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Visitor Orientation:
Human-Computer Interaction in Digital Places

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Licentiate Dissertation

CID
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Visitor Orientation

Human-Computer Interaction in Digital Places

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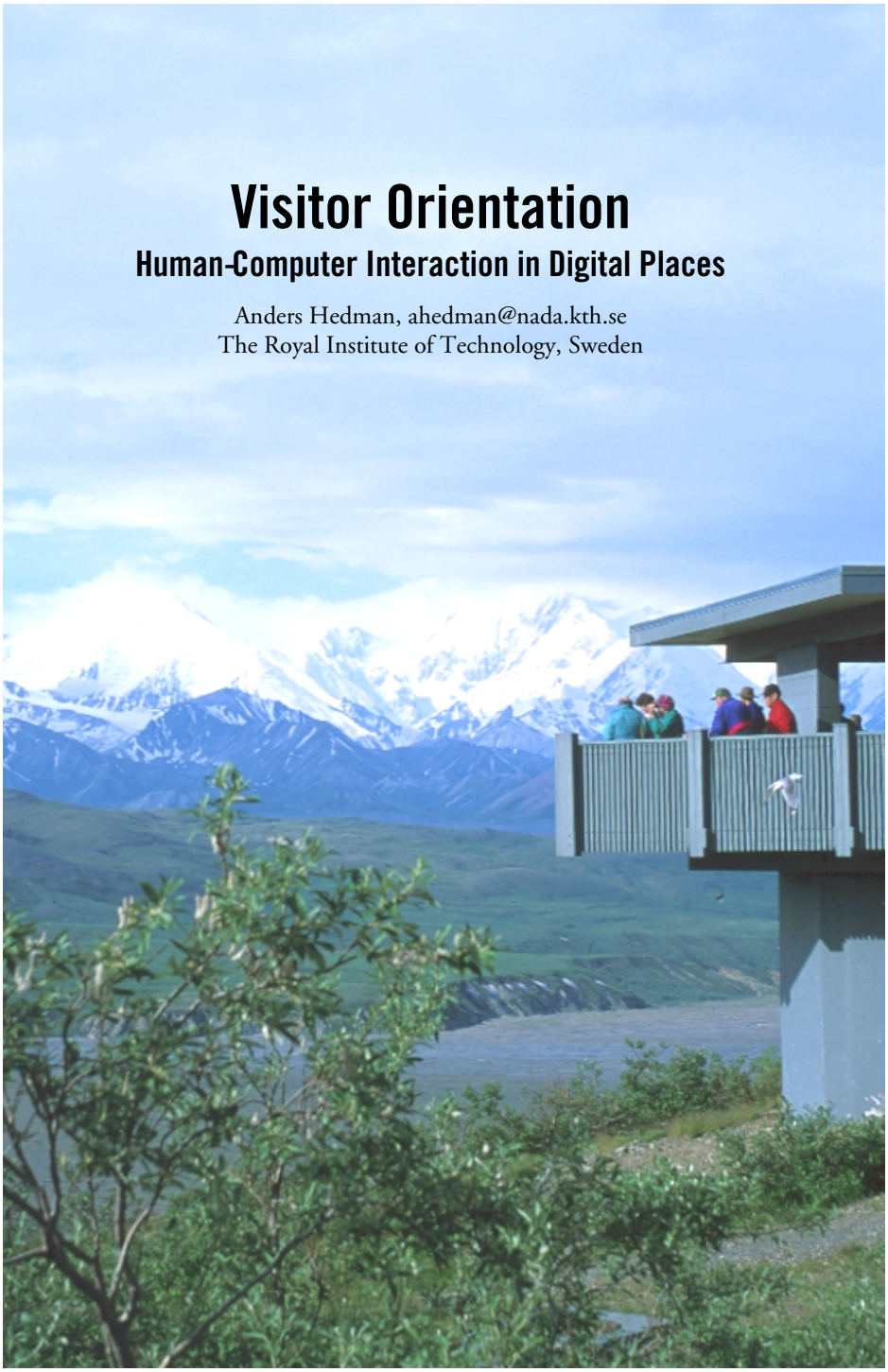

This is a licentiate thesis in Human-Computer Interaction at NADA, KTH (the Royal Institute of Technology), Sweden. The work has been performed at CID, the Centre for User-Oriented Design which is a multidisciplinary research institution that seeks to further our understanding of human-computer interaction and to explore new venues for such interaction. This thesis is about human-computer interaction in 3D digital environments and it consists of a collection of published papers that have here been given a context. The papers are largely based on studies conducted at CID. These studies have formed a basis for developing the perspective of visitor-orientation. In the main, the thesis aims to:

- Explain visitor orientation and its emergence
- Show how visitor orientated studies can be conducted
- Show that visitor oriented studies can yield interesting results

Thus the thesis has conceptual and argumentative sections, as well as sections which rely more on empirical work. The goal is to build a viable perspective on human-computer interaction that caters for today's growing community of visitors of digital environments. While the focus is on 3D digital environments, the results from this thesis also apply, even if less directly, to other digital environments with connotations of place such as web sites and other online services with clients characterized as visitors rather than users.

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advisor. John has read and critiqued much of my writing and each time helped me see the core issues more clearly. John is knowledgable and insightful, humanistic and technical, and capable of quickly grasping virtually any subject. My colleague Sören Lenman who has been the second author on several papers we have written together is my primary research partner and has helped me develop many ideas, which at first were obscure and muddled. I have greatly enjoyed working with Sören on our papers and have learned much from our work together. I would also like to thank Kerstin Severinson-Eklundh for her support and I am very grateful to have been able to discuss papers and experiments with her. Kerstin, with her equally genuine dedication to the field of HCI and to supporting students, has helped by indicating possible research directions. It has also been rewarding for me to work with Eva-Lotta Sallnäs on research papers and with experiments. I am happy to have had the early support of Carl-Gustaf Jansson who is such a cheerful and kind spirit, and never sees problems, but challenges and opportunities. Whithout the support of Carl-Gustaf I would have felt lost many times in the complexities of academic life. Lastly, but not least I would like to thank my family and my dear life companion Ylva, for their understanding and concern for my well being when I have been busy with research. Without their support and encouragement, this work would not have been possible.

Abstract

The thesis presents a visitor-oriented perspective on human-computer interaction and offers it as an alternative or complement to user-orientation. The thesis reports from studies of visitors in digital environments with strong connotations of place. The main findings are that visitors have unique needs going beyond usability needs.

- They are concerned with environmental sterility/richness
- They seek environmental perspicuity
- They experience informational content in novel ways
- They have strong opinions about digital environments
- They develop strong attitudinal responses
- Transportation tools do not help visitors to develop more positive environmental attitudes

In order to explain the visitor-oriented perspective a comparison with the user-oriented perspective is presented. Limitations of the user-oriented perspective are brought to the foreground and its dominance is questioned. The dominance of the user-oriented perspective in human-computer interaction is questioned against the background of a growing field of practical possibilities inherent in: the online world, the world of gaming, and virtual environments. In these settings, the subject is often more of a visitor than a user.

1. Introduction

Thesis objectives and overview

Over the last three decades there has developed a tradition of research on user interfaces and users of computer technology. Thanks to this development much has been learned about human-computer interaction (HCI) from a use perspective and especially from an instrumental use perspective. Designers of user interfaces can build on a tradition of human-computer interaction research, avoid well-known pitfalls and make use of design guidelines. However, the aspect of use is only one aspect under which human-computer interaction takes place and other aspects of human-computer interaction are less well researched. This thesis is about one such aspect: that of visiting a digital environment. It is common to speak of visitors of digital environments such as online services, i.e., websites and chat sites. Moreover, many 3D games and other interactive 3D environments have stronger connotations of place and involve visitors in more obvious ways. It is therefore an interesting hypothesis that it would be both possible and fruitful to construct a visitor-oriented perspective on human-computer interaction. This hypothesis entails that we think of humans interacting with digital environments as visitors of places and bring the shared understanding of visitors and places into the digital realm as an ideational basis for research. Thus e.g., it is possible to think of visitors of museums in the real world, as well as in the digital realm and in both of these settings it is meaningful to ask how visitors regard their environments and interact with them.

The work is about human-computer interaction in 3D digital environments with strong connotations of place. It is based on five published papers that develop a visitor-oriented perspective. These papers aim to:

- Describe key concepts of visitor orientation
- Provide arguments for the visitor-oriented perspective
- Compare and contrast user- and visitor orientation
- Show how user- and visitor orientation can work together
- Provide a methodology for visitor-oriented research
- Report from visitor-oriented studies
- Give advice on how to build visitor-oriented 3D digital environments

The papers can be found in appendixes 1-5. The thesis provides a larger context for these papers and:

- Presents them in an organized manner
- Adds further explanations of key concepts
- Provides a discussion of the work in its entity
- Gives suggestions for further research

The thesis is organized in five chapters:

- Introduction
- Tools and Users
- Structure and Nature of Digital Environments
- Visitor Orientation
- Discussion and Future Directions

There is an appendix with pictures of the trial environments used in studies. The questionaires for these studies are also included along with the published papers at the back of the thesis.

This introduction explains the objectives of the thesis and gives an overview of the work. The chapter *Tools and Users* treats mainly of the tradition within HCI that concerns itself with questions of usability and users. This tradition is dominating research within HCI. Alternative approaches are recognized and encouraged, but as will be argued, viewed as building on top of user-orientation and not in a parallel fashion. The chapter Tools and Users seeks to reveal this fundamental ontology of users and to challenge it. This is done in order to set the stage for visitor-

orientation as an approach that is not dependent on user-orientation or on users as a fundamental unit of analysis. *Structure and Nature of Digital Environments* is for those readers who are new to virtual-reality technology and gives a brief overview how such technology is used to create digital environments with convincing representations of place. *Visitor Orientation* delineates and explains further the perspective of visitor-orientation. It also describes the methods used in conducting controlled studies and presents results from those studies. *Discussion and Future Directions* provides a discussion of the results from the studies and reflects on the thesis as a whole. It also presents topics for further visitor-oriented research along with conceivable challenges.

1.1 Studying visitors

As in any empirical enquiry methodological decisions had to be made in order to start investigating the subject at hand. This fact became especially obvious at an early stage of this work since there was no (and there is still no) established body of research that reports from earlier studies aiming to discover facts about visitor-interaction in 3D digital environments. The approach here builds on controlled studies in trial environments. As opposed to the tradition of studies within 3D digital environments, the environments constructed were not built with a concern to explore any specific environmental features or mental abilities. Thus for example, they were not built so as to explore navigation, object manipulation, lighting or realism, but rather for exploring what can be thought of as the uniqueness of visitor psychology. More specifically, the aim of the research was to bring to the foreground exactly those features of digital environments that filter in to the process of visitors accommodating (a description of the term accommodation as used in this thesis follows shortly) to them. If one attempted to count all of those features, one would most likely get a huge list. It seems that there is a potentially open-ended set of such features. However that may be, it is feasible to ask which of those possible features are more primary than others.

The term accommodation has many different meanings. In this thesis, accommodation should not be interpreted as the accommodation process involved in vision, nor in the Piagetian sense of having to do with cognitive adaptation. The correct way to think of accommodation for the purposes of this thesis is as a process of developing attitudes to a place that a visitor goes through as she explores it over a short or long period of time. Accommodation is a technical term, when applied to digital environments and visitor orientation, but it corresponds roughly to the meaning of the term that describe the process of finding oneself at home in everyday life situations as one resides in various places. So for example, as one comes into a hotel room to unpack one may or may not feel accommodated. Some

of the reasons contributing to one not feeling accommodated may be that the water does not run in the faucet or that the room is too cold and these reasons pertain to functionality. But, other non-functional reasons may also contribute to one feeling accommodated or not: if the hotel room has a vase with fresh flowers, a nice rug on the floor and paintings, one might feel more accommodated than if the room was devoid of those things. As one stays in the hotel room one will also be provided with the services of the hotel and its workers such as cleaning personnel and other staff. They may or may not provide the kinds of services that one requires and this will in turn effect the way one feels accommodated. Accommodation with respect to services does not only depend on the actual services provided, but also on the way in which they are provided, i.e., on the manner in which the staff provide the services. Thus the staff members can, i.e., be hostile or friendly while performing the services. Whether one feels treated well or badly is a question going beyond the functional value of the services provided. Altogether one's accommodation is dependent then not only on functional features of the environment, but also on features going beyond such features and we may characterize these latter features as being accommodational and non-functional. Thus non-functional in this sense has nothing to do with malfunction or dysfunction. Although accommodation depends on both functional and non-functional features, priority has been given to explore the non-functional factors of accommodation since such features remain largely unexplored within the literature.

In order to begin the exploration of unique visitor needs in digital environments some decisions had to be made pertaining to the construction of trial environments for controlled studies. The empirical work described in this thesis depends on a certain logic of aesthetics for constructing such environments. Since the work is not concerned with applying earlier theoretical work within visitor-orientation, but to break new ground, the design agenda must come from a vacuum it seems. It is therefore natural that the design work of this thesis is based on a minimalist approach. By a minimalist design approach is meant a logic of aesthetics that is characterized by a general concern for constructing digital environments that are as simple as possible for the purposes at hand. In a certain sense such environments can be said to be manifesting the absence of design. This sense of minimalism can be understood as design that does not attempt to make any kind of design statement (i.e., to be impressive or unique) and is not manifesting any design agenda other than that of following the most basic and generally agreed upon design principles (i.e., avoidance of an excess of colors, good contrast, alignment and grouping). When a minimalist environment has been constructed it is possible to conduct trials within it and learn which features are appreciated, which are not appreciated and what features are desired, but lacking.

It is also possible to, on the basis of feedback from trials, construct successively refined environments that better capture the needs of visitors. In summary, the approach to designing trial environments has been minimalist and iterative.

1.2 Results from studying visitors

As this thesis proposes visitor orientation as a perspective on human-computer interaction it must show that it is not merely a concept to be pondered in the abstract, but that visitor orientation lends itself to empirical investigations and that such investigations can yield interesting results. This will be shown in the chapter *Visitor Orientation* which grounds the perspective empirically. The findings (discussed more fully in that chapter and in conjunction with the published papers) can be stated here briefly.

Visitors are concerned with environmental richness

When subjects were presented with minimalist environments most of them found them to be sterile. Many suggestions were given by subjects as to how minimalist environments could be enriched and made more inviting. Such suggestions involved the use of decorative elements and the inclusion of warm colors.

Visitors seek environmental perspicuity

Many subjects that were presented with environments that were too large to be easily surveyed raised complaints about this. Such complaints were not generally accompanied by statements expressing needs to navigate efficiently within the environments and thus indicated that being able to see an environment in toto has a value in itself that may not simply be reducible to usability issues.

Visitors develop attitudinal responses to the environments

Most of the subjects expressed aesthetic concerns and offered suggestions on how the environments could be made more pleasing. They also made suggestions as to how the environments functioned and could be made to work better. Their concerns and affectual responses shaped general attitudes towards the environments. Few subjects were indifferent to an environment and most expressed a considerable degree of engagement.

Visitors experience informational content in novel ways

It is a fact of rhetoric that the way in which information is presented affects the way the audience perceives the information. One could expect then that if the same information was presented in a 3D environment as in a 2D environment that the subjects would not perceive the information in the same way. This was confirmed and it was found that attitudes towards a learning material were more positive when the material was presented in a 3D environment than when it was presented in a 2D environment, i.e., a web site.

Visitors do not like to walk around more than necessary

Many subjects in environments that were large and could have been built in more compact ways complained about having to walk around too much. They were annoyed about having to run around in order to find information even though it was possible to move rapidly in the environment and the amount of physical energy exerted was minimal. These latter facts indicate that the subjects were bringing concerns from everyday life with them into the digital environment. In ordinary life we try to avoid walking around too much because it is physically exhausting and we commonly do not want to waste time.

Visitor are not obviously helped by transportation tools

Although subjects expressed desires to be able to click on parts of the environment in order to be transported to those parts, when such functionality was implemented it was not found to bring about more positive environmental attitudes. Thus although excessive walking was disliked, a more reasonable amount of walking appeared to be just as good as walking very little and using tools for automatic transportation. When subjects were interviewed they generally indicated that being transported is less engaging than walking by one self.

Novice visitors rapidly learn how to explore environments

The subjects in the studies that had no previous experience with digital 3D environments learned with ease how to explore the environments. To be moving around in a digital 3D environment came naturally to them and this was surprising since with most software there is usually an initial period of frustration before novices become able to interact easily with them.

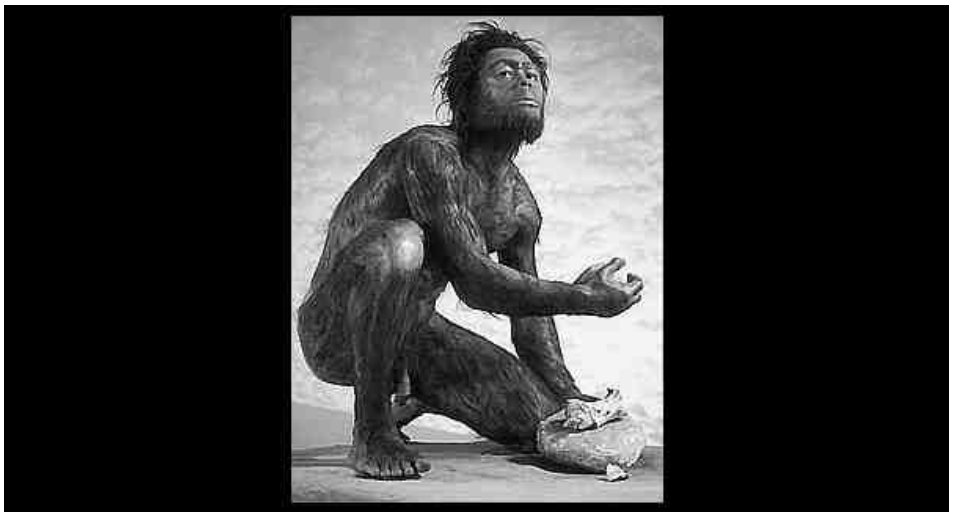

Fig 1–Homo Habilis, distinguished by the production of pebble tools. Courtesy of the Hunterian Museum, Glasgow.

Computer technology is constantly evolving and at a faster pace each day that goes by. In accordance with this rapid evolution, the challenges of HCI are also changing swiftly. At the same the importance of HCI research grows for it serves the role of a gating function to new technology [Strong 95]. If the human is going to be able to find herself comfortable with technology so it becomes empowering rather than intimidating or difficult to understand, then it must be crafted with her in mind. Today people engage in a greater multitude of different roles when interacting with computers than only a few years ago. During the past decade the working community of the industrial world has gone online, and the Internet has changed people's ways of interacting with computers drastically as it interfaces with the home environment. Especially noticeable is the fact that digital artifacts have, on a wide scale, become more than tools. They are also sources of entertainment, places to visit, work or study in. Still, our conception of the human

in human-computer interaction expresses itself by a focus on users. Thus the human in human-computer interaction is largely characterized as the human qua tool user.

2.1 The homo habilis view

The term "usability" and the expressions "user centered design", "user oriented design" and "usage centered design" are linguistic manifestations of this underlying assumption: that humans interact with computers as tool users. Constantine and Lockwood make one of the most poignant expressions of this idea:

> Humans are tool users. We use tools to extend our grasps, to see beyond the horizon and beneath the soil, to build things and to tear them down. We use tools to carry things and to move ourselves. We use them to make goods and even to make other tools. All software systems are tools, and software developers are, therefore tool builders. Whether we are writing routine business applications for internal use by our employers or we are part of a team developing shrink-wrap software for sale, whether our programs are only new twists on old standards or we are devising exotic control programs for a new generation of peripherals, we are building tools. [Constantine & Lockwood 99 p5]

We can think of the view of HCI manifesting itself in the above quote as the **homo habilis** view. This view is also prevalent in general definitions of HCI [Hewett et al 92 p5, Dix et al 98 p. xv, Preece et al. 94 p. 1, Norman & Draper 86 p.1, Martin et al., 97 p. xi]. These writers all describe HCI as being fundamentally about the relation between the users on the one hand and tools on the other. Admittedly, they all advocate broad perspectives on HCI that in reality go well beyond the use of tools, but such broader perspectives are presented against the backdrop of the user-oriented paradigm. Why are users and tools seen as being so absolutely fundamental to HCI? It is easy to understand Constantine's enthusiasm for the computer as a fascinating multi-purpose tool. The computer is just marvelous in terms of what it can do and the possibilities of computer technology appear virtually unlimited and many fascinating claims have been made about the computer in science, as well as in science fiction. At the same time it is the fascinating possibilities with computers that makes it natural to question the homo habilis view. After all, if we can do so many marvelous things with computers then why should we not be able to make artifacts that are not primarily experienced as tools? And indeed there are plenty of such artifacts today. The gaming industry has produced a very large number of them. They literally make up for a considerable part of many youngsters everyday experiences and are better characterized as digital

places rather than tools. Just ask the kid who plays Doom, Quake, Myst or any other of the popular 3D games what his or her experience is like. Is it like using a tool or is it like being in an exciting place? If the game is any good at all, the answer to that question should indicate that it is not experienced or thought of as a tool, but as something making up for a rich and stimulating environment that the person actually feels immersed in. Note also that these games mentioned here only provide for simple 3D environments. There are much more advanced systems around using all kinds of sophisticated technology such as Head Mounted Displays (HMD:s), rooms with projection walls and sophisticated surround sound systems (CAVE:s) and so forth. These are just some graphic examples of how computers can be interacted with on another basis than that of the homo habilis. Moreover, graphics is just one way to create digital places since the experience of place does not depend exclusively on graphic representations. The proponent of the homo habilis view might say to this that even if we can experience computer artifacts as other things than tools, such experience is actually secondary to the fundamental relation of tool use. All other kinds of possible relations and experiences that we can have with computers then occur only within this backdrop of tool use and that is why HCI must be characterized as the science of tool use.

