D1.4a User needs study for person-centric well-working

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Summary

This document provides a literature overview of the user needs for person-centric well-working applications. It can be used for the elicitation of future user requirements, or to support the implementation of well-working applications.

This document introduces the user needs and challenges regarding the creation of well-working systems. It does so in the context of the COMMIT SWELL project. These needs and challenges were derived from literature in this subject, and from existing project deliverables. In general, users want the system to be easy to configure, they want it to be unobtrusive, self-adaptive and it should respect their privacy. Failure to do so on any of these subjects might result in the failure of the system as a whole. More hurdles and obstacles are discussed.

A literature study was performed, looking at different methods, techniques, and theories regarding the field of well-working. We describe ways of recognizing context, how to model the user state, and how to influence the user. These three combined will allow the future context-aware well-working application to be as effective as possible.

Since computers have been used to increase user productivity for years, a short overview of existing productivity applications is given. In general, we can say that these programs are primarily aimed at one single task, and do not consider the rest of the well-working scope.

As of current, we can observe a gap between the state of the art, as developed by research institutes and universities, and what is implemented in commercially available software systems. It is recommended that this gap is closed by integrating functions among software systems, utilizing context information, improving privacy and increasing adaptability.

Contents

1 Introduction

Over the years, we have seen a shift in the way people work. With new ways of communicating, new ways of working have arisen. Endless flows of information can easily find their way to the knowledge worker, both at work and at home, affecting all parts of his life. Combined their increasingly sedentary lifestyle, we can conclude that there is room for improvement with regard to the different aspects of the life of knowledge workers.

In this document, we look at the user needs regarding well-working support systems by studying existing literature on this topic. We first look at user demands and potential hurdles, after which we study methods, techniques, and theories regarding systems that are to support knowledge workers. Thirdly, existing productivity tools are explored. Finally, we discuss the current gap between the literature and practice, and draw conclusions from this.

1.1 Smart reasoning for well-working

Current technology supports us to accomplish more work in shorter times. However, (Ruff, 2002) states that too much technology may induce the feeling that we are controlled by technology, rather than we are controlling the technology. The internet provides us with vast amounts of new information to be considered, mails are waiting for us to be checked and answered, and our mobile phones is never off. Two effects on people are characterized by (Ruff, 2002) as 'plugged in compulsion', being "the strong need to check mail and the internet to stay in touch", and 'hurry sickness', being "the belief that one must constantly rush to keep pace with time".

In these times it is hard to work in a calm and focused manner, without experiencing interruptions and stress. (Mark, Gudith, & Klocke, 2008) investigated the cost of interruptions and came to the conclusion that "after only 20 minutes of interrupted performance people reported significantly higher stress, frustration, workload, effort and pressure." (Bakker, Holenderski, Kocielnik, Pechenizkiy, & Sidorova, 2012) explain that stress can either directly lead to illness through its physiological effects, or indirectly through maladaptive health behavior like smoking, poor eating habits, or lack of sleep.

SWELL aims to tackle these work-related problems and improve well-being at work by supporting knowledge workers whose main task it is to interpret and create information using a computer. A first step for the knowledge worker towards more grip on working manners and stress is gaining insight. (Schon, 1983) describes the process of reflective practice, i.e. the process of oneself thinking about and critically analyzing one's actions with the goal of changing and improving occupational practice. Schon distinguishes two situations. Situation one is that you work efficiently and feel you are making good progress. In that case, he states, you should think about why this works well. In situation two, you may have the feeling your days are not going according to plan. In that case, you should wonder why this is, whether you lack knowledge, resources, or what makes things difficult. You could then come up with alternative ways of working. SWELL should help in this process. Therefore we are developing software applications that can detect the development of work-related stress of a knowledge worker, and that can provide advice to the knowledge worker or exert actions so as to contravene the stress development.

Four research challenges in the domain of persuasive technology for human well-being are identified by (Eyck et al., 2006): (i) context sensing, (ii) appropriate feedback, (iii) need for longitudinal user

studies and (iv) ethical concerns. For SWELL to be a successful project, all these aspects will have to be addressed in an appropriate manner.

Until now, well-being at work is often investigated by means of questionnaires like WEBA, as defined by (Dhondt & Vaas, 2001). Action is taken on the organizational level by reorganizing the work. Our approach instead is real-time and allows the user himself to adapt. Our project is similar to the project Stress@Work as described by (Bakker et al., 2012), in which also data mining and predictive modeling are used for gaining insight in stress effects of work and providing timely and personalized coaching. However, the target group of Stress@Work (teachers and medical staff), and the set of sensors to be used differs from ours, as we focus on computer work.

