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The Virtual Reality of Work – How to Create a Workplace that Enhances Well-Being for a Mobile Employee

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1. Introduction

New developments in information and communication technology have changed the way people approach their life and work. Mobile virtual work is no longer bound to fixed locations as utilizing information and communication technology allows people to function freely in various environments. The employee is considered as mobile, when he works more than ten hours per week outside of the primary workplace and uses information and communication technologies for collaboration (Gareis et al., 2006; Vartiainen & Hyrkkänen 2010). Virtual reality (Fox et al., 2009), as an environment related to the new 'anytime anywhere work', can be called *the virtual workplace*. The virtual workplace provides connectivity through different size of devices and is accessed by different interfaces when supporting the performance of both individual and collaborative activities (Nenonen et al., 2009).

The interest of this article is the interrelationship between the physical and the virtual workplace not only with regard to their infrastructure, but also to their social and cultural contexts. Both prerequisites connected to the virtual workplace and its actual use can be challenging. It could be claimed, for instance, that simultaneous physical and virtual co-presence is generally not yet mastered in an effective way and that there still exist certain bottlenecks for a mobile employee in entering virtual reality.

Vischer (2007, 2008) has analyzed the workplace as a physical, functional and psychological entity in order to identify features related to comfort and fit between a workplace and an employee (fig 1). When the environment sets inappropriate or excessive demands to users, in spite of their adaptation and adjustment behaviors, it manifests the concept of misfit. In a good fit there is a balance between a person's abilities, skills, degree of control and decision latitude and the work environment's demands, complexity, expectations and challenges. The nature of person-environment transactions arouses the sensation of either comfort or stress. Comfort may be considered as the fit of the user to the environment in the context of work. (Vischer 2005, 2007, see also Dainoff et al. 2007.)

According to Vischer (2007), environmental comfort encompasses three hierarchical categories: the physical, functional, and psychological. Physical comfort relates to basic human needs, i.e. safety, hygiene and accessibility. These needs are responded to by

applying building codes and standards. Functional comfort is defined in terms of support for users' performance in work-related tasks and activities. Psychological comfort is related to feelings of belonging, ownership and control over workspace. We have expanded the category of psychological comfort and fit also to cover the social factors, and named the third category psychosocial comfort and fit.

