POSITIONING OF VIRTUAL WORKSPACES IN WORKING SITUATIONS FOR COLLABORATIVE DESIGN TEAMS

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Abstract

Today, product development in distributed teams is gaining popularity. This often saves time, and it can be very cost-effective due to reduced business travel. At the same time, there has been a shift from video conferencing equipment to modern desktop-conferencing tools. As a result, the usual working situation is that each team member is sitting behind his or her PC.

This paper addresses virtual collaboration in a larger perspective. This perspective connects active work surfaces with virtual collaboration tools. These work surfaces are used actively as an integrated part of a holistic approach. In particular, the importance of good visualization tools to create a shared understanding is emphasized. The goal is to equip the physical rooms and surroundings where we work, with virtual characteristics.

1 Introduction

This paper describes positioning of a virtual workspace in various working situations. New emerging technologies bridge the gap between virtual workspaces and our physical surroundings. In particular, projectors and digital whiteboards introduce new opportunities. An example of such a digital whiteboard technology is e-beam, which is used at NTNU. These technologies create interactive surfaces for design, visualization and presentation purposes. In turn these can be linked to virtual workspaces in ways that make the transition from collaborative design activities to digital files more efficient. These tools can be utilized in many different design situations. Hence, there is a need to understand the relations between the workspace and the various remote technologies the workspace is linked to. This can be described as positioning of the workspace in various working situations. These mechanisms have been explored in a series of case studies in 2001 and 2002.

The label virtual workspace is an attempt to recreate virtually what is known from the physical domain. This is described by Maher [2]. A workspace is a “place” a person can attend to when he or she is about to engage in work related activities. This place is equipped with a set of supportive tools. The standard process until recently has been to recreate as much as possible of the physical domain in virtual workspaces, giving a “physical” look and feel. This paper discusses the impact of actively positioning the workspace in various contexts

or working situations. The goal is to gain a better understanding of the relations between the tools designers use when designing, communicating and collaborating. Designers often use both a main virtual workspace and various remote technologies of a supportive character. Figure 1 shows how there is a need to balance and position virtual workspaces in the right context.

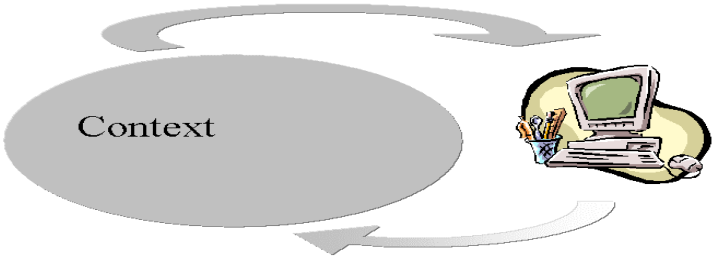

Figure 1. Positioning virtual workspaces in the right context [6]

The workspace discussed in this paper is a web-based, integrated product development portal solution. This consists of a collection of synchronous and asynchronous communication tools, document handling capabilities and an information bank. It is labelled PU-Portal, and it is designed to facilitate a variety of different working situations. Observations indicate that standardization of tools will lead to a more effective and efficient overall product development process. In particular this seems to be true when the standardization occurs across the different situations designers find themselves in over time.

2 Existing Design Methodology

The process of design can be seen as "changing existing situations into preferred ones" [3]. This definition is usually utilized when designing artefacts, but it can also be used when designing the *working situation*, where the design of artefacts takes place. Product development theory describes product development as a sequence of distinct activities. What are often described are *what* to do, and sometimes also a rationale explaining *why* this approach is necessary or suitable. However, a detailed description of *how* to perform a design task is often omitted. Problem solving can be described as a selection from available means, the one best suited to established ends. However, the broader concept of *problem setting*, where the decision to be made, the ends to be achieved, and the means which may be chosen, is often ignored [3]. The activity of formulating and debating a design problem, where knowledge is represented as an open, multi-faceted problematic, is essential in product development. In this paper the context of the problem is considered a part of this problematic.

Hence, how to solve an ill-defined problem does not only depend on the character of the problem, but also on the situation in which the problem presents itself. Configuration of contextual factors in different working situations thus can be handled as a means to enhance the problem solving capabilities. This can be describes as building contextual support for the different product development processes. First, increasing the effectiveness of the design process by improving work portability between working situations is considered important. Second, increasing the efficiency of the design process by creating value-adding surroundings is also discussed.

