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User Interpretations of Virtual Prototypes: Physical Place Matters

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Abstract. Technology is known to affect users' understanding of virtual products. We study whether also physical place in which the product images are presented affects our understanding. To study this, we conducted user tests with furniture prototypes that were presented in 3D virtual environments. We focused on user interpretations of virtual prototypes in two distinct physical places: in a fair and in a virtual environment laboratory. The results reveal that, in the laboratory, users broadly focus on technical features, whereas, in a fair, the users' main focus is on product models. The implication of our study highlights the influence of the place in virtual prototype presentations.

Keywords: interpretative research approach, phenomenography, place, user interpretations, virtual environments, and virtual product prototypes.

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1 Introduction

Nowadays products are commonly presented via information technology (IT). What is actually presented is a visual image or a virtual prototype of the product. It is known that several aspects affect the way users understand them. Previous studies indicate that the presentation technology is one significant element. For example, users understand moving product images better than plain pictures and 3D images better than 2D pictures (Suh and Lee 2005; Jiang and Benbasat 2005; 2007).

The other effectual reason for differences in understanding is the users themselves. Users' assumptions, expectations and knowledge affect the way they understand technology and products presented with it (Orlikowski and Gash 1994). This socio-cognitive analytical lens is referred to as technological frames (Bijker 1987; Orlikowski and Gash 1994; Davidson 2002; Lin and Silva 2005). Technological frame is composed of the concepts and techniques employed by a community in its problem solving. It includes different elements in relation to the technology: current theories, tacit knowledge, goals, problem-solving strategies, and practices of use (Bijker 1987). Technological frames are simultaneously an individual as well as a socially constructed phenomenon (Orlikowski and Gash 1994).

As the studies of technological frames deal with incorporeal elements (such as knowledge and practices) as well as with some material elements, we assume that physical place might be an element which shapes users' technological frames. The assumption that physical place matters is acknowledged in consumer studies, as it has been recognized that situational variables are essential for explaining and understanding consumers' behavioural acts (Belk 1975). The place in which the consumer is situated is important, as it relates to experiences, memories, and emotional attachment (Turner and Turner 2006). These place-related memories, conceptions, interpretations and feelings are referred to as place-identity (Proshansky et al. 1983).

We use the notion of place-identity to study IT users' interpretations of IT-related objects. In this paper, we focus on *the effect of a physical place on user interpretations of product images*. To study this, we selected two places which hold different meanings for users. For contrast, we chose a fair and a laboratory. A fair is a business event where either products are traded between business people or showcased to a largely consumer audience and where human-related issues, such as needs, feels and wants are foremost. A laboratory, on the other hand, is a place where science and technology are investigated and created with special equipment (Latour and Woolgar 1979). Typically, laboratory is an isolated place for conducting controlled, objectively measured experiments.

User tests were organized in these two distinctive places. The test users were asked to watch and evaluate 3D virtual prototypes of furniture presented to them in a highly immersive virtual environment (VE). Furniture, a collection of design-intensive products that everyone owns, offers promising opportunities for studying subjective interpretations, since there is not just one normative concept for all. As a result, we reached alternative descriptions. In the fair test, the interpretations of the virtual prototypes were more focused on products, whereas, in the laboratory, the test users discussed mainly the presentation technology and its technical quality.

This paper is structured as follows. First, we describe the previous user-centred studies about IT and place. Second, we focus on the practical background and technical considerations of our

study. Third, we outline the accomplished research process, including methodological issues and user tests in practice. Fourth, we describe the study results: the diversity in user interpretations concerning 3D virtual prototypes in two contrasting places. The paper concludes with a discussion of implications and limitations.

2 Previous studies of IT and place

The concepts of place and space are commonly used in information systems (IS) studies, though they are viewed in various ways (Saunders et al. 2011). In this paper, we follow those definitions which see a relationship between place and space. A place is a locale whose form, function and meaning are self-contained within the boundaries of physical contiguity (Harrison and Dourish 1996). Space is a practised place: it is a place with actors (Wise 1997). Space includes a conceptual triad: three moments of space, which should be looked at simultaneously (Lefebvre 1998). The first moment is spatial practice. That is a perceived space which is empirically observed. The second moment is a representation of space, the conceived space. These are abstract, conceptualized spaces, based on all what is lived and what is perceived with what is conceived. The third one is a space of representation, which is directly lived through its associated images and symbols (Lefebvre 1998).

An example of IS studies' way to view place and space is presented by Harrison and Dourish (1996). They claim that "Places, not spaces, frame appropriate behaviour." They give an example that a community hall can be used as a rock venue, a sports arena, and a place of worship service. On these different occasions, it is not the structure of the space which frames people's behaviour, but the place where they find themselves (Harrison and Dourish 1996). When the opposite use of terms place and space is disregarded, the above example can be explained with Lefebvre's three moments. Although the physical place is located at the same geographical spot and the outdoor walls are the same, the inside views differ. The first moment focuses on the elements of the space which can be objectively observed (Lefebvre 1998): for example, the objects, sounds, and people in the hall. The second moment focuses on the visitors' actions and experiments within the space; in a rock concert and in a worship service people act differently, which is a part of a different experience. The third moment focuses on the images and symbols (Lefebvre 1998), and they are different in the above three situations.

Besides place and space, the third central concept is place-identity. It is defined as a "potpourri of memories, conceptions, interpretations, ideas and related feelings about specific physical settings as well as types of settings" (Proshansky et al. 1983, p. 60). Although this definition includes many important dimensions of place-identity, it embodies one fundamental problem. That is its individualistic dimensions, as, according to Dixon and Durrheim (2000), place-identity is something that people create together through talk; it is socially constructed. One advantage of this approach is that it recovers the irreducibly social origins of place identification. Not only does it acknowledge the relevance of places to their collective senses of self, but it also highlights the collective practices through which specific place identities are formed, reproduced and modified (Dixon and Durrheim 2000).

In the IS studies, the discussions of space and place concerning the development of Computer Supported Collaborative Work (CSCW) started in 1990s (Dourish 2006). Early CSCW systems were designed to connect people who were working together from remote physical locations. They were tools for solving the problem of users being in different places. The first solutions to support collaborative work over distance were group-support systems, such as Lotus Notes (see, e.g., Orlikowski 1992) and systems for collaborative writing (see, e.g., Berk 1995).