There are at least two major problems with assigning such primacy to tool use in HCI. The first problem is that just the fact that computer artifacts can always be viewed as tools on some level of description does not necessarily imply that they must always be fundamentally viewed as such. After all, almost anything can be thought of as a tool–even humans–although morally that seems repugnant. The fact is however, that the ways in which we choose to describe the world around us are not set in stone and it is always possible to assign tool-like descriptions to anything. Thus we can think of buildings as tools we use to keep the rain out and paintings as tools for producing emotional reactions. Anything we can think of as being used can in principle be thought of as a tool although it does indeed seem awkward to think of many things as tools. Moreover, people who constantly look for the use of things are generally held to be missing out on many other aspects of life. But, it is possible to question anything in terms of its usefulness; it is just a matter of how we view the world. So when Constantine and Lockwood argue that "computer games can be thought of as tools in that they help people have fun or learn or improve eye-hand coordination or just relax" [Constantine & Lockwood 99 p5] it is a true statement, but nevertheless misleading. To indicate that our rock bottom basis for analyzing human-computer interaction is use is simply to impose an awkward description that does not capture the subjectivity involved. Historically, such a description has been more universally acceptable, at least with respect to the concrete artifacts built in the early days of the history of the computer. Those artifacts that were deployed exclusively by scientists and

operators really did not allow for the rich experiences possible with the computers of today.

It seems limiting and irrational to go on with the homo habilis view today, however, and it should be seriously questioned so we can rid HCI of the confusion that it expresses and at the same time fosters. It is only natural that the perspectives and approaches of HCI change and never become completely static. How could they become static when all parts of the relation expressed by HCI are dynamic and evolving? Indeed writers have pointed to the evolution of HCI and how the underlying conditions of the field are not fixed, but change with time as the result of evolutionary processes [Bowers & Rodden 93, Grudin 90, Grudin 93, Kuuti 93]. Much of the work of these writers in these papers centers around the issues of users and user-interfaces as these notions are found to be problematic in themselves or otherwise used in problematic ways. Most of these writers point to the problems involved with thinking of the user-interface as a singular entity which can be de-contextualized from the larger environmental setting in which it exist. Their arguments, while being illuminating are not against the discoursal dominance of use and users per se, but about how use and the conditions for use and users have been historically construed. Thus the homo habilis tradition is not exposed or explained by them, but remains a parallel issue that is left lurking in the dark.

2.2 Homo habilis and "hard" science

To understand the homo habilis tradition within HCI it is helpful to take a look at some influential claims made about computers that have shaped the view of the computer within HCI. By examining how the second part of the acronym has been commonly characterized, it will then be possible to understand how the first part is characterized as homo habilis. Many historical accounts of the history of HCI describe the first era of computer history as being about calculation. The era of machine calculation roughly begins with Wilhelm Schickard's invention of the mechanical adding machine in the early 17^{h} century [Williams 97 p199-124] and dominates until at least the middle of the 20th century. Vannevar Bush is often seen as having challenged the purely calculative deployment of computers and to have proposed new and novel uses [Baecker et al 95 p35]. In his famous paper [Bush 45] proposed a new artifact–the Memex–designed to help man's intellect in ways going beyond the purely calculative mode that computers had previously operated in. Bush attempted to tackle a new problem that he saw as challenging in his era: to handle the vast amount of information amassed in science and other intellectual traditions by using microfilm and mechanisms of associativity. In principle, his goal was to make all of that information readily accessible to a single human intellect and not have it distributed in isolated chunks of information. The

way in which he thought such access could be physically realized did not turn out to be accurate and the technology of his day, microfilm did not develop in the way that he had suggested. What is more important, however, than his mistaken beliefs regarding the development of microfilm is his general concern for making information readily accessible through associative information retrieval pathways. This concern served to inspire much work on hypertext [Engelbart 62, Engelbart 63, Engelbart 86, Nelson 65, Nelson 73, Nelson 81]. The work of Engelbart and Nelson has in turn laid the groundwork [Engelbart 98] for today's hypermedia and the World Wide Web [Berners-Lee et al 92]. It also inspired early work on extending the human intellect itself. Bush himself speculated about more direct ways of linking information to the brain than the human senses. That was not possible in his days, but it is revealing of the dream that Bush had of extending the mind and making it more powerful with respect to its capacity for thought and handling information. That mind and machine could be hooked up together and form a new generation of cognitively enhanced beings is surely one of the most fascinating prospects in the history of the computer and it was followed up by many enthusiastic researchers. It was science fiction then, as it is today, but it is a remarkable fact of literature in the history of computers that science fiction is often cherished rather than avoided even among scientists. In human-computer interaction, there does not seem to be any clear distinction between science and fiction.

One writer that followed up on the fascinating speculations of Bush on the extendibility of mind was Licklider [Licklider 60] who made a particularly strong claim on how the human mind would come to evolve together with the computer into an intimate relationship. Licklider suggested that not only would it be possible to extend the mind by giving it external information storage capacities and immediate input channels, but what is more, mind and machine could on Licklider's view participate in a *symbiotic* relationship. Licklider turns to biology in order to paint a picture of how man-machine interaction will develop in the future that is common in our era of science fiction (one example are the “Borgs” in the TV series Star Trek–beings of living flesh, circuitry and electromechanics). First he describes how the fig tree is dependent on the insect Blastophaga grossorum for its pollination and consequently for its survival while the insect itself is dependent on the fig tree for its survival. He then goes on to argue that in the future man and machine will find a relationship like the one between the fig tree and the larva. Man and machine evolution will literally merge into single evolutionary unit that cannot be taken apart because it would destroy both of the parts of the unit. Thus, Licklider is making an evolutionary point by telling us his story and one is inclined to ask Licklider why evolution will change in the way proposed? Why will machine and mind join into a symbiotic relationship? Licklider does not answer this directly

but mentions some benefits of the symbiosis. The unit formed by the symbiosis will "think as no human brain has ever thought before". He then goes on to give examples of how calculative and analytic reasoning could become greatly enhanced. Notice that this general concern for thinking and problem solving is also present in Bush's earlier article. The focus of these writers is on the conditions of operation for thinking minds and it turns out for them that machines are central to understanding those conditions. An important difference between them is that Licklider goes further than Bush in saying that the human mind is not only to be extended, but transformed into a new being through a symbiotic relationship. Thus Licklider does not hold the human mind as anything primary to the other part of the equation, i.e., the machine just as the fig tree is not any more important than the larva. This is a significant difference because Licklider paves the way for a way of looking at the human mind as a system that can be made interoperable with another system, i.e., the computer. On Licklider's view, if we figure out how to connect the brain system with the computer system then we can create a larger system that can do marvelous things. Common to the writings of Licklider and Bush is that they, in different ways, paint a picture of human-computer interaction in which the distinction between the brain and the machine appears to become blurred. It is with this blurred distinction between human and computer and the vision of extending the intellect in various ways that HCI is often described as having important historical heritage.

A problem with getting a scientific account of HCI was, however, that although one part of the relation between human and machine was well understood, i.e., the computer, the other part, in particular the brain of that part, was not so well understood. Indeed, in the main, it is still a mystery how it works. But, with the development of what is generally referred to as the cognitive sciences, it appeared that there was a simple solution to understanding how the brain works–it is a computer. Moreover, many argued that although the brain is made up of different physical parts and has a different structure than computers constructed by humans, it still does the same kinds of things as computers on a higher level of abstraction. What is the right level of abstraction then?

The answer proposed by the cognitive sciences at large is that the brain and the computer are both information-processing machines. Many researchers in HCI adopted this view because it enabled them to formulate an exact science that seemingly held the promise of delivering dependable factual results and increase our knowledge of HCI in the same way that the "hard" sciences increase their body of knowledge. The user on this view is a computer just like any other computer, because the user is essentially an information processor with memory along with input channels and output channels. The senses are input channels, the brain is the

information processor with memory and the motor abilities make up for the output channels [Card et al 83]. In the mid eighties Newell and Card put forth an agenda for HCI that attempts to save HCI from what they saw as a potential disaster. They observed that psychology–a "soft" science used in analyzing the human in HCI–was being pushed out of HCI in favor of more rigorous and formal approaches. In order to save psychology in HCI they proposed a programme to transform it into a "hard" science by providing engineering-style theories of the user [Newell & Card 85, Sasse 97].

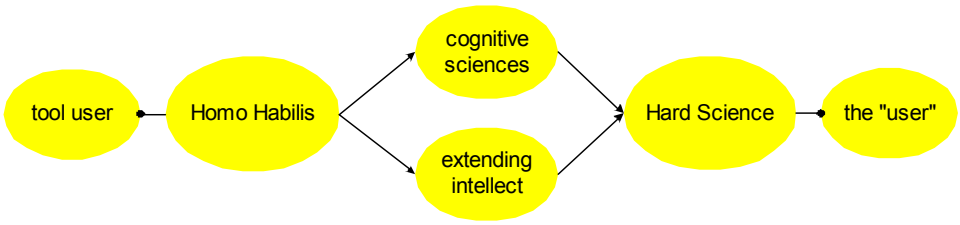

Fig 2–From tool user to the “user”

From the analysis of the notion of the user so far, we now have two different perspectives, one of them is the broad common sense perspective, i.e., the homo habilis perspective, and the other is the "hard" science perspective [Newell & Card 85, Newell & Card 86] which provides a refined version of the user and defines the user clearly and precisely just the way a good unit of analysis should be defined. On the "hard" science perspective, HCI is about causal interactions between two different kinds of machines operating on the same principles of information processing, the brain on the one hand, and the machine on the other. How can this interaction be analyzed? The answer given by the "hard" science perspective is that the user has a mental model of the computer and the computer can have a model of the user. Thus causal interaction between the two systems is analyzed both in relation to general results from the cognitive sciences on how the brain supposedly works and in relation to user models that can be general or specific to a certain application. In addition, the states of the systems change on either side of the equation and both entities in the relation therefore must dynamically adjust their models of the other part. The way in which both parties of the interaction go about in adjusting their models is by inference from the behavior of the other part. Without making any judgment on the possibility of this inferential approach when it comes to use analysis of traditional applications such as word processors and other common software tools, it appears to break down when the digital artifact becomes more than a tool. Think for instance of the person who visits a website and just stops on a page to admire it. What is the causal relation? Moreover, what

clues does the computer get to infer what the user is doing? How does it come to the conclusion that the user is admiring the page? The same behavior could be the result of the user stopping because the page appalls him, has left the room, or started to think about income taxes or any other plausible reason.

To sum up the discussion about the term 'user' in HCI, the common sense homo habilis view was rejected because it does not seem to capture the rich experience of HCI that goes beyond the use of tools. The more refined hard-science approach to HCI does not to do justice to HCI because the "hard" science approach depends on a causal analysis, which in turn depends on overt behavior, and in many important cases there is no overt behavior at all to be analyzed. What is the solution then, if we have no adequate technical definition of the 'user' and no common sense definition of the 'user' that works? The real solution is not really a solution at all, but what we have to face is a dissolution. The problem began when we first started to think of HCI along the line of a special unified ontology and in replacing the human with was was thought to be a better-defined term. It cannot and should not be done. Another way to state this more precisely is to say that interaction with computers is always aspectual, computers can be experienced under an unlimited number of different aspects and therefore HCI is always aspectual. There is nothing intrinsic to HCI that calls for viewing the human fundamentally as a tool user. As it has turned out over the course of history most researchers have viewed the relation between human and computer as being of tool use, but historical roots and tradition alone are poor reasons for advocating the homo habilis view. Whether HCI can ever be a "hard" science is really a separate issue and will work itself out in time, but however, that turns out to be, HCI will still always be about aspectual interaction. There is no way of carving off the subjectivity of such aspectual interaction and still do justice to HCI in toto. This may seem threatening to the prospect of HCI developing into a "hard" science, but threatening as it may be, we have to accept it.

2.3 Pluralism

Before concluding this discussion I would like to bring up one more possible objection and that is to say that the 'user' should not be thought of as referring to a singular well defined entity, but the term should instead be thought of as a term whose use derives from an open-ended set of activities. What we have then is a third possibility of analyzing the term and a possible defense for keeping the term as a valid replacement for the first part of the acronym HCI. So although the characterization of human interaction with computers so far might be agreeable, the user can still be saved as the fundamental unit of analysis. The term can be saved because the user is not a common sense term, nor a technical term with a

precise definition, but it is a term with a plurality of meanings learned by the active researcher within the field. Let us turn briefly to the philosophy of language in order to analyze how words can be used in extremely open-ended ways while still retaining their sense and meaning. The philosopher Wittgenstein points out that it is a mistake to think that every noun must refer to some clearly defined singular entity and he turns to the word 'game' to illustrate how a word can have an open-ended set of meanings. Although this word is understood by anyone it is not so easy to spell out what it is about a game that makes it into a game. What feature or set of features needs to be present in an activity if we are to rightfully call it a game? The game of chess appears to be very different from the activity of the child who just bounces a ball around or the kind of games that people involved in romantic affairs play to test each other psychologically. Now perhaps the word user is like the word game? It does not have a singular definition, but can only be understood in the context of an open-ended set of language-use activities. So, the researcher within HCI only comes to understand the term user through doing such things as going to HCI conferences, talking to experienced HCI-researchers, hearing lectures on HCI and reading the literature. If it is the case, however, that the word user does not have any precise meaning other than that derived from the interactions with computers, then one is inclined to ask what is gained from replacing the term 'human' with the term 'user' in HCI? To state this more precisely, if there is nothing other that defines the word 'user' than the interactional relation that humans have to computer technology then wherein lies the descriptive gain of replacing the word 'human' with the word 'user'? Moreover, for the sake of science, would it not be better to work out a more describing and detailed taxonomy of human-computer interaction? As it is now, there are at least three different "camps" of research within HCI, the homo habilis advocates, the "hard" science proponents and what we can think of as the pluralists and these groups all use the word differently. Thus the word 'user' does not seem to bring anything in terms of added clarity or unity to HCI, but only confusion. As a side note, not even Wittgenstein would say that this is a good situation for science, because he believed it to be both possible and desirable to have relatively stringent definitions for scientific discourse.

2.4 Concluding remarks

This thesis is, to an important extent, the result out of a growing frustration with contemporary HCI and the user terminology. It attempts to take a step away from the standard terminology, although it is arguably within the scope of HCI. For purposes of simplicity I will refer to users as defined within the homo habilis perspective or the "hard" science perspective. These two perspectives capture the bulk of work within HCI and create a backdrop against which alternative

approaches are generally discussed and evaluated. Both of these perspectives see use as logically fundamental in HCI and thereby convey a misleading ontology. This thesis is about visitors of digital environments with strong connotations of place. It centers on how they find themselves at home in these environments and what they require to become accommodated. Digital environments with strong connotations of place and experienced by the general public have traditionally been found within the gaming industry. Since the late seventies computer games which rely on interactive 3D graphics have been commonplace throughout the western world. Today, however, the scope of 3D environments is much wider. The worlds of education, business and art are all part of a widening spectrum of 3D environments. But, 3D graphics is just one way to create strong connotations of place. There are many web sites that utilize 2D representations to produce environments for people to visit such as Comic Chat [Kurlander et al 96, Rekimoto et al 98]. To an important extent every web site is also a place. Everyday language use reveals this to us. The language games we play with respect to web sites centers around visitors. The online business community was quick to notice this and almost exclusively categorizes their customers as visitors rather than users. When this author examined sixteen books from the Internet business literature only one of them brought up the issue of usability (see the bibliography for a complete list of these books). It is unfortunate that usability has not made its way more strongly into the Internet business literature. The user is simply not a part of the general discourse and use of language within this body of literature. Why are there such discrepancies between on the one hand, the way that people on the net characterize themselves and the way the business community characterize people and on the other hand, the way they are characterized by the HCI community? The user is one of many possible descriptory labels, which has proven itself to be fruitfully applicable in many settings. If evidence reveals that it is not fruitfully applicable in some circumstances then there is no reason to cling to it. Such clinging reflects the mentality of the proverbial man that searches for his lost keys under street lamp were it is light, rather than in the bushes were they were lost. The usability stance is found within a perspective on the human qua user, but it is possible to replace the human with other terms and still stay within the scope of HCI. Substituting the term human with the word 'visitor' allows for researching the domain of digital environments with connotations of place in more varied ways. The human qua visitor has different experiences than the human qua user in digital environments. While the user is deploying tools in order to accomplish some *effect* or reach a certain goal, the visitor interacts with places in richer more *affective* ways and is concerned with the process of accommodating to a digital environment with all that such accommodation entails. In some situations accommodation is largely about the functional design of the environment, i.e., if the visitor is only concerned with its functionality, but it must be remembered that functionalism is not an intrinsic feature of digital environments just as little as it is

an intrinsic feature of traditional environments. Functionalism is merely a way of viewing the world. Visitor orientation goes beyond the purely functional and caters for the visitor as an aesthetical being living within a cultural background and with personal preferences.

Various terms and expressions have been used to describe 3D digital environments with strong connotations of place. The expressions "virtual reality" and "virtual environment" are often said to be misleading for there is no such thing as "virtual reality", it is a contradiction in terms. The fact that digital environments are computer generated does not make them virtual or less real as. However, the expression "virtual reality", on one interpretation, is not simply a carelessly formulated oxymoron, but is to be understood in relation to the technical expression "virtual image" from optics.

> Virtualization may be defined as the process by which a human viewer interprets a patterned sensory impression to be an extended object in an environment other than that in which it physically exists. A classical example would be that of a virtual image as defined in geometrical optics. A viewer of such an image sees the rays emanating from it as if they originated from a point that could be computed by the basic lens law rather that from their actual location. Virtualization, however, extends beyond the objects to the spaces in which they themselves may move.[Ellis 91]

On the interpretation of Ellis a virtual reality environment would be one that gives the illusion of an environment which is not actually there, much in the same way that a mirror gives the illusion of there being something behind it. In this thesis, however, the expression "digital environment" is used since it is both describing and without possible misleading metaphysical connotations and hype [Bowers et al 96]. In order to use the expression with the greatest precision it must however be qualified in each an every instance. For example, digital environments vary greatly with respect to being place-like and immersive. As mentioned previously the domain of this thesis is about digital environments with strong connotations of place. There are many kinds of such environments. The term "virtual environment" is usually used to indicate three-dimensional, computer-generated,

simulated environments allowing for real time interaction. This corresponds to digital environments with strong connotations of place since places are normally experienced in real time and three dimensions of space. From here on "3D digital environment" (sometimes 3D environment for brevity) will be used to refer to such environments. With respect to interfaces, 3D environments differ markedly from most common applications, which exhibit the direct manipulation interface [Schneiderman 82]. Since 3D environments are experienced as places, they allow for interaction not available in two dimensions. In a 3D environment it is possible to move around in digital places and interact with objects that may or may not resemble objects in the world outside of the computer.