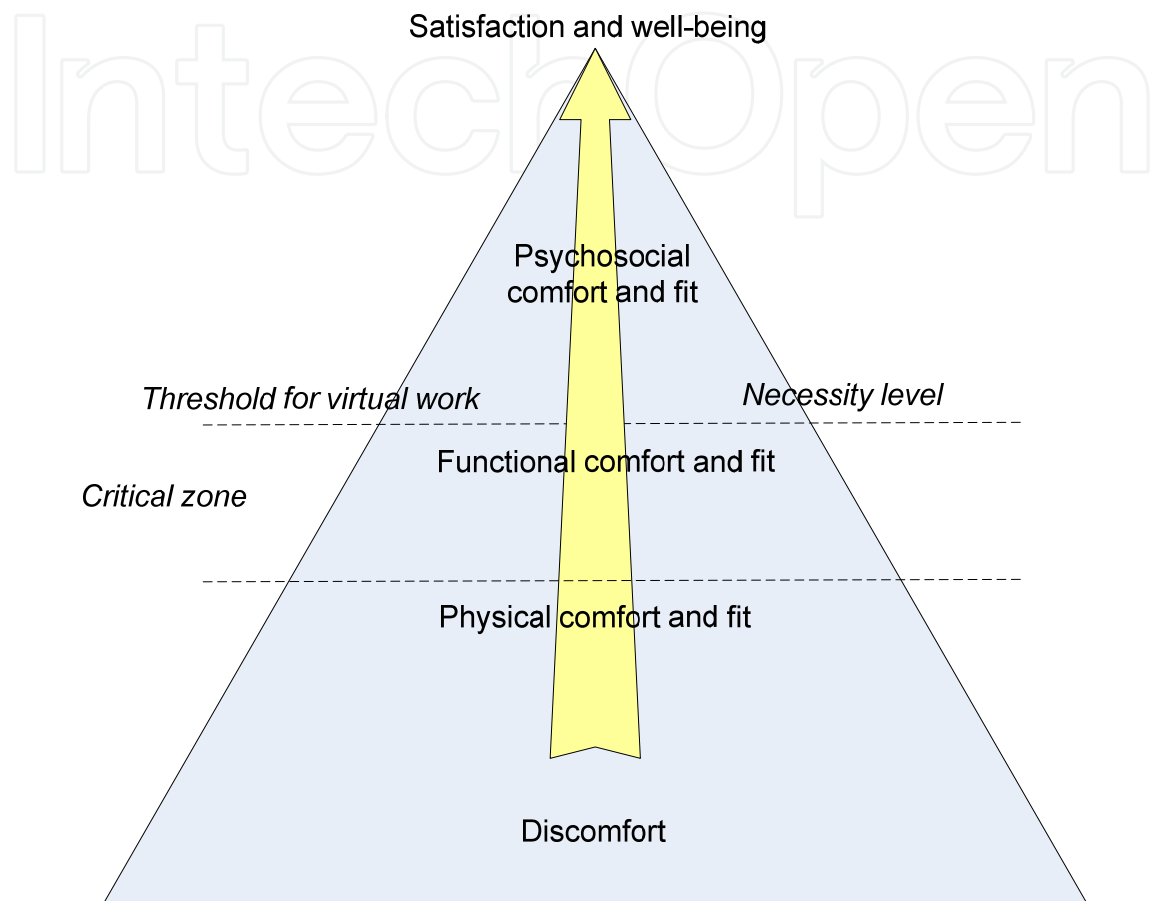


Fig. 1. Vischer's (2005) model of comfort and fit modified (Hyrkkänen & Nenonen, 2011) for assessing virtual work places

Vischer's user-centered model (2007) merges environmental aspects with psychological aspects in a dynamic way. Vischer has developed this abovementioned model for assessing the fit or misfit of physical workspace. We have tested and developed its applicability for assessing virtual places (see Hyrkkänen & Nenonen 2011). In this article, the virtual workplace will be analyzed as a three-level entity that enhances well-being from the point of view of the mobile employee.

The purpose of this chapter is to explore what are the elements of the virtual workplace that either hinder or enable productive mobile virtual work processes and well-being at work. The script will proceed as follows: first, there will be a broad literature inspection of the physical, functional and psychosocial elements of comfort and fit which either hinder or enable productive mobile virtual work. Secondly the method and findings of a preliminary study called "virtual me" will be presented for enlivening the literature review findings with vivid up to date data.

2. Background

The basic proposition in the background of this research follows the idea of Vischer's modified and tested model (Hyrkkänen & Nenonen 2011). The factors of fit and misfit are in the upcoming chapters examined from the physical, functional and psychosocial perspectives.

2.1 The elements of physical comfort and fit in the virtual workplace of a mobile employee

The elements of physical spaces and places impact on the possibilities for effective virtual work. Constraints of physical places hamper the mobile worker's way to virtual work places. It could be claimed that the access to the virtual reality is restricted in many ways by poor and out of date working environments, their lay outs, electrical designs and furniture. The reviewed articles demonstrated and confirmed this by describing many situations where the mobile employees met physical hindrances.

Despite the increase of "hot desking", many odd places are still offered for building up a work station, especially if the mobile employee is an occasional visitor (Hislop & Axtell, 2009; Mark & Su, 2010) at his own company's or customer's premises. At public places, mobile employees have even reported the need to compete for electrical power due to a limited amount of power outlets (Axtell et al., 2008; Brown & O'Hara, 2003; Forlano b, 2008; Mark & Su, 2010).