1.2 Smart reasoning for well-being

SWELL Deliverable D1.3 *User needs study for person-centric well-being* by (Achterkamp, Vollenbroek, Bosems, & Van Sinderen, 2012) looks at user needs regarding well-being, as opposed to well-working, support systems. The average age in the Netherlands is rapidly rising, causing increased costs for health care. In order to counteract the increasing costs, applications have been suggested that are to increase the user's level of physical activity, and thus improving their health, delaying possible illness later on in life.

Deliverable D1.3 starts off by discussing ways of measuring physical activity, after which methods of influencing this activity are discussed. The document concludes by giving examples of current applications that can help to increase physical activity in order to make the user healthier. The authors note that although current tools do provide some level of support, they lack proper knowledge of human cognition, an aspect that might make the tools more effective.

2 User needs and challenges

Development of systems is always driven by the needs and demands of users and stakeholders. In this chapter, we discuss some of these user needs, and contrast these using hurdles and obstacles, both with regard to technological possibilities and representation of the application to the user.

2.1 User needs

The terms 'goal', 'need', and 'requirement' are often used interchangeably. We shall use the following definitions:

- Goal: a desirable state that one wants to achieve.
- Need: something that one wants in order to sustain or improve life, in general a product or service.
- Requirement: a condition on the acceptability of something.

From these we can deduce the following:

- A need may lead to a goal;
- An achieved goal may fulfill a need;
- A goal may be decomposed in sub-goals;
- Each sub-goal may be driven by a (sub-)need;
- Needs and goals may induce requirements on the means that are employed for the purpose of fulfilling needs and achieving goals.

In SWELL Deliverable D1.1 *User and domain requirements,* (Bosems, Sinderen, Marin-Perianu, Dantzig, & Sappelli, 2012) look at the requirements users of context-aware well-being applications might have. In order to gather these requirements, workshops were organized. During these workshops, personas were created who would aid further requirements elicitation. These persona descriptions included a background description and persona goals. The requirements are divided into three categories. The first includes "shall" requirements; these requirements are absolute and must be implemented. The second category entails the "should" requirements: these are strong recommendations and should be carefully weighted if not implemented. The final category of requirements are the "may" requirements, indicating optional extra's to the system.

One of the "shall" requirements as described by (Bosems et al., 2012), is that the system should be as unobtrusive as possible. Referenced numerous times, the Microsoft Office Assistant, also known as Clippy, is an example of technology that is often perceived as too intrusive and as such is not accepted as a helpful tool by to the user.

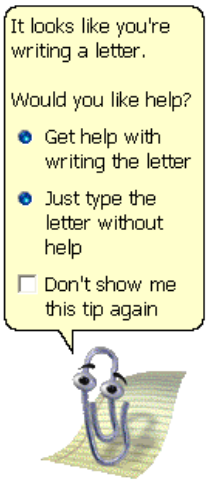

Figure 1 The Microsoft Office Assistant

A second important requirement is configurability and adaptability: the user should be able to set goals, and the system should help the user to pursue these goals. Furthermore, as users have different personalities, the system should be able to adapt such that the way advice is given matches the user's preference; these preferences are to be learned by the system.

The requirements listed described by (Bosems et al., 2012) also deal with security and privacy requirements users might have. However, these points are only discussed briefly. More on this subject is covered in SWELL Work Package 4 *Context-aware adaptive privacy*.

The "should" requirements include productivity enhancing system features like the automatic categorization of new mails, helping users search and manage documents, preventing distraction from the current task, and time registration and reporting.

2.2 Hurdles and obstacles

On the 21st of October 2010, a workshop was organized by TNO to gather ideas for a tool that is to support self-management in order to improve well-working ("arbeidsvreugde"). The tool was described as one that is to observe the user and judge these observations against known norms. Using this evaluation, the user is then to change his behavior in order to match established norms, and potentially alter his own norms. During the workshop, participants were asked what features should and what features should not be implemented in such a tool.

One of the workshop results was the insight that users do not like to be pointed out what things they are doing wrong or incorrectly. The feeling of being judged could have an adverse effect on the adoptation of the tool.

The way advice is given is also highly important to the success of the tool; some workshop participants indicated they would only like to be informed about statistics collected, while others preferred concrete advice on what (not) to do. Furthermore, when presented with statistics, some users preferred a condensed view, for example a traffic light to indicate how well they were performing, while others preferred to see all data in detail. These differences might pose possible representation problems when implementing the tool: if the application cannot be adapted to the user's needs, the interface might become a hindrance, which will result in the user abandoning the tool.

Further interface concerns are related to the ease of use of the application: if usage requires too much time, or the program is hard to install and configure, adaptation by the users is unlikely. The users need to see why the tool should be used, or what benefits this usage might yield.