An alternative solution for collaboration over distance is to create a shared virtual space (Dourish 2006). The system often relies on spatial metaphors (Messeter 2009) as meeting places (see, e.g., Saunders et al. 2011). These kinds of solutions were based on the idea that human territoriality and the space and place-based dynamics of human life can somehow be replaced by using new technologies (Turkle 1997; Graham 1998). Virtual reality solutions include both Internet solutions (such as Second Life, e.g., Saunders et al. 2011) and Cave-like VE solutions, in which the virtual space is created in the actual site and the user can walk in the space (Leigh et al. 1996). In the VE studies, besides the concepts of place and space, also telepresence, or shortly just presence, is essential. Presence means the feeling of being present somewhere else than in the actual physical environment (Steuer 1992; Suh and Lee 2005).

The development of technology and also its use have opened new research streams. Wireless and mobile technologies have enabled the use of IT solutions without fixed or stationary place, which has opened new possibilities to question the old constraints of place in IT use and CSCW (Dourish 2006).

There are several different study areas related to wireless and mobile technologies. First, we present the type, which mixes physical and virtual elements with augmented reality technology. Typically, these are solutions which add some virtual elements to physical environment; this can be done by watching the world via a technological tool (such as a mobile phone or virtual helmet) which locates virtual elements to designed spots. These kinds of solutions are used, for example, in illustrating the history of user's actual place for teaching purpose (Hsu and Chen 2010; Cocciolo and Rabina 2011) and for research purposes, as when reconstructing archaeological landscapes (Eve 2012). Furthermore, mixed reality solutions can be used for illustrating plans, as an alternative or additional method for interior design (Park 2011).

The second mobile research stream is studies of location-aware systems. Currently, the focus is on information content and the different mechanisms for matching information delivery to user needs (Jones et al. 2004; Messeter 2009; Benyon et al. 2013). One of the earliest examples of a location-aware system is CyberGuide (Abowd et al. 1997), a mobile context-aware tour guide, which uses location and the history of past locations to provide contextual information to tourists. Besides location-awareness, new tourist-guiding solutions benefit also mixed reality solutions by adding some virtual objects (Benyon et al. 2013).

The third stream of mobile research studies investigates how to make the use of IT efficient, or even possible, in alternative places. Recent studies in the field of Human-Computer Interaction (HCI) have focused on whether mobile machines are usable in different places (Kjeldskow and Stage 2004). For example, interruptions, movement, noise, and multitasking that could affect the users' performance are not present in laboratory tests or normal office situations (Tamminen et al. 2004; Kjeldskow and Stage 2004).

Although place is discussed widely in IS studies, especially in the CSCW field, just few studies focus on the relationship between IT use and physical place, especially in relation to whether

users' interpretations of presented information of virtual objects differ when the physical place is different. One such study is that of Akpan et al. (2013), which analyses how people engaged with the same interactive installation in ten situations with varying spatial and social properties interact. Their main finding is that a social context could overcome a poor physical space and encourage interaction.

Furthermore, in the HCI field, Kjeldskov et al. (2004) and Kaikkonen et al. (2005) have compared usability tests in a laboratory and in the field for practical research purposes, not for discussing the meaning of place for users' interpretations. Both studies found that the same usability problems appear in both of the tests. The only difference was that in the field the test took longer time, as the users tended to describe more their interpretation. Based on their comparison, Kaikkonen et al. (2005) recommend conducting usability tests in laboratory because the time needed in the field is longer and the effort required higher.

For the purposes of usability testing, wider answers in the field setting may be seen as a waste of time. Instead, this gives us promising opportunities for studying how users understand virtual objects in different physical places. Furthermore, previous research tells little about the meaning of physical place in users' interpretations, as there is a lack of empirical studies which compare IT use in different places. Our study fills this gap.

3 Practical and technical background

For our comparison of users' interpretations of virtual objects in different places, we first needed to decide about two features, the first feature being the two alternative places which differ from each other by all three moments (Lefebvre 1998). We chose a fair and a laboratory. The first moment focuses on their objective attributes: the views and the sounds of a fair and a laboratory differ, the number of people in them is different, and so on. The second moment is the subjective lived space, that is, the individual experience of those two spaces. The third moment is connected to the representation: a fair represents business and consuming, whereas a laboratory represents science (Latour and Woolgar 1979).

The second feature was to decide about the objects whose virtual prototypes were to be presented in the two alternative places. We chose furniture, as they are everyday products which are familiar to everyone. This helps the selection of test users, many people having enough expertise in the studied field. Furthermore, pieces of furniture are design-intensive products. It is an area in which people are allowed to hold alternative opinions, so there is no dominant, normative way that should be followed.

For practical test setups, we organized a research project with 20 small and medium-sized local furniture companies in Finland. The research project investigated alternative ways to present furniture prototypes to customers, which was also the furniture companies' motivation for their participation. The following two setups are related to the research project.

The *Fair Setup* was located in the largest Finnish furniture fair called Habitare. Over 60,000 visitors, most of them consumers, visit the fair during the event. We had a stand at the fair for presenting our virtual prototypes. The stand opened to two corridors, so that visitors walking through them could see the presentation and observe users' actions (Figure 1). Around our

Figure 1: Our stand at the fair (Fair Setup)

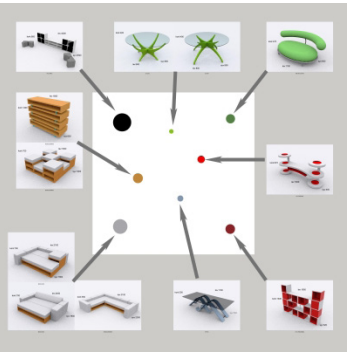

Figure 2: The virtual prototypes of furniture presented in the virtual fair hall (Fair Setup)

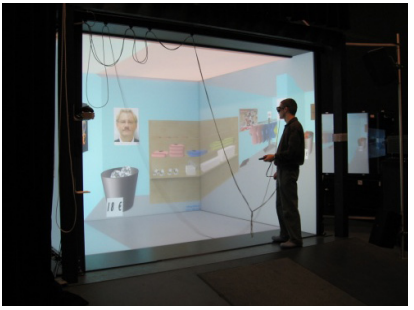

Figure 3: The physical appearance of VE (Lab Setup)

Figure 4: The virtual apartment where the prototypes were on display (Lab Setup)

stand, there were other exhibitioners' furniture stands displaying sofas and chairs, among other things.