When executing the anywhere working style, the employee will undoubtedly encounter many physical places that are not in the first hand designed primarily for working purposes. This is likely to happen at airports, in different means of transportation, in cafeterias or in hotel rooms (Axtell et al., 2008; Breure & van Meel, 2003; Brown & O'Hara, 2003; Laurier, 2004; Laurier & Philo, 2003). Their furniture is primarily designed for travelling or for leisure time activities. They are hardly convertible for working. For example, in trains there are no flat surfaces large enough for laying down portable mobile devices (Perry & Brodie, 2006).

In the physical fit of virtual reality lies also the question of its appropriateness to the human sensory system. For example visual and auditory problems may arise. For ensuring the success of work, mobile employees carry many tools with them - including redundant tools to be on the safe side. To avoid letting the burden grow beyond measure, increasingly smaller-sized devices are selected. With small size you inevitably choose small displays - and visual difficulties. (Axtell et al., 2008; Brown & O'Hara, 2003; Felstead et al., 2005; Hislop & Axtell, 2009; Mark & Su, 2010; Perry et al., 2001; Perry & Brodie, 2006; Vartiainen & Hyrkkänen, 2010; Venezia & Allee, 2007.)

Noisy physical environments may disturb and interrupt concentrated working in virtual reality. Especially in public places, in trains and airplanes, tourists and neighbors near the mobile worker may disturb the work (Axtell et al., 2008; Breure & van Meel, 2003). On the other hand, a smooth level of discussing voices e.g. in a cafeteria may help the worker to relax and lose him/herself in virtual reality (Forlano, 2008a; Rasila et al. 2011).

The contradictory relation between the physical and virtual worlds might cause the misfit which may also lead to safety risks, e.g. when driving a car (Laurier & Philo, 2003; Perry &

Brodie, 2006). Switching concentration from driving to working with ICT-tools causes hazards and is therefore for safety reasons limited by law and norms. (Hislop & Axtell, 2009).

2.2 The elements of functional comfort and fit in the virtual workplace of a mobile employee

The functional fit or misfit of the workplace can be assessed by defining the degree to which occupants can either conserve their attention and energy for their tasks or expend it to cope with poor environmental conditions. Related to the functional fit of virtual places, the connectivity problems that cause disturbances and hindrances to virtual work flow are crucial. The maturity and sophistication of the ICT infrastructure is one of the key factors. For example, the Wi-Fi connections are not yet fully developed in all environments (Axtell, et al., 2008).

Some of the connectivity problems are derived from the limited skills of mobile workers in employing virtual settings and infrastructure (Hallford, 2005; Mann & Holdsworth, 2003; Mark & Su, 2010; Perry & Brodie, 2006; Vartiainen & Hyrkkänen, 2010; Venezia & Allee, 2007). Time constraints and tight schedules of mobile employees together with time-consuming downloads of connections and programs also make it unreasonable to start virtual work (Axtell et al., 2008; Brown & O'Hara, 2003; Breure & van Meel, 2005; Mark & Su, 2010; Perry et al., 2001; Perry & Brodie, 2006).

The security regulations of mobile employees' own or their customers' companies may hinder the access to and functioning in virtual places (Brown & O'Hara, 2003; Mark & Su, 2010;). In addition very expensive connections may present a barrier to employing functional connections (Axtell et al., 2008).

2.3 The elements of psychosocial comfort and fit in the virtual workplace of a mobile employee

In Vischer's (2005, 2007) environmental comfort model, psychological comfort links psychosocial aspects with environmental design and management of workspace through the concepts of *territoriality, privacy and control*.

A sense of territory is associated with feelings of belonging and ownership. Territoriality of the virtual work place may be considered as a different composition of public, semipublic and private virtual places. Public shared places and platforms include the internet, many applications of social media and interfaces which are open for everyone. Semipublic areas include applications and media channels which demand an identity but are still shared among a defined group of users. The private zone requires a personal key and passwords and the content is not shared or if so, the principles of sharing are decided by the individual user. Virtual territory is personalized by individual choices e.g. in screen savers, chosen applications and programs. The visual appearance is a significant factor indicating both individual ownership and social belonging e.g. to the organization (see Ettlinger 2008).

