 0 && sensorValue2 >=
120) {
  distance();
  if (cm >= mid) {
    timer1();
    press_count1 = 0;
  } else if (cm <= mid) {
    timer();
    press_count1 = 0;
  } else {
    press_count1 = 0;
  }
}
}

```

Distance

```

void distance() {
  countMillisA = millis();
  if (countMillisA - countMillisB >= 1000)
  {
    unsigned long t1;
    unsigned long t2;
    unsigned long pulse_width;
    // Hold the trigger pin high for at
    least 10 us
    digitalWrite(TRIG_PIN, HIGH);
    delayMicroseconds(10);
    digitalWrite(TRIG_PIN, LOW);
    // Wait for pulse on echo pin
    while (digitalRead(ECHO_PIN) == 0)

```

```

;
// Measure how long the echo pin was
held high (pulse width)
// Note: the micros() counter will
overflow after ~70 min
t1 = micros();
while (digitalRead(ECHO_PIN) == 1)
;
t2 = micros();
pulse_width = t2 - t1;
// Calculate distance in centimeters
and inches. The constants
// are found in the datasheet, and
calculated from the assumed speed
//of sound in air at sea level (~340
m/s).
cm = pulse_width / 58.0;
countMillisB = countMillisA;
}
}

```

High timer

```

void timer1() {
  ledoff();
  startMillis1 = millis();
  runTimer2 = true;
  g = PeriodInterval * press_count;
  while (runTimer2) {
    buttonii();
    distance();

```

```

currentMillis1 = millis();
unsigned long a2 = (currentMillis1 -
startMillis1);
h = g + (PeriodInterval *
press_count1);
if (a2 >= 0) {
  pixels.setPixelColor(0, 48, 32, 47);
}
if (a2 >= (h * 0.1)) {
  pixels.setPixelColor(1, 48, 32, 47);
}
if (a2 >= (h * 0.2)) {
  pixels.setPixelColor(2, 48, 32, 47);
}
if (a2 >= (h * 0.3)) {
  pixels.setPixelColor(3, 48, 32, 47);
}
if (a2 >= (h * 0.4)) {
  pixels.setPixelColor(4, 48, 32, 47);
}
if (a2 >= (h * 0.5)) {
  pixels.setPixelColor(5, 48, 32, 47);
}
if (a2 >= (h * 0.6)) {
  pixels.setPixelColor(6, 48, 32, 47);
}
if (a2 >= (h * 0.7)) {
  pixels.setPixelColor(7, 48, 32, 47);
}
if (a2 >= (h * 0.8)) {
  pixels.setPixelColor(8, 48, 32, 47);
}

```



```

}
if (a2 >= (h * 0.9)) {
  pixels.setPixelColor(9, 48, 32, 47);
}
blinky2();
pixels.setBrightness(150);
pixels.show();
Serial.print(startMillis1);
Serial.print(" ");
Serial.print(press_count1);
Serial.print(" ");
Serial.print(a2);
Serial.print(" ");
Serial.print(h);
Serial.print(" ");
Serial.print(cm);
Serial.println(" high table ");
if (a2 >= h) {
  servolow();
}
// if (a2 <= h && cm <= mid) {
//   runTimer2 = false;
// }
if (press_count1 == 3) {
  runTimer2 = false;
}
}
press_count = 0;
ledoff();
}

```

Low timer

```

void timer() {
  ledoff();
  startMillis = millis();
  runTimer = true;
  m = PeriodInterval * (press_count);
  while (runTimer) {
    buttonii();
    distance();
    currentMillis = millis();
    unsigned long a = (currentMillis -
startMillis);
    t = m + (PeriodInterval *
press_count1);
    if (a >= 0) {
      pixels.setPixelColor(0, 48, 32, 47);
    }
    if (a >= (t * 0.1)) {
      pixels.setPixelColor(1, 48, 32, 47);
    }
    if (a >= (t * 0.2)) {
      pixels.setPixelColor(2, 48, 32, 47);
    }
    if (a >= (t * 0.3)) {
      pixels.setPixelColor(3, 48, 32, 47);
    }
    if (a >= (t * 0.4)) {
      pixels.setPixelColor(4, 48, 32, 47);
    }
    if (a >= (t * 0.5)) {
      pixels.setPixelColor(5, 48, 32, 47);
    }
  }
}

```