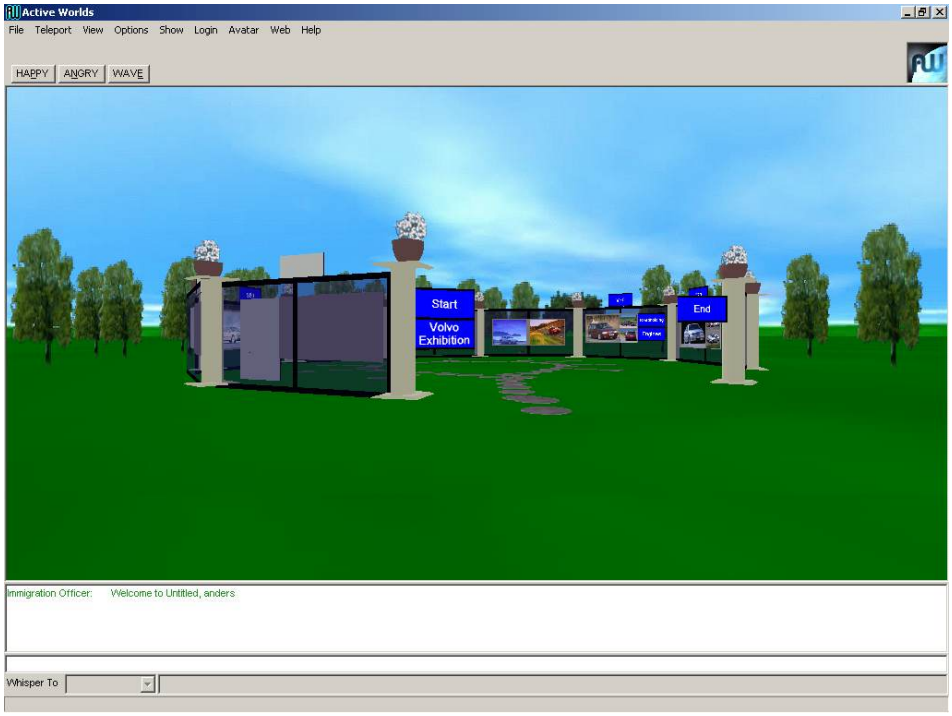

Fig 3–A 3D environment (ActiveWorlds)

The classical two dimensional direct manipulation interface is more limited with graphical icons and labels. The distinction between 3D environments and direct manipulation interfaces with 3D graphics may not always seem clear. Although direct manipulation interfaces with three dimensional graphics (see fig 5) can in some sense also be thought of as 3D environments, the sense in which the expression 3D environment is used here is limited to those environments that allow subjects to have the experience of moving about within them in ways that are spatially relatively unconstrained. Those environments which have 3D graphics

but do not allow for moving about within them in this way are often referred to as 2½ D since it is felt that they exhibit something more than simply a 2D graphical environment while not being 3D environments.

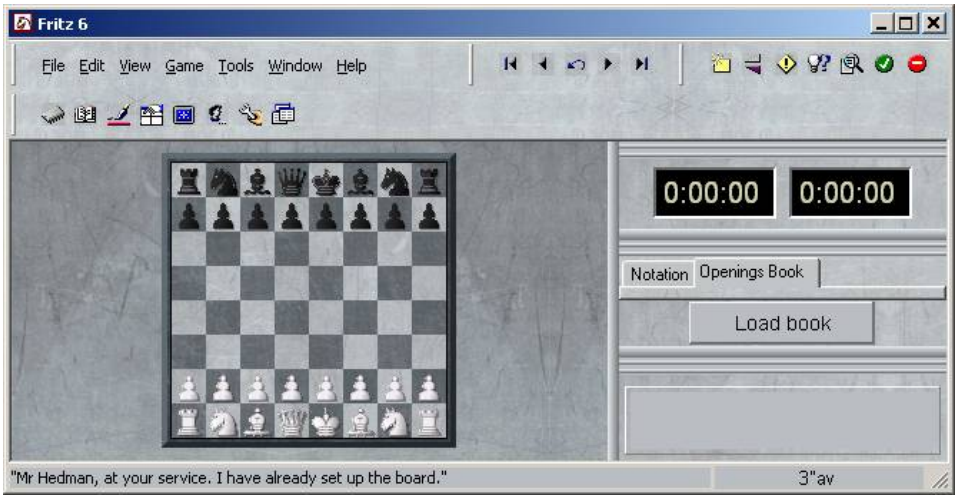

Fig 4–A direct manipulation interface (Fritz 6)

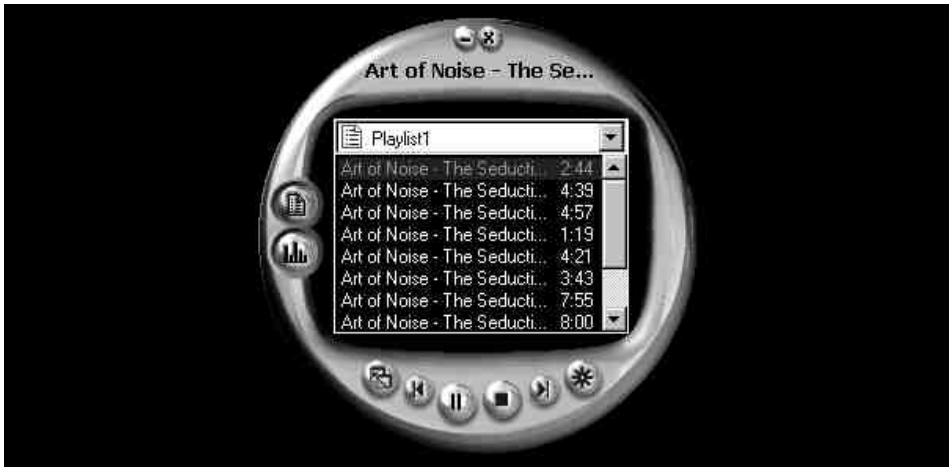

Fig 5–Direct manipulation interface with 3D graphics (MS Media Player)

Throughout the history of virtual reality various approaches have been explored in attempts to build environments that are experienced as immersive and in which one can feel a high degree of presence. Early on, experiments were made with large and heavy head mounted displays [Schroeder 96 p27-29, Heim 98 p20-23]. One important aim with such displays is to fill the field of vision with a digital

environment so that the subject sees it and no other things in her immediate surroundings. Traditional input-devices such as ordinary mice and keyboards have generally been avoided in immersive 3D environments. Such input devices have been avoided partly because they have been thought to conflict with the experiences of immersion and presence. For example, if the subject has to look down on a keyboard and navigate with the arrow keys, this draws her attention from the 3D environment. Traditional input devices have also been avoided because they are not made for 3D environments, but for 2D environments. Although is possible to use a traditional mouse and keyboard to navigate within 3D environments, the input from these devices must be mapped to three dimensions in ways which are often experienced as awkward. In short, ordinary input devices such as traditional mice and keyboards do not offer the same ease and freedom of movement as is available in non-digital environments. Much of the early research in virtual reality attempted to tackle this problem by developing new input devices such as body suits, wired gloves and 3D mice [Schroeder 96 p31-35]. A body suit is a wired garment used to detect the positions of limbs and/or body posture. With a body suit it is possible to move and interact within a 3D environment in much the same way that people interact with non-digital environments. Thus it is possible to walk within a 3D environment by walking and grasping things by grasping with ones hand. While body suits allow for mapping the limbs of the entire body, a wired glove only allows for mapping the movements of fingers. The 3D mouse does not allow for an intimate coupling between limb movement and body posture on the one hand and actions within a 3D environment on the other, but allows for efficient interaction within 3D environments. A problem with wearing equipment such as head mounted displays, body suits and wired gloves is that such equipment has traditionally been uncomfortable to wear. The development of the CAVE [Cruz-Niera et al 92, Cruz-Niera et al 93] was an effort to provide immersive experiences without the need to wear a head mounted display. A CAVE consists of a room of projection walls and surround sound systems. In terms of resolution and field of vision the cave offers great improvements over head-mounted displays, which generally have poor resolution and only provide a limited field of vision. While the CAVE provides a nice alternative to the head mounted display it does not solve the problem of attaining transparent and natural interaction with 3D environments. In order to tackle this problem a number of tracking devices have been explored apart as alternatives to the body suit, the wired glove and the 3D mice.

The ways in which 3D environments are rendered have improved greatly during the past few years. Such advances depend both on software and hardware. For the general public it is now possible to navigate in sophisticated 3D environments with relatively cheap hardware. 3D-graphics cards for a couple of hundred dollars today

match the performance of hardware costing hundreds of thousands of dollars only a few years ago. As more sophisticated hardware and software techniques becomes commonplace it makes it possible for developers to build more realistic environments [Ernshaw & Vince 95 pxix-xx]. One possible way of furthering the degree of experienced realism in a 3D environment is to use sophisticated models for calculating the way light is reflected within the environment, and to carefully define and place light sources where they work best. By increasing the number of polygons that vector objects are made of it is possible to make them look smooth. The quality of the textures used on objects is also important in producing environments with a high degree of realism.

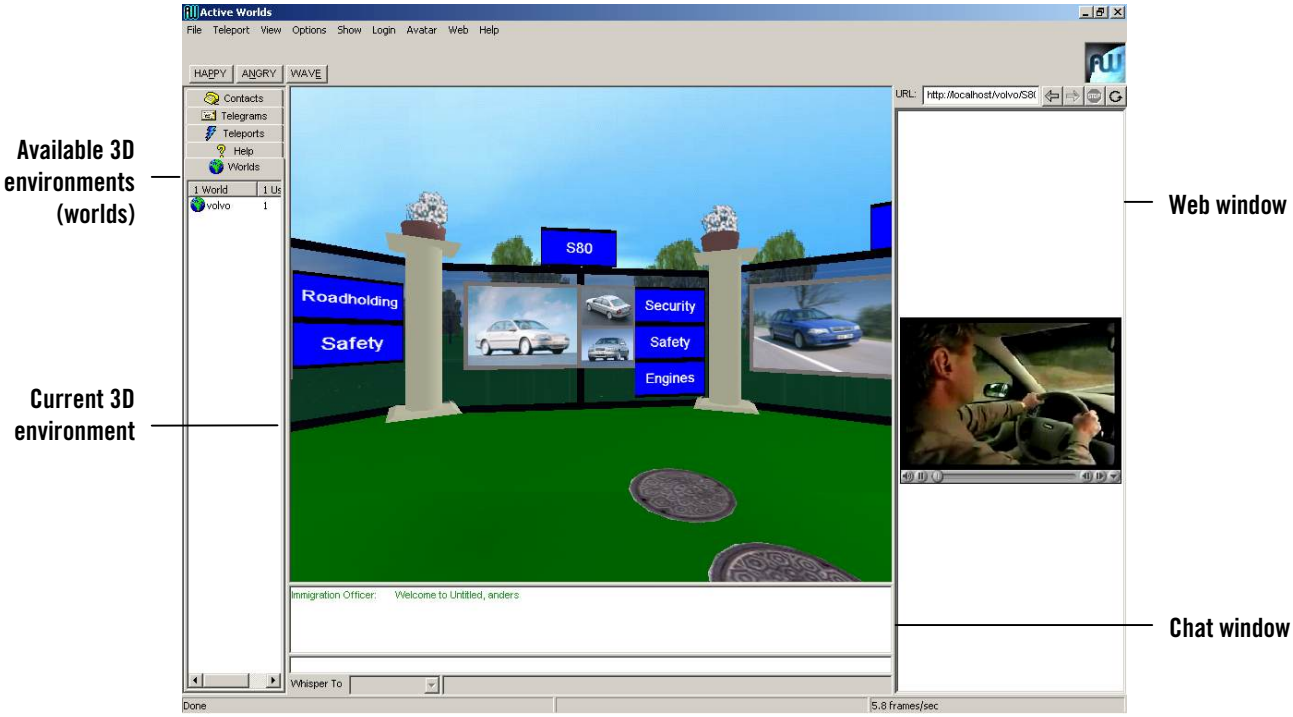

Fig 6–ActiveWorlds Desktop 3D environment

As an alternative to immersive 3D systems there is also a class of simpler systems that can be run on standard PC:s and without any special equipment. These systems, i.e., desktop-virtual reality systems are relatively easy to use and as a rule inexpensive. ActiveWorld's (http://www.activeworlds.com) is an example of a desktop-virtual reality system and it was used for the studies reported from in this thesis. Many desktop-virtual reality systems evolved on the Internet as a way of constructing digital communities. The ActiveWorlds desktop-virtual reality system has been particularly successful and has several hundred thousands of 'citizens', i.e.

members. Another successful desktop-virtual reality system is that offered by Blaxxun: Cybertown (http://www.cybertown.com). The number of members of Cybertown is almost as great as the number of citizens in ActiveWorlds and both of these systems could be said to be wide spread.

Fig 7–Modifying an environment by copying objects

Fig 8–Selecting an avatar

Recent developments in display technology gives reason to think that more advanced 3D environments will soon be available to a much larger audience than before. Both Sony and Olympus have started to sell small HMD displays with relatively low price tags and good performance. The unit depicted here (fig 9) has

VGA resolution and gives the user the impression of sitting 2 meters from a 52" screen. It does not provide any tracking mechanisms, but it is priced below $2000. As prices continue to fall and technology advances we might soon see advanced HMD units in the home setting.

Fig 9–Wearable display: a means of attaining some degree of immersivity (Olympus EyeTrek)

At this point, both Sony and Olympus appear to target the more affluent in their marketing. However, the products are mass-market products and in being so they are revealing of what will come on an even broader basis.

In order to understand how 3D environments are fundamentally constructed it is important to grasp some things about the general principles of interactive computer graphics [Foley et al 90]. Although modern computers display graphics in the same way, i.e., as dots on a visual display unit, the way in which those dots are stored and processed by application software differs. Computer images can be stored in two different ways or formats. These two main formats: pixel based graphics and vector based graphics each carry specific constraints on the kinds of processing that can be performed with them. The simplest way of storing images (3D or 2D) is by means of pixel-based graphics. Pixel-based graphics is sometimes also referred to as point-based graphics since the pixel is the smallest graphical unit that can be displayed and is simply a point with the attributes of color (or grayscale) and intensity. All images displayed by traditional computers consist of collections of such points arranged so as to form images. So letters, photographs, drawings and 3D objects are all displayed using pixels or points. The display unit consists of a series of pixels and the pixel-based graphics is also stored as a series of values to map onto those pixels. Because of the one-to-one mapping relation between stored images and the points displayed, pixel-based graphics is sometimes referred to as bit-mapped graphics. To display an image stored using this schema is

simply a matter of lighting the points on the screen corresponding to the values stored for that image within the program. Pixel-based graphics does, however, have several limitations. For example such graphics seldom scale well: curved shapes turn jagged when they are enlarged and fine lines can disappear completely or partially as images are scaled down. In the context of 3D graphics, the most sever limitation with pixel-based graphics is that it does not support rotations and scaling well. It is possible to avoid these problems by using another general scheme: vector-based graphics. With vector-based graphics images are stored using vectors or mathematical descriptions of geometric shapes. The shape of vector-based images can be preserved even as they are made larger or smaller. Fonts for word processing systems are usually rendered using such mathematically defined shapes. To change the size of a mathematically defined font is accomplished by using different size parameters for the rendering algorithms.

Objects within 3D environments are generally rendered using both pixel-based representations and vector-based representations. While the shapes of objects are defined using vectors, the appearances of the surfaces of objects are often rendered using pixel-based imagery, i.e., textures. Not all textures are pixel based, however, it is also possible to use mathematically defined representations of surfaces and such textures are generally referred to as procedural textures, because they are calculated using mathematical procedures. The complete information about how an object is stored is found within what is termed an object definition. Such object definitions can contain information about how the image is to be rendered, but also links to resource files needed to construct an object such as a link to a texture file. In order to construct a 3D environment it is not sufficient to have a set of object definitions and resource files. The objects must also be assigned to locations and directions in a coordinate system. The 3D environment can then be rendered on the screen by what is termed the world engine as it consults both the object definitions, as well as, the current state of the coordinate system.

Since the objects are vector based and internally represented using three dimensions they can be rotated and scaled with standardized mathematical functions. Through rotation and scaling of objects it is possible to create the experience of movement within a 3D environment. For example, when a visitor in a 3D environment moves forward, the vector-based objects in front of the visitor are redrawn using different parameters that make them appear larger. Although it is possible to construct 3D objects using a simple text editor most designers use 3D-development applications such as Maya, 3D Studio or Caligari True Space. These environments differ greatly in terms of their possibilities and tool set, but it is common to them that they allow the interactive design of 3D objects, i.e., the designer can view the objects using different views as the object is being developed.

The most fundamental view is the wire frame view, which displays the object as a geometric object consisting of lines and curves. Depending on the speed of the computer it may also be possible to view the object fully rendered, i.e., as it will look in the environment. To allow the designer greater design perspicuity different perspective views can be used simultaneously. To become a skillful developer in any of these environments can take a considerable amount of time, but it is not always necessary to know the operation of a 3D-development application in order to create a 3D environment.

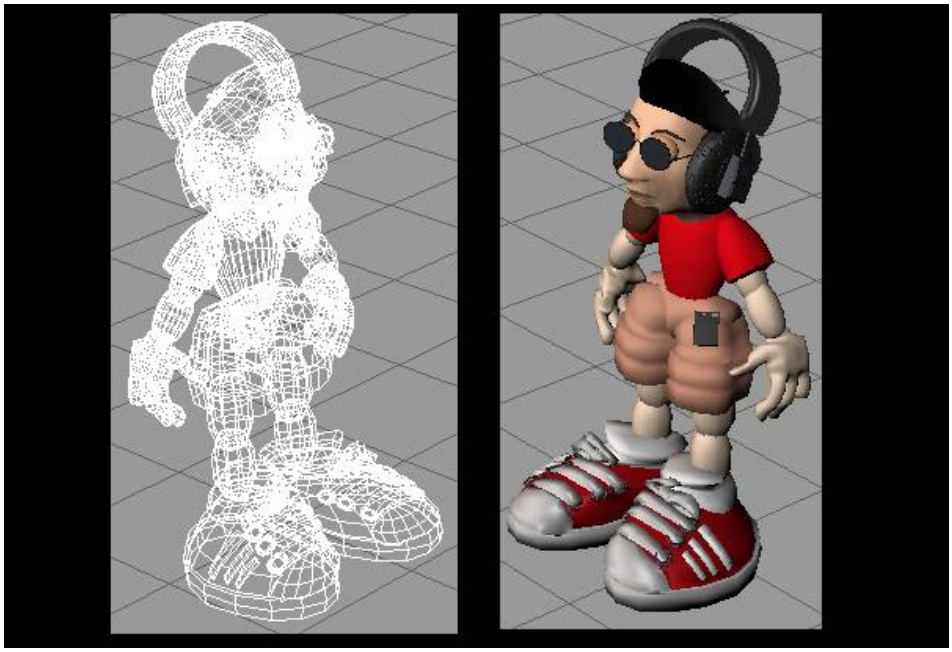

Fig 10–Wire frame (left) and rendered object (right)

Some software such as the ActiveWorlds environment come with integrated functions for constructing, extending and modifying environments. In the ActiveWorlds environment, the designer can transform an existing object into another kind of object and perform other functions on preexisting objects.

Thus in the ActiveWorlds environment it is possible to circumvent the complexities of 3D design applications and still be able to construct interesting and satisfying 3D environments. The design of a 'world' using ActiveWorlds begins with an initial world consisting of a singular object, an area or ground with a certain texture and a backdrop image. The designer can transform the initial object into any other object available in libraries of pre-built objects; she/he can also copy objects and in turn transform them into other objects. The functions of

copying and transforming in conjunction with functions for deleting, moving, and rotating objects is all that is needed to construct a 3D environment. More sophisticated functions are also available for working with textures, colors and object behaviors, e.g., a sound can be procuded when the object becomes visible or is within a certain distance.

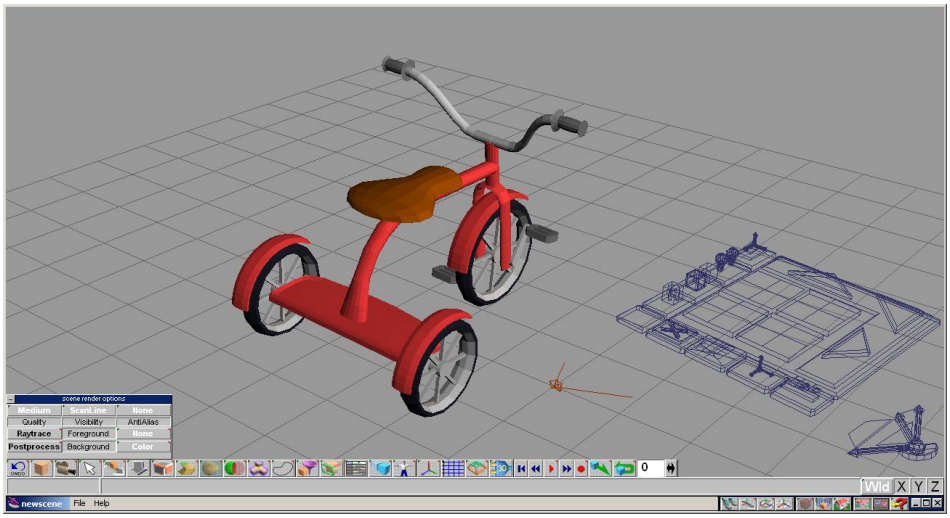

Fig 11–Caligari TrueSpace 3D modeling application with rendered object

The ActiveWorlds and Cybertown environments also allows members to select their own avatars, i.e., their digital embodiment within the 3D environment. Moreover, they offer extended freedom to the person who is able to use a 3D drawing program capable of exporting to the right file format. By using such a program and adhering to certain avatar design rules, it is possible to construct completely new avatars for use in ActiveWorlds.