In many cases, the need for belonging will not come true in virtual spaces (Brown & O'Hara, 2003; Hallford, 2005; Mann & Hodsworth, 2003, Perry et al., 2001). The lack of belonging is affected also by limited access to colleagues and individuals, who are distant. This is the case of the mobile employee's physical world but also the case of virtual reality, e.g., when

an employer attempts to avoid huge operating expenses (Axtell et al., 2008). Furthermore, the perceived problems of spreading tacit knowledge in virtual spaces (Hallford, 2005) can be seen as a factor of territoriality. The sense of presence is not easy to create.

According to Vischer (2007), privacy is best understood as the need to exercise control over one's accessibility to others. In virtual spaces and places there are, e.g., problems in controlling simultaneous co- and telepresence (Brown & O'Hara, 2003; Hallford, 2005; Green, 2002; Mark & Su, 2010; Tietze & Musson, 2005). In addition, the need for better privacy mastery is confronted (Axtell et al., 2008; Brown & O'Hara 2003; Breure & van Meel, 2003; Hislop & Axtell, 2009; Mark & Su, 2010; Perry & Brodie, 2006) e.g. when you are handling confidential things with your ICT tools.

In Vischer's model (2005), environmental control consists of mechanical or instrumental control, and empowerment. Instrumental control exists, if the employee masters his furniture, devices and tools. Empowerment as a form of environmental control arises from participation in the workplace decision making. The reviewed articles highlighted the lack of control in staying in virtual reality. The stress arose from expectations of continuous availability (Brown & O'Hara, 2003; Felstead et al., 2005; Hallford, 2005; Green, 2002; Mark & Su, 2010; Tietze & Musson 2005).

When comparing the factors identified in the reviewed articles to Vischer's psychosocial factors, the similarities are evident. Ensuring the psychosocial fit of a virtual workplace is the question of territoriality, privacy and control.

3. Method

In order to reflect the results of the literature review, a small scale empirical survey was carried out. The experience sampling method (ESM) was used as the research method. ESM refers to a technique that enables the capturing of people's behaviors, thoughts, or feelings as they occur in real time (Hektner et al. 2006).

The ESM research process consisted of five stages. In the first stage the design for the research was made and the diary booklet was designed and tested. In the second stage the subjects were contacted and the diary booklet was delivered to them. The sample of 20 employees (users) from different organizations participated. They were instructed to carefully enter all their actions and places they had been to in a diary booklet. The diary phase focused on what virtual devices and tools are used and for what purposes. In the third stage, the filled diary booklets were retrieved and familiarized with and the first interpretations were made. In the fourth stage, the interviews concerning the themes of fit and misfit in virtual work places were finalized and carried out with 10 users. The aim of the interview phase was to examine employees' experiences of fit or misfit concerning physical, functional and psychosocial features of their virtual workplace. In the fifth and final stage the final interpretation of the collected material was done with help of AtlasTi-program.

ESM can be seen as an application of a probes method. The probes method is a user-centered design approach and a qualitative knowledge gathering research tool that is based on user participation by means of self-documentation (Gaver et al. 1999; Gaver et al. 2004; Boeher et al. 2007; Mattelmäki 2008). The purpose of the method is to understand human phenomena and find signals of new opportunities by examining users' personal perceptions and background.

More precisely, probes are a collection of evocative assignments through which or inspired by which the users actively record requested material (Mattelmäki 2008). The most typical forms of traditional self-documentation are diaries and camera studies. The academic purpose of self-documentation is to examine the daily factors of human lives. (Graham et al. 2007; Mattelmäki 2008.) A relevant feature of self-documentation is collecting data from several situations that increase the reliability of the research (DeLongis et al. 1992). Self-documentation also minimizes the observers' possible influence on the person observed.

