Workflow Coach: a Tangible Tool for Time Management Through Interactive Lighting and Pattern Recognition

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ABSTRACT

Time management is a concept that is very important for efficient work habits and is used in various ways among students. An attempt was made to guide users in practicing time management well, through optimization of their personal workflow and the use of timeboxing. A tangible tool called the Workflow Coach is presented, which uses interactive lighting and pattern recognition to aid the user in managing their work and break time. The tool is designed to shift easily along the Interaction-Attention Continuum [1], which ensures the device does not distract the user from their work and provides a pleasant experience. The design was evaluated in two user studies, one qualitive and one quantitative. The results will be presented and discussed in detail, which lead to future implications and improvements to the presented design.

Author Keywords

Workflow; Time Management; Office Setting; Timeboxing; Pattern Recognition; Interactive Lighting;

INTRODUCTION

Time management is a concept that is practiced by lots of individuals while they are working or studying. Efficiently managing your time and eliminating distractions can be tough, certainly in the world that we live in today. More and more distractions are added to the office setting, like a mobile phone and website notifications. Furthermore, there are many ways to spend your time, which makes it hard to wisely divide your time over tasks. Another related problem among mostly students and young professionals is procrastination.

Procrastination is very common among students. Research on academic procrastination shows that 46% of subjects reported that they nearly always or always procrastinate on writing a term paper. Similarly, 23.7% of the students felt procrastination was nearly always or always problematic, and 65% stated they wanted to reduce their procrastination when writing a term paper. Furthermore, it was found that two major reasons for procrastination are “You had too many other things to do” (60.8% of subjects) and “You felt overwhelmed by the task” (39.6% of subjects). Both of which refer to difficulties in managing time [2].

Procrastination can be tried to be overcome in different ways, this paper will present one of them, namely a tangible tool called the Workflow Coach. The Workflow Coach is a tangible tool that advises the user on time management through interactive lighting and machine learning. The tool will be discussed in more detail in the design process and final design section. A personal workflow is the preferred time schedule for working and taking breaks of one individual. Work and break cycles are used to more efficiently manage time. The workflow may be very different for each individual. Therefore, a highly personal tool is needed.

The tool is targeted at young professionals that desire more guidance during their studying or working days. It is common that young professionals and students have lots of freedom in scheduling their working time. This means they have days where they need to make their own schedule and can work on their own pace. The lack of guidance can be difficult to handle when first encountering it and may result in low productivity and no feeling of satisfaction from working, or even dissatisfaction. To bring back the feeling of time and control to the students, the tool will ensure the user will consciously think about the time they spend working and taking breaks. It will also aid the user in finding their optimal personal workflow. The tool is aimed to be in the sweet spot between having effect on the user’s workflow and being unobtrusive. To make sure the tool is unobtrusive, peripheral interaction is a major aspect of the final design [1], which is discussed in more detail later on.

The aim of this paper is to explore new possible applications for designing applications of the Interaction-Attention continuum and machine learning. The paper introduces a concept called the Workflow Coach and is evaluated on whether it fulfills its goals and whether the target group is willing to use the device.

THEORETICAL BACKGROUND

The main theoretical knowledge that is used in the design process is the Interaction-Attention Continuum and the Pomodoro Technique. The final design also utilizes machine learning, more specifically Nearest Neighbor pattern classification.

Interaction-Attention Continuum

In everyday life, actions are performed with various levels of attention. One may use their phone to look up the current weather data, which can be described as focused interaction, since the user focuses all his attention on the interaction. One may notice their lights being turned on when the sun is set, which can be described as implicit interaction, since the user did not focus their attention on turning on the light, but the system performed the action automatically. These two types of interactions are the ones that are designed for the most and most present in the everyday life. However, Bakker and Niemantsverdiet observed and introduced a third interaction attention level, namely peripheral interaction. One may have a conversation while driving a car, which can be described as peripheral interaction, because the user can perform the action of having a conversation with minimal attention. There is a huge potential here, since peripheral interaction can increase the amount of tasks one can perform at the same time. Peripheral interaction comes with a small cost, since the control that the user has over tasks that are performed in the periphery of attention is a little less precise than with focused attention. The three beforementioned interaction types, focused interaction, peripheral interaction and implicit interaction are together called the Interaction-Attention continuum [1]. The presented design aims to smoothly shift between the different levels of attention in the continuum to provide the user with very efficient and satisfying interactions.