3D environments are experienced along several dimensions. An immersive experience is one during which a person feels isolated from one's physical surroundings and absorbed by the 3D environment. Another aspect of the subjective experience of visiting a 3D environment is that of 'presence'. Presence is related to immersion, but differs from it. While immersion has to with the degree to which one feels absorbed by a 3D environment, presence is (on a common definition) about how ones cognitive and sensory systems receive stimuli, which lead these systems to report that one is located, somewhere else than in the actual physical location [Witmer and Kline 98]. It should be noted, however, that there are other writers that do not define presence and immersion in these ways and that the subject of presence, as well as that of immersion are theory laden. An exception

is the work of Bowers et al on how to practically accomplish immersion [Bowers et al, 96]. While much work has focused on how to create 3D environments which are immersive by using sophisticated technical arrangements, Bowers et al argue that immersion can be accomplished by social means. On this view of immersion, immersion is not analyzed in relation to the isolated phenomenological realm of the individual, but in relation to the the social reality within the 3D environment as it develops against the backdrop of social reality in toto.

In multi-user environments online visitors must be able to communicate with each other. While this is an obvious requirement, how to fulfill it is perhaps not so obvious. On a very simple model, everyone within a multi-user environment would be able to communicate with everyone else at all times and locations within the environment. For very small environments with few visitors this may work, but as the environment grows larger and has more visitiors problems arise. One issue has to do with *turn taking* [Bowers et al, 96], i.e., who should talk or send text messages at a particular moment and who should listen or receive text messages, although turn taking can be problematic even in small environments with few visitiors [Economou et al 99]. One attempt to structure and limit communication and awareness within environments build on a spatial model for interaction [Benford and Fahlén, 1993]. This model incorporates the concepts of *aura*, *awareness*, *focus* and *nimbus* which serve to define spaces for interaction and has been incorporated partly in DIVE [Carlsson & Hagsand 93; Carlsson & Hagsand 93-2] and more fully in MASSIVE [Greenhalg & Benford, 95; Greenhalg & Benford, 95-2; Grenhalg & Benford, 95-3]. The aura is a sub-space around an object, e.g., a visitor representation that allows the object to stand in communicative relations (audio, visual or text-chat) with other objects. Thus when the auras of two objects overlap, communication between the objects becomes possible. Auras can be defined in terms of the size of the environment and the number of objects so as to limit the possible interaction between objects to reasonable levels. Furthermore, the degree of awareness between objects is modulated in terms of focus and nimbus. Focus describes the direction of attention of an object towards another and nimbus the observability of an object.

Multi-user 3D environments for social interaction and collaborative work are often referred to as collaborative virtual environments (CVE:s) and much of the research [Fahlén et al 93, Benford et al 94, Benford et al 95] has been influenced by work in CSCW (Computer Supported Collaborative Work) [Schmidt & Bannon 1992, Grudin 94]. In later years the research on CVE:s has focused increasingly on large scalable multi-user 3D environments such as MASSIVE. One reason for this might be that environments without people or with few people are not as attractive as those with many visitors. As mentioned, environments with many people that are

engaged in the production of an orderly social reality may also be experienced as more immersive [Bowers et al 96].

It has been argued that the development of CVE technology has largely been driven by the challenge of overcoming technological problems such as photorealistic rendering and supporting a large number of simultaneous participants while issues pertaining to usability has been largely overlooked [Economou et al 99]. There is, however, a body of research that focuses on the practical and social aspects of CVE:s [Bowers et al 96, Bowers et al 96-2, Shroeder 97, Shroeder 96] and Kaur has done considerable research on usability within VE:s [Kaur 98, Kaur 99]. Such work is of benefit to the designers who wishes to construct CVE:s that are more satisfying and useful for visitors. The DiME (Digital Meeting Environments) project also relied on user-orientation in order to develop a virtual meeting environment [Ståhl 99, Sundblad & Taxén 00] using the DIVE plattform. In the DiME project members from SICS (Swedish Institute of Computer Science) and Telia Research (a major telecomonunications research company in Sweden) cooperated with CID to develop a CVE for formal meetings. The aim of the project was to create a CVE that could be used in practical meeting scenarios for geographically distributed members.

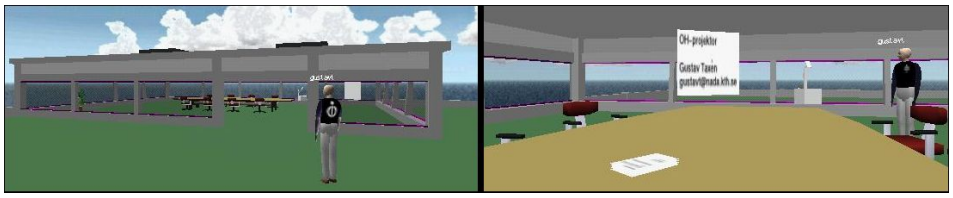

Figure 12–The DiME meeting environment

While most existing groupware systems have limited support for the social interaction of meetings, the DiME project aimed to develop a CVE more capable of supporting such interaction by focusing on the communicative and social needs of the of the participants. The participants themselves determined the ways in which the meeting environment evolved through participating in recurrent trials of the system during which actual meetings were held.

4. Visitor Orientation

A perspective on human-computer interaction

Visitor orientation as a perspective on human-computer interaction is the result of a development process that began with a desire to enable the design and production of digital environments that are more capable of broadly accommodating human needs. Although research within the field of HCI as it relates to 3D digtial environments, has been relatively unconcerned with general attitudes towards environments and concepts such as alienation and acceptance-rejectance, early experiences from one project: WebHouse, indicated that subjects can have strong attitudes to digital environments as places. In the WebHouse-project, a simple prototype application was developed that enabled subjects to create their own digital workspaces. This application presented the subject with HTML forms to fill in and automatically generated organizational structures consisting of pages for the organization, the workgroup and organization members. When the application was informally evaluated, it soon became evident that most subjects thought it was rigid and did not appreciate its hierarchical structures. The attitudes revealed were less than positive and the project took a new direction. A new prototype was developed and it enabled the generation of, not hierarchically structured organizational workspaces, but similarly hierarchically structured digital libraries consisting of subjects, books, chapters and content pages. The reactions to this application: Learning Tree (also referred to as the Universal Simulator), were largely positive and indicated that when the digital environment is seen as a tool rather than a place (were the subject is to find herself confined), the hierarchical structure and its rigidity is more acceptable. In order to further study the influence of attitudes of acceptance/rejectance and how such attitudes arise in the context of digital environments, software applications with more convincing representations of place were sought for conducting empirical studies.

4.1 The ActiveWorlds environment

Several alternative desktop virtual environment systems were evaluated such as ActiveWorlds, Community Place and Blaxxun. ActiveWorlds was then settled on

for decisive reasons. It is a stable environment and although it is not devoid of bugs, it allows the researcher to set up experiments and studies with relatively few technical mishaps. It also performs well in terms of speed and demands little from the hardware of the computer; any standardly equipped modern PC will do. Moreover, constructing 3D environments in ActiveWorlds is relatively easy and simple environments can be produced quickly using pre-defined objects. The ActiveWorlds system consists of three components: the client software, the universe server and the world server. These components are parts of a communicative infrastructure in which the universe software plays an interconnecting role.

The client software, i.e., the ActiveWorlds browser, serves as the interface to the ActiveWorlds system and is used for a number of different purposes. It allows visitors to experience 3D environments by moving about within them. Moreover, visitors can use the browser to build new environments, as well as to modify and extend environments ('worlds' is the correct ActiveWorlds terminology). A chat-window makes it possible for visitors to communicate with each other. Visitors can also collaborate and send each other files and web pages. Web pages sent from one user to another can be displayed automatically in the ActiveWorlds browser's web window. Apart from catering to visitors the ActiveWorlds browser also has a set of features that let administrators setup and maintain both universes and worlds. There is more that one can do with the ActiveWorlds browser, and the curios reader can download the software from www.activeworlds.com free of charge. Only the most important features of ActiveWorlds are covered here.

The ActiveWorlds universe server acts as an intermediary between browsers and worlds. An ActiveWorlds world cannot exist in isolation from an ActiveWorlds universe, and becomes accessible to ActiveWorlds browsers through an ActiveWorlds universe. A constraint on this relation is that for each ActiveWorlds world and each ActiveWorlds browser there can be only one universe. This is dictated by the ActveWorlds system architecture, which is strictly hierarchical and non-recursive. By non-recursive is here meant that there cannot exist ActiveWorlds worlds within ActiveWorlds worlds or ActiveWorlds universes within ActiveWorlds universes. There can, however, be many ActiveWorlds worlds within a single ActiveWorlds universe and many visitors can visit each of these worlds

simultaneously. People meet within worlds to socialize and there are many returning visitors, ie., regulars that spend much time in them.

4.2 An overview of the studies and the methods used

This thesis presents three studies conducted using ActiveWorlds technology. These studies depended on the construction of trial environments or ActiveWorlds worlds. Images of these trial environments are in the appendix and the questionnaires that were used can be found along with the published papers in the back of this thesis. The first ActiveWorlds world was developed in cooperation with DSV (The Department of Computer Science at Stockholm University). This environment was built for a course on conceptual modeling. Conceptual modeling is often taught to students of computer science and is a diagramming technique for representing relations between objects that can be physical or abstract. When learning conceptual modeling techniques students are often given concrete scenarios from everyday life such as a teaching scenario were the teacher, e.g., stands in certain relations to the student and the faculty. Having grasped the fundamentals of conceptual modeling through simple examples from everyday life, students can then apply their conceptual modeling skills to software design and systems modeling. Although the basic course text had been chosen for the course, no material for the trial environment had found its way into digital form. Thus all materials for the environment had to be specially created for it. With the kind help of the instructor for the course and his teaching assistants, it was possible to produce the digital material for the course. The instructor made a collection of sketches which were reproduced in a drawing application and then put up as posters in the environment. The teaching assistants also agreed to be photographed and filmed as they explained core concepts of the course. These photographs and short film clips were also included. As the trial environment evolved I discussed it with the teaching assistants, as well as with the instructor and corrected mistakes in the learning materials. The 3D environment built in ActiveWorlds worked as an encasing for the digital materials produced at DSV which was stored and accessed through a simple website.

Website of learning materials:
drawings, video clips, pictures, texts

|

ActiveWorlds world
3D exhibition with instructional posters and links to website

The environment was designed in accordance with a minimalist design philosophy and was rudimentary in terms of layout, design and functionality. During the

study, information on how to improve this simple environment was gathered through questionnaires, interviews, and videotape analysis. Interaction in the 3D environment was also compared to interaction with the website in isolation from 3D encasing. On the basis of feedback from participants in the studies two new 3D environments were constructed and similarly evaluated. It was found that many subjects were concerned with issues such as environmental sterility, density and perspicuity. It was also found that attitudes to the content, i.e., the learning materials were more positive in the 3D encased environment. Thus even this rudimentary 3D environment was found to have a positive effect on the learning experience.

After this initial series of studies with the environment for learning about conceptual modeling, a new series of studies has since been initiated with the same environments but housing content within the commercial realm: Volvo cars. This series of studies has confirmed the observations from the first series of studies regarding environmental sterility, density, and perspicuity, however, attitudes toward the content housed were not found to be less positive in the website only condition than in the 3D encased environment. Interaction in the Volvo-environment was also explored in a third study where participants cooperated in order to solve a simple task. In this study, the subjects were divided into three different groups based on the modalities used to perform the task: text-chat, speech with headsets, or video teleconferencing. This study also confirms the findings regarding environmental sterility, density and perspicuity. No papers have been published on the studies with commercial content and the thesis will only refer to these studies briefly since analysis remains to be done.

4.3 Published papers

A number of papers based on the first three studies have been published at internationally recognized conferences on HCI. The aim here is to provide for a rich context for these papers and to give a picture of how they fit together. The first paper–*Creating Digital Libraries Together*–is about Learning Tree (also referred to as the Universal Simulator). The paper explains in more detail how Learning Tree works and places Learning Tree within a larger context. This context is of infrastructure and is inspired by my own work at the Berkeley library as a truck driver during my undergraduate studies. As I worked at the Berkeley library I could not help but notice how complicated and refined the interlibrary infrastructure and its accompanying processes were. In fact, non-digital libraries are as a rule part of large-scale infrastructures consisting of other libraries and various facilities with specialized functions at different locations. The main contribution of the paper is to bring the notion of place and high-level

infrastructure into the discussion of digital libraries. Together with WebHouse, Learning Tree represents an initial attempt to work with high-level and abstract notions of place in the construction of software. After Learning Tree the notion of place was explored more directly in 3D environments.

The second paper–*Visions of Hypermedia Architecture*–discusses visitor-orientation from a hypermedia perspective. This discussion builds on the recognition that hypermedia is associative in nature. The same can also be said of hypertext, which sometimes is treated in the literature as being text-based only, while hypermedia is then said to be the host of all kinds of media. There is a clear path of writings on associative media starting with Vannevar Bush's article on Memex that goes through many figures such as Douglas Engelbart, Ted Nelson, and Tim Berners Lee. These theoreticians, researchers and writers have all done work on situating the subject within a context of informational associativity. They all work with the subject as an information nexus rather than with external structures. On the view of hypermedia there is no correct way of organizing information, but the conditions of satisfaction on a corpus of information cannot be separated from the associativity of the information seeker. Thus whatever is consistent with the information seekers background, stances, dispositions and beliefs is a way of structuring information that becomes natural for the information seeker. Visitor orientation is also oriented to the subject and the kinds of associations she makes in entering a digital environment. The paper brings to the forefront the background of the visitor and argues that this background stands in a two-part relation of which the other part is the environment. The paper attempts to delineate the process during which a visitor either comes to reject or accept an environment and this process is given the term accommodation. This concept of accommodation is also contrasted with another concept: orientation. In the paper orientation is described as the process of orienting oneself within an environment and to explore its functional possibilities. While most human-computer interaction research of virtual environments has dealt with the concept of orientation, relatively little research has been done with regards to accommodative factors. Thus although we know quite a bit about how people interact with virtual environments from a functional, navigational and use perspective, relatively little is known about what kinds of digital environments visitors prefer and why they would do so. It may turn out that all people have unique and more or less idiosyncratically organized preferences in which case research into accommodation would perhaps seem futile. However, the studies reported from here indicate that it is possible to find general sets of preferences that extend over many individuals and which are exclusively accommodational, i.e., they do not depend on orientational- or functional requirements.

The third paper–*Orientation vs. Accommodation*–attempts to describe in a more precise manner what accommodation and orientation are and how these concepts can be seen as important to human-computer interaction. The paper discusses orientation in relation to work on usability. Along with the development of modern graphical user interfaces much of usability has been concerned with making the underlying functionality of software available to the user as effortlessly as possible. Usability can bee seen as being largely about letting the user orient themselves easily within sets of functions that become visible to the user through orienting structures. In a graphical user interface the aim is often to let the functions "stand out" by means of buttons, menus and labels so that the user can easily navigate between the functions of the software artifact. A similar trend can also be seen in the work on efficient use of 3D environments. The paper then contrast orientation with accommodation and argues for the importance of accommodation in relation to 3D environments.

The fourth paper–*Accommodation and Learning in 3D Environments*–is the first in the series of papers that mainly reports from the studies performed within the ActiveWorlds trial environments. It is a short paper and the reporting is brief, focusing on a few general findings thought to be of interest to the human-computer interaction community. Some of the subjects within the study interacted with a website only and did not explore the 3D environment. The content was the same in both conditions, however, and so it was not expected that the materials should be easier to learn in any of the conditions. Contrary to this it was found that the subjects using the 3D environment did report that the materials were easier to learn and more exciting. The material is thought to be difficult by most people outside of the study and takes a long time to "sink in" and to understand fully. The attitudes towards the learning materials in the 3D environment are therefore surprising. The attitudes reported were not only mildly positive with respect to how easy the materials were to learn and how exciting the materials were, but strongly so. Moreover, when the subjects were e-mailed follow up questions about a month after the study we found nothing but poor retention/understanding of the material. It would seem then that what made subjects report positive attitudes towards the difficult and abstract content of the environment was accommodative factors and the paper suggests this as a possibility. Nothing indicated that accommodation had any effect on learning within the 3D environment.

The fifth paper–*Visitor Oriented Design*–expands on the fourth paper and it is the most complete in terms of reporting from the studies in the ActiveWorlds trial environments. It also attempts to explain the research more fully from the perspective of visitor-oriented design. This perspective had not been worked out in

the earlier papers although it laid latent within the research. Visitor-oriented design is an expression that brings out much of what had earlier been written about in terms of accommodation. The term accommodation is still used, but it is subordinated under the more general expression visitor-oriented design. In the paper, visitor-oriented design is compared and contrasted to the dominating perspective within human-computer interaction, i.e., user-oriented design. The paper also provides a context for visitor-oriented design in comparing the perspective with some of the general ideas that Terry Winograd has in his book *Bringing Design to Software* and Brenda Laurel in her book *Computers as Theatre* (Laurel 93). Terry Winograd takes on an architectural approach to software design and Brenda Laurel chooses a dramatic (in the sense of drama) approach. They are interesting from the perspective of visitor-oriented design because they are both working with alternative views of the human in human-computer interaction, and put forth views that cater for the subjectivity of the experiential realm rather than tool use and instrumental aspects of interacting with computers. The approach in this thesis differs from theirs since it does not focus on inhabitants of software or subjects entertained by drama, but on the ordinary notions of visitor and place. I have chosen to view human-computer interaction under the aspect of visiting digital places and the paper attempts to justify this choice and make evident that the perspective is viable. The ontology proposed consists of a two dimensional space. One of the dimensions is the degree of resemblance to a physical object that a digital artifact has. Some purely abstract artifacts, e.g., command line interpreters do not resemble any physical object at all while others closely resemble some imaginary or real physical object, e.g., a music player with a three dimensional interface. The other dimension in the proposed ontology is the human dimension and it represents the roles we play in human-computer interaction. On one end of the human dimension we are tool users and on the other visitors. Using these two simple dimensions I have attempted to plot common digital artifacts in the space created by the dimensions. In doing so I wish to provide an intuitive picture of how human-computer interaction can be characterized from a more inclusive perspective than that of the traditional user-oriented perspective. If this picture is found to be accurate, then there is much work within human-computer interaction that could preferably be done from a visitor-oriented perspective rather than a user-oriented perspective. By proposing this perspective I do not mean to say that we should at times think of users as visitors, but rather that we should at times think of humans interacting with computers as visitors.

4.4 Further elaboration of the results

The publications presented in this chapter have served the dual purposes of working out the visitor-oriented perspective and to show that it is feasible to

conduct research within this perspective. The visitor-oriented perspective has been worked out step-by-step and the last paper exhibits the more elaborated and complete version of the perspective. This does not mean that the perspective has been fully elaborated or reached a final state and the discussion at the end of this thesis offers suggestions on possible routes for further development.

Attitudinal responses

As the studies of visitor-orientation were initially setup little was known about how the subject would react to environments as visitors. One concern regarding this was that the subjects would perhaps not worry about visitor-related issues and only about usability issues. It became evident, however, that they did develop strong attitudes to the trial environments and that those attitudes went well beyond issues of use. They commented on the nature of the trial environments in ways which indicated how they felt about them and whether or not they were accommodating to them. While most subjects found the environments to be at least mildly pleasant, one of the strongest statements regarding accommodation was negative and made by one user who claimed that "the environment is like a steel cage" and that she experienced it as a prison. The wide discrepancies between attitudes reveal how complex the design of accommodating 3D digital environments is and that further research is necessary in order to understand how to think about such design.

Environmental richness

The initial trial environment was sparse and simple. It was designed from the minimalist perspective and as such was not crafted to be experienced as warm and inviting. Still many found the environment to be pleasant:

> The exhibition gave a nice impression.

> Easy to use, clean and beautiful.

> It was nice to go around and look at.

Others found it to be sterile and sparse and offered suggestions on as to how it could be improved.

> Boring. A big open field with a fence of steel. It feels like a prison. More garden-like would have been better.

The second environment was not perceived to be as sterile as the suggestions for modifications had been taken into account. Still some thought that this second environment was also sterile:

> I am thinking that one could include adornments, perhaps some trees…one could make tufts of grass so it looks cozier

In summary, perceptions of environmental richness differed greatly among subjects. At one extreme lies those who desire a rich ornamented environment and at the other extreme those who desire the sparsest possible. However, there is a middle ground between the extremes that appears to be acceptable to most.