4. Results

Virtual devices and applications make it possible to work from almost any physical location. Some of the users started the working day in bed when waking up in the morning, by reading emails with their mobile phones and ended it in the same place before going to sleep. The use of virtual tools was constant: at all times, in all places, in work and in leisure. For instance, both making and answering work related phone calls and emails are done when shifting from one physical location to another in staircases, streets, cars, public transportation vehicles, taxis, airports and airplanes. The virtual tools are also used in the middle of different kind of work and leisure related events and meetings such as in lunch restaurants, cafés and bars, offices, seminar facilities, saunas and at home. As one user (U4) wrote in his diary: "I welcomed seminar guests and at the same time I answered some phone calls".

4.1 Physical comfort and fit in the virtual workplace of a mobile employee

The themes of discourse about physical comfort included tools and application for the virtual work as well as the places for the work including the theme of ergonomics (fig. 2). The employees used multiple physical places for work during their working days and the amount of different devices and applications that were utilized was numerous and varied from user to user. The most common virtual devices carried with were laptop and mobile phone. Some users also worked with table computers. The most common virtual application was the e-mail. Additionally, users applied a wide range of other applications. Some of them were used via the Internet e.g. Facebook, Skype, Google, blog, virtual newspapers and net banks. Some of them did not demand an internet connection like shared hard disk, virtual calendar and notebook, Microsoft Office programs and work specific applications such as ArchiCAD.

In many cases the virtual tools were utilized concurrently. The users had usually many applications open at the same time and they used them alternately. Some users also applied different devices for fulfilling the same task. As an example, a user (U6) was waiting for his next flight at the airport. The battery of his laptop was running low and he was charging it while waiting for the boarding call. When the call came the battery was 70% recharged. The user decided to answer some of the latest emails with the laptop and older ones with his mobile phone. The concurrent use of different devices requires a large enough flat surfaces to place the devices - this was not fulfilled especially in the means of transport or was hardly fulfilled in bus stations, railway stations or airports. Also the lack or paucity of functional power points or internet plug-ins or wireless webs was considered hampering the work especially during transitions. The inability to use the printers or totally non-working printers was a problem for some of the users.

The layouts of the physical workspaces were seen as a challenge in many cases. While on the move it was especially hard to find a place that supports quiet work or confidential discussions. For these reasons, working with certain tasks with virtual applications was considered difficult.

Also the decent ergonomics of the workplaces used was important. Many of the mobile employees mentioned the fatigue of musculoskeletal organs due to bad work postures. Inappropriate furniture and visual difficulties were the main causes for impairing working postures. On the other hand, some virtual tools allow flexible changes not only in the physical work position but also in bodily postures. According to the interview, the mobile phone appeared to be the most flexible virtual tool from this point of view.