Pomodoro Technique

The Pomodoro Technique is a well-known time management technique invented by Francesco Cirillo. The technique is based around a tomato timer of 25 minutes, which is used to time one cycle of work, also called a 'pomodoro'. The user is supposed to formulate a task with an estimated duration of approximately 25 minutes. During the pomodoro, the user will try to finished the task through eliminating distractions while working and through timeboxing. Timeboxing is a time management technique that lets the user create boxes of time (e.g. 25 minutes) which they will then spend on one task only. The user will be pressured a bit by the timer and deadline, and will therefore be working more efficiently. After each pomodoro, the user is supposed to take a short (5 min) break in which they do not pay attention to anything work-related. This will get the user's mind and brain ready for the next pomodoro. When four pomodoros are performed in a row, the user should take a longer break and continue afterwards. The technique will help the user to discover how much effort activities require, will cut down on interruptions and will increase the productivity and satisfaction of working [3].

Nearest Neighbor pattern classification

Lots of research has been done about machine learning in the past, but the applications of machine learning are still in a very early stage. This is caused by the fact that advanced machine learning only became possible a few years ago, due to advancements in computing speed and availability of big data. There are many different algorithms being used in the field of machine learning, one of which is called Nearest Neighbor pattern classification. It is an algorithm that utilizes supervised learning, which means that the system learns based on examples of inputs and their desired outputs and needs to be trained with known examples. The input features might be the time of the day, the outside temperature or the location of the user. Output features could be a song or the estimated duration of a certain task.

To determine the output of the algorithm, the program will look at the previously collected data points and map those in an x-dimensional graph. The amount of dimensions x is the same as the amount of input features that are selected. Then, the k data points that are closest to the current situation (the nearest neighbors) are selected and used for further processing. K is an integer that stands for the amount of nearest neighbors that should be selected, a higher value of k results in more accurate outputs. Based on the nearest neighbors that are selected for this situation, an output can be generated that is similar to the previously obtained usage data. Therefore, this algorithm can be used to recognize patterns in data sets [4, 5]

RELATED WORK

CtrlWORK

CtrlWork is a software tool used for increasing productivity and work satisfaction mainly for desktop computer users. It provides the user with notifications every hour to take a short break and perform an exercise. The tool is aimed at making sure the user is not spending too much time looking at screens, and tries to improve the mental and physical health of workers that sit behind their desk and computer for entire days. The tool also gives personal feedback to the user on the way they use the computer and gives an overview of the use of computers [6]. From this tool it may be noticed that the notifications are quite obtrusive and do not take the Interaction-Attention continuum into account. These aspects could be taken into account when the final design is being made. It needs to use peripheral interaction and should allow users to change the frequency at which they are receiving information from the system.

DESIGN PROCESS

The design process started by setting a domain in which the Interaction-Attention continuum and Machine Learning could be applied; productivity in the office setting. More specifically, the aim of the design is optimizing the personal workflow. The personal workflow is defined as the work-break cycles that a user goes through while working. The most optimal workflow can be achieved by personalizing and adjusting the duration of each work and break cycle to the user's needs. The target user group was set to be students and young professionals, since it was found that this group has trouble dealing with procrastination and efficiently managing time [2]. This user group was also very accessible to the researcher, which made it easy to involve users in large parts of the design process and achieve short iteration cycles. At this point, four semi-structured interviews were conducted with potential users to get an impression of the current workflow and ways to improve the workflow. Furthermore, interesting background material in this domain was found, like the Pomodoro Technique and CtrlWORK.