According to Ulrich and Eppinger, the product development process can be described as *"the sequence or steps that an enterprise employs to conceive, design and commercialise a product"* [4]. The traditional, sequential, problem-oriented approach prescribes a logical cause and effect relationship between current design problems and how to solve the problem. The essential relation is between the problem and the standard problem solving method for that particular problem or group of problems. Lerdahl has described these context free methods as follows: *"The user context is then viewed as one of many rational criteria in the specification phase. Furthermore these methods try to be independent of the context in which the product is supposed to fit"* [5]. Hence, traditionally, external factors in product development have not been considered to be important. However, product development is a very complex activity where the designer typically changes environment several times per day. The availability of tools and people, in addition to differences in the surroundings, change as the designer move from one working situation to another. Contextual factors should be treated as a mediating element in working situations. The framework discussed here suggests that the problem solving process should be a configuration of the best available problem solving methods or activities that are properly aligned with a supportive combination of contextual factors.

3 Technology as a Contextual Factor in Product Development

Contextual factors in product development can be described as surroundings, people and technology [6]. Different surroundings define the physical context of any design process. Different team configurations (the people aspect) within certain surroundings influence the way and how often we communicate with each other. Technology influences the way we perform design tasks by introducing new opportunities and new ways of communicating, exchanging and sharing information. In addition, technology enhances the overall functionality and improves flexibility. This makes it possible to perform design activities independently of time and location.

Engineering designers utilize and depend on both their physical surroundings and different tools in order to be effective. These are often technology-based, and they can be generic or engineering-specific. In other words engineers "orchestrate" their design process using the wide array of tools and contextual factors that are available at their disposal. It is still possible to identify and categorize the various contextual factors and tools in use, and place these in the physical or virtual domain respectively. However, it is no longer possible to categorize the *process of designing* in such a manner that it can be placed solely in one category or the other. This is due to the fact that the physical and virtual domains are approaching each other, and that they are becoming increasingly interdependent.

Figure 2 describes how physual designing in the *physual domain* combine the favorable characteristics of both the physical and the virtual domain. By doing this, it is possible to obtain a combination of effective visualization across time and space, with increased flexibility. This will in turn increase the ability to carry out product development in globally dispersed teams. In addition, it is made possible to effectively and continuously monitor the early phases of product development. The physical domain, or what we normally perceive as surroundings, is very powerful in terms of supporting a feeling of presence and real time collaboration. It is also powerful in terms of communicating through effective, large-scale visualization and the use of body language, which can trigger many senses simultaneously. Surroundings thus provide a broad, shared framework that can add value to a process. This is

done by acting as a platform for shared mental models, and by supporting a feeling of presence, trust and close collaboration.

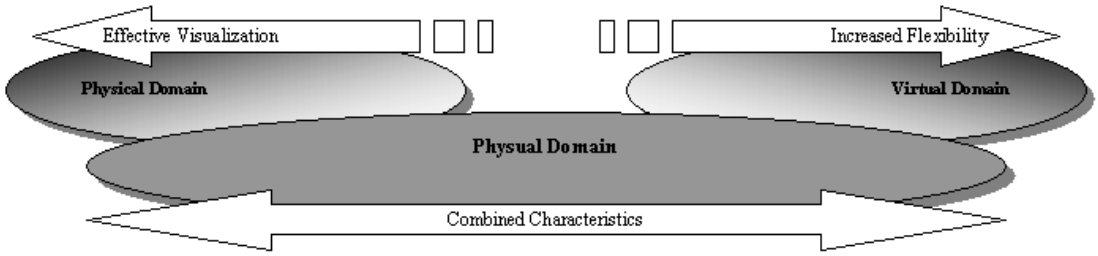

Figure 2. The physual domain, combining the physical and virtual domains [1]

New remote technologies offered today can be linked to virtual workspaces. Hence, they provide a bridge between what we perceive as being a part of our surroundings and what we normally would refer to as technology. By making better use of such technologies and by adapting them to the design goals, it is possible to combine favorable characteristics of suitable, value-adding surroundings and well-adapted technologies that increase work portability across different working situations. Technologies such as digital whiteboards placed in our surroundings offer the advantage that the input and output surfaces remains the same. This is well adapted to the favorable process that takes place during engineering design, where the designer actively reflects on his or her own design process [3].

3.1 Virtual Workspaces

Today, virtual workspaces often are presented as portal solutions. This approach signalises that the virtual workspace provides a single point of entry for all information. Department of Machine Design and Materials Technology at NTNU has developed its own virtual workspace, called “PU-portal” from the Norwegian term *produktutviklingsportal*, which translates into *product development portal*. This portal solution is an attempt to develop a fully integrated system of synchronous and asynchronous communication tools combined with document handling capabilities adapted to the needs of engineering designers. A main virtual workspace like this gives the virtual workspace certain “physical” properties, supporting a feeling of shared presence over distance. As shown in figure 3, the PU-portal consists of these features: A main workspace, a navigation bar, document templates and other document handling capabilities (adapted to the design methodology taught at NTNU). In addition, it contains a discussion forum, a tool guide (to assist students in using the different ICT tools available at NTNU), and a full workgroup mail client including calendar, tasks and journal. It also contains a messenger client combined with a status display for online coordination, and to see whether team members are online or not. Finally, there is an integrated SMS (short message service) client for effective and efficient team coordination even when the team members do not have a computer available. This system is set up with mobile group messaging, so each of the team members can reach the group by entering a simple code before the text message from their own cellular phone, making team coordination very flexible.