Due to the nature of context-aware well-being applications, privacy is a major concern. Users should be in control of their own data, and be able to delete it if they desire to do so. Here, however, a potential conflict exists between the employer and the employee: if the application is to be deployed on a company infrastructure, the employer might want to own all the data collected about all the employees of the company. As such, the employer might be reluctant to allow employees to delete their data. Furthermore, the usage of this highly personal data by managers in order to make decisions, is an idea which none of the workshop participants liked. We can therefore conclude that the usage of this type of application within a company can only succeed if the user has full control over his own data, and no one but the user himself is able to read this information.

3 Methods, techniques and theories

In order to improve well-working among knowledge workers, we can use several different techniques. Firstly, we can try to gather more information regarding the context of the user and adapt our support accordingly. For this, we use *context recognition*. Once we have obtained the bigger picture regarding the user's way of working and environment, *user state modeling* can be used to have a representation of the user's current state, which can be used by the application. Finally, *persuasive techniques* can be used to influence the user into working differently.

3.1 Context recognition

(Reuters, 1998) describe the phenomenon of information overload, which is recognized as an important influence on stress as well as job satisfaction. In 1990, (Schick, Gordon, & Haka, 1990) defined information overload as *"occurring when the information processing demands on an individual's time to perform interactions and internal calculations exceed the supply or capacity of time available for such processing"*. It is believed that this reduces an individual's decision making capabilities. An example of source of information overload is mail. According to (Chui et al., 2012), a knowledge worker on average spends 28% of his or her time on handling mail. Additionally, it is a source of interruptions, which also has a negative impact on well-being. A solution for this problem is to make more efficient use of time or increase the time available.

One way to accomplish this is to use intelligent agents that can support users with their tasks. (Horvitz, Breese, Heckerman, Hovel, & Rommelse, 1998) developed the Lumière System that uses Bayesian Models to estimate the likelihood that a user requires assistance. It focuses on providing help with tasks in Microsoft Excel. (Myers et al., 2007) use the Believe-Desire-Intention model to understand what the user wants and needs. They developed an intelligent assistant that supports routine tasks.

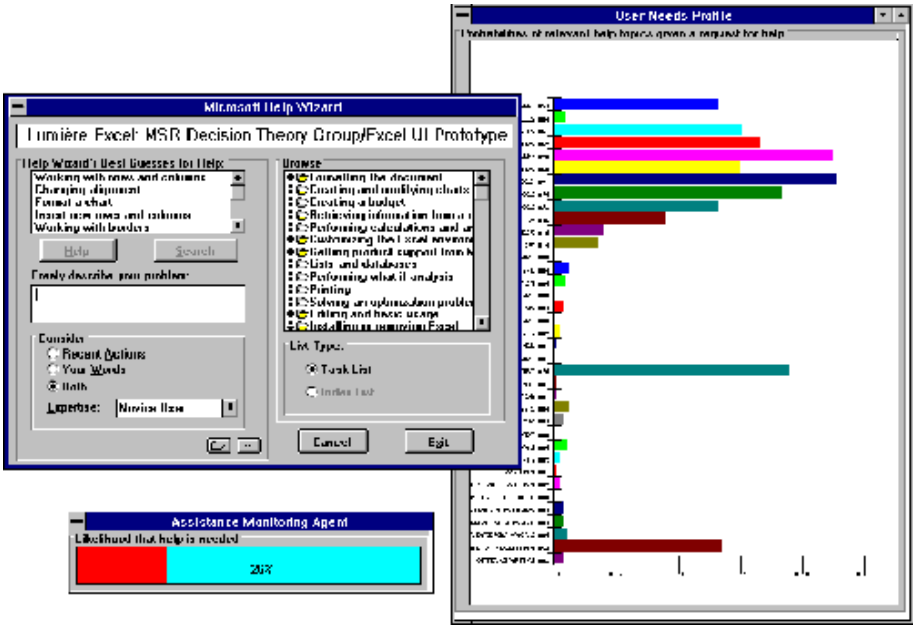

Figure 2 Screenshot of the Lumière Project interface (Horvitz, 2005)

Another way to make more efficient use of time is to "work in context", a concept that (Gomez-Perez, Grobelnik, Ruiz, Tilly, & Warren, 2009) mention. They define context as "a set of information

objects that are frequently accessed concurrently or within a very short time-span" which relates to our interpretation of "content context". The method of "working in context" targetes at improving the ability to find and access information sources. Information sources are associated with the contexts in which they were produced. This is the approach that is taken in the SWELL project. By recognizing the current context, information sources from other contexts can be filtered out such that they cannot distract the knowledge worker anymore. The knowledge worker can stay focused on the relevant and important sources.

There are several existing approaches to associate information objects with contexts and to recognize these contexts. (Bauer & Leake, 2001) have developed the WordSieve algorithm for extracting context during web browsing. This algorithm distinguishes contexts based on frequent terms in a sequence of document accesses. In IRIS, as defined by (Cheyer et al., 2005), users can create personal maps of their information sources. IRIS can help by discovering contacts and presenting salient phrases of optional clusters of information sources. (Kellar & Watters, 2006) use decision trees to identify a user's web tasks. (Oliver, Smith, Thakkar, & Surendran, 2006) cluster window events by looking at the relatedness of the window titles and the temporal closeness of the window activities.