An ideation session was organized from which the preliminary concept (Workflow Coach) was obtained, through mind mapping and brainstorming. It is a tangible tool that advises the user on what the optimal workflow for them is and when work and break cycles should be performed, through interactive lighting. It allows for feedback to be given back to the system by turning the knob, which increases or decreases the duration of the current work/break cycle. The concept is based on personal timeboxing, which helps users increase productivity and get more satisfaction from their work [3].

An exploration of form and interaction was performed with sketches. A round design was chosen, since this invites and tells the user that the knob may be turned, and enables a clear visualization of the work and break cycles to be incorporated. The interactions that were chosen, e.g. turning the knob completely to the end of a cycle to end the work cycle and start a new break cycle, were designed to be rich interactions [7]. From this, a static prototype and video could be made and presented (see figure 1).

Figure 1. First prototype of the Workflow Coach

The design was evaluated by professional designers and fellow students, which lead to a few minor and one major improvement to the concept. Machine learning was added to make the tool have some intelligent behavior, the final design section will elaborate on how this is done.

Now the concept was finalized, a final and functional prototype could be made. The shape of the device was perfected in a 3D modeling computer program, called SolidWorks. This model included room for electronics in the prototype and was 3D printed with two materials. The main body was built from plastic and a small attachment was made on the bottom from rubber, to make sure the device will not slip when the knob is being turned. The electronics were soldered together and a software program was written in Arduino. The Workflow Coach prototype communicates back and forth with an online database. The function of this database is to save the user data (cycle durations) for later reference and to provide the device with new program data that went through a machine learning algorithm. A schematic representation is given in figure 2.

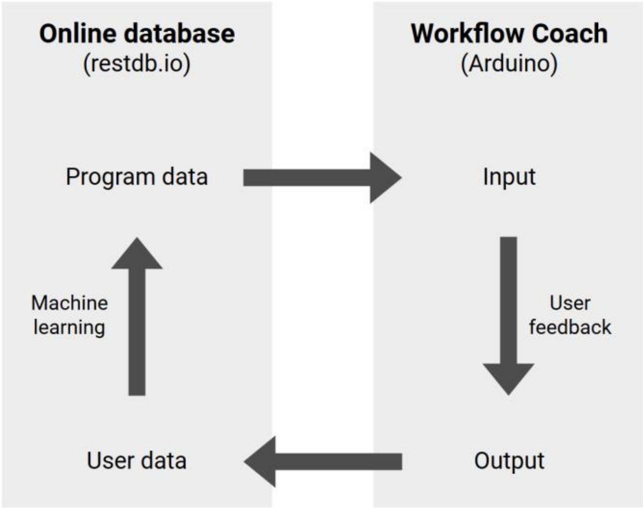

Figure 2. Schematic representations of the data processing.

The final design that followed from the described design process is presented in the next section.

FINAL DESIGN

The Workflow Coach is a tangible tool that advises the user on time management through interactive lighting and pattern recognition. It visualizes the amount of time the user still has to work and shows when a break is advised. These work and break cycles are based on a technique called personal timeboxing, which is also used in the Pomodoro Technique [3]. The device will also suggest how long breaks should last. The user can give feedback to the device by turning the knob, this will either increase or decrease the time that is left for the current cycle. Due to the fact that the user will be consciously thinking about the time they are working and taking breaks, they hopefully get a more satisfying and efficient workflow. The device will also try to recognize patterns in the workflow of the user and will improve over time to match the personal workflow better. The device is made portable, to ensure it can be placed anywhere on the desk and can be used at all locations one may want to work at.

The goal of the project is to give young professionals more guidance in their working habits and workflow, to optimize the time they spend working and to minimize the amount of procrastination. Furthermore, the device aims to increase the level of satisfaction one gets from working, by getting reminded of how well you are doing at each work cycle you complete. This higher level of satisfaction will hopefully lead to the user spending more time working and less time taking breaks or procrastinating. The user studies that will be introduced later, validated made assumptions on this matter.