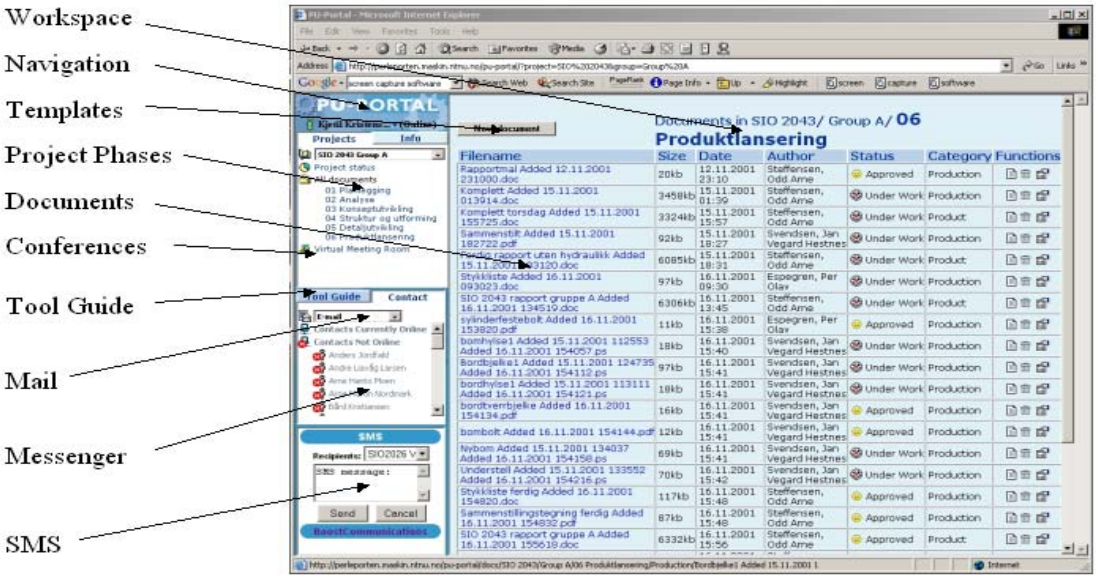

Figure 3. The PU-portal and its components

3.2 Remote Technologies and Peripheral Devices

While the virtual workspace gives the digital world "physical" properties, the role of the remote technologies discussed below are rather the opposite. These peripheral devices are physical artefacts designers interact with in a physical context, and they distinguish themselves from the virtual workspace they are connected with by providing a link in the opposite direction. Hence, they give the physical world digital, virtual characteristics. This supports the feeling of shared presence over distance by removing communication barriers such as the capability to work on the same sketches over distance. This is nearly impossible through the use of traditional methods, and the same is in fact true for stand-alone virtual workspaces. In particular, these do not provide the required functionality for engineering designers with diverse sketching needs.

Through a series of case studies, observations indicate that in order to be effective, the virtual workspace should be treated as a part of a larger context. It is thus necessary to move from a viewpoint that the workspace is a stand-alone tool to a viewpoint where the workspace is properly positioned in a larger context. Remote technology or peripheral devices such as capturing tools, digital cameras, automatic scanner systems, LCD projectors, digital whiteboards, web cameras, electronic pens & tablets et cetera all represent tools that facilitates transfer of work either from the digital world out in the physical world, or vice versa. As such, remote technologies can be used to bridge context and workspaces. Thus, these technologies improve work portability.

In addition to improving work portability, these peripheral devices are also considered an important part of the surroundings by suggesting particular working methods for a particular room or location. Hence, they can also be viewed as atmosphere-creating enablers. The choice of peripheral devices can also be used actively as a means to create atmosphere and to provide extra value in certain situations, by defining their character. The main virtual workspace should therefore be viewed as the carrier of work between different working situations.

Peripheral devices, on the other hand, should be viewed as enablers that make it possible to position the virtual workspace effectively with each working situation. This is done by providing the necessary connections between surroundings, technology and natural input/output means for designers.

Among the input devices that have been tested are various digital electronic pens, such as Wacom Graphire, whiteboard-capturing devices such as e-Beam and Smartboard. These input devices allow “physical work” such as sketches and drawings, to be automatically digitalized and ready for real time sharing in dispersed teams. Output devices such as LCD projectors provide the other necessity in addition to input devices with physual characteristics. It is these that facilitate the transition from digital files to “physical representations” of the contents.