The technology of the Fair Setup included a portable active-stereo-based 3D wall, with the dimensions of 1.7 m x 1.3 m. The display resolution was 800 x 600 pixels. The visitors, using a pair of shutter glasses, could evaluate the 3D models presented in a virtual fair hall. The products in the fair stands included sofas, shelves and tables; one product on each stand was modelled by design students (Figure 2). There was a control unit for locomotion control and for changing product models: for example, a particular product could be seen in different colours.

The *Lab Setup* was located in a VE laboratory, in one wing of a university building, behind locked doors. The lab itself was a large room painted black, with a view through a window to a room full of computers. From a technical point-of-view, the Lab Setup was a five-sided Cave-like walk-in VE (Figure 3). The VE had five rear projection surfaces: three walls, a floor and a ceiling. Its height was 2.4 meters, and the other dimensions were 3 x 3 meters. The display resolution was 1280 x 1024 pixels. The user employs a pair of shutter glasses to see 3D images. There was a control unit for locomotion control and for changing and moving the pieces of furniture.

In the Lab Setup, the virtual furniture prototypes of furniture companies were on display in a virtual apartment (Figure 4), which was decorated like a home, with a table and chairs in the kitchen and a television in the living room.

4 Methodology

In line with the categorization of Gregor (2006) we follow the idea about theory as "statements providing a lens for viewing or explaining the world" (Gregor 2006, p. 613). Furthermore, the aim of this kind of study is to create a theory for explaining to supplement the already existing theories for analysing, for predicting, for explaining and predicting, and for design and action. This type of theory explains primarily how and why some phenomena occur. This could well be labelled the theory for understanding, as it often has an emphasis on showing others how the world may be viewed in a certain way, with the aim of bringing about an altered understanding of how things are or why they are as they are (Gregor 2006). In our case, the aim is to widen our understanding about users' interpretations of virtual objects, and that is done by comparing them in two different places. We want to explain how and why users interpret the objects.

Studying user interpretations from the user's point-of-view requires a method which gives space to informants. Qualitative methods satisfy this aim by focusing on empirical material without any a priori expectations. From among the possible empirically-based methods, we chose phenomenography since it aims to describe, analyse and understand the variation of conceptions held by individual informants (Marton 1981).

Phenomenographical research aims to "find and systematize forms of thought in terms of which people interpret aspects of reality" (Marton 1981, p. 180). In general, some categories offer a wider or richer perspective and often come to embrace others in an inclusive structure (Renström 1988). Phenomenography can focus on multilevel issues, starting from individual user interpretations at the lowest level and progressing to collective levels of interpretation. When phenomenography is used in this way, it gives space to informants' own interpretations and also enables the forming of these informants' collective view (Renström 1988).

In the following sections, we outline the research procedure and data analysis used in this study.

4.1 Procedure in data gathering

In the phenomenographical approach, people's views are studied with empirical material, through which people describe how they view the world (or a phenomenon) (Marton and Booth 1997). The empirical material is generally collected by interviewing informants (Marton 1988). Phenomenographers have made attempts to direct the interviewees' thinking to specific and more tangible contexts, such as role play (Boustedt 2009), to discuss the activity afterwards. Combining user tests and interviews is also possible (Kaapu and Tiainen 2012), and it was done in this study.

The interview themes were similar in both of the setups (see Appendix 1). Each test user was guided to evaluate certain prototypes and asked to think aloud. Before starting, the interviewer told them that the task is to evaluate furniture. The interviewer asked for more comments, for example:

- Interviewer: "Do you see anything interesting here?"
- Interviewee: "I like that…"
- Interviewer: "What do you mean?"

Our aim was to find consumers of different ages, of both sexes and with an interest in interior design to act as test users. Their number finally totalled 33 in the two setups (details in table 1).

	Fair Setup	*Lab Setup*
Physical place	A stand in a middle of the fair hall	A laboratory in a university building
Virtual place	Virtual fair stands	A virtual apartment
Technology	A portable 3D wall	An immersive Cave-like VE
Prototypes	Virtual 3D furniture models	Virtual 3D furniture models
Participants	13 users	20 users
Data collection	A VE visit and individual interviews during/after the visit. The interviews were written down (about 2 pages text per person).	A VE visit and individual interviews after the visit. The interviews were recorded and transcribed (about 8 pages text per person).

Table 1. The two setups and data gathering in them

The test users in the *Fair Setup* were visitors to the fair. We invited those who had been walking or standing near our stand to come in and observe the virtual prototypes. When they entered, we introduced the equipment. Then each of these test users was taken to a guided tour around the virtual fair hall to see all the prototypes. They could also go around some of the prototypes or change their colours. During the tour, the test users were asked to evaluate the furniture.

For the *Lab Setup*, we sought test users via two open seminars, two academic web sites and several mailing lists. The Lab test use had three parts. First, there was a short introduction to VE. Then there was the VE visit. In each virtual room, the test users needed to evaluate some variation of furniture: for example, a sofa in different materials. The third part was an individual interview just after the test use. Also in this setup, the interviews focused on users' evaluations of virtual furniture prototypes.

In phenomenography, data gathering continues until the saturation point is reached, i.e., new informants do not contribute any new elements to the categorization. In prior phenom-

enographical studies, twenty informants have been found to be a sufficient number for the theoretical saturation level in most cases (Sandberg 2000). We used a higher number – i.e., 33 interviewees – since we had two setups.

4.2 Analysis of the interview data

In our analysis of interviews, we wanted to get a sense of the worlds that interviewees themselves experience and describe. When the interviews are analyzed following the phenomenographical approach, no theoretical framework can be used, as the purpose is to outline the concepts of the empirical material (Marton and Booth 1997). Besides categories, phenomenography requires investigation of the relationships between the different categories, highlighting the variations "exemplified by individual respondents" (Entwistle 1997, p. 133).

We divided the analysis to seven phases.