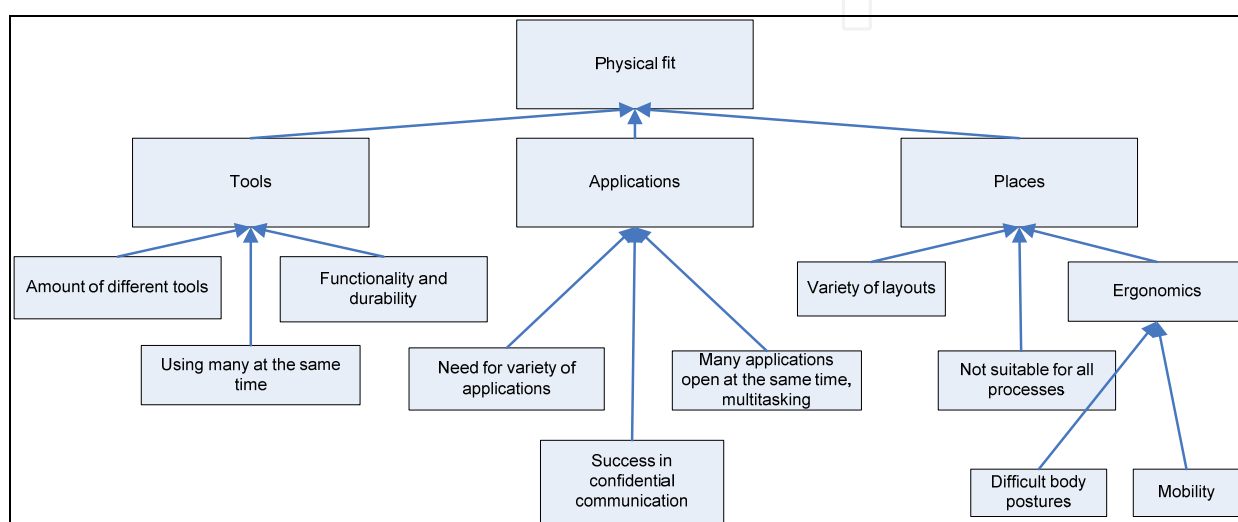


Fig. 2. The elements impacting the physical fit or misfit of virtual workplaces

4.2 Functional comfort and fit in the virtual workplace of a mobile employee

The leading themes of data included the connectivity and effective use of time (fig. 3). The most important thing when considering the nice and smooth i.e. functional use of virtual devices and applications seemed to be the availability, speed and functionality of the internet connection. Most of the notes in the diaries were somehow related to the use of an internet connection. Altogether, the internet connection, which was non-functional or difficult to access, was regarded as the key hindrance of productive knowledge work in virtual workplaces. There was a requirement that a quick and easily accessible internet connection should be available everywhere. This also presents requirements for the infrastructure of both virtual and physical places: they should guide you in getting quickly connected.

Because the workdays of the employees seemed to be busy with many things to do, the baseline assumption was that the use of virtual devices and applications is quick and smooth. If not, the irritation on account of wasted time increased, e.g., when sending emails took a few seconds instead of being instant. The interviewed subjects described the wasted time as a time that was spent with virtual tools but which did not directly contribute to completing the work related tasks and duties they were working with. An example of an experience of wasted time is a laptop that took 10 minutes to turn on. Another example is a

situation where the user spent hours learning to use free program to find out if it is suitable for his purposes – it was not and the time was wasted.

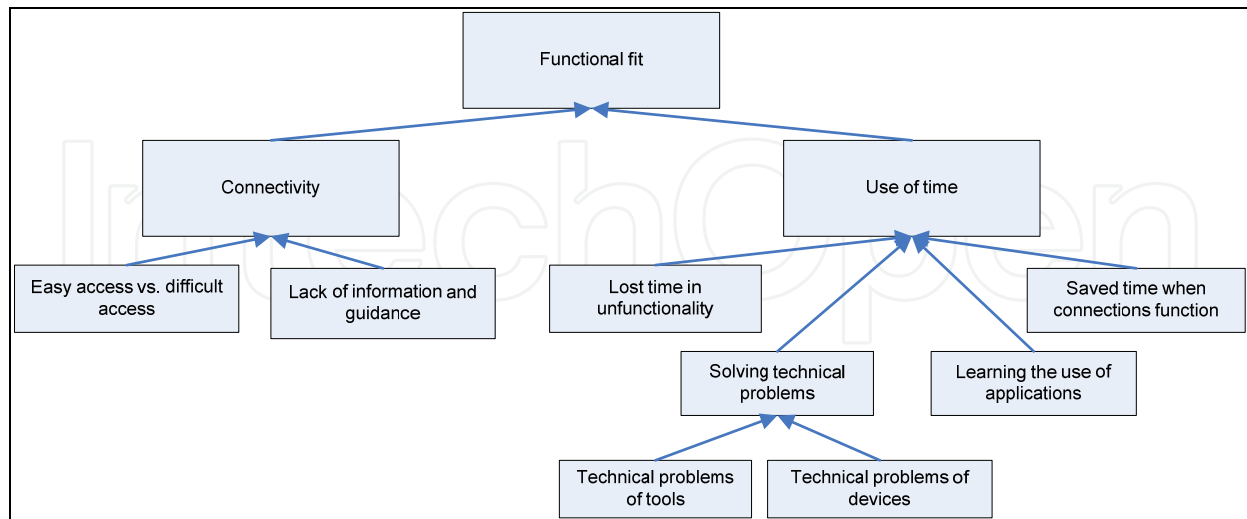


Fig. 3. The elements impacting the functional fit or misfit of virtual workplaces

4.3 Psychosocial comfort and fit in the virtual workplace of a mobile employee

The discourse concerning the psychosocial fit of virtual places dealt with the concepts of territoriality, privacy and control (fig. 4).