(Warren, Gomez-Perez, & Ruiz, 2010) distinguish in the ACTIVE project the process of context discovery and context detection. The first process analyzes content of information sources and co-occurrence of document access to identify relations between documents which may form new contexts. The users are in charge of interpreting the relations and providing a name for the context. Information sources are tagged with this name. The process of context discovery refers to the identification of the current context by observing active documents and their associated context tags. When the system identifies a possible context switch, for example because a new document is opened that is tagged with a different context, the user is asked to confirm this.

3.2 User state modeling

(Eyck et al., 2006) state that one of the key research challenges in the area of persuasive technology for human well-being is: the quality and relevance of the machine sensing and inference techniques. We will now present some theory on user state modeling. Insight from these studies can be used in SWELL to select appropriate concepts to be modeled and sensors and features to be used for their automatic recognition. The success of our SWELL tool is crucially dependent on this.

In the area of user state modeling, (Neerincx, Kennedie, Grootjen, & Grootjen, 2009) present a cognitive task load model. Three factors are defined that have substantial influence on mental effort and task performance: (i) the time occupied, (ii) the level of information processing (skill-, rule- or knowledge-based) and (iii) the number of task switches. These three dimensions can be visualized in a cube, as visualized in Figure 3, in which different areas can be labeled as, for example underload, overload or optimal workload.

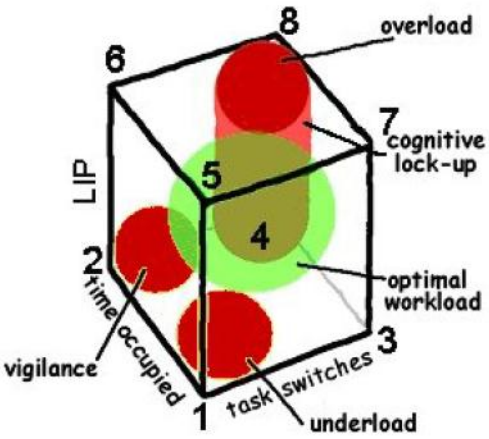

Figure 3 Cognitive task load model

In a second study the applicability in a real-world setting on a naval ship was tested by (Grootjen, Neerincx, Weert, & Truong, 2007). Features used were: audio (four raw speech features likely to be related to stress), video (emotions analyzed by FaceReader (Noldus, 2012)), eye tracking, physiological data (respiration, heart rate and heart rate variability), subjective data (complexity, effort, performance, scored every minute) and task data (videos analyzed by experts). Some of the issues encountered were missing data in case of eye tracking and problems with FaceReader due to bad illumination and different poses of the head. In general, real-world settings are challenging. In a paper on machine understanding on human behavior, (Pantic, Pentland, Nijholt, & Huang, 2006) mention the following problems: sensor malfunctioning, noise in sensed data, intra-class variations and spoof attacks of the users. It is thus important that in SWELL we do not only test applications in idealized lab settings, but to test the sensors and algorithms in the real-world and handle arising problems adequately.

Besides cognitive task load, (Neerincx et al., 2009) also model emotional state, which is defined in terms of arousal (low/ high) and valence (positive/ negative). The emotional state classes are: bored, relaxed, excited, stressed and neutral. These give us information on how someone is working. Based on a study, (Truong, Neerincx, & Leeuwen, 2008) conclude that the main challenge of inferring emotional state is that emotion recognizers should be able to deal with gradations of emotions which are common in realistic settings instead of only the extremes.

A related area of research investigates the interruptability of users. In a study by (Bailey & Iqbal, 2008), pupil dilation was used as a measure of workload. They found that different types of subtasks induce different amounts of workload and that workload is lower at subtask-boundaries. The authors conclude that interrupting users at subtask boundaries has a lower cost of interruption. For a real-world setting, however, they see little potential of using pupil dilation as measure for workload. Instead they suggest to use workload-based heuristics, i.e. a given type of subtask results in a certain workload, detect boundaries directly from a user's execution data or real-time measures of workload, like eye tracking or heart rate measures, with a side note on the detection method's intrusiveness.

(Hudson et al., 2003) performed a wizard of Oz feasibility study to find useful sensors for estimating interruptability. In this study users provided self-reports of interruptability (experience-sampling

technique) and humans coded the collected sensor information. A variety of different classification approaches were applied (naïve Bayes, support vector machines, AdaBoost with decision stumps) which yielded similar results. Their final model used the following most useful features: a sensor that measures whether anyone is talking, a telephone, a keyboard, a mouse and the time of the day. This choice was partly based on ease of implementation.