Perspicuity

The initial environment was so large that, while being simple, it was not perspicuous since all the points of interest could not be easily surveyed from a single vantage point. The subjects also complained about having to walk around too much to get to the points of interest in the initial environment. The second environment was made more compact and given a semi-circular shape and this was found to be appreciated by subjects as they could more easily see what was in the environment. However, relatively few commented about the perspicuity of the environment in the second environment. In comparison to the first environment and the navigational environment it was, however, clear that while poor perspicuity was an issue in these latter environments is was not an issue in the second environment and the problem was solved.

Experience of content

It was found that the way in which the content was presented affected the way in which it was perceived. When the same web pages were presented within a 3D environment the content of those pages was experienced as more engaging and easier to understand than when those pages were presented by themselves. This could surely be expected on a rhetorical basis. However, although the means of presentation was expected to affect the perception of the content it was not expected that the effect should be strongly in favor of the 3D environment. After all, it was very rudimentary and perceived by many as a bit sterile.

Primacy of place

Since the 3D environment only served as an encasing for the website which was self contained it was expected that some subjects would abandon the 3D environment and only use the web pages. However, only one subject did so and this indicates that the subjects chose to use place as an organizer of information and not escape from it. This was so even though the experiment was not timed and the subjects had ample time to explore the environment. To use only the web pages would have been more efficient for the subjects and they were not told to stay within the 3D environment. The subject who only used the web pages was unusual in that he was categorically against 3D environments and did not like them since he "lived in a 3D world already".

Walking

In the first environment subjects complained about having to walk too much. When the environment was redesigned in a more compact fashion such complaints came to an end. Thus a moderate amount of walking was agreeable to the subjects. In both the first and the second environment some had suggested, however, that it should be possible to click on places within the environments to be transported to those places. At least one subject also complained about the experience of walking within the environment:

```
why does it feel like I am going around in a carriage?
```

This complaint makes sense because the walking movements within the ActiveWorlds environment are not so natural. One's field of vision does not indicate that one is walking within the environment since it remains level and does not go up and down as it does when one walks in the real world. Another subject also made a similar complaint:

```
When one walks quickly and the lets go of the CTRL-button it
continues to walk for a short while.
```

The unrealistic movements involved in walking have also been noted by subjects in later studies I have done in ActiveWorlds, which are not part of this thesis.

Pathways

In the first environment there were no paths and many subjects suggested that such should be built. Many argued that paths would make it easier to navigate within the environment. However, when paths were built in the second environment the subjects did not use them. What is more, they did not wish for them to be removed when this was suggested. When being asked about their removal they often claimed that the paths served a decorative purpose and that they were not in the way. Furthermore since many had desired paths but they were not used it was reasonable to expect that there was something wrong with them and that the subjects should come up with suggestions for better paths. The subjects failed to do so and it is plausible that the paths were not judged in terms of function, but aesthetics.

One subject answered as follows when asked about the usefulness of the paths:

```
I did not think that the paths were all that helpful just
because I did not need them
```

and when asked if they should be removed:

```
no, they are beautiful, they can well be left, but I do not
use them...
```

Whatever purpose the paths had in the environment it was not obviously related to issues of use.

Transportation tools

As was previously mentioned some subjects in the fist two environments had offered suggestions on transportation tools, i.e., they wanted to be able to go to locations within the environment by clicking on signs or other objects near the point they wished to reach. In the third environment such transportation tools, i.e., teleports were implemented. From the standpoint of efficiency the teleports were a success and allowed the subjects to go faster through the environment and finish quickly. Since the teleports were the only change in the third environment one could expect that the increased efficiency would lead to improved attitudes to the environment. This was not so. The attitudes did not change much at all. Thus walking, while inefficient as compared to teleporting was just as good. When asking subjects informally about these teleport functions in a later yet unpublished

study, they have provided two different types of answers for why they fail to some extent. One type of answer has to do with the fact that when subjects teleport, they become less autonomous since they are not moving by themselves, but with the help of a transportation tool. The other type of answer has to do with feeling present in the environment. Being teleported is a more artificial means of getting around in an environment than walking. Another interesting finding was that when subjects were asked to go back into the environment after having explored it and to locate information stations within it, they never used the transportation tools, but walked back into the environment. This was not because they had forgot where these places were located since they more often than not went straight to the right stations. It was as if they were drawn back into the environment and did not have anything like the classical mental model of usability research. On the whole, what the issue of teleports show is that efficiency is just a part of the equation in building 3D environments and that other, more accommodative factors can be just as important.

Novices

Many subjects throughout the studies had never explored 3D environments prior to their participation in the studies. One concern prior to the studies had been that such novices might not be able to participate in a meaningful way and would find trial participation to be a cumbersome and frustrating experience. As it turned out, however, novices learned quickly how to get around and explore the environments and were not more frustrated than other subjects. It appears then that 3D environments come natural to people and that they quickly find themselves at home within them. On this line of reasoning it could be argued that 3D environments are more concrete to people since they build on our solid and absolutely fundamental understanding of the real world around us. Web sites, in comparison, can be said to be far more abstract since they do not directly build on any fundamental understanding of the real world around us. Thus the subject who wishes to understand what the World Wide Web is needs to understand the concept of networking on a global scale. The subject in a 3D environment is perhaps less likely to ask such questions since she can rely on her background from living in a three dimensional world. The first kind of understanding, i.e., of web pages is instrumental, while the second, i.e., of 3D environments is non-instrumental and builds on our understanding of simply coping with the world. Another way to think of this is that the first kind of understanding is more rule-like and representational, at least in the beginning, while the second kind of understanding builds more on know-how and intuition.

Complexity

From the beginning a decision was made to emphasize design minimalism. As has been argued elsewhere this was for reasons of simplicity and because of lack of knowledge of how to design for visitors which was in fact the subject under investigation. The subjects that had participated in trials did therefore not complain about the complexity of the simple environments. This could only be expected, but some subjects were also exposed to the more complex environment built primarily for testing navigation. This environment was not built from the standpoint of design minimalism but from prior research on navigation and wayfinding in 3D environments. It was the size of a soccer field and housed many more objects and paths. Even so subjects that had participated in the trials with this environment did not raise concerns regarding its complexity. Subjects did raise such concerns, however, when they were exposed to this complex navigational environment after they had been exposed to the minimalist environments.

```
[subject]
God help, to try to find something here?

[interviewer]
it is the same content in this environment

[subject]
aha it is so the posters are the same?

[interviewer]
yes, but here we work more with rooms and space

[subject]
it would be considerably more difficult to orient oneself,
it is like when you play a videogame it is really that
capacity that you train

[interviewer]
what do you think, if you compare this environment with the
other, how do they differ?

[subject]
well, here if I would do the same thing then to orient
myself would impose enormous limitations, I would at least
get tired a lot faster if I would have to look for
information.
```

Another subject expressed similar concerns:

> I would have become enormously frustrated, I would hurry…to need to sit here and look and not even get to the right place!

It appears that these subjects were right about the overhead required to navigate within the complex environment. Most subjects within the complex environment paced themselves so as only to explore a fraction of the content that was explored by subjects in the more simple environments. Subjects that do not have anything to compare with do not seem to be able to fully understand what it means for a 3D environment to be complex or simple since they do not complain about complexity. Still they have a fundamental capacity for pacing themselves and finished the studies in the time that was suggested for completion. This pacing is interesting since it worked so well even with complete novices. How is it possible for a novice to, on the basis of seeing a 3D environment the size of a soccer field, and with many information stations each with several informational components, to accurately pace themselves? Whatever it is, it does not seem to be a fully conscious activity since at no time did any of the subjects verbalize or give indications regarding concerns of pacing. It appears to be something they just do.

Realism

While many subjects raised concerns indicating that they desired the environment to look real and convincing some took the opposite stand. Three subjects argued against making the environments look real. They shared a common attitude that can be characterized along the dimension of authenticity. These subjects claimed that a) 3D digital environments are obviously artificial and impersonal and b) there is no way of making them appear real. On the basis of a) and b) they reasoned that the only honest or authentic way of designing 3D digital environments would be to make the inherently artificial character of such environments apparent and not try to hide it by using decorative elements or attempt to make them appear natural.

After one person had been in the second environment, which had been environmentally enriched, he commented:

> Perhaps you should not try to make it look natural, ok we are in a virtual environment, you cannot make anything look really good then you just make it DIVE-like (DIVE is a 3D

> environment), you know how DIVE looks it is very sterile, …almost no textures

He was then presented with the initial environment, which was sparser:

> I personally like this one better because this is less, more computer…more you do not try to make it look like there is grass and flowers…

What is involved here may not be a step away from realism, but a kind of realism in itself, which could be termed *veridical realism* since the person is concerned with how things actually are and not with how they appear. Thus people who desire environments to appear realistic while being simulated can be thought of as *phenomenal realists* and those who require that the experience should be expressive of the underlying technological substrate can be thought of as *veridical realists*.

Context

One dimension that came up during the studies and was brought up by at least two subjects was that the environment would work best if its design was governed by the informational content. One subject painted a scenario in order to illustrate her thoughts on the matter. She envisioned a setting in which the informational content would be the manufacturing process of an industrial product and that the environment in this case could be in the form of an industrial setting. This would provide for a richer and more meaningful context of learning she suggested.

Aesthetics

It was an aim of the studies to explore aesthetical concerns of the visitors. The questionnaire was designed to probe for how the subjects experienced the environments from an aesthetical perspective. The subjects were, e.g., asked about their architectural preferences and they had to pick their preferred style from three alternative categories: Victorian, modern, and functionalistic. This turned out to be problematic, however, since many subjects did not understand what these terms denoted. A much better approach would be to provide subjects with example images of different architectural styles and have the subjects rank those images by order of preference. At any rate, no obvious relationships were found with regards to architectural preference. It had been expected that the subjects who preferred a functionalist- or modern architecture would rate the minimalist environments better than those who preferred Victorian style.

The aesthetical concerns, however, centered more around high level observations such as if the environment was beautiful or not but also around the overall psychological experience such as feeling that one was in the middle of a field or in a cage. Some comments regarding the second environment are listed below:

```
Marvelous

The exhibition looked realistic, but a bit strict, on the
border of being boring

Quite nice
```

The color schema within the environment was also commented on. Some subjects suggested that warm colors should be included and one female suggested that the design must have been done by a male since it had no warm colors, but depended heavily on the colors: blue, green and white.

4.5 A proposed guideline for building digital environments for visitors

The research described in this thesis lends itself for suggesting a guideline for the development of 3D digital environments from a visitor-oriented perspective. This guideline is based on the qualitative and quantitative results from the studies.

Make the environment rich enough so that it is not perceived as sterile

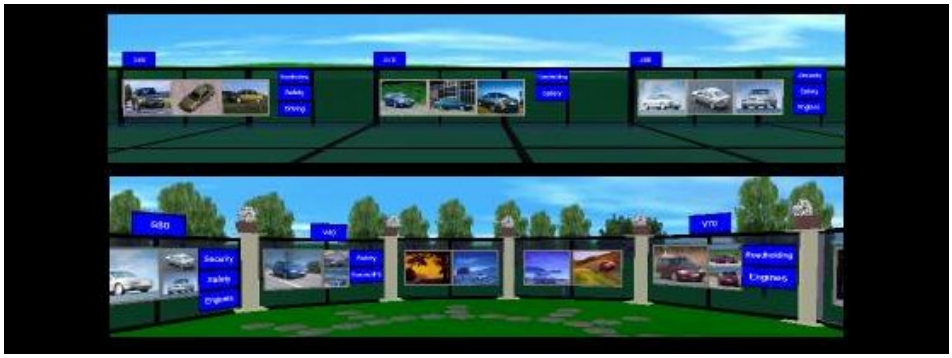

Fig 13–Sterile vs rich

While individuals differ widely with respect to the conditions under which they will rate an environment as sterile or non-sterile, many will find sparse environments to be sterile. If a sparse environment is moderately enriched with elements such as pathways and trees, people are likely to find the environment less

sterile. Moreover, people are not likely to complain about such moderate enrichments as being unnecessary.

Include at least one warm color in the design

Fig 14–Without and with a warm color (bottom)

Sparse environments can be conceived as sterile and the solution is to make such environments richer by adding appropriate elements. However, although an environment is rich in terms of things within it and colors used, it can still be conceived of as cold unless some warm color is used.

Design in a compact fashion

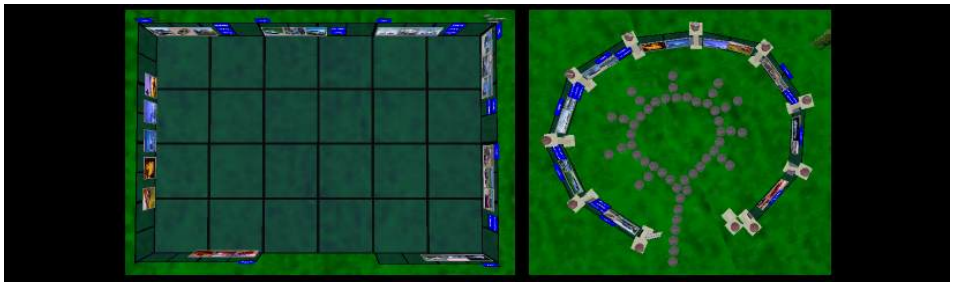

Fig 15–Spread out vs compact

Visitors complain when they have to walk too much in order to get to points of interest. The amount of walking should be experienced as being in reasonable proportion to the information found within the environment.

Design iteratively taking visitor feedback into account

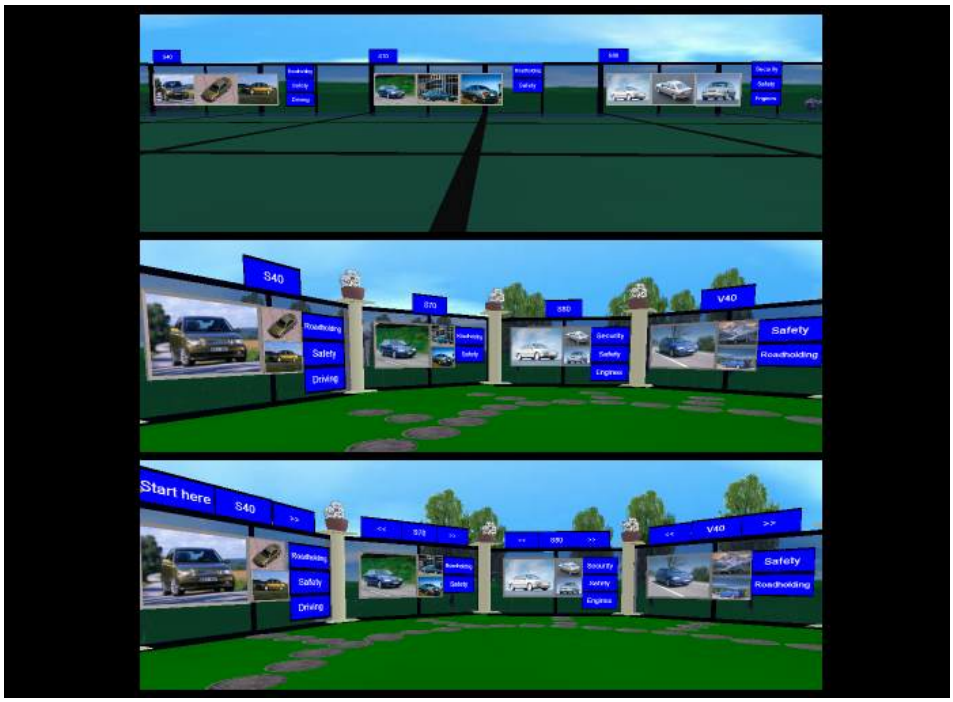

Fig 16–Two iterations on the initial environment (top)

The method adopted in constructing trial environments for studies was to build environments in an iterative manner. After starting out with a minimalist initial environment more complex environments were produced in successive iterations. This method worked fine as a method for conducting studies and developing this tentative guideline.

Be consistent

Fig 17–Inconsistent design (sign missing on right)

Visitors are easily annoyed by even minor internal inconsistencies in the environment. If e.g., an information station does not have the same features as

another this can cause frustration and annoyance and visitors are quick to notice such inconsistencies.

Use transportation tools with caution

Fig 18–Transportation signs (on top)

Transportation tools can make environments more efficient to use. Such tools, however, also change the experience of interacting with environments and compete with other forms of interaction such as walking. When transportation tools replace walking in an environment, the visitors may not feel as engaged or autonomous in exploring and interacting with the environment.

Provide paths

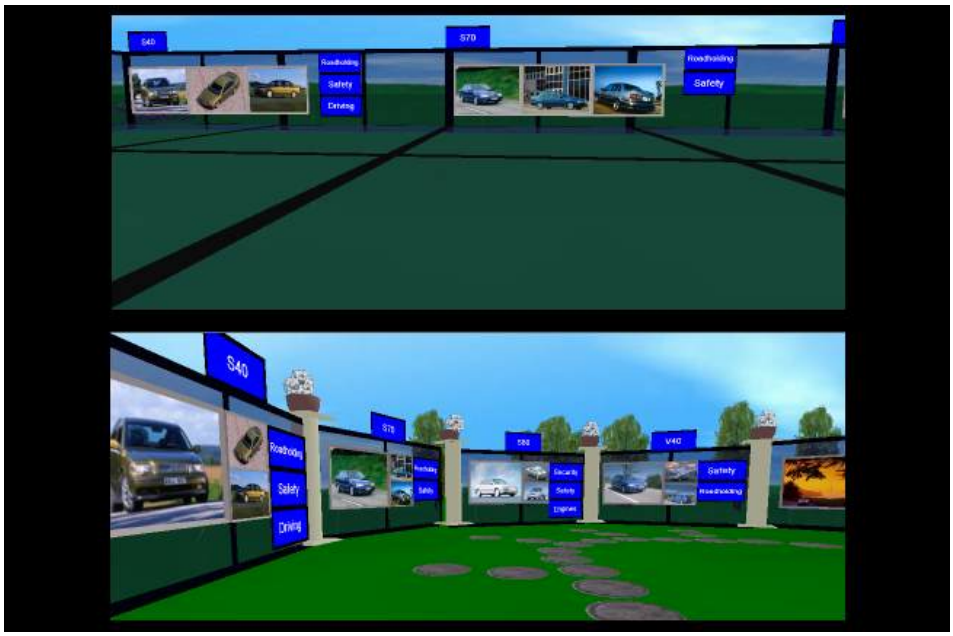

Fig 19–Environment without paths and environment with paths (bottom)

Paths for walking are desired even in simple environments. They need not necessarily fulfill a functional role since people may not use the paths provided in an environment, but still claim that they should be kept.

Avoid complexity

The relative complexity of an environment should be kept low for several important reasons. One is that as the complexity of the environment becomes great it may become less stable and more sluggish to explore. Another issue is that complex environments put a cognitive burden on the visitors.

Design for perspicuity

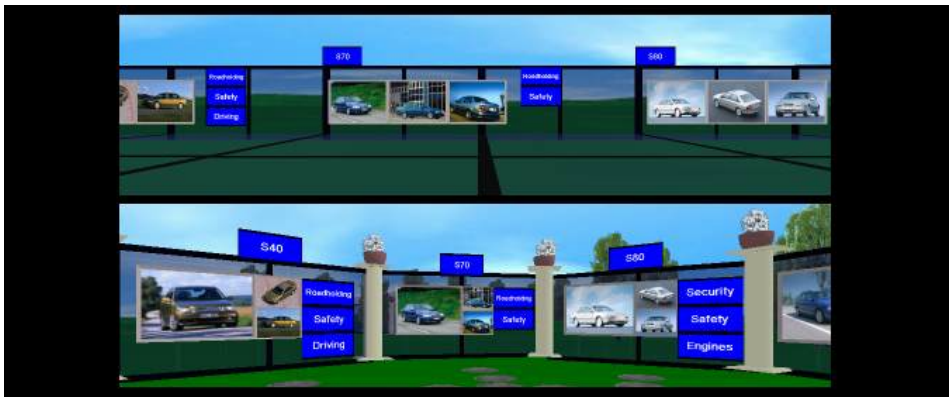

Fig 20–A rounded environment is more perspicuous than a rectangular (top)

Many subjects are annoyed by not seeing the environment in its totality as a result of the environmental design being unnecessarily large or complex. In some cases one might wish to design an environment, which is not perspicuous for reasons having to do with, e.g., cognition or other factors. Thus if one is exploring wayfinding and/or navigation one might choose to build a complex non-perspicuous environment. One might also wish to explore how subjects may or may not use an environment for recollecting information and perhaps use rooms and spatial arrangements to present information. Another possibility is to build environments for both informational content and for social interaction with meeting places. In all of these cases the spatial complexities are likely to conflict with the need for perspicuity that subjects reveal.