When the employees described the matters of territoriality, they stressed the importance of selecting the right virtual communication tools and channels. For example, sending emails was not the channel for enhancing **belonging**; more nuanced communication channels were selected and used.

The interviewed subjects described the virtual teambuilding methods that enhance belonging they have used or participated in. For this reason the normal working tools and applications were used for sharing work divergent matters. For example they shared photos of leisure time and discussed their holiday plans with live-meeting tools.

The managers of distributed teams expressed the essence to select and use the most suitable virtual behavior for enhancing the belonging of individuals. For example the calls “for no particular reason” played important role in enhancing employees’ feeling of belonging.

According to the interview data, the concept of privacy consisted of three components. The interviewed described privacy through problems in simultaneous co- and telepresence, simultaneous use of many virtual communication and collaboration channels as well as problems followed from simultaneous use of work and leisure related virtual environments. The ensemble of the privacy was related to the concept of accessibility: the feeling of fit arose from the good control over the multidimensional opportunities to access both physical and virtual worlds.

Simultaneous co- and telepresence enabled simultaneous use of many communication and collaboration channels. For example, when taking part in a conference call without visual communication employees tend to do many other duties too, i.e., mute the microphone and

communicate face to face with colleagues and send e-mails. Simultaneous use of many virtual communication and collaboration channels blur also the boundaries of work related and leisure related virtual places. While working in virtual places, many employees amused themselves by occasional visits in leisure related places, e.g., in their own Face book pages.

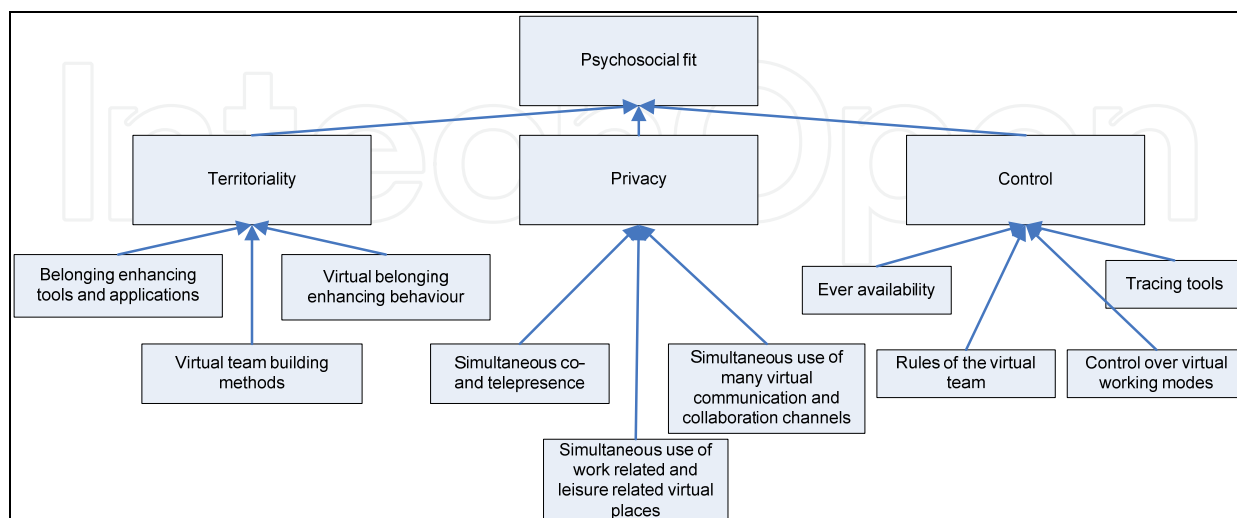


Fig. 4. The elements impacting the psychosocial fit or misfit of virtual workplaces