1. *Reading the whole text and marking where interviewee discussed virtual prototypes.* We started the analysis process simultaneously with first interviews. The first analysis step was to make ourselves familiar with the data. Phenomenography recognises "ways of experiencing" as the "primary unit of analysis" (Säljö 1997, p. 176). We aimed to find differences in these ways of experiencing. We explored the data by reading through the whole data in order to find all aspects of the interviewees' conceptualizations. When the interviewees talked about the studied phenomenon of virtual prototypes, we kept the question "How do they talk about it?" in mind while reading the text.

2. *Making a preliminary description of understanding virtual prototypes*. Based on the empirical material, we found the main emphases on what and how when talking about our virtual prototypes: the product and the technology. This seemed meaningful also because the discussion about technology is common among IT professionals (e.g., Greenbaum and Kyng 1991; Davidson et al. 2001), as well as in the VE field. On the other hand, the virtual products and their evaluation are the reasons why the VE is developed. We found also diverse sub-descriptions of understanding prototypes via a product or technology.

3. *Grouping the descriptions into categories, based on similarities and differences.* We created an initial categorization based on the objects of thought expressed by the interviewees. During this process, we made comparisons between meanings of single statements and the surrounding statements, and the data as a whole. We formed the categories to describe informants' conceptions as precisely as possible. The results, thus, were made up of parts and their interrelationships. First, we considered if interviewees talked about the technology or the products. The ways of understanding these two are different, so their location to separate categories was unproblematic. Second, we examined the contents of both categories. The technology category was homogeneous. However, as the product category was incoherent, we continued its analysis by focusing on the question about what was told about the products. The answers were divided into three categories: the image of the product, the product itself and the evaluation of the product. We conducted six analysis rounds, including comparisons and cross-checkings based on similarities

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and differences with the whole material, so that, finally, our categorization represented the interviewees' views.

4. *Creating a hierarchy for the categorization.* Our categorization formed a hierarchy, presenting different kinds of expressions (Table 2). Related to this, the notions of "deep" and "surface" are highly important in the phenomenographical research tradition (Webb 1997). In our categorization, "deep" and "surface" expressions are related to how much the prevailing category provides for evaluating a product image. For example, if an interviewee is mainly discussing something else than actual product properties, this is "surface" because it does not give many possibilities for evaluation.

5. *Summing up the individual categories that are used to describe forms.* As the categorization presents the elements which are used in describing the prototypes, we also outlined the corresponding forms based on how individual interviewees used the categories in description. Instead of categorization, the form presents a more collective level of understandings: the wideness or scope of thinking and the alternative perspectives that were used (Marton and Booth 1997). In our case, forms are a combination of alternative conceptions (or elements of the categorization) with which each interviewee can describe virtual prototypes. To define the forms, we first summed up how many times each interviewee mentioned each category during the interview.

   The interviewee's individual form included all the conceptions she/he used the most. We defined used the most to mean:

   - the category/categories that include most of the interviewee's narration, and
   - the categories that are used at least half as often as the most often used category.

   For example, if an interviewee used category X the most = nine times, his/her individual form includes all categories s/he used five or more times.

6. *Describing similar individual forms of thought.* After summing up the individual use of the categories, we connected the similar individual forms (Table 3). In similar forms, the highest used category is the same and also other categories below the highest category are used similarly.

7. *Analysing the use of forms in two physical places.* Finally, we compared how the individual forms of thought were used in two places (Figure 5). For comparison, we used a percentage of interviewees who used the form in each of the two places.

5 Results

This study shows the changes in user interpretations concerning virtual prototypes presented to them in two different places: in a fair and in a virtual reality laboratory. The results include three parts. The first one deals with the conceptions the test users used in describing the prototypes. Their conceptions shape the hierarchical categorization. The second part presents the forms, which give the whole picture of each test user's description. These forms include alternative com-

binations of the concepts by which the test users describe the virtual prototypes. The third part of the results focuses on the effect of the physical place in which the virtual prototypes are evaluated. This effect can be found by comparing the individuals' conceptions about the two places.

5.1 Categorization of user interpretations

The first result is a hierarchical categorization of concepts related to virtual prototypes. In it, the lowest category focuses on the technical issues which are present and shaping the platform for virtual prototypes. The highest category focuses on the evaluation of the prototypes – on the task that the test users were asked to perform. The categorization is summarized in table 2, and the categories are opened for expansion after that. For illustration, we use the interview quotes that refer to individual interviewees in the Fair Setup (F) or in the Lab Setup (L).

Category	*Approaches to product prototypes and presentation technology*
Category 4: Desired or disliked product	Products are evaluated as positive/negative, based on personal preferences. Invisible role of technology: it is there but is not commented.
Category 3: Concrete product	Interpretations on how a product is build. Technology accepted for virtual product presentations.
Category 2: Photograph of a product	Evaluations of individual features of a product. Comparing the image in the VE to a traditional photograph.
Category 1: Technical implementation	Product features are not evaluated. Evaluations of technology and modelling.

Table 2. Categorization of conceptions related to virtual prototypes.

Category 1: Technical implementation

In Category 1, the user describes the advantages and disadvantages of the technological implementation. The interviewees discussed the product (as they were asked to do) without including the product features in the discussion. Instead, they used technology-related language. They used words like "pixels" and "modelling", as the Quotes 1 and 2 show.

Quote 1:

Interviewer: How about this rocking chair: would you like to buy it for your own home?
Interviewee L15: It seems so real, I can assure you. This room is quite small, however, and the chair is almost transparent in principle. The texture that was used in the model should have been more precise, with more pixels. In some other models, I actually think that another program was used for modelling because the surface was so clean. There was this line between the floor and the ceiling, and when I moved the picture was distorted.

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Interviewer: Ok. So what did you think about the rocking chair?
Interviewee L15: There was a kind of discontinuation point, as I mentioned. But otherwise it was ok.

Quote 2:

Interviewee L17: This bedroom was interesting.
Interviewer: Why so?

Interviewee L17: Well, there was a very large bed. I couldn't form any idea of it. It seemed to me that I could be sinking to it, to that model. The modelling wasn't very good. The model didn't give me any feelings: it was so reduced. I was just thinking that it could be nice to get a feeling of the bed somehow: how soft it is or hard. This presentation has still many limitations, you know.