As the constitutive papers of this thesis have been presented at various conferences they have been critiqued in ways which have been conducive to the development of visitor orientation as a perspective. In an effort to explain the perspective further a summary of some of the more interesting objections are provided here. An attempt has been made to reproduce them as faithfully as possible.

5.1 Discussion

For convenience the objections to visitor orientation have here been named and categorized by the author. These objections concern the perspective in its current practical state but nothing is said about its further development or more theoretical issues. These latter issues are dealt with in the next section entitled Future Directions.

The user-orientation in disguise objection

Some have argued that visitor-orientation is just another name for user-orientation and that the perspective is vacuous. The answer to this question is that the two perspectives are genuinely different since they involve the analysis of two different aspects of human-computer interaction. While the user-oriented perspective focuses on the aspect of use, the visitor-oriented perspective focuses on the aspect of visiting. Moreover, since users deploy tools and visitors interact with places these two notions must also be brought into the analysis. Thus user-orientation concerns itself with tools and tool-using scenarios while visitor-orientation concerns itself with visitors and places. Unless one wishes to equate users and tools with visitors and places it is not possible to consistently argue that the perspectives are the same. Admittedly it is possible to argue from a pluralistic language game perspective and to declare that the term "user" means all kind of things and consequently allows for all kind of aspectual interaction. This argument does not

work however since the notion of the "user" then breaks down from a scientific discourse perspective as has been argued in the chapter Tools and Users.

The naive perspective objection

Visitor-orientation is offered as a perspective on human-computer interaction and on this perspective humans are seen as visitors of places. It has been suggested that it is naïve to talk about visitors in human-computer interaction since being a visitor is simply a possible role that people play when interacting with computers and has nothing to do with how reality is constituted. This objection represents a deep misunderstanding for visitor orientation is not about classifying humans, but about investigating aspectual interaction with computers. To say that a human interacts with computing technology under the aspect of being a visitor is not an attempt to reveal the true ontology of the world, but simply to describe a mode of interaction.

The methodological superfluosness objection

Some have argued that visitor orientation is an unnecessary perspective since it adds nothing more to the subject of human-computer interaction than the user-oriented perspective. The argument is that the same results that have been arrived at through visitor-oriented studies could have also been arrived at through user-oriented studies. Let us suppose then that there are two teams conducting studies on people in 3D digital environments and that one team call themselves user-oriented researchers and the other team visitor-oriented researchers. Moreover, they reach the exact same results. Now, has not the visitor-oriented perspective been shown to be superfluous? The answer is no, because one can also imagine a third team studying pedagogy or anything whatsoever and coming up with the exact same results as the first two teams. The ultimate proof of whether a perspective on human-computer interaction is viable or not lies not only in its results but also in its directedness and approach to studying the subject at hand. Thus mindsets, metaphors, goals, aims and focus are all important factors in determining whether an approach to human-computer interaction is any good or not. Visitor-orientation is good for studying visitors since it aims at studying visitors, it focuses on visitors and it represents a mindset of holding visitor and place in first regard.

The methodological dependence on user-orientation objection

This objection is mainly meant against the way that the studies reported from the constitutive papers of this thesis are setup. Since they are all setup as studies where

the subjects perform a task described in a scenario, the argument goes, the studies must either be directly about task performance or dependent on a task performance scenario. Therefore the studies must be characterized as either user studies or dependent on user-orientation as a general framework. This argument confuses the actual subject of the studies with the perceived subject. Thus the subject perceives that topic under investigation is one thing while it is in fact another. This is what psychological experiments are often about, setting up a study in such a way that the subject can not guess what the study is actually about, while thinking that she has guessed it. To be deceived like this is not always a comfortable experience and the subjects were therefore carefully de-briefed about the real aims of the study. Even so, some were slightly annoyed by not having been able to prove what they had learned within the environments. Thus, from the perspective of visitor orientation, the assignment of a learning task was in actuality a distractor and a way of motivating them to stay in the environment for some time.

The insufficiency objection

It has been pointed out that the visitor-oriented perspective is limited and this is surely so. Adopting a visitor-oriented perspective will not solve all problems in human-computer interaction and in fact many times it is much better to focus on users and usability. This does not imply that the visitor-oriented perspective is especially problematic. Nor that it cannot be combined with a user-oriented perspective. It is simply a matter of picking the right stance for the purposes at hand. If the focus is on users and tools then the user-oriented perspective is better and if the focus is on visitors and places the visitor-oriented perspective is better.

5.2 Future directions

This work has introduced visitor-orientation as a perspective on human-computer interaction. This was done from a minimalist standpoint, both in terms of conceptual basis and design of trial environments. Starting out in this naïve manner has some clear advantages:

- To start out naively enables one to ask the most fundamental questions and not be mistaken by false beliefs. Less simplistic and more theoretical approaches can be guiding and helpful, but they can also be blinding and misguiding, especially when the subject at hand is not well known.
- Minimalist trial environments are, in virtue of being simple and having few features, easier to study empirically than

more complex environments.

- Minimalist environments are easier to construct and build than more complex environments.
- Minimalist environments will usually run smoother and with fewer mishaps since they are simple and involve few elements and features.
- Minimalist environments are easier to understand for the subjects during trial runs since they are simple.
- Minimalist environments are not “design statements”, i.e., they can be constructed so as to minimize the influence of particular design agendas or personal taste.

Now that the initial ground has been broken it is possible to look more into developing a theoretical framework for visitor-orientation. There are at least four potential areas of research that could serve to fuel such a prospect: the philosophy of place (Casey, Malpas), architecture (Hesselgren, Alexander, Hillier and Hanson), environmental studies (Tuan) and the philosophy of the Background (Searle, Wittgenstein).

The philosophy of place

It is part of our world picture in the industrial world that there are electronic places to go and visit online and many are those who spend time in electronic 3D games, while still others interact with more immersive 3D environments. In the main, however, HCI does not concern itself with visitors. Why is this? The online business community has, as mentioned earlier, adopted the visitor as their unit of analysis and the 'user' is largely unheard of. The person playing the 3D game has the experience of a visitor as well as the one immersed in a more sophisticated 3D environment. One possible reason is that the words 'visitor' and 'place' do not seem to be acceptable scientific terms. The philosophers Casey and Malpas both offer comprehensive works on the philosophy of place and can serve as sources of more detailed analyses of the subject. Both argue that the notion of place has been forced out of the modern western worldview, but that it is a rich and important notion that cannot be de-coupled from what it means to be a human being. As human beings we always find ourselves within places. Edward Casey brings out the tension between the 'space' of modernity and 'place'.

> In the past three centuries in the West – the period of modernity – place has come to be not only neglected but actively suppressed. Owing to the triumph of the natural and social sciences in this same period, any serious talk of place has been regarded as regressive or trivial. A

> discourse has emerged whose exclusive foci are Time and Space. When the two were combined by twentieth century physicists into the amalgam 'space-time', the overlooking of place was only continued by other means. For an entire epoch, place has been regarded as an impoverished second cousin of Time and Space, those two colossal cosmic partners that tower over modernity. [Casey 93, p.xiv]

The writings on electronic spaces support the argument that 'place' has given way to 'place'. There is a whole genre of literature about cyberspace, but we also find writings on electronic spaces closer to academia. There is for example, a large body of literature treating of “media spaces” [Bly et al 93], but the expression "media place" is not used in this literature. Nor do we speak of “cyber places”. Other kinds of common computer related spaces often referred to are “information spaces”, “virtual spaces” and together with the expression “media space” these expressions have acquired the status of being technical rather than just descriptory. Within the field of CSCW, some writers have argued that 'place' is a better term to use than 'space' when describing the whereabouts of virtual cooperative work for the term is more closely tied to the realities of social life [Fitzpatrik et al 96, Harrison & Dourish 96]. Place can also be said to be important for understanding our inner lives and identities [Malpas 99 p2-10]. Something that Wordsworth expresses in many of his poems:

> …grossly that man errs, who should suppose That the green Valleys, and the Streams and Rocks, were things indifferent to the Shephard's thoughts.[Wordsworth 1955 from Malpas 99 p2]

The space of modern science does not seem to hold the social and psychological richness of 'place'. Space is more of an objective resource that also fits in better with the pre-existing 'user' terminology. This thesis has in some small way sought to bring place and visitors to the foreground of HCI. In doing so the focus is taken from the instrumental use of 'space' to the subjectivity of being in a place.

From a subjective stance, we get more involved with 3D digital environments than tool-like environments since we interact with them on a broader basis. We bring with us a considerable baggage from the real world and experiences therein of places. This baggage consists of stances, dispositions, attitudes, and general ways of coping with the world around us. This is only natural for we are at each and every moment of our conscious lives placed and cannot escape from this condition except for brief periods occurring under extraordinary circumstances. It is, i.e., possible to become dislocated under torturous conditions such as being in

completely dark and sound-isolated cell. Many prisoners of Alcatraz experienced the resulting condition of disorientation, but it did not last for long as they learned to create their own virtual places within their minds in order to remain sane. One surviving prisoner I listened to (on a tape) as I visited Alcatraz told the story of how he at first experienced the terror of disorientation in "the hole", but soon created a TV-set within his mind and watched it throughout his tortuous stay in the pitch black silent isolation cell. This dramatic example is revealing of how mental life is shaped by, and demands the experience of place. Where there is no place we create one as place is a condition of our existence.

The philosophy of the Background and related theories

The philosopher John Searle is mostly known for his work on speech acts [Searle 69], but he has also written extensively on what he terms the Background [Searle 92, Searle 95]. The Background is a technical notion and is to be though of as roughly made up of mental capacities that serve as preconditions of intentionality [Searle 83]. Intentionality in turn is a subject that is frequently discussed in the philosophy of mind and also in the philosophy of language. Although intentionality is a technical notion that has been heavily debated and would need a longer explanation to do it full justice it can be explained as having to do with the mental ability that the mind has to direct itself to things, i.e., its directedness. Intentionality should not be thought of as being the same as intending or some capacity to be intending to do one thing or another since intending is just one way in which the mind can direct itself. Examples of intentional states are beliefs, desires and intentions. Such states, on Searle's view all have some kind of mental content, i.e., the person who believes must believe something, the person who desires must desire something and the person who intends must intend something. The "something" in all these expressions is the mental content and so if I believe that Steve Ballmer is the CEO of Microsoft then that Steve Ballmer is the CEO of Microsoft is the mental content or in technical jargon the representational content of the belief. Searle postulates the Background as a necessary capacity for the possibility of having beliefs partly since representational content alone cannot explain understanding. Representations are just representations like sentences or diagrams they do not explain themselves. Moreover, it is not possible to analyze understanding in terms of a network of representations as one may think since no representations explain themselves and understanding is not exclusively dependent on there being many representations that support each other in some way or another. On Searle's view then the understanding of representational content and intentionality is dependent on some mental entity which is not reducible to representations alone and which enable intentional states and intentional actions. This entity is the Background. Searle argues that the background consists of two

parts; one is the biological Background and the other the cultural Background. While the biological Background enables people to engage in activities that are derived from human physical capacities, the cultural Background is developed in virtue of living in a culture. Examples of capacities of the biological Background would be the many capacities that are related to the senses such as being able to see and hear by making sense of the impressions that impinge upon the perceiver. Examples of the cultural Background would be to be able to conduct oneself in social life or the way in which an experienced driver maneuvers her car through traffic. While there are rules in both these two latter cases the skillful person does not need to bring them to her consciousness but rather directs herself eloquently without thinking about them. The skillful person can do this because of having adopted capacities of the cultural Background according to Searle and is not driven or guided by representations as she conducts herself in the above mentioned activities. Although Searle does not tell how the Background works apart from its manifestations and thinks it is one of the least worked out parts of his writings, one could argue that it would be in principle possible to describe the ways in which the Background manifests itself in more detail. This would imply taking on the prospect of developing a taxonomy of the Background and I attempted this in my honors thesis for Searle at Berkeley. In my forthcoming dissertation I would like to bring up the possibility of describing a specialized taxonomy for the Background in relation to visitors in digital 3D environments. The suggestion here is that such a taxonomy could serve as a discussion piece for how visitors interact with digital 3D environments from a pre-intentional perspective.

There are also many other writers that have written about related subjects. Wittgenstein is one of the more influential writers and it is no coincidence that some of his writings shed light on Searle's notion of the Background since Searle read Wittgenstein as "a puppy" (from conversation) and has deep respect for his work while at the same time disagreeing with him. In particular Wittgenstein's writings in On Certainty [Wittgenstein 69] provides the notion of a "world picture" which is closely related to Searle's notion of the Background. Since my notion of accommodation is largely dependent on stances, readiness and ways of acting that can not be understood to operate simply in virtue of representational content it is an interesting and challenging prospect to analyze this notion with the help of the philosophers that have taken steps away from the purely representational model of the mind: Searle and Wittgenstein. Such an analysis could yield a framework for understanding accommodation and offer suggestions on how accommodation should best be studied and conceptualized.

So far it has been suggested that the philosophy of place and that of the Background should be studied but no clear explanation has been given as how

these two philosophies could be combined. The explanation is that they are complementary. While the philosophers of place are not experts on the philosophy of the Background Searle is no expert on the philosophy of place. It would therefore be feasible to make use of the philosophy of place to understand the Background with respect to human interaction and place. It may also be possible to understand the notion of place from studying the Background. What the philosophers of place and Background provide then is a theoretical basis for discussing a possible taxonomy of accommodation to place. They do not, however, provide empirical observations and studies of actually existing environments and places. There are a number of writers within different disciplines who provides such work and they could serve to ground the theoretical work in the real world to some extent. The main disciplines are: architecture and environmental studies.

Architecture

The theories of Alexander [Alexander 79, Alexander et al 77] and Hesselgren [Hesselgren 69, Hesselgren 75] while standing in sharp contrast to each other can contribute to an understanding of our choices of different architectural structures in environments. Alexander, in his theories of patterns focus on the functional role of architecture, Hesselgren is more concerned with architectures impact on subjective experience. Alexander's writings on design patterns in architecture emphasize the need to think of the context of use for architecture. So far, there is no established body of research directly relating to VE design that utilizes Alexander's patterns. Hesselgren has empirically investigated environmental perception and used drawings of urban environments which he presented to subjects along with questionnaires in order to compile what he termed preference profiles. These profiles consist of 34 different dimensions that serve to capture environmental attitudes. Examples of these are: unpleaseant-pleasant, depressing-elevating, and disturbing-peaceful. The beauty of Hesselgrens work as it pertains to VE design is that he has worked out an approach for evaluating environmental scenes and his multidimensional profile lends itself for evaluating VE designs empirically since it builds on such high level general attitudinal constructs. Hesselgren stands in contrast to Alexander in that he has a deep concern for the aesthetic experiences involved with the perception of environmental scenes. Thus while Alexander's writings on patterns consistently stresses the context of use, Hesselgren focuses on the subjective experience of being in environments, i.e., factors of common environmental settings that make people react emotionally and develop attitudes to them.

Environmental studies

Tuan [Tuan 74] has made extensive studies of various physical environments within which humans find themselves and the role of culture in fostering environmental attitudes and values. Sociologists such as Hillier and Hanson [Hillier and Hanson 84] have also made extensive studies on the sociology of space. Their work serves also as a good contrast to Alexander. Together, Alexander, Hesselgren, Tuan, and Hiller and Hanson provide four contrasting perspectives on environments and their relations to their inhabitants.

Studies of visitors in traditional museums

Sociologists such as Dirk vom Lehn have made extensive studies of visitors of traditional museums [Vom Lehn et al 00]. Such studies provide detailed and focused information on interaction in traditional exhibitions as compared to the digital exhibitions reported from in this work.

On the order of the fields suggested for exploration

Although the three fields of exploration: philosophy of place, the Background, architecture and environmental studies have here been described sequentially this is not meant to be interpreted along some priority agenda or hierarchy. The fields are meant to be studied in concert and to serve as interpretative context. Moreover, the aim is not produce an exact theory or anything like a deterministic science, but to problematize the very notion of accommodation and make it more easily understandable. Once the notion of accommodation can be explained more fully it will shed light on visitor orientation as a perspective and provide a ground for its further development.

Further empirical work

Two studies have not been incorporated in this work. In one study I conducted with Eva-Lotta Sallnäs we examined how two people collaborated in an ActiveWorlds environment to solve a cooperative task. This environment is the same as the initial minimalist environment, but with new content. The content is from Volvo and makes up for a car exhibition, although no 3D models of cars are incorporated. The general setup is the same as in the learning environment with images and short film clips. The aim with this study is to further explore visitor-orientation by varying the content while keeping the environmental design the same. A small study with singular subjects within this environment was also conducted. Another study has also been conducted at Teracom on digital TV.

Subjects in this study were observed as they interacted with a digital TV application. Since this application exhibited a 3D interface and something like a small 3D world it could be studied from a visitor-oriented perspective. From the analysis of this study I hope to gain a better understanding of how subjects characterize themselves in relation to simple 3D environments with very limited possibilities. The environment is not sophisticated enough to qualify as a full 3D environment, but lies on the border between 2D and 3D and is therefore especially interesting. There are many other possible studies that could be done and I would like to continue with an Art-exhibition and have gathered photographs and film clips of a Dutch artist, which I hope to put together in a trial environment. If this environment is completed and trials are run within it, then the classic categories of education, business and art will have been explored from a visitor-oriented perspective. This would be important since the relation between content and environment is likely to be rich and interesting. Some content may, e.g., turn out to work better from a visitor-oriented perspective than other content and an analysis of the relation between content and environment is therefore important in suggesting especially promising areas of future developments in 3D environments.

5.3 Closing words

Our relation to technology is difficult to bring out in the open and make clear and perspicuous. It is a complex relation and one that is not only of fact, i.e., the current state of technology and science, but also of human culture. Technology can only exist in an ongoing dialectic with culture and it is through an analysis of this dialectic that we may come to steer its course. Human-computer interaction has been dominated by a homo habilis view that neglects this dialectic for it holds that our relation to computers is in its essence of use while in fact this relation is always aspectual. A future challenge of HCI lies in not only discovering what aspects of human-computer interaction are prevalent and important to study, but also in critically analyzing the dialectic between culture and the loosely defined set of machines that we regard as computers. Only through such an analysis will it will be possible to make sense of human-computer interaction and to steer its course. This work manifests a desire to take on the full dialectic of human-computer interaction by providing an alternative perspective, not just on homo habilis, but on the human. Visitor-orientation is hopefully one of many such future perspectives.

The following environments were used for the empirical studies reported from in this thesis.