Interactive prototype

A functional interactive prototype was crafted as described in the design process. This prototype was used in both user studies described below. The device allows for tangible and rich interactions to be made, which increases the likelihood of the device being perceived as intended. The default work cycle lasts for 25 minutes and the default break cycle for 5 minutes, which is based on the Pomodoro Technique. These defaults would soon be adjusted with the user feedback that the device gets and pattern recognition, to match the personal workflow of the individual user. The final prototype is depicted in figure 3.

Figure 3. Final interactive prototype of the Workflow Coach

Interaction-Attention Continuum

The device was designed to easily shift along the Interaction-Attention Continuum. Different types of interactions and levels of attention are used for various purposes and operations of the device.

Focused interaction is designated for precise control. It is therefore used to precisely checking the time that is left in a cycle, for precisely increasing or decreasing this same time and to turn the device on or off. Peripheral interaction is used for actions that may happen in the periphery of attention, which makes them useful for actions that should catch your attention too much and can be performed with a little lower precision. Examples of such interactions that are incorporated in the design are imprecisely noticing the time that is left in a cycle, imprecisely and swiftly increasing or decreasing this same time and noticing a transition from work to break without directly looking at the device. Implicit interaction happens without the user taking any direct actions, the actions are automatically performed by the device. Examples of these interactions are the shift from a work to a break cycle at the end of a work cycle, the amount of LEDs that are lit which decreases over time and the optimization of the personal workflow that happens in the background through pattern recognition in the data.

Machine learning

Machine learning is a major part of the final design, more specifically, a Nearest Neighbor pattern classification algorithm was designed for this specific use case. The reason for choosing this technique was its appropriateness for the project (pattern recognition) and its relative simplicity. Pattern recognition is used to recognize patterns in the work and break cycles. K is set to be eight, so the algorithm will look at the eight nearest neighbors when recognizing patterns. This value of k is chosen to be in the sweet spot between a big number (10+), which gives more accurate results, and a small number (5-), to be efficient in the small data sets that are used in the user study. The algorithm takes two steps to come to the desired output, it makes use of data that is previously obtained by the device [5]. The first step is determining the current situation or context it is in and the second is finding eight previous situations, or nearest neighbors, that were similar to the situation at hand. The settings (cycle durations) of the similar situations are averaged to become the settings of the current situation the user is in. The input features of the algorithm are time of the day and day of the week. Weekdays are assumed to be similar in a regular working week, as well as the weekend days are. The output features are the work and break cycle durations that the device should work with at the current time of the day and day of the week.

Two common problems are tried to be overcome with the design of the algorithm. The cold-start problem is not an issue, since data is generated quickly that can be used by the algorithm. The device can already start learning from data point one and will only become more accurate and advanced over time. Overspecialization might be a problem in the current design, since the user may infinitely increase or decrease the work or break cycle durations. To overcome this issue, a feature was implemented that sometimes makes random suggestions.

USER STUDY SETUP

Two user studies were conducted to evaluate and validate the concept that was designed. The in-depth study is qualitive and consists of open interview question, it aims to evaluate the underlying principles of the design and how the design is perceived. The evaluation study is quantitative and tries to evaluate whether the aims of the design are achieved.

In-depth study

The first study was designed to get insights in how the device may be used in a real life situation. The aim was to validate whether the users would use the device as intended, whether it added value to the office setting and whether the target goals were achieved. The final prototype (see figure 3) was given to one user for seven consecutive days, in which they could use it the way they seemed most valuable. Only minor instructions about how to operate the device were given, the user was free to choose the spot they put the device in and was unaware of the fact that the device was trying to recognize patterns in their workflow.

Open questions were asked after the seven days test. The intention was to start discussions about the answers that were given by the participant, to get in-depth insights of the usage of the device and behavior of the participant. The asked questions are listed below.