In Quotes 1 and 2 (and in other similar quotes), the interviewees talked about the quality or other technical features of VE. Here they describe technology and modelling, such as requirements, costs, and how simple, immersive or affecting the solution is.

Category 2: Photograph of a product

Category 2 is fundamentally different from Category 1 because the focus is not solely on technology, the product itself receiving a great deal of attention. The intention is to describe the prototypes while the interviewee adds the product features to the technical implementation. In Quotes 3 and 4, it will become clear that the focus is the furniture. Despite the product features, the interviewee did not describe the prototype in 3D but instead compared the image in the VE to a traditional photograph.

Quote 3:

Interviewer: Is there some furniture that is interesting for you here?
Interviewee F6: I saw some nice furniture. Still, it was somewhat strange to see furniture like that. No, I don't mean that anything was wrong with them. I just had a feeling that they are photographs of some interior design magazines, magnified and blown out of proportion.
Interviewer: Ok, can you give me an example?
Interviewee F6: That sofa there is similar to most sofas, and I can see what it looks like. But I can't understand why you have to present it like this. You could just give me a paper leaflet about it.

Quote 4:

Interviewer: At the beginning, we went to the living-room. Was there something interesting that you saw?
Interviewee L4: Yes, I liked that bookcase. I have one that is almost like that in my own home. I just think the presentation technology is not that good. For example, I can find better pictures in printed catalogues.
Interviewer: What do you mean by that?

Interviewee L4: I could see there (in the laboratory) the basic shape of the bookcase, and I can visualize that in my mind: it is traditional and elegant. However, the quality of the picture is not as good as the quality in colour photographs. I don't know what it is supposed to be that this (VE) adds to it.

Category 3: Concrete product

Category 3 is distinguished from the previous categories in that the level of understanding here is even more closely attached to a product. So a virtual piece of furniture is understood in a concrete form. In Category 3, the approach to virtual product prototypes incorporates the intention to provide a technological solution on how to present the prototypes. As will be shown in Quotes 5 and 6, the intention of evaluating virtual prototypes is to put the furniture models in the focus.

Quote 5:

Interviewee F5: It is a shelf that is lifted to a stand. It looks like a real one, and it includes several boxes. It is red – and what else should I say about it? It is a shelf, and that's it.

Quote 6:

Interviewer: Were there some interesting furniture for you?
Interviewee L14: Yes, definitely. All those presented were quite typical: a sofa, TV and stuff in the living-room, a bed in the bedroom, and a table with chairs in the kitchen. By their dimensions they were suitable for those areas.
Interviewer: Can you tell a bit more about one of them?
Interviewee L14: For example, the table in the kitchen was made of wood, and there were different chairs with that table.

Category 4: Desired or disliked product

Category 4 also uses furniture models as a part of the intention, but, in contrast to Category 3, its interpretation contains also the possibility to describe more personal preferences and to evaluate the product because the nature of the product is understood. In Category 4, the intention encompasses the accumulation of the user's skills, experiences and knowledge about furniture, interior design, and personal preferences. Quotes 7 and 8 and other similar interview quotes revealing the understanding in Category 4 enable evaluations of prototypes based on personal preferences.

Quote 7:

Interviewer: Did you find some of the furniture interesting?
Interviewee F4: Yes, the table that had a glass cover and bowed wooden legs. It looked modern and light. Do they already manufacture this item? I have a place for it in my home. I particularly like its shape and size; it is compact enough.

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Quote 8:

Interviewee F10: That chair looks very smooth to sit on and I like the way it is designed. Still, it looks somehow dangerous because the back rest is so small and apart from the seat. Could my son become trapped in there? Something should be done about it.

Besides the above positive evaluations, there were also more critical ones. Sometimes an interviewee disliking some model would say that she/he is unable to evaluate a piece of furniture at all or might just ignore it. However, the kind of statement similar to Quote 9 reveals that the person is interpreting the image as furniture and also has evaluated it.

Quote 9:

Interviewee L1: That environment was annoying - please, do not let engineers design decoration. For example, that kitchen: the wallpaper was so shocking that I didn't pay attention to any furniture there.

5.2 The forms of describing virtual prototypes

Above, we presented a categorization of the conceptions which interviewees used when they described their interpretations of virtual prototypes. In this subsection, we explain how individual interviewees used the categories presented in table 2.

The result includes four forms: Technology-centred, Product-oriented, Fluctuating, and Design-intensive. Each of these forms is based on the highest most used form in the interviews. The white areas in table 3 represent the categories that the interviewees used the most in the interviews. One interviewee may use one or several of the categories created.

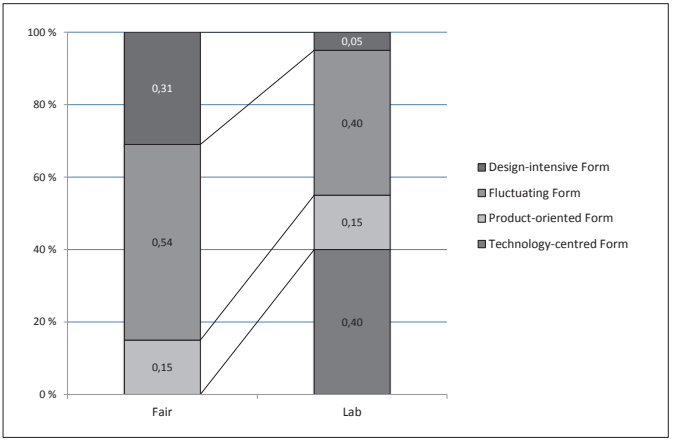

Figure 5. Use of forms based on the Fair and Lab Setups

<table>
<tr><th></th><th>Technology-centred Form</th><th>Product-oriented Form</th><th>Fluctuating Form</th><th>Design-intensive Form</th></tr>
<tr><td>Category 4: Desired or disliked product</td><td></td><td></td><td rowspan="4">7 Fair-interviewees
8 Lab-interviewees</td><td>4 Fair-interviewees
1 Lab-interviewee</td></tr>
<tr><td>Category 3: Concrete product</td><td></td><td rowspan="3">2 Fair-interviewees
3 Lab-interviewees</td><td></td></tr>
<tr><td>Category 2: Photograph of a product</td><td rowspan="2">0 Fair-interviewees
8 Lab-interviewees</td><td></td></tr>
<tr><td>Category 1: Technical implementation</td><td></td></tr>
</table>