3.3 Theory on persuasive technology

Once we inferred information about the user, applications can use this information to provide tailored feedback and support. One important aim of SWELL is to improve well-being by giving insight in the manner of working and development of stress, and enable the user to learn better behavior patterns, e.g. for coping with stress.

There are various manners in which people cope with stress, which are listed by (Carver, Scheier, & Weintraub, 1989). Basically, there are two categories. First of all, problem focused coping, in which the source of stress is addressed. Examples are active coping (remove or circumvent the stressor), planning (coming up with an action strategy) or restraint coping (wait until an opportunity to act presents itself). Secondly, emotion focused coping in which emotional distress is managed. Examples are positive reinterpretation, seeking of emotional support or denial. Different people have different coping tendencies and some are more effective than others. SWELL could help people to become more aware of their stress levels and adopt a good way of coping.

As SWELL is aimed at changing behavior, several factors that are of influence on human behavior will have to be taken into account. These factors are described by (COI, 2009). Firstly, knowledge and awareness play an important role and providing information is often the first step towards behavior change. Secondly, attitudes play a role as they lead to intentions. Thirdly, habit and routine, which can become a key factor in driving behavior, are important factors. Fourth, self-efficacy plays a role; the lack of agency can be a strong barrier to behavioral change. Finally, emotions influence our behavior, both conscious and unconscious. Moreover humans are prone to certain biases. We tend to prioritize short-term reward over long-term gain and we have a natural preference for the status quo. The tool should support humans to overcome such shortcomings for successful behavior change.

(D Lockton, Harrison, & Stanton, 2009; Dan Lockton, Harrison, & Stanton, 2008) published several papers on designing for sustainable behavior. Their method is called ‘design with intent’, in which a product is designed in such a way that the desired behavioral change is made easy for the user. Examples are: rewards (bonus functions), real-time and summary feedback, scores (comparison to reference) or emotional engagement and personality (so users feel emotionally connected). Different persuasive strategies are listed by (B. J. Fogg, 2002). In our case the following strategies seem appropriate: Tailoring (individual customization), suggestion (intervention at the most opportune moment), self-monitoring (allowing users to track their own behaviors) and conditioning (reinforcement). Furthermore, (Cialdini, 2004) lists the following persuasive strategies: reciprocity (people feel obliged to return a favor), scarcity (when something is scarce, people value it more), authority (when a request or statement is made, people are more inclined to comply), commitment and consistency (people do as they said they would), liking (people say ‘yes’ to people they like). The effect of several strategies will have to be tested in user studies.

Certainly, individual differences will play a role. In a study by (Kaptein, Lacroix, & Saini, 2010) different persuasive strategies were tested. Most of their strategies aim at decreasing the perceived effort, while increasing anticipated rewards. They found that interventions that are tailored to the users' persuasion profiles were more effective.

A final concern is that attempts to create persuasive technology often fail, as is observed by (B J Fogg, 2009). According to the author one problem is that many projects are too ambitious. He provides an 8 step process, in which the main tip is to start with a simple problem and a receptive audience to test the success of small interventions. On basis of trial and error then the best strategies can be extended and built upon. A further tip he gives is to find out what prevents the target behavior: a lack of motivation, lack of ability or lack of a well-timed trigger to perform the behavior. The identified 'lack' is then to be addressed in order to improve the target behavior.

In general, the application's long term effectiveness is a very important concern. There is a need for long term user studies to establish the pleasantness of use, as well as its effectiveness for behavior change. (Eyck et al., 2006) state some important questions: 'Will the technology be perceived as subtle and non-irritating, or as bullying or patronizing?' and 'How tolerant will we be to incorrect inferences, improper feedback or bad timing?'. Good human-computer interaction will be crucial for our SWELL tool.

4 Existing applications

Although the idea of a completely integrated application that is to improve both the well-being and the well-working of knowledge workers is novel, several products already exist to support either one of these. In this report, we shall focus on the well-working applications; SWELL Deliverable D1.3 *User Needs Study on Person Centric Well-Being* deals with well-being support systems.

The best known software application for time management is likely to be Microsoft Outlook (Microsoft, 2012). This program, besides being a mail client, enables the user to create and manage calendars, task lists and todo lists. Although the application allows for a certain degree of self-management, it is a passive tool, in that it is to be fully configured by the user: it can provide the user with alarms and reminders for events, but only does so when configured to. The tool does not exhibit intelligence itself. Furthermore, Outlook can only be used as a planning tool. It does not provide the user with feedback regarding tasks performed, or advise about planning.