1. How did the device affect your workflow and time management?
2. What features of the device did you like and dislike the most?
3. How did you perceive the interactions that the device offered?
4. Where did you put the device?
5. How much attention to the device was needed when using the device during work?
6. Do you have any additional comments or suggestions?

Evaluation study

A second study was performed to evaluate the device in a more structured and fast way. It was aimed at finding out whether the users think the device can be useful for eliminating distractions, improving productivity and work satisfaction and decreasing the amount of time spent procrastinating.

The tangible device was introduced to nine individual users and explained by letting them read the final design section of this paper. The users could interact with the device for a moment and where then asked to fill in to what extent they agreed with the following statements. The statements are five point Likert-scale based, ranging from “strongly disagree” to “strongly agree”.

1. This tool will help me to control the time I spend procrastinating.
2. This tool will improve my productivity while working.
3. This tool will increase the level of satisfaction I get from working.
4. This tool will help me to eliminate distractions while working.
5. This tool will improve my ability to efficiently manage my time.
6. I would like to use this tool on a regular basis.
7. If you have any additional comments or suggestions, please write them down below.

FINDINGS

The findings of both user studies are stated in the following sections.

In-depth study

Insights from the qualitative in-depth study were combined with the usage data that was collected by the device, both will be presented in this part.

User data

The average work cycle of the participant lasted for 23 minutes, the total amount of minutes worked is 563, which is slightly over 9 hours. All data points are visualized in a graph and presented in figure 4.

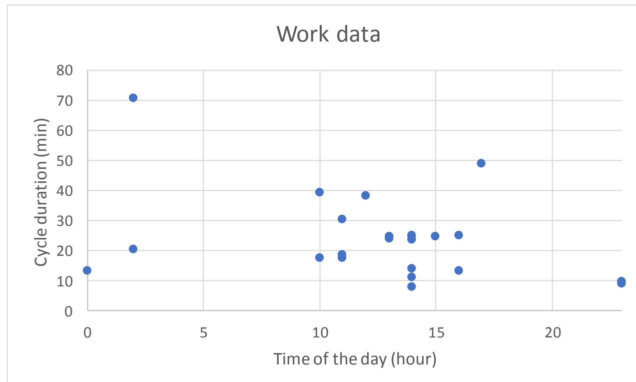

Figure 4. Visualization of the work cycle duration data

The average break cycle of the participant lasted for 7 minutes, the total amount of minutes of taking breaks is 132, which is slightly over 2 hours. All data points are visualized in a graph and presented in figure 5.

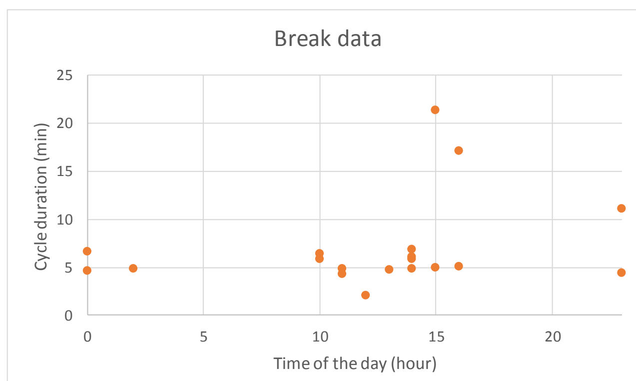

Figure 5. Visualization of the break cycle duration data

Interview

The answers that were given to the interview questions and the discussions that followed are summarized to cover the most relevant outcomes:

The Workflow Coach helped me to better manage my time. I noticed I was more aware of the time I spent either working or taking breaks, which helped me to procrastinate less and focus more on work-related tasks. At first, I did not really adjust the suggested workflow I liked the tight planning that was offered. Later I tried to give feedback to the device, I noticed my working time became longer in the afternoon and the work cycle duration became shorter in the evening, which quite well suits my workflow. I liked the fact that you can approximately see how much time there is left in a cycle. I disliked that you did not exactly know how much time there was left and that I sometimes did not notice that my break time already ended 3 minutes ago. The interactions with the device were easy and smooth, not much attention needed to be paid to the device. Therefore, the device did not distract me from my work. The device was put on my desk in a quite notable place next to my laptop. It was clearly visible all time and could be perceived without paying much attention to it.