Table 3. Interviewees' use of categories

The Technology-centred Form view of the prototypes is a technical implementation or a photograph of a product (Categories 1 and 2). The view deals with technology development, as in it the interviewee concentrates on the quality of the presentation technology and other technology-centred issues. This kind of understanding does not provide much to discuss as regards the product features. The Product-oriented Form contains product features, but the interviewees who used this form could not evaluate virtual prototypes as real-world products based on their preferences. The Fluctuating Form connects the technological focus and the products to interviewees' personal desires and wishes. The Design-intensive Form, on the other hand, is focusing on seeing virtual prototypes as desired or disliked products (Category 4). This kind of interpretation is needed for being able to evaluate virtual prototypes.

5.3 The forms used in the two places

Besides individual differences there were also differences between the two research setups. Figure 5 depicts the use percentages of these setups. It shows that there are clear differences between the results based on the places. In the furniture fair, most interviewees use the Fluctuating Form, whereas in the laboratory the Technology-centered Form is used as often as the Fluctuating Form. Furthermore, the Design-intensive Form is commonly used among the test users of the furniture fair, but it is hardly ever used among the test users of the laboratory.

6 Discussion

Our paper describes how user interpretations of virtual product prototypes differed from each other in two physical places where we presented the prototypes to users. After interviews and a phenomenographical data analysis, we came up with four categories and four forms of user interpretations. The results reveal that, in the laboratory, users broadly focus on technical features, whereas, in the fair, users' main focus is on product models. Below we describe theoretical contributions and practical implications and conclude with a discussion of limitations and future research directions.

6.1 Theoretical contributions

Earlier IS studies on user interpretations about technology have overlooked the connection between physical places and user interpretations. There are few empirical studies divided into different physical places for comparison. However, the context of technology use is recognised in technological frames (by Orlikowski and Gash 1994). With those contexts, the authors refer to organizational environment, not the physical place. Our study indicates that, when focusing on technology use in leisure time, organizational context becomes irrelevant (Yoo 2010) and physical place becomes relevant. Understanding physical place and user interpretations calls for a reorientation of our focus from information processing to lived experiences of everyday life activities that are digitally mediated.

The spatiotemporal context gives an explanation why physical place affects user interpretations (Yoo 2010). This context unfolds over time, and humans come to experience artefacts and the natural world and other social actors (Yoo 2010). This is closely connected to Lefebvre's second moment, which is a conceived space. That is an abstract, conceptualized space, based on all what is lived and what is perceived (Lefebvre 1998). According to Lefebvre, space includes a conceptual triad formed of three moments of space, which should be looked at simultaneously. The two other moments focus on objects and the symbolic aspect. Next we discuss how they are seen in the two places of our study.

In the case of the fair, the test users came there to see novelties in the furniture area; that shaped their expectations about what they would see during their visit to the fair. The test users would then continue in the research that tested use by evaluating virtual prototypes. Our case was linked to the test users' previous actions and led to the users' descriptions of product features.

In our laboratory case, the test users registered as volunteers, their visiting time to the VE having been arranged beforehand. On their arrival to the laboratory, the test users knew that they would participate in a scientific test use; what to expect was confirmed by the university building and the VE laboratory. Introduction to VE was aimed to change their focus from research and technology towards (virtual) products. The analyzed test use took place in a virtual apartment, where the test users evaluated virtual prototypes of home furniture. The test users had formed different assumptions about their VE visit. The description included all different forms, i.e. technology-centred, product-oriented, fluctuating and design-intensive forms.

In the previous HCI literature, there is an assumption that VE visitors immerse themselves into a computer-created world in VE so that the ambient physical world becomes irrelevant to them (Turner and Turner 2006). Previous product prototype studies state that high quality of technology helps users to understand product images better (Suh and Lee 2005; Jiang and Benbasat 2005; 2007). In our case, the VE applications were on a similar level, but the VE technology was different. The laboratory environment, including the immersive Cave-like VE, was of a high technological level, whereas in the fair the level reached that of a portable 3D wall only. Nevertheless, in the user tests, the fair visitors used higher forms than the lab visitors in describing prototypes, i.e. they focused more on the products.

Our study states that several attributes affect users' understanding of virtual objects; besides technology, also physical place matters. Lefebvre (1998) presented the three moments of space, which are 1) empirically observed spatial practice, 2) conceived space, and 3) space of images and symbols. We assume that the three moments of space are meaningful, but they need to be studied more.

6.2 Practical implications

Our study aimed to explain how users interpret virtual objects. This kind of aim is connected to the theory for explaining, which can be extended towards the theory for design and action, which says how to do something (Gregor 2006). Although we have not yet embarked on the theory for design and action, we can discuss some ideas about what practical benefits the results of this study could offer.

From a practical viewpoint (of the participating furniture companies), this research was motivated by a desire to make those presentations more appealing and useful. There has been a constantly widening effort to increase visual realism. In the search for realism, a number of designers have used 3D space to build places that are visually impressive. We encourage designers to consider and design also the physical place where the VE is located. The main implication is that more attention should be paid to understanding the different ways in which participants perceive the physical place in which a VE is placed. This is important with highly immersive environments (such as Cave-like VEs) that are not easy to move, but also with mobile applications.

Another practical implication for design is related to how to test VE setups, as it seems that the environment affects test user performance. According to Roto et al. (2004), a field test method is suitable for situations where not only interaction with a system is tested but also user behaviour and environment is examined. The time needed in the field is longer and the effort required higher. Our result, showing that the test users used higher forms in the fair, is positive towards using field tests, while the physical place is meaningful when using context. If the place is unfamiliar or uncomfortable, then it could inhibit having interpretations of virtual prototypes.