Fig 21–Environment 1: The initial minimalist environment

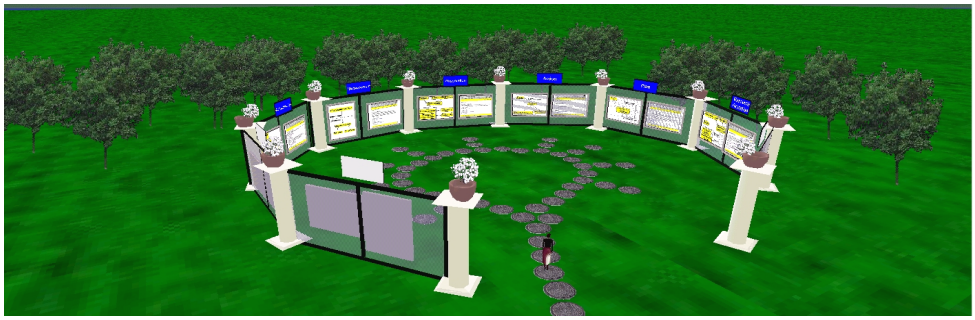

Fig 22–Environment 2: The enhanced environment

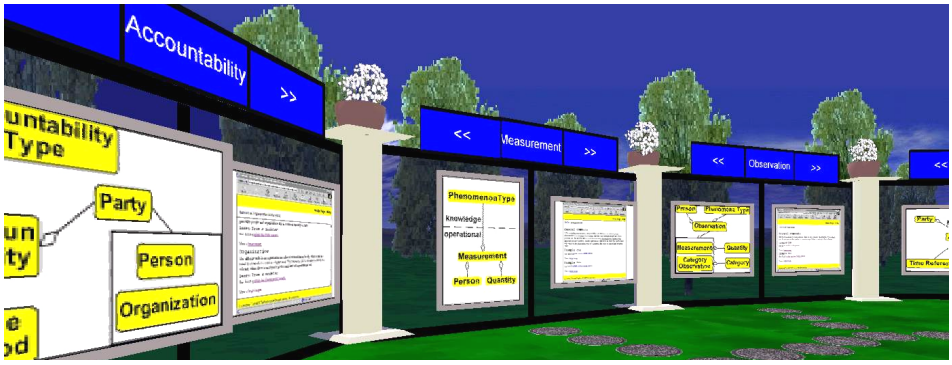

Fig 23–Environment 3: The environment with transportation tools

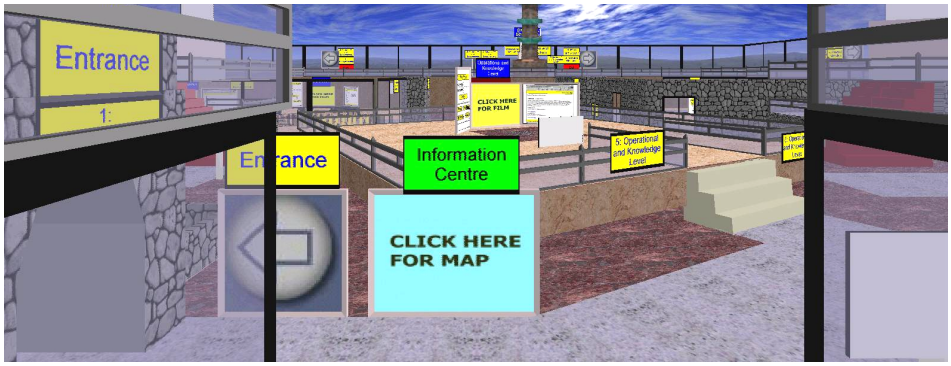

Fig 24–The navigational environment built by Rod McCall

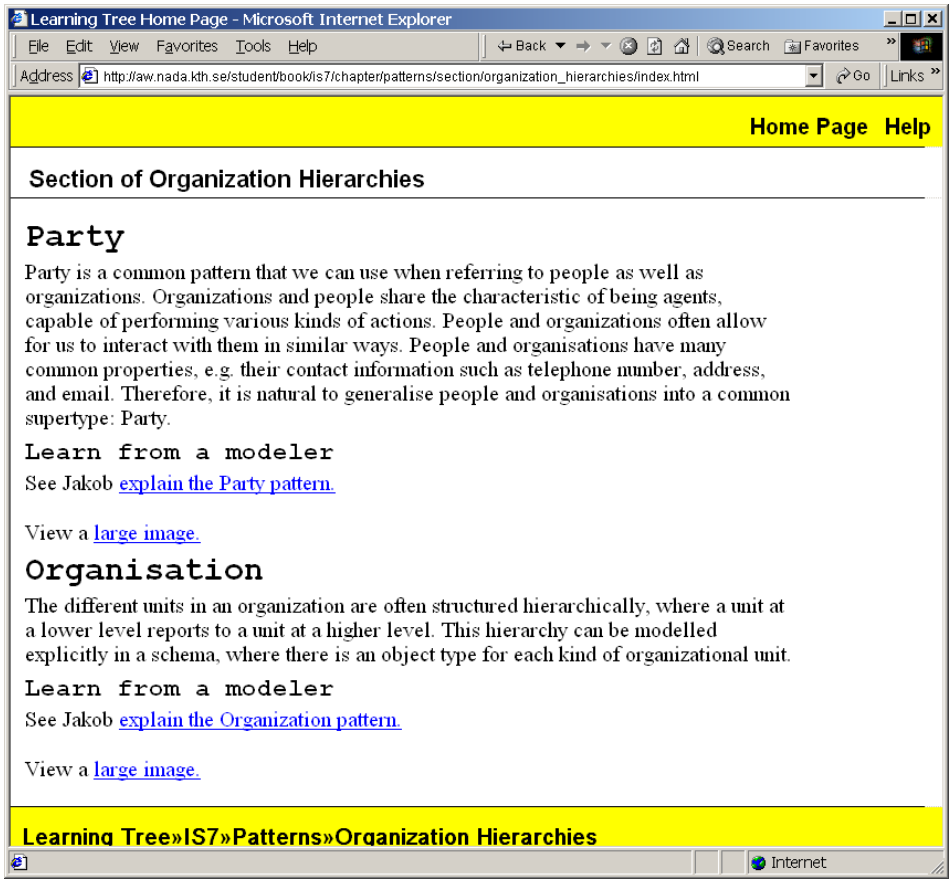

Fig 25–A page from the website used in the first study

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Blaxxun
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Cybertown
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Cycore
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Doom & Quake
http://www.idsoftware.com
The Palace
http://www.thepalace.com

Creating Digital Libraires Together

Collaboration, Multimodality, and Plurality

In *Proc. of ITiCSE '99*, The 4th SIGCSE/SIGCUE Conference on Innovation and Technology in Computer Science Education, Cracow, Poland, June 27, p147-150.

Creating Digital Libraries Together— Collaboration, multimodality, and plurality

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ABSTRACT

Many have tried to answer the question of what a digital library is and how such libraries should be built. But, in a sense the question of how to construct digital libraries as well defined entities is misguided from the beginning. There are many approaches to building digital libraries [7, 18, 4] and each approach must be understood from within a context. Some contexts such as information retrieval and digitizing of existing materials have received much attention [12, 22, 18, 17], while other contexts have been more or less ignored [19]. One such context is that of networking from a higher level of abstraction [8, 11]. Since traditional libraries have long since existed in elaborate and large-scale physical networks it is only natural that we should see such structures mirrored in the world of digital abstract networks. The Universal Simulator [10] application builds on the idea that research in digital libraries need not necessarily focus on micro level infrastructures, but that we may also find interesting possibilities on the macro level of digital library infrastructures. Moreover, at such a macro level we may find important new ways of collaborating and building digital libraries in educational settings.

Keywords

Digital libraries, collaboration, multimodality, infrastructure

1. DIGITAL LIBRARIES

The concept of a library from the very beginning presupposes cooperation. Without at least the cooperation of content producers (writers and other media producers), libraries could not exist. Indeed, what could be more fundamental to a library than it in essence being a cooperative effort? It is people that create libraries together although they may not know each other, or even think about where their works end up. How exactly does this cooperation take place? In the world of print the process is largely determined by authors and publishers, but in the electronic world, the situation need not be the same. In the electronic world anyone can be both an author and a publisher (as evidenced by the World Wide Web). This is the starting point for many debates about media control. But, also for debates about the very process of creating communal resources through cooperation, which is what libraries are most fundamentally about. As with traditional libraries this cooperation takes place through networking, but electronic networking with respect to the idea of a library opens up different possibilities.

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FOR THE COPYRIGHT NOTICE

1.1 Infrastructures

One way to approach the field of digital libraries is from the viewpoint of networking as a general concept. In a physical library setting networking means that we concentrate on how materials pass physically between main libraries, sub-libraries, interlibrary lending facilities, storage facilities, binderies, publishers, patrons, and other entities. Such physical networks for the transfer of resources have developed over the years, and are expressions of what we may think of as traditional library culture.

In facing the era of digital libraries we can only speculate and experiment in order to arrive at what will one day be part of our future library culture. Whatever that culture will be like, we can be sure of that networking will be prevalent. One possible networking infrastructure is hypermedia and the World Wide Web [9, 2].

1.2 Substrates

While both traditional libraries and digital libraries can be seen as networked information storage facilities, only the digital library houses the possibility of being both an information storage facility and tools of production. Although this latter possibility has been largely ignored, there is no technical or practical reason why digital libraries should not work as information *substrates*–entites allowing for the dynamic generation of content. Such an approach would enable the creation of digital libraries from the grassroots level [20] and can be seen as influenced by the Scandinavian School of participatory design [3, 5, 15, 6]. Since a digital library has the quality of being a *software artifact* (however complex it may be), we can also think of it as an artifact capable of letting patrons generate their own catalog items. A digital library could in principle perform a wide range of software authoring functions. Putting the three ideas together, i.e. collaboration, infrastructure and substrate artifacts, we arrive at one particular view of digital libraries–the view of digital libraries as collectively constructed through networking infrastructures.

2. THE UNIVERSAL SIMULATOR

The World Wide Web has two of the qualities brought forth: it is a collective effort and it depends on a common infrastructure, but

it is not a substrate. It does not allow for its patrons to author their own content as they visit parts of this giant, unstructured digital library. The Universal Simulator is an effort to show how such authoring is possible. It is a substrate technology, and an authoring tool allowing its patrons to generate their own information structures, and to create or add existing content to those structures. It is built with standard Internet technologies and can be used by anyone with a web browser.

2.1 Digital library visions

Collaborative digital libraries can be used for constructing communal repositories of knowledge resources. The universal simulator was constructed with this aim in mind. It is possible to let students and teachers cooperate to build their own multimedia digital libraries. Such digital libraries could serve as backdrops for regular courses. They can also fulfill three important learning objectives: multimodality, collaboration and plurality.

2.1.1 Collaboration

Collaborating to construct digital libraries is not simply a matter of building learning resources. Inherent within the possibility of dynamic generation of digital libraries using substrate technologies, is also the possibility of learning through the very act of collaboration. Students using digital libraries on the Internet learn about IT and Internet-technologies at the same time. Moreover, we hope that students deploying the Universal Simulator will also learn about the subjects they are studying through creating their own parts of the digital library.

2.1.2 Multimodality

The Universal Simulator can harbor any multimedia content on the Internet. Using multimedia elements such as Java-applets, Shockwave and dynamic HTML allows for concepts to be visualized and portrayed in a variety of ways. A student can, for example, watch how Newton's law of gravity work or see how mathematical equations appear when plotted. The content is in many cases readily available on the Internet and the Universal Simulator can then be used as a meta-library, i.e., the content is accessed through the Universal Simulator, but resides elsewhere.

2.1.3 Plurality

In an ordinary school setting, the learning materials are limited. Although it would in many cases be better for students to have more extensive course materials, economics does often not allow this. However, in the setting of digital libraries, several different versions of the same learning materials could be used since publishing and distribution costs are small. Another way to put this is to say that digital libraries are well suited for parallel publishing. Parallel publishing possibilities could in turn aid various target groups based on qualities such as gender, age or learning abilities.

2.2 Building digital libraries

The universal simulator server is a web server, but it is also an authoring tool. What is authored is both structure and content. The structure is a scaffolding of HTML pages with links and the content can be any content compatible with HTML, i.e. any content that we may find on the Internet. The universal simulator enables visitors to write their own HTML-documents in real time.

Where the content resides is largely irrelevant and the Universal Simulator can build libraries which are free from local content. It is transparent to library patrons where the content comes from, just like it is on the World Wide Web at large.

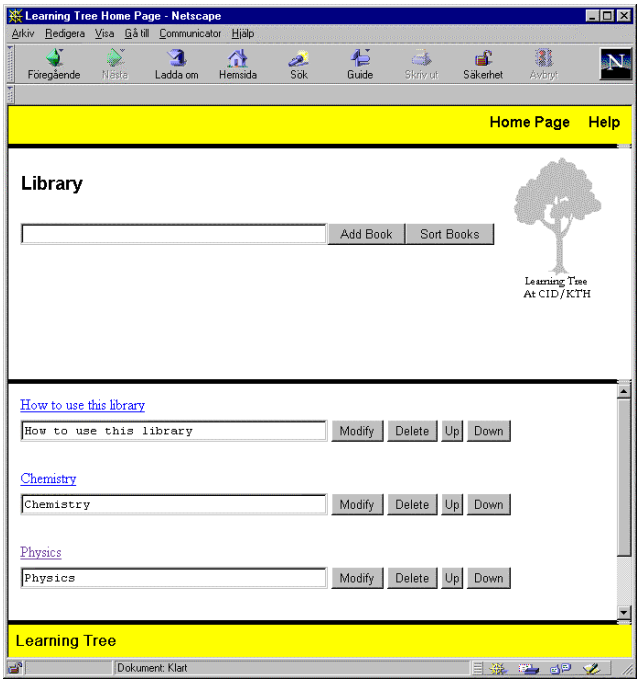

Figure 1 – Universal Simulator

Creating digital libraries and adding content requires no special technical skills other than being able to click on links and fill in forms. The structure is hierarchical and provides a high level of predictability.

Figure 2 – Hierarchical structure of the Universal Simulator

In order to aid the user further the location within the library is always shown. This information is shown as path, and the visitor can click on different parts of the path to navigate within the library.

2.2.1 High level infrastructure analysis

The Universal Simulator application can run on almost any machine connected to an intranet or the Internet.

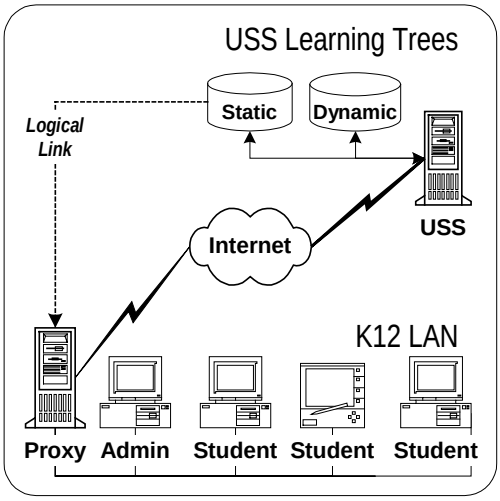

Figure 3 – Infrastructure of the Universal Simulator

In brief the Universal Simulator server generates two distinct, but isomorphic web sites: a *dynamic site* and a *static site*. One of these sites is dynamic and this site houses the authoring tools. The other is static and functions more like a traditional library in the sense that visitors are not allowed to make any content changes. The dynamic site provides an interface to the substrate functions of the universal simulator server. New structures and pages are generated transparently by Java-programs as the users work with library production.

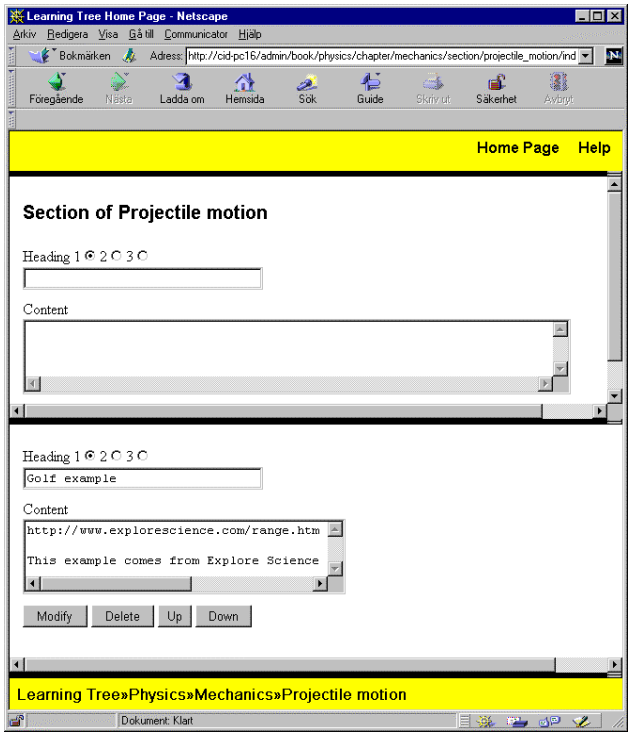

Figure 4 – Dynamic Site

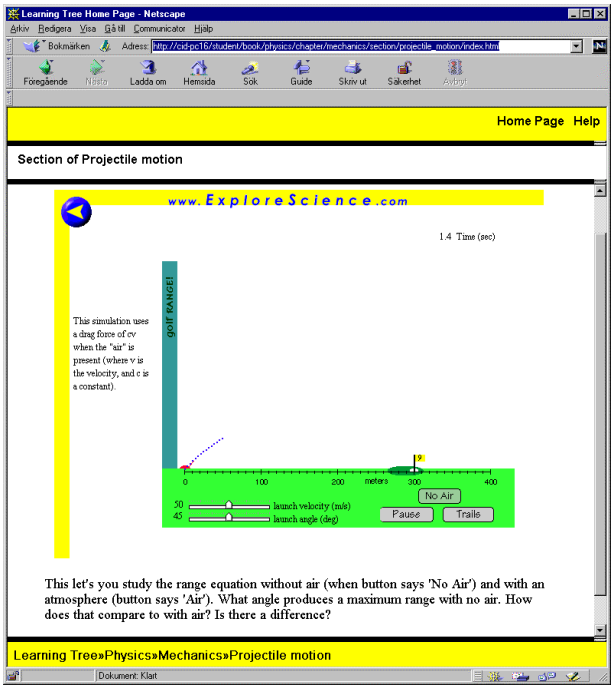

Figure 5 – Student view[1]

2.2.2 *Level of infrastructure analysis*

The universal simulator provides an infrastructure inspired by traditional library systems.

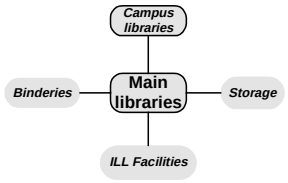

Figure 5 – Library infrastructure elements

The higher level infrastructures applicable to digital libraries can naturally be conceived of in a variety of ways. The one explored here is based on sites that are used to build libraries and those that provide access. Since the sites that merely provide access are self-contained they can be copied to local area networks.

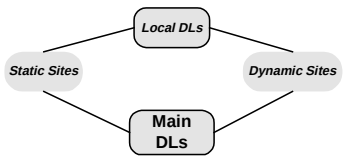

Figure 6 – Infrastructure elements of The Universal Simulator

Another possibility with this infrastructure is to link different libraries together in higher level indexes.

[1] Shockwave application by courtesy of Raman Pfaff.

3. CURRENT USE SCENARIOS

This paper has focused on digital libraries as information tools, but in order for them to work we also need to consider the cultural and social spaces [1, 24, 13, 23] in which they have their life. By building a VRML entrance to the Universal Simulator and placing it in a digital worlds project[i] we hope to provide a social setting which allow us to better study the digital library from a digital community perspective. Another line of investigation is taking place at a Swedish university[ii], where our focus is on implementing and evaluating cognitive apprentice–ship [16]. In this latter case teachers at the University of Stockholm will use the dynamic server to generate the digital library and the students will use the static server for accessing multimedia demonstrations and course materials

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Visions of Hypermedia

Beyond Correctness

In *Proc. of AUSWEB '99*, the 5th Australian World Wide Web Conference, Ballina, Australia, April 18-20 1999, p170-177

Visions of Hypermedia Architecture— Beyond Correctness

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KEYWORDS: Hypermedia architecture, orientation, accommodation, visualization, sensitization.

INTRODUCTION

Digital worlds on the World Wide Web (and elsewhere) in all their shapes and forms have gained greater momentum. This becomes evident from new terms in the general computer science discourse: digital libraries, digital communities, virtual worlds, and virtual reality. We believe, however, that an understanding of the requirements of digital worlds cannot be detached from a specific kind of subjective stance since digital worlds are necessarily digital information environments. This kind of subjectivity is indicated by the word "environment".

COMPUTER ARTIFACT DESIGN

There was a time in the field of computer science when software design was the sole privilege of engineers. That time has come to pass now. The road from the inception of the computer science field to today has been a road of theories, methodologies and ideologies. In the early days the focus of design was naturally on the software systems. They were difficult enough to design without taking the psychology of the user into account. Moreover, the early technologies and the lack of development tools did not allow for developing anything like advanced graphical and dynamic user interfaces.

After roughly fifty years of computing [Carlsson 96] we have the chance to experience a Copernican-like revolution. Today the focus is often said to be on "usability". The early days of computing focused more on the pure engineering aspects of design. The spotlight is on the user today. If we insist on a model of the user qua rational cognitive agent Schneider 98, Dix 93, Baecker 95], however, we will not be able to solve problems that lies within the subjective sphere of interactivity. We are like the man trying to find his lost keys under a street light rather than in the bushes were he knew he lost them.

BEYOND CORRECTNESS

In one digital worlds project [Hedman 97] we found that users disliked hierarchical structures. When we let users interact informally with a demonstration prototype of a dynamic web-based community they invariably complained about the rigid hierarchical structures. The complaints did not focus on the navigational inefficiency of the structures, but rather on their structural rigidity. The reactions were strong enough for us to abandon the project and go back to the drawing board. When similar hierarchical structures were deployed in a digital library application [Hedman 98, Hedman 99], no complaints were made.

Why was it users complained about the hierarchical structures in one application, but not the other? After all the structures were completely isomorphic. Our tentative answer is that one application was seen as a digital environment and the other was not. The library was simply viewed as a tool to handle information. The digital world was perceived as a place providing personal accommodations.

With regards to the HCI of digital worlds certain aspects are mostly cognitive. Users wish to be able to orient themselves and be able to find information. Some factors worthy of being mentioned in this respect are:

- Perspicuity (structural, procedural and social)
- Logical, predictable structures
- Perceptualization (ways of encountering information and structure)

The cognitive requirements are such that they do not depend on the psychology of the user per se. Thus we assume that all users want their digital environments to be perspicuous, logically arranged and encountered through adequate ways of perceptualization. These are requirements of a rational user. On such a perspective we neglect to take into account any background factors having to do with the associativity of the user. Our way out of this dilemma is to turn to the 'philosophy' which has embraced associativity in computer science–hypermedia.