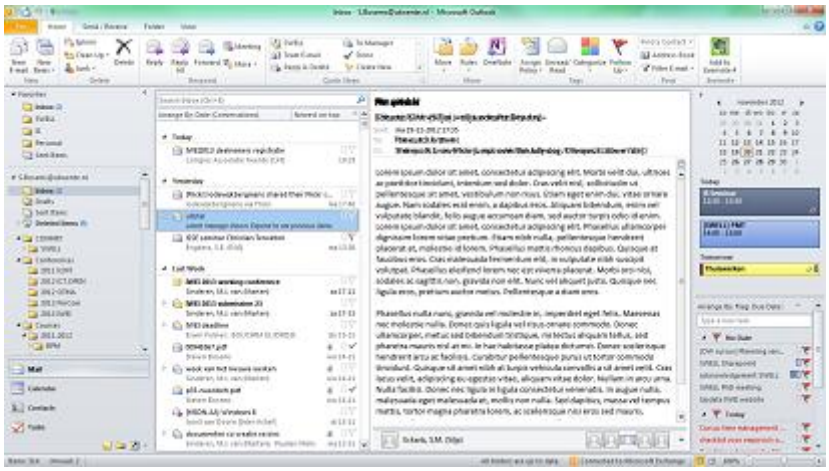

Figure 4 Microsoft Outlook

Another example of a task management application is Todoist (Doist, 2012). This cross-platform tool is available for all popular mobile and desktop operating systems and can also be accessed through a web interface. Although filtering on tasks, such that the user can track his productivity, can be performed, the tool does not allow for concrete time management, and does not provide the user with feedback based on his performance.

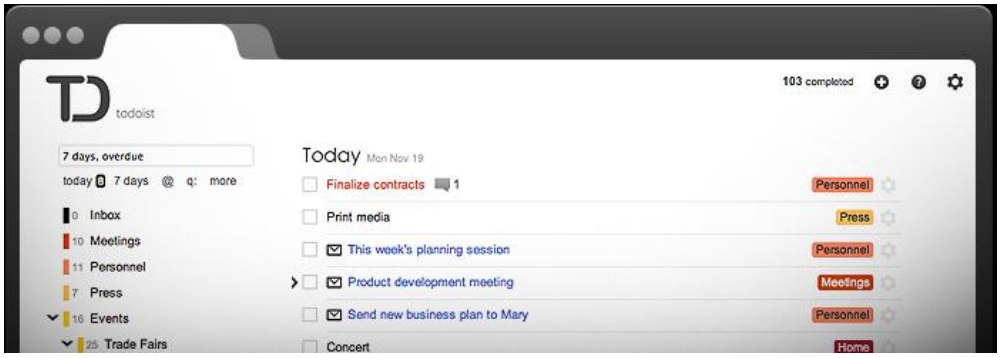

Figure 5 Todoist web interface (Doist, 2012)

Two systems that allow for detailed insight in one's time usage are Slife (Slife Labs, 2012) and RescueTime (RescueTime, 2012). Both these products are installed on the user's computer, after which the gathered data can be accessed through a web interface. Although the locally installed application has a simple interface, both websites offer extensive details about the user's computer behavior. This information includes the programs that have been used and for how long, websites visited and tasks performed. A drawback of the approach taken by these systems, is that the data presented to the user might be too extensive, resulting in a cluttered overview. Additionally, the tools can only provide a statistical overview: no feedback regarding work is provided.

Figure 6 SlifeWeb (Slife Labs, 2012)

An application designed to improve productivity is Stayfocusd (Transfusion Media, 2012). The tool allows the user to either block, or specifically allow websites for a given period of time. As such, it can prevent users from getting distracted by websites that do not benefit productivity. Due to the nature of this tool, it is an extension to the Chrome web browser, not a lot of additional features can be expected. The tool performs its single task in order to prevent the user from procrastinating and wasting time.

The cross-platform tool Evernote (Evernote Corporation, 2012) allows the user to keep notes and categorize files. Notes and files can be tagged, and assigned to notebooks. All notes created in the application are synchronized with the Evernote servers; when using a different computer or device, these notes can then be retrieved. Evernote allows for the creation of todo-lists in notes; when searching, the user can look for all notes that contain uncompleted todo-items.

Figure 7 RescueTime web interface (RescueTime, 2012)