6.3 Limitations and future research

Our study gives a promising new element (physical place) to our understanding about how users' interpretations are shaped. However, the study is limited in various respects. First, there were

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some methodological limitations in our operationalization. The two different physical places of our study can also be seen as a challenge: the configuration takes resources and compels us to make some decisions the consequences of which should be discussed as limitations of this paper. The main difference between the setups in two different physical places was that the presentation technologies used in the fair differed from those in the laboratory. The practical reasons for this were that we needed portable equipment for the fair and that we were not allowed to present the companies' furniture models in public. However, this difference does not weaken our result because the level of modelling was similar in both setups. The difference in equipment should have resulted in an opposite effect: our finding was not expected since in many studies it is assumed that a better presentation technology creates better user experience (Suh and Lee 2005; Jiang and Benbasat 2005; 2007). In our study, the VE technology in the Laboratory Setup was of higher quality than the one in the Furniture Fair Setup. Future research should seek to develop settings with similar VEs.

Other differences in our study were related to the study process and test users. In the fair, the time for each participant was limited because the users also wanted to see other stands. However, the process in both of the setups was similar. The people who participated in the two setups were not the same individuals, but they had similar interest on furniture and decoration. We argue that this is acceptable because we focused on identifying user interpretations in VE but did not investigate any causal relationships. For future studies, the same participants should be tested in two physical places to find out what makes this "sense of place" and whether it is possible to create it also in a laboratory (or home, etc.) via technological innovations. Another question for future research concerns how different the physical places should be to make the IT users' interpretations differ. Future research may create a setting for a range of places rather than just for a fair and a laboratory.

7 Conclusion

It is known that technology affects users' interpretations of virtual objects (Suh and Lee 2005; Jiang and Benbasat 2005; 2007). We studied whether also the physical place in which the virtual objects are presented affects the interpretations. Based on Lefebvre (1998), a physical place includes three moments which focus on objective attributes, lived experience, and symbolic image.

We analysed users' interpretations in two alternative places, which differ from each other by all three moments. These places were a furniture fair and a VE laboratory. The interpretations were different: in the fair, users focused more on product features, in the laboratory, on technology features. The level of VE technology was higher in the laboratory, which makes our results even more significant. Based on our results, we suggest that professionals studying, designing, and implementing new systems to users should be encouraged to pay closer attention to the place-identity, to what is happening immediately around the users. The emphasis on place means that professionals have to think more carefully about the meaning of place in IT.

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References

Abowd, G. D., Atkeson, C. G., Hong, J., Long, S., Kooper, R., and Pinkerton, M., (1997). Cyberguide: A mobile context-aware tour guide. *Wireless Networks*, (3:5): 421-433.

Akpan, I., Marshall, P., Bird, J., and Harrison, D. (2013). Exploring the Effects of Space and Place on Engagement with an Interactive Installation. In: *CHI 2013, Proceedings of the SIGCHI Conference on Human Factors in Computing Systems,* ACM, New York, USA, pp. 2213-2222.

Belk, R. W., (1975). Situational Variables and Consumer Behavior. *Journal of Consumer Research,* (2), 157-164.

Benyon, D., Quigley, A., O'Keefe, B. and Riva, G., (2013). Presence and digital tourism. *AI & Society* (Online 17 July 2013), 9 p.

Berk, E., (1995). Changing documents/documenting changes: using computers for collaborative writing over distance. In: *The Cultures of Computing,* S.L. Star (ed.), Blackwell, Oxford, pp. 53-68.

Bijker, W. E., (1987). The social construction of Bakelite: Toward a theory of invention. In: *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology,* W.E. Bijker, T.P. Hughes, and T. Pinch (eds.), MIT Press, Cambridge, Massachusetts, pp. 159-187.

Boustedt, J., (2009). Students' understanding of the concept of interface in a situated context. *Computer Science Education*, (19:1), 15-36.

Cocciolo, A., and Rabina, D., (2011). Does place affect user engagement and understanding? Mobile learner perceptions on the streets of New York. *Journal of Documentation*, (69:1), 98-120.

Davidson, A. L., Schofield, J., and Stock, J., (2001). Professional cultures and collaborative efforts: A case study of technologists and educators working for change. *The Information Society,* (17), 21-32.

Davidson, E., (2002). Technology Frames and Framing: A Socio-Cognitive Investigation of Requirements Determination. *MIS Quarterly*, (26:4), 329-358.

Dixon, J., and Durrheim, K., (2000). Displacing place-identity: A discursive approach to locating self and other. *British Journal of Social Psychology,* (39), 27-44.

Dourish, P., (2006). Re-space-ing place: "place" and "space" ten years on. In: *CSCW'06, Proceedings of the 2006 20th anniversary conference on Computer supported cooperative work,* ACM, New York, pp. 299-308.

Entwistle, N., (1997). Introduction: phenomenography in higher education. *Higher Education Research & Development*, (16:2), 127-134.

Eve, S., (2012). Augmented Phenomenology: Using Augmented Reality to Aid Archaeological Phenomenology in the Landscape. *Journal of Archaeological Method and Theory,* (19:4), 582-600.

Graham, S., (1998). The end of geography of the explosion of place? Conceptualizing space, place and information technology. *Progress in Human Geography,* (22:2), 165-185.

Greenbaum, J., and Kyng, M., (1991). Introduction: Situated Design. In: *Design at Work: Cooperative Design of Computer Systems,* J. Greenbaum, and M. Kyng, (eds.), Lawrence Erlbaum Associates, Hillsdale, New Jersey, pp. 1-14.

Gregor, S., (2006). The nature of theory in information systems. *MIS Quarterly,* (30:3), 611-642.

Harrison, S., and Dourish, P., (1996). Re-Place-ing Space: the roles of place and space in collaborative systems. In: *CSCW 1996, Proceedings of the 1996 ACM conference on Computer supported cooperative work,* ACM, New York, pp. 67-76.

Hsu, T., and Chen, C., (2010). A mobile learning module for high school fieldwork. *Journal of Geography,* (109:4), 141-149.

Jiang, Z., and Benbasat, I., (2005). Virtual Product Experience: Effects of Visual and Functional Control of Products on Perceived Diagnosticity and Flow in Electronic Shopping. *Journal of Management Information Systems,* (21:3), 111-148.

Jiang, Z., and Benbasat, I., (2007). The Effects of Presentation Formats and Task Complexity on Online Consumers' Product Understanding. *MIS Quarterly,* (31:3), 475-500.