4 Positioning Virtual Workspaces in Working Situations

By combining input and output devices with physual characteristics, it is possible to improve the feeling of shared presence over distance. Combined, these tools can therefore be described as presence-enhancing tools.

By orchestrating the surroundings and the technology, with emphasis on tools enabling physual designing processes, the PU-portal can be positioned effectively in the office, meeting room, design studio, and a variety of other settings, assisting collaboration where it is needed. Hence, it is possible to support a continuous transformation cycle between the physical, artefact-based world and the virtual world, with its flexible characteristics in terms of allowing information to be shared over distance, and in a variety of formats. This cycle is shown in figure 4.

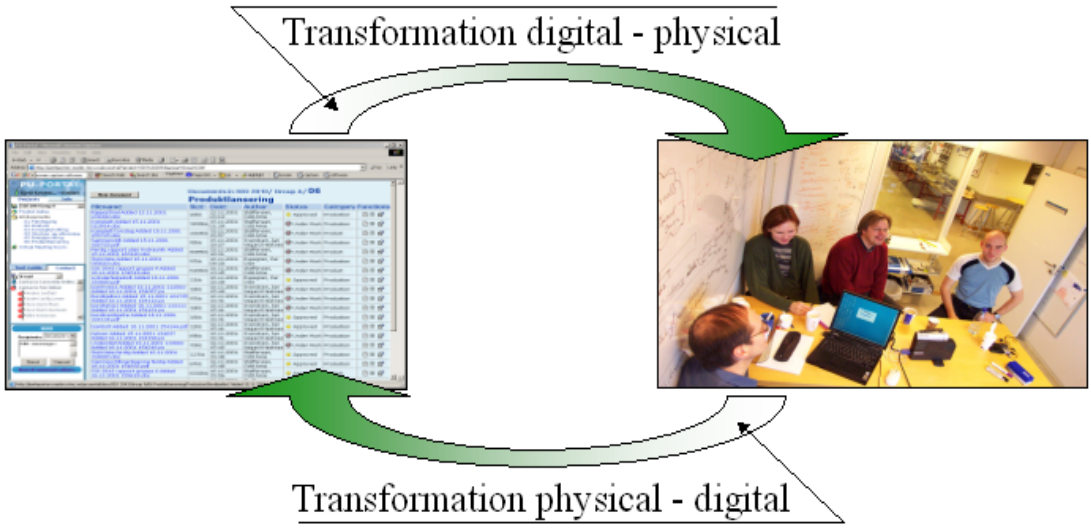

Figure 4. Work portability – transformation cycle physical-digital

The core technologies in use in product development should be used to create a usable context for design activities. These are connected to the surroundings through their input and output

devices. The latter is especially true for peripheral devices. In order to build sufficient contextual support for various design processes, these peripheral devices play an important role as connectors where designers can interact with complex systems, and as enablers making it possible for designers to communicate and perform design activities in a natural manner, with few constraints.

Creative processes are most effective and efficient in contexts that are relatively hassle-free and where disturbances play only a minor role. Put simply, the context of working situations must be *usable*. ISO 9241 part 11 [7] defines usability as "The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use." Although defined for products, this definition can be used to illustrate the importance of having access to a usable context, in which to perform design activities. Design processes should also be effective, efficient, and provide some level of satisfaction for the designer. Furthermore, the team configuration and the essential technology necessary to perform the desired activities must be usable. In order for virtual workspaces to become adequately usable, it is necessary to position the workspace and manage its relations with other contextual factors. In this paper the importance of creating a strong contextual foundation through positioning well-adapted peripheral devices such as capturing tools, scanners, et cetera is highlighted. Finally, the remaining aspects of the context, the surroundings, should also be usable in terms of adding value to the process by suggesting a certain atmosphere or mood. Technology can play an important role in this category as well.

5 Conclusions

Case studies at NTNU have indicated that the context of the design process should be considered important. The contextual factors defined by surroundings, people and technology should be viewed as an interrelated system where the various components must be properly positioned in relation to the other components of the system. This is important in order to provide full contextual support for the ongoing process. In particular, this is true for virtual workspaces. One should make sure that there are adequate connections between the virtual workspace and the surroundings. This can be accomplished by actively using peripheral devices such as capturing tools, scanner systems and projectors to enhance work portability and create value-adding surroundings. A well-adapted system of a main virtual workspace, and a set of suitable peripheral devices form a good basis for a system with high usability. The main virtual workspace here provides a single point of entry across all working situations, while the peripheral devices should be adapted to each situation. Combined, they provide contextual process support.

Suggestions for further research include strengthening the framework. This could be done by identifying ways of configuring a suitable set of peripheral devices when a design problem is given. The team setting, and the particular context will then provide additional input in order to create adequate support for the virtual workspace in a variety of working situations.

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