```

}
if (a >= (t * 0.6)) {
  pixels.setPixelColor(6, 48, 32, 47);
}
if (a >= (t * 0.7)) {
  pixels.setPixelColor(7, 48, 32, 47);
}
if (a >= (t * 0.8)) {
  pixels.setPixelColor(8, 48, 32, 47);
}
if (a >= (t * 0.9)) {
  pixels.setPixelColor(9, 48, 32, 47);
}
}
blinky();
pixels.setBrightness(150);
pixels.show();
Serial.print(startMillis);
Serial.print(" ");
Serial.print(press_count1);
Serial.print(" ");
Serial.print(a);
Serial.print(" ");
Serial.print(t);
Serial.print(" ");
Serial.print(cm);
Serial.println(" low table ");
if (a >= t) {
  servohigh();
}
// if (a <= t && cm >= mid) {
//   runTimer = false;

```

```

// }
if (press_count1 == 3) {
    runTimer = false;
}
}
press_count = 0;
ledoff();
}

```

Blinking

```

void C1() {
    pixels.setPixelColor(0, 96, 145, 145);
    pixels.setPixelColor(1, 96, 145, 145);
    pixels.setPixelColor(2, 96, 145, 145);
    pixels.setPixelColor(3, 96, 145, 145);
    pixels.setPixelColor(4, 96, 145, 145);
    pixels.setPixelColor(5, 96, 145, 145);
    pixels.setPixelColor(6, 96, 145, 145);
    pixels.setPixelColor(7, 96, 145, 145);
    pixels.setPixelColor(8, 96, 145, 145);
    pixels.setPixelColor(9, 96, 145, 145);
}

void C2() {
    pixels.setPixelColor(0, 96, 73, 196);
    pixels.setPixelColor(1, 96, 73, 196);
    pixels.setPixelColor(2, 96, 73, 196);
    pixels.setPixelColor(3, 96, 73, 196);
    pixels.setPixelColor(4, 96, 73, 196);
    pixels.setPixelColor(5, 96, 73, 196);
    pixels.setPixelColor(6, 96, 73, 196);
    pixels.setPixelColor(7, 96, 73, 196);
}

```

```

    pixels.setPixelColor(8, 96, 73, 196);
    pixels.setPixelColor(9, 96, 73, 196);
}

void blinky() {
    unsigned long a = (currentMillis -
startMillis);
    if (a >= (t * 0.9)) {
        if (15000 >= (t - a) && (t - a) >=
14000) {
            C1();
        }
        if (14000 >= (t - a) && (t - a) >=
13000) {
            C2();
        }
        if (13000 >= (t - a) && (t - a) >=
12000) {
            C1();
        }
        if (12000 >= (t - a) && (t - a) >=
11000) {
            C2();
        }
        if (11000 >= (t - a) && (t - a) >=
10000) {
            C1();
        }
        if (10000 >= (t - a) && (t - a) >=
9000) {
            C2();
        }
    }
}

```

```

    if (9000 >= (t - a) && (t - a) >=
8000) {
        C1();
    }
    if (8000 >= (t - a) && (t - a) >=
7000) {
        C2();
    }
    if (7000 >= (t - a) && (t - a) >=
6000) {
        C1();
    }
    if (6000 >= (t - a) && (t - a) >=
5000) {
        C2();
    }
    if (5000 >= (t - a) && (t - a) >=
4000) {
        C1();
    }
    if (4000 >= (t - a) && (t - a) >=
3000) {
        C2();
    }
    if (3000 >= (t - a) && (t - a) >=
2000) {
        C1();
    }
    if (2000 >= (t - a) && (t - a) >=
1000) {
        C2();
    }
}

```

```

    }
    if (1000 >= (t - a) && (t - a) >= 0) {
        C1();
    }
}

```

Blinking 2

```

void blinky2 () {
    unsigned long a2 = (currentMillis1 -
startMillis1);
    if ( a2 >= (h * 0.9)) {
        if (15000 >= (h - a2) && (h - a2) >=
14000) {
            C1();
        }
        if (14000 >= (h - a2) && (h - a2) >=
13000) {
            C2();
        }
        if (13000 >= (h - a2) && (h - a2) >=
12000) {
            C1();
        }
        if (12000 >= (h - a2) && (h - a2) >=
11000) {
            C2();
        }
        if (11000 >= (h - a2) && (h - a2) >=
10000) {
            C1();

```