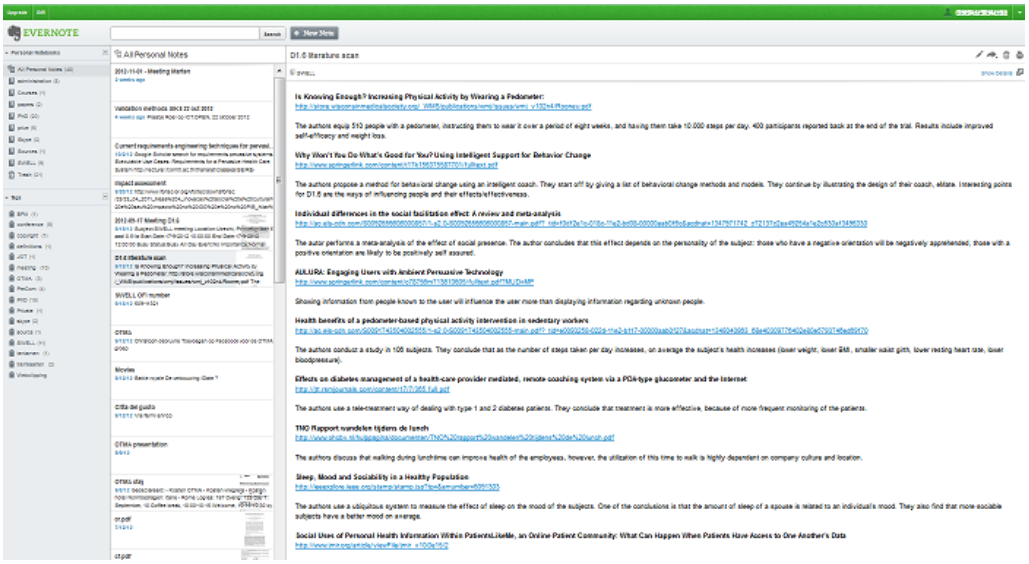

Figure 8 Evernote web interface

5 Discussion

In the previous chapters, we have discussed novel techniques and methods to improve well-working. Furthermore, we have taken a look at existing commercially available applications that are designed to enhance the user's productivity, or provide an overview of his work. In this chapter we discuss the gap that exists between what is possible and needed, and what is currently offered by commercial products.

5.1 Needs vs. available support

When comparing the current productivity tools available on the market with the research performed and the user requirements of well-working systems, we find that a lot has to be done in order to fully support the knowledge working in an everyday job.

We see that current tools support only one part of the user's work; some tools provide for task and calendar management, others allow the user to organize his documents, and yet another category of tools give the user insight in his everyday life and work. Full integration of these tools, however, is not yet available. As such, the tools do not have all potential information available that could be useful for the workings of the tool. A task management tool might benefit from insights into a user's calendar and a document management system could allow for the linking of documents to tasks, if it had this information.

When looking at the privacy settings that are offered by the tools, we see that these are not at the same level as the users might want them to be.

When looking at the tools that are currently commercially available, we see that nearly all of them heavily rely on the interaction with the user through a user interface: they cannot capture (through sensing) and infer (through reasoning) information themselves and require the user to input all data. This "feature" is the opposite of the user demand of a tool that does not hinder day to day activities and is ubiquitous. Through the use of context recognition, we can improve this. As described in section 3.1, these sensor based techniques allow us to recognize and use information about the user's context.

In order to make the system aware of the environment of the user, and of the user's current state, user state modeling can be applied. These techniques allow programs to better align with the demands of a user, given a certain state of mind. Due to the current levels of user context collection, however, these techniques cannot be used yet: as no context information is collected by the commercially available tools, we cannot infer the user's context, and as such, we cannot determine the current state of the user.

As none of the current tools provide us with context information, no persuasive techniques can be used that are specifically tailored to the user. As such, advice given will remain general to all users, which might result in less effective applications.

5.2 Recommendations for well-working applications

In this chapter, we have seen that as of current, a gap exists between products that are available, and techniques that exist in the lab. Due to this discrepancy, we can make several recommendations regarding the future development of well-working and productivity tools.

Firstly, in order to aid the user in all parts of his work, it is important for tools to be integrated or at least be able to use information stored in other tools. By combining information about the user, we obtain a better picture of him and as such can support him better by providing advice tailored specifically to him.

Secondly, context information ought to be collected and used in user-centric well-being applications. This information, again, will allow for the program to form a more complete picture of the user and tailor advice specifically to him. In order to be able to do this, both explicit and implicit user behavior should be studied and learned from.

Thirdly, as we are working with highly personal data, the user should have full confidence about the process of data collection, interpretation, and storage. If the user assumes his data is being misused, the usage of the system as a whole will suffer from this. As such, context-aware well-being applications should provide a transparent privacy policy and allow the user to manage what happens to his data at all times, including deletion of data.

Finally, the system should be adaptable to the user's needs. The user interface and other manifestations of the system to the user are likely to be personal, and in order to have the greatest effect, they should fit the user's expectations and preferences as good as possible. Again, this should be learned from both explicit and implicit user behavior.

6 SWELL related work

In initial research by (Sappelli, Verberne, & Kraaij, 2012) investigated whether directory structure on the user's file system could be used to label e-mail messages. The underlying idea is that the file system is better structured and that there is a correspondence between e-mail messages and documents on the file system. By using the structure on the file system, the user would not have to indicate or train the labels for the categorization of their e-mail messages, while still having personalized labels, which is in line with the goal of the SWELL project to provide unobtrusive personalized support. However, initial results indicated that it is not beneficial to use documents as training examples for e-mail categorization. The main reason is the importance of social aspects in categorizing mails, which is less important for categorizing documents.