Taking over the fit of psychosocial elements in the virtual workplace the success in **control** is essential. The interviewed subjects defined the control to flow from the success in handling the demands of continuous availability, clear communication and collaboration rules inside the team as well as a good command over the different virtual working modes. They also pointed out the negative features of control. For example, the virtual tracing methods may also be used in a way that reflects a sign of distrust.

5. Conclusions

This research showed that Vischer's model (2005, 2007) of environmental fit is useful for a more detailed classification of virtual places and spaces. In virtual work the threshold of usability is at the functional level due to accessibility demands (see fig. 1). The work of a mobile employee will stop completely if the worker is not able to connect.

In order to develop well-functioning virtual workplaces for mobile employees, extensive attention should be paid to the whole system, within which employees confront their duties in different locations. Gaining comprehensive understanding on the context in which a given task is performed starts by forming questions first on the physical places and later on psychosocial themes. As such a vast field, the process demands profound multidisciplinary collaboration of different actors in organizations and support functions. The inspection of different fit levels is a useful tool for helping different authorities to explain their expertise in relation to other authorities. Gaps in management may also be demonstrated. There is a need for putting more emphasis in analyzing the non-visible work processes we have learned to conduct in virtual entity.

According to this research with Vischer's model as a frame of reference, it can be stated that

- At the level of physical fit, building codes and standards should be expanded to cover also the needs generated from the new working modes i.e. mobile work. The layouts of different premises should be clear and also instruct occasional visitors to quickly settle for working. The physical places should guide your route to virtual reality. Because the virtual reality is its own world with its voices and vistas, the disturbances caused by physical reality should be diminished, also when you are working in the places not primarily designed for work, i.e. trains, cafeterias, hotel rooms. This is a truly and demanding challenge for construction planning. The demands of performing mobile work should be taken into account also when designing furniture for premises not primarily aimed at working.
- At the level of functional fit, the access creates the threshold of work. Entering virtual work places i.e. the virtual reality of work is a question of existing and well functioning infrastructure. Moreover, questions concerning the easiness of connecting signals as well as of finding help and support in using information technology are essential. The transfer to virtual work places via well functioning infrastructures and applications must be attained regardless of the time and physical place. The operational environment of mobile employee should be portable as well as easy perceivable. (cf. Hyrkkänen et al, 2007.)
- Enhancing the fit at the psychosocial level, the mixture of physical and virtual worlds and simultaneous existence in both should be more effectively understood and supported. Particular and a lot of learning demanding challenge lies in controlling the simultaneous co- and telepresence, simultaneous use of many virtual communication and collaboration channels as well as simultaneous use of work and leisure related virtual channels. Although one of the major goals driving the development of virtual reality has been in providing a space for people to interact without the constraints of the physical world the fact seems to be that we can not totally rid ourselves from being physical as well (c.f. Fox et al, 2009). On that account, we have to learn to behave and work also in the interspace i.e. controlling simultaneous existence and belonging in the mixture of physical and virtual worlds. The integrated design, which seamlessly combines the physical and virtual places, needs to be developed further as well.

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Virtual Reality is clearly interdisciplinary research. It has, not only Information Technology importance but social, educational, economical importance too. It combines multiple disciplines for the development of virtual reality systems in which the user has the immersive feeling of being in the real world. Virtual reality has several applications in almost all fields of real life. The most typical fields for the application of virtual reality are health-care, engineering and game industry. This book may be a solid basis for the novice and advanced engineers who would like to develop user friendly Virtual Environments for education, rehabilitation and other applications of Virtual Reality. Our book provides a resource for wide variety of people including academicians, designers, developers, educators, engineers, practitioners, researchers, and graduate students.

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