```

    }
    if (10000 >= (h - a2) && (h - a2) >=
9000) {
        C2();
    }
    if (9000 >= (h - a2) && (h - a2) >=
8000) {
        C1();
    }
    if (8000 >= (h - a2) && (h - a2) >=
7000) {
        C2();
    }
    if (7000 >= (h - a2) && (h - a2) >=
6000) {
        C1();
    }
    if (6000 >= (h - a2) && (h - a2) >=
5000) {
        C2();
    }
    if (5000 >= (h - a2) && (h - a2) >=
4000) {
        C1();
    }
    if (4000 >= (h - a2) && (h - a2) >=
3000) {
        C2();
    }
    if (3000 >= (h - a2) && (h - a2) >=
2000) {

```

```

        C1();
    }
    if (2000 >= (h - a2) && (h - a2) >=
1000) {
        C2();
    }
    if (1000 >= (h - a2) && (h - a2) >= 0)
{
        C1();
    }
}

```

Light

```

void showTouch() {
    // pixels.Color() takes RGB values, from
0,0,0 up to 255,255,255
    // pixels.setPixelColor(i,
pixels.Color(50, 0, 150));
    if (press_count == 0) {
        ledoff ();
    }
    else {
        for (int i = 0; i < press_count; i++)
{
            pixels.setPixelColor(i, 50, 93,
206);
            pixels.setBrightness(150);
        }
        pixels.show();
    }
}

```

```

}
void Lights () {
  unsigned long countMillis = standMillis
- sitMillis ;
  unsigned long a2 = countMillis;
  if (a2 >= 0 && a2 == 0) {
    pixels.setPixelColor(0, 150, 93, 206);
  }
  if (a2 >= (g * 0.1)) {
    pixels.setPixelColor(1, 150, 93, 206);
  }
  if (a2 >= (g * 0.2)) {
    pixels.setPixelColor(2, 150, 93, 206);
  }
  if (a2 >= (g * 0.3)) {
    pixels.setPixelColor(3, 150, 93, 206);
  }
  if (a2 >= (g * 0.4)) {
    pixels.setPixelColor(4, 150, 93, 206);
  }
  if (a2 >= (g * 0.5)) {
    pixels.setPixelColor(5, 150, 93, 206);
  }
  if (a2 >= (g * 0.6)) {
    pixels.setPixelColor(6, 150, 93, 206);
  }
  if (a2 >= (g * 0.7)) {
    pixels.setPixelColor(7, 150, 93, 206);
  }
  if (a2 >= (g * 0.8)) {
    pixels.setPixelColor(8, 150, 93, 206);
  }

```

```

}
if (a2 >= (g * 0.9)) {
  pixels.setPixelColor(9, 150, 93, 206);
}
pixels.setBrightness(150);
pixels.show();
}
void ledoff() {
  // Set all pixel colors to 'off'
  pixels.clear();
  pixels.show();
}

```

Sensor

```

void sensor () {
  if (currentTime - prevTime > 100) {
    if (sensorValue > 20) {
      state = 1;
    }
    else {
      state = 0;
    }
  }
  if (state == 1 && prev_state == 0) {
    prev_state = 1;
  }
  // if state changes and user release
the sensor
  // counter ++, and check
  if (state != prev_state && state == 0)
  {

```

```

    prev_state = 0;
    press_count++;
    if (press_count > 10) {
      press_count = 0;
    }
  }
  prevTime = currentTime;
}
}
void buttonii() {
  lastButtonState = currentButtonState;
  currentButtonState =
digitalRead(Button);
  if (lastButtonState == HIGH &&
currentButtonState == LOW ) {
    press_count1 ++;
  }
  if (press_count1 > 4 ) {
    press_count1 = 0;
  }
}

```

Servo (atomization of desk change)

```

void servolow() {
  if (cm >= sit) {
    digitalWrite(7, HIGH);
  } else {
    digitalWrite(7, LOW);
    runTimer2 = false;
  }
}
}

```

```
void servohigh() {  
  if (cm <= stand) {  
    digitalWrite(6, HIGH);  
  } else {  
    digitalWrite(6, LOW);  
    runTimer = false;  
  }  
}
```