Jones, Q., Grandhi, S.A., Whittaker, S., Chivakula, K., and Terveen, L., (2004). Putting systems into place: a qualitative study of design requirements for location-aware community systems. In: *CSCW '04, Proceedings of the 2004 ACM conference on Computer supported cooperative work*, ACM, New York, pp. 202-211.

Kaapu, T., and Tiainen, T., (2012). Phenomenography: Alternative Research Approach for Studying the Diversity of Users' Understandings. In: *20th European Conference on Information Systems,* AISeL, 12 p.

Kaikkonen, A., Kekäläinen, A., Cankar, M., Kallio, T., and Kankainen, A., (2005). Usability testing of mobile applications: a comparison between laboratory and field testing. *Journal of Usability Studies*, (1:1), 4-17.

Kjeldskov J., Skov M. B., Als B. S., and Høegh R. T., (2004). Is it Worth the Hassle? Exploring the Added Value of Evaluating the Usability of Context-Aware Mobile Systems in the Field. In: *Proceedings MobileHCI 2004 conference*, Springer-Verlag, pp. 61-73.

Latour, B., and Woolgar, S., (1979). *Laboratory Life: The Social Construction of Scientific Facts,* Sage Publications, Beverly Hill.

Lefebvre, H., (1998). *The Production of Space,* Blackwell, Oxford.

Leigh, J., Johnson, A. E., Vasilakis, C. A., and DeFanti, T. A., (1996). Multi-Perspective Collaborative Design in Persistent Networked Virtual Environments. In: *VRAIS'96, Proceedings of the IEEE 1996 Virtual Reality Annual International Symposium*, pp. 253-260.

Lin, A., and Silva, L., (2005). The Social and Political Construction of Technological Frames. *European Journal of Information Systems*, (14:1), 49-59.

Marton, F., (1981). Phenomenography – describing conceptions of the world around us. *Instructional Science*, (10), 177-200.

Marton, F., (1988). Phenomenography: Exploring different conceptions of reality. In: *Qualitative approaches to evaluation in education: The silent scientific revolution,* D.M. Fetterman (ed.), Praeger, New York, pp. 176-205.

Marton, F., and Booth, S., (1997). *Learning and awareness,* Lawrence Erlbaum, Mahwah, New Jersey.

Messeter, J., (2009). Place-specific computing: a place-centric perspective for digital designs. *International Journal of Design,* (3:1), 29-41.

Orlikowski, W. J., (1992). Learning from Notes: Organizational Issues in Groupware Implementation. In: *CSCW '92 Proceedings of the ACM conference on computer-supported cooperative work*, pp. 362-369.

Orlikowski, W. J., and Gash, D., (1994). Technological Frames: Making Sense of Information Technology in Organizations. *ACM Transactions on Information Systems,* (12:2), 174-207.

Orlikowski, W. J., and Iacono, C. S., (2001). Desperately Seeking the 'IT' in IT Research: A Call to Theorizing the IT Artifact. *Information Systems Research,* (12:2), pp. 121-134.

Park, J.-S., (2011). AR-Room: a rapid prototyping framework for augmented reality applications. *Multimedia Tools and Applications,* (55:3), 725-746.

Proshansky, H., Fabian, A.K., and Kaminoff, R., (1983). Place-identity: Physical world socialization of the self. *Journal of Environmental Psychology,* (3), 57-83.

Renström, L., (1988). *Conceptions of matter. A phenomenographic approach.* Acta Universitatis Gothoburgensis, Göteborg studies in educational sciences, 69, University of Göteborg, Sweden.

Roto, V. Oulasvirta, A. Haikarainen, T. Lehmuskallio, H., and Nyyssönen, T., (2004). *Examining mobile phone use in the wild with quasi-experimentation.* HIIT Technical Report 2004-1, August 13.

Sandberg, J., (2000). Understanding human competence at work: An interpretative approach. *Academy of Management Journal,* (43:1), 9-25.

Saunders, C., Rutkowski, A. F., Van Genuchten, M.. Vogel, D., and Orrego, J. M., (2011). Virtual space and place: Theory and test. *MIS Quarterly*, (35:4), 1079-1098.

Steuer, J., (1992). Defining Virtual Reality: Dimensions Determining Telepresence. *Journal of Communication,* (42:4), 73-93.

Suh, K.-S., and Lee, Y. E., (2005). Effects of Virtual Reality on Consumer Learning: An Empirical Investigation in Web-Based Electronic Commerce. *MIS Quarterly,* (29:4), 673-697.

Säljö, R., (1997). Talk as data and practice – a critical look at phenomenographic inquiry and the appeal to experience. *Higher Education Research & Development,* (16:2), 173-190.

Tamminen, S., Oulasvirta, A., Toiskallio, K., and Kankainen, A., (2004). Understanding mobile contexts. *Special Issue of Journal of Personal and Ubiquitous Computing*, (8), 135-143.

Turkle, S., (1997). *Life on the Screen: Identity in the Age of the Internet.* Simon & Schuster Trade.

Turner, P., and Turner, H., (2006). Place, Sense of Place, and Presence. *Presence,* (15:2), 204-217.

Webb, G., (1997). Deconstructing deep and surface: Towards a critique of phenomenography. *Higher Education,* (33), 195-212.

Wise, J. M., (1997). *Exploring Technology and Space,* Sage,Thousand Oaks.

Yoo, Y., (2010). Computing in Everyday Life: A Call for Research on Experiential Computing. *MIS Quarterly,* (34:2), 213-231.

Appendix

Interview plan (originally in Finnish)

[Participant arrives]

- Informing the study
- Signing the consent form
- How would you describe your interest in furniture and interior design?
- How would you describe your interest in virtual environments?

[Testing procedure]

- Guiding to evaluate certain prototypes
- Asking to think aloud
- Themes for the interview
- Which of the furniture prototypes did you watched? Something interesting?
- There (in the test use) you said "xxx", what do you mean by that?
- What furniture prototypes did you like and/or dislike? – Why?
- Which of them appealed to you the most/the least? – Why?
- How was your experience with them? – Why?
- Anything else you would like to say? – Why?
- When you leave from here and meet your family or friends, what will you tell about your experience?
- What did motivate you to volunteer for this study?

[Ending]

- Thanks for participating, participant leaves