(Koldijk, 2012a) aim to develop a tool that supports knowledge workers during their work. The final aim is to increase well-being at work. Therefore, the tool should be perfectly adapted to the user's current context and user state to provide appropriate feedback and support for their work. Feedback can create more awareness of e.g. mental workload or stress, and possible underlying causes. By providing support, e.g. presenting useful information just in time, the mental workload and stress can be kept in optimal ranges, ensuring well-being at work. The authors' three main research topics are:

- Requirements for the tool: which aspects need to be considered for making an effective support tool?
- Automatic recognition of context and user state: how can we enable inference of relevant aspects of context and user state, based on unobtrusive sensing?
- Developing feedback and support: which methods of feedback and support are most effective for the user?

These three aspects are elaborated on by (Koldijk, 2012b), where the author outline planned research approaches. Furthermore initial results are presented. Regarding requirements we present results from our questionnaire among knowledge workers to get better sight on the manner of working and experienced problems. Regarding recognition of context and user state we present our first model of sensors to be used and how they link to the different concepts to be recognized. First results regarding automatic recognition of the task a knowledge worker is currently working on, based on computer logging data, is presented. Regarding feedback and support ideas resulting from a workshop session with knowledge workers are shared.

(Koldijk, Staalduinen, Neerincx, & Kraaij, 2012) look at the possibility of recognizing user tasks based on computer activities. They state that knowledge workers rely on software for communication, information gathering, document creation and work planning, so a vast collection of digital traces is left behind on their computer. These are available in the form of mouse motion, click events, key presses and active window changes. The authors describe how they use these traces to automatically infer what task a user is currently performing. This enables them to automatically create a real-time overview of tasks for the user in an unobtrusive way.

To recognize knowledge workers' tasks automatically, a framework was necessary that specifies the mapping from low level computer interaction data to performed tasks. Therefore, the authors have defined a set of task labels based on a questionnaire among knowledge workers. They selected fea-

tures that can be derived from computer logging data that were most useful for distinguishing the defined tasks, e.g. the active application or amount of chars typed. Four classification approaches were then evaluated on a real-world dataset in which 11 knowledge workers annotated their activities.

The research shows that task recognition on the basis of PC activity is challenging but feasible. Task recognition is personal as different users have different work styles and task mixes. Nevertheless, it is recognized that on an individual basis, the simple classifiers used learn to recognize tasks work quite fast, yielding a performance up to 80% which is reasonable high, considering 12 possible task labels that were used. Finally, since different users show different patterns of behavior when performing a task, the classification model should be trained for each specific user to yield optimal task recognition. The authors conclude that no more than 2.5 hours (30 instances) of representative training examples is required to train a good model.

(Koldijk, Neerincx, & Kraaij, 2012) investigate how well-being at work can be improved by means of computer tools. They focus on the unobtrusive measurement of workload and stress in order to give knowledge workers feedback and support in their way of working, preventing burn-out in an early stage. In this extended abstract for MB 2012 the authors describe how the context and user state of an individual knowledge worker will be captured, interpreted and used in a coaching tool aimed at changing behavior, resulting in improved well-being at work.

The determinants for well-being at work, which were identified based on a literature study, are outlined. For providing effective support to knowledge workers it is crucial to understand their current situation. The authors intend to capture these contexts automatically, without user effort. The inference of context will be formulated as a pattern recognition problem. From various sensors, specific features will be extracted which are provided to a classifier to assign a label. A model for linking different sensors to aspects of context to be recognized is presented.

(Bosems, 2012a, 2012b) recognizes that current requirements engineering methods are insufficient for the emerging class of context-aware systems. As a result, system features do not fulfill the user requirements, which may result in the risk of an incomplete system, or a system that is a hindrance to the user. If this is the case, the user will neglect the system. The author proposes a model-driven method of requirements engineering to mitigate these risks. The envisioned method is to improve the alignment of user requirements and system architectures by increasing user involvement in the requirements engineering process, and increase reuse of system artifacts created during the RE phase of the project.

7 Conclusions

In the current information age, knowledge workers can easily obtain a nearly infinite amount of information that can aid them in their work, and can communicate with somebody on the other side of the planet with the push of a button. The turn side of this, however, is that communication finds their ways to the worker too, causing distractions, task switches, and as a result, stress. SWELL aims to develop a smart-reasoning tool that will aid the knowledge working in obtaining and attaining a state of well-working.

In this report, we have seen that a lot of research already exists in the field of context recognition and user persuasion, but that these techniques have not yet found their way to current commercial products. Current tools do provide means to increase productivity, but lack the ability to support the user into gaining insight in their daily activity, and improve their own way of working. We have proposed advices that should improve current and future tools if they are implemented. When combining the tool as envisioned with methods to improve the physical well-being of knowledge workers, we can improve the experienced well-being as a whole.

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