Evaluation study

Each statement in the study will be individually presented with their results below.

The majority of participants (7 out of 9) agree or strongly agree that the tool helps them control the time they spend procrastinating. Little over half of the users (5 out of 9) agree or strongly agree that the tool will improve their productivity while working. The increase to the level of satisfaction they get from working is received quite diverse, although it leans towards agreeing with the statement (2 disagree and 5 agree out of 9). The participants do not think the tool will help them to eliminate distractions while working (4 neutral, 2 disagree and 3 agree out of 9). Furthermore, 6 out of 9 say the tool will improve their ability to efficiently manage their time and 7 out of 9 state they would like to use the tool on a regular basis.

An interesting additional suggestion made by a participant was to include some sort of insights system based on past behavior to get statistics and feedback on your productivity and work schedule.

DISCUSSION

The findings of the user studies are discussed in the following paragraphs. An overall discussion of the design and research is given as well.

In-depth study

From the work data no accurate patterns can be distracted. Although, the start of a small pattern is noticed that occurs at night, the user works for short amounts of periods (10 minutes) and regularly takes breaks. This finding is based on four data points, which is too little to conclude something, but may indicate a pattern is present here. In the break data no pattern can be found. The only overall finding here is that the user likes to take slightly longer breaks than initially suggested, namely 7 minutes instead of 5.

From the interview, it can be argued that the presented tool is received positively by the participant. They state that the tool helps them to better manage their time and decrease the amount of procrastination, which were the main aims of the design. The dislikes of the user may be taken into account when iterating over the current design and developing it further. For example, a sound notification might be added to make the user more aware of the transitions between working and breaks, or the device could be placed in a more predominant spot on the desk.

Evaluation study

From the evaluation study, it can also be argued that the presented tool is received well among the participants. The overall score is that the aims of the design are achieved for the most part. Interestingly, the tool is not perceived to eliminate distractions, which brings us to re-evaluate this assumption. It is quite logical that the tool is not eliminating distractions, since it is focused more on guiding the user in time management than on what tasks or devices the user is working on. This causes the tool to not have an direct effect on the distractions that are to be dealt with by the user. The additional suggestion that was made by a participant is very promising, thus the feature of presenting statistics and feedback will be added in a future design.

Overall

A limitation of the studies that were conducted is the size of the participant groups, which could be underrepresented or biased. For more accurate and significant results, the tool should be tested with larger user groups and the tool should stay with each participant for a longer period of time. Then the learning algorithm can really get to its full power and adjust perfectly to the user's personal workflow. Now, all conclusions that are made are limited and could be made more promising by having more data and tests.

The target group of both the design and the studies now was students. However, the tool can be used by lots of other user groups as well, since it is valuable for all people that struggle with time management and desire guidance while working and taking breaks.

Future work might be done to improve the design that is presented, to evaluate other aspects of the design through user studies or to find other applications where peripheral interaction and pattern recognition could be combined to generate promising solutions. The design could be enhanced by adding new features to it, like the statistics and feedback section to optimize and personalize one's workflow even more. The studies could be improved by making a higher quality prototype which looks more like a real product, to get the participants out of the test setting.

CONCLUSION

The Workflow Coach aims to guide users in finding their optimal workflow and increase their skill in time management. The concept is uses timeboxing, pattern recognition in the user's personal workflow and interactive lighting to deliver value to the user. The design was received positively by the participants in both studies. It looks like the concept works well for improving time management and decreasing the amount of time spend on taking breaks. Further research and development of the concept and design are suggested, to improve the impact the tool has.

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