Hypermedia once revolutionized our ways of thinking about information. It was the visions of people like Vannevar Bush, Ted Nelson, and Douglas Engelbart that opened up the field of mechanized associative information structures. They took the first steps away from the traditional ways of structuring information so emphasized before. They taught many of us that there is no correct way of structuring information, but only a giant field of possibilities. Inherent in much of the three giants of hypermedia is a kind of thinking that goes well beyond the user qua rational cognitive agent. Vannevar Bush wanted to save science from unmanageable information overload, Douglas Engelbart had visions of extending the human intellect and Ted Nelson conceived of giant public electronic libraries.

Inherent in the seed of hypermedia are the ideas that we need not think of information as having foundations, starting or end-points. How else could we conceive of information? Information has always, and will always be situated in networks, irrespective of its particular mode of

existence. Printed matter, spoken words, flickering images on a computer screen–these are all modes of information, but what is common to these modes is that they could not exist unrelated to other information. At a basic philosophical level, ideas and concepts can not be conceived of without relating them to other concepts and ideas [Searle 93, Searle 95]. On a somewhat higher level of abstraction, articles, magazines, and books are similarly related to other such entities. We see connections between the various works and we interpret them in the light of such relations.

Our model of digital worlds requirements builds on the associatively holistic tradition. As we move into the realm of digital worlds, we must rethink our very core concepts regarding the user as:

- A cognitive agent
- Goal driven
- Rational

Non-rational, subjectively determined behavior should be seen as the norm rather than the exception [Laurel 97, Nardi 96, Winograd 97]. Thus all design of digital words should be considered from a subjective stance embracing associativity as a truly essential characteristic of such environments.

NON-RATIONAL FACTORS AND ACCOMODATION

In lack of terminology we would like to describe the general subject matter as falling under a proposed label: accommodative design. What we mean by this kind of design can be roughly delineated as design from a perspective of:

- Estethics
- Culture
- Background and values

Whether a user prefers one digital hypermedia environment or another is on our proposed model not simply a matter of user-qua-rational-user requirements. We focus on the user experience within digital environments rather than the way they rationally process information. Instead we propose a subjective model:

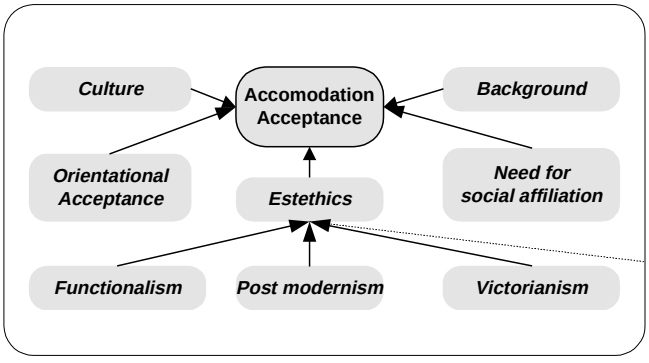

Figure 1 – Accommodation acceptance

We think of the subjective factors as determining how well a user accommodates to a digital community environment. Accommodation is seen as something unique to the user–a complex attitude to a digital environment–not lending itself to formal reduction. Just as there is in general no correct way of arranging information, there is no correct way of accommodating a digital environment. In our view attitudes stem from associativity and rather than modeling the user qua rational agent we think of the user qua associative agent.

ACCOMODATION VS ORIENTATION

Our conceptual basis for studying digital environments is based on the notions of accommodation and orientation. We see them as equally important to understand, and at the same time difficult to study. Admittedly, the concepts are hard to define and they overlap. Moreover, so far we have found no previous research that quite captures what we mean by accommodation. By accommodation we do not mean the way a user can adapt to the environment. Those who have studied Piaget's notion of accommodation might think our notion is the same as his [Bringuier 89]. We, are however, not primarily interested in those processes which lead a subject to be able to cope and master the challenges posed by her surroundings. Nor do we assume deterministic systematicity behind accommodation. Our notion of accommodation is more closely tied to attitudes and the willingness to accept or the readiness to reject an environment. In this sense the value of understanding processes becomes retrospective rather than prospective. If a user reveals accommodative dispositional attitudes then we ask ourselves why within a retrospective framework. Is it something within her general background, which triggered these attitudes? How can we analyze and trace out the relations between such background factors and the accommodative dispositional attitudes? We believe that it is possible to trace out taxonomy of archetypal background factors (accommodative determinants) that will help us understand better the dispositional attitudes of accommodation. Such a taxonomy is not meant to be thought of as deterministic, but as a framework for discussion.

One of the main difficulties is that accommodation and orientation can not be understood in isolation from each other. The phenomena are enmeshed with each other and cannot be clearly separated. Every three dimensional ordinary environment from baseball fields to forests and shopping malls provides us with accommodational as well as orientational cues. The same is true for any such environments simulated in digital environments. It appears we can also reverse the analysis and make the claim that accommodation is dependent on orientation, because if we are completely unable to orient ourselves in an environment then we will not be able to accommodate to it, thus orientational blindness leads to accomodational indifference. On our view the concepts go hand in hand and there is no way to reduce the one to the other. The strife towards such a reduction is as futile as that challenged by the proverbial riddle of the hen and the egg.

VISUALIZATIONS AS ORIENTING STRUCTURES

Our approach to visualization, which represents a continuation of earlier work [Lenman, See, Century & Pennycook 1996], emphasizes that users require different views of information at different times, depending on preferences, circumstances and tasks, and that procedures for switching between views must be user-controlled, rapid and appear seamless. Thus, an important aim is to make it possible for users to easily create views for exploring existing information structures, for generating new content and structures and for communication and collaboration. On this model, the parameters of visualization that needs to be considered are semantic zoom, filter and metaphor.

Semantic zoom refers to how much detail about content and structures is shown in a given view. The purpose of semantic zoom is to provide a bridge between orienting

overviews and closer views. For example, a user could quickly zoom out to get a contextual, orientating view, grasping the large picture of the structure, and then zoom in on a specific item. Such a mechanism is one way to simplify navigation in hierarchical information structures. An advanced, earlier system using this principle is Pad++ [Bederson 95].

Filter refers to what kind of content is shown in a view. For example, a user could choose to see only content related to "digital libraries". All other information in the view could then be filtered out completely, or shown in some subdued rendition. Filtering in visualizations can be regarded as a complement to searching, a way to keep the general picture while searching for specific information. It supports working with large amounts of information in flat, network views, as an alternative or a complement to hierarchical views of information structures.

Metaphor refers to the frame of reference used to organize the information in a view. A variety of metaphors can be used for visualizing the same content, e.g., a general information space, folders and subfolders in a desktop metaphor, or rooms, shelves and books in a digital library in a shared, three-dimensional digital world. The purpose of a metaphor is to reduce complexity in organizing information and to aid users memory by exploiting prior knowledge from different domains. However, forcing a single, detailed metaphor can be both cumbersome and counterproductive [Waterworth 89], and it is important to provide users with alternative ways of perceiving information.

Our current interest is in applying the visualization model to three-dimensional information spaces There are two lines of investigation that mostly are concerned with how different metaphors could be used to provide orienting structures. One line of work explores abstract visualizations: molecule-like, abstract representational forms, both as means for viewing existing structures of information and for generating new ones. This work is based on Visage [Algevere, Bäckström, Ehn, Hellvig, Nilsson, Wabyick, Weijnitz, 1997], a Java engine for automatically generating visualizations in VRML of documents and link-structures on the web. Currently very simple principles are used for representing information and links and for arranging them in 3D-space. As to documents, only two kinds are distinguished: HTML documents, which are represented as spheres, and non-HTML documents, which are represented as boxes. Links are represented by extended cylinders. The spatial arrangement is not related to the semantic content of the document; representations are simply placed where they fit. This will of course be elaborated upon in future versions. Recently work has also been initiated to create a shared editor using this technology [Trujillo 1998].

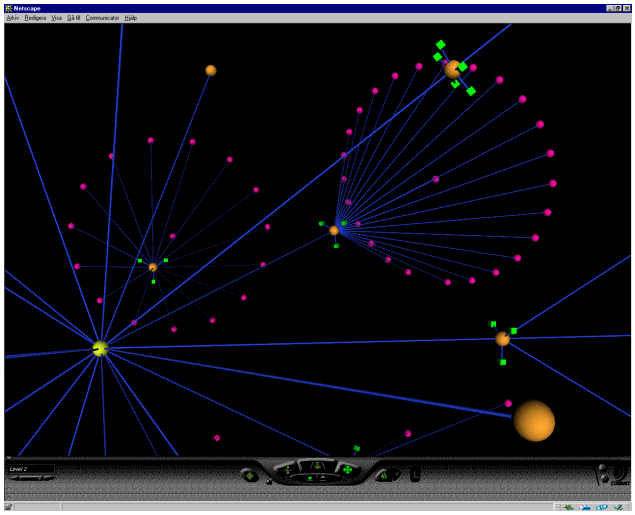

Figure 2 – Visage Visualization

Another line of work, taking the point of departure at the opposite end of the spectrum of metaphors, explores the use of shared 3-dimensional spaces for visualization, based on real-world metaphors. Orienting structures can be represented, e.g., as buildings with rooms, bookshelves and books. Users are visualized as avatars, and simultaneous users can see each other, and communicate in real time through text chat. The Active Worlds technology[1] is currently used for prototyping, but a number of suitable tools for this purpose are rapidly becoming available. An interesting problem concerns automated construction of digital worlds, i.e., how to algorithmically generate structures in accordance with a certain real-world metaphor.

STUDY OF ORIENTATION AND ACCOMODATION

In order to study the notions of orientation and accommodation as they apply to digital environments, we have recently initiated a project were students from the University of Stockholm will have the opportunity to make use of course material from within a digital worlds environment. A setting such as this with a group of students enrolled in a distance learning course enable us to evaluate our model and engage in empirical research. In order to do this we have placed a web-based digital library [Hedman 98, Hedman 99] within a digital world. The students can access the library with its course materials through the digital world, but they can also move out into the digital world from the digital library. Traditionally distance education over the Internet has not involved digital worlds. Most courses have been built around hyperlinked web pages. In such settings the students will, in our view, not have a chance to experience accommodation to any greater degree. Without strong accommodation we hypothesize that the setting can not be fully experienced as a place of learning, but rather as an orientational structure harboring information–an information nexus.

Our aim is to go beyond an information nexus and provide place of learning. Such a place will be characterized by the information available, as well as the accommodations provided. For example, the students may decide to visit the library as a quick way of obtaining information, but when they feel a need to communicate with other students they might venture out into the digital world were they could discuss the course materials with other students and instructors. The digital world, however, provides for more than social interaction. It is also a place were students can

walk around in an exhibition hall with learning materials. Such three dimensional exhibitions provide for ways of organizing and interacting with learning materials.

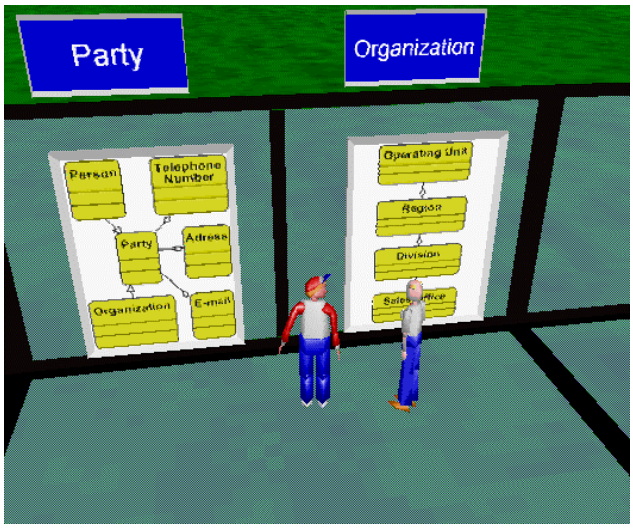

Figure 3 – In the exhibition hall

The ways in which users can orient themselves within an exhibition hall cannot be de-coupled from the process of leaning. The person familiar with cognitive psychology is likely to have stumbled on the notion of cognitive maps as a way of memorizing and accessing information. Roughly, such maps are spatial representations that a person deploys as a memory aid. Thus if one wishes to hold a speech, for example, one can visualize a familiar spatial setting such as a campus, and then mentally place different parts of the speech in different locations on it. Holding the actual speech then becomes a matter of walking through the campus picking up the relevant parts of the speech as one is holding the speech. The mental representation in such a case serves as an orienting structure helping one to navigate through the parts of the speech. In a similar vein, we wish to see how students could deploy parts of a digital world as orienting structures for learning materials.

CLOSING WORDS

Hypermedia has revolutionized our ways of structuring and working with information. The works of Bush, Engelbart and Nelson has opened up our eyes to associative ways of organizing information. What has largely been neglected, however, is the idea that what fueled the fire of the hypermedia revolution was insights regarding our ways of working with information. The visionaries of hypermedia were all aware of our powers of association. Thus Nelson has long argued that the world of literature has always existed in an associative network, and Engelbart wished to augment our intellects through associative texts as did Bush. In a sense what we are advocating here is that we take a step back into "the head" and reexamine what bearing associativity has on our interaction with hypermedia and digital worlds. It is the neglect of the associative mind within the HCI of digital worlds that we find troublesome. What associations a particular human being makes in a digital world, what attitudes arise from those associations, and her emotions is something that goes beyond correctness and the user qua rational agent.

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[1] http://www.activeworlds.com

Orientation vs Accommodation

New Requirments For The HCI Of Digital Communities

In *Proc. of HCI International '99* the 8th International Conference on Human-Computer Interaction, Munich, Germany, Aug 22-26, 1999, p457-461

Orientation Vs Accommodation —New Requirements for the HCI of Digital Communities

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1 Introduction

We focus on a single qualitative aspect of digital communities. One that we see as important yet ignored. The aspect we have in mind we baptize as *accommodation*. With this word we wish to draw attention to subjective factors of digital communities directly determining attitudes of accepting/rejecting ones environment.

2 Digital communities

There are many ways to define the term virtual, or digital, community (Mynatt et al 1997), e.g., by geographical area, social norms or types of social interaction. Our working definition is that a digital community must have at least these two important qualities:

- Being digital
- Having accommodation-like qualities

By accommodation-like qualities we mean that the digital community must be experienced as a place that can be visited. Accommodation-like qualities indicate a mental stance rather than a physical fact.

3 Hierarchies as logical scaffolding

Hierarchical hypermedia structures in one digital community project– WebHouse–were found to be unpopular among users (Hedman 1997), but isomorphic de-compositional structures received positive regard when deployed in the Learning Tree digital library (Hedman and Jacobsson 1998). Early investigations suggest that these isomorphic hypermedia structures performed functions that were differentially perceived in the projects.

In the WebHouse project we developed an application prototype that allowed users to generate their own web-based organizational spaces consisting of web pages. The structures were hierarchically arranged into organizations, groups, and individuals:

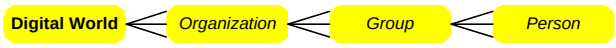

Figure 1 WebHouse Structure

Users interacting with this prototype were in general critical to its rigid hierarchical structure. As a result we were driven to rethink the entire project. In Learning Tree an analogous hierarchical structure was received with positive regard:

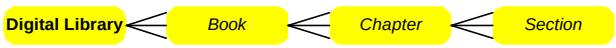

Figure 2 Learning Tree Structure

Thus the same logical ”scaffolding” was deployed in both instances: dynamically constructed hierarchical hypermedia structures. In addition, the user interfaces were similar. What accounted for the differential perceptions of the underlying scaffolding in each case?

We suggest that there is an obvious answer to this question. In the first case the users saw themselves as acting in a digital community, while they did not do so using the digital library. On the one hand, a *digital library* is something you primarily use to get information – the primary process is *orientation*. On the other hand, a *digital community* suggests something different. A digital community suggests a place of habitation – the primary process is *accommodation*.

4 Orientation

Orientation means knowing ones field of possibility within a particular software artifact. Classical HCI has focused almost exclusively on this area (Schneider

1998, Dix et al 1993, Baecker et al eds 1995). The movement from text based to graphical user interfaces can largely be seen as an effort to reveal the field of possibilities inherent in software artifacts. The interface is a mediator of functions and the functions define the field of possibility. Another way of putting this is to say that much of HCI efforts have been aiming at greater *perspicuity* for the user. The workings of a computer artifact must stand out to let the user *orient* herself within its field of possibility. The workings should be self-evident. However, in examining users in digital environments, we run into difficulties stemming from human subjectivity.

5 Accommodation

A digital community carries connotations. One connotation that is crucial is that of being a location, a place in time and space like any other place. Every place we visit makes an impression on us that goes beyond functionality and perspicuity. This is most evident in the cases of architecture and interior design, were the concept of impression management is systematically explored. Living accommodations can express a wide range of personal styles, they can for example be:

- Bohemic
- Practical
- Impressive

They also express esthetical and cultural concern and can be part of traditions:

- Gothic
- Roman
- Victorian

This latter list can naturally be extended almost endlessly. But we think the point we want to make is obvious: if choice of accommodations is such a complex issue involving mainly personality and culture, then these factors are similarly complex in digital communities. Unless of course one wishes to claim that accommodations can only be found in the physical world, which seems like a limited perspective in our minds.

6 Investigating new requirements

We plan to investigate further the accommodative aspects of digital communities, which we see as potentially very interesting. These investigations can be understood as following a more subjectively oriented approach to HCI (Laurel 1997, Nardi 1996, Moser 1996, Hedman 1996). We are also inspired by

Winograd and Tabor (Winograd and Tabor 1997) who examine software design from an architectural perspective.

On our proposed model we measure both orientation and accommodation, e.g., on scales ranging from 0 to 1. How well a user can orient herself and make use of the functional and informational aspects of a computer artifact is measured by the orientation index. The acceptance of the artifact as an electronic place is measured by the accommodation index.

Using this proposed model we aim to discover sets of predictor variables for orientational and accommodational attitudes.

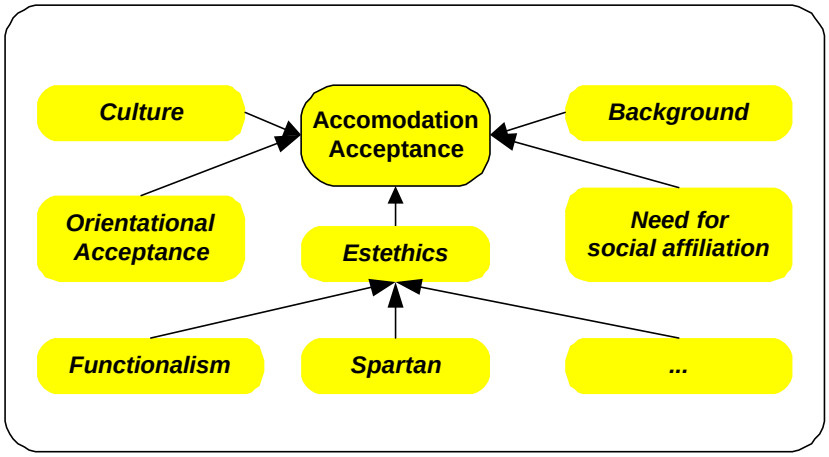

Figure 3 Accommodation Acceptance

We plan to explore these questions and others as we study users of our Learning Tree digital library[i] and users in our ongoing digital community's projects[ii].

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[i]The setting is students using Learning Tree during a course at Stockholm University. The project is sponsored by the Graduate School for Human Computer Interaction in Sweden.

[ii] Digital Worlds on the World Wide Web – Center for user oriented design at the Royal insititute of Technology, Sweden.<

Accommodation and Learning in 3D Environments

In *Proc. of WebNet 2000* World Conference on the World Wide Web and the Internet, San Antonio, Texas, October 30-Nov 4, 2000, p727-728

Accommodation and Learning in 3D Environments

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Abstract: This paper presents early results from three user studies carried out to investigate if encasing a website with learning materials with a 3D environment has any impact on user attitudes toward the learning materials. The results indicate that user attitude toward such learning materials can be enhanced by even a rudimentary 3D environment and more so by more sophisticated 3D environments.

Introduction

From overviews of the HCI-literature (Helander 1997, Schneiderman 1998) it is evident that studies in HCI are largely about users as cognitive rational beings and not about attitudes and subjective components. Works that treat of subjective approaches to HCI such as those by Laurel and Moser (Laurel 1997, Moser 1996) are seldom combined with empirical work. The effort here is to understand the subjective phenomenon of accommodation (Hedman 1999) through user studies. The notion *accommodation* denotes those *workings of human subjectivity* that determine and constitute attitudes of accepting/rejecting an environment such as a digital community or a web site. Accommodation is e.g., important to understand for business organizations crafting digital communities on the Internet. More generally, accommodation should be taken into account by digital environment designers guided by what is normally termed a *user oriented* perspective. The expression *user orientation* is misleading, however, for it does not adequately indicate the focus of analysis. User orientation applied to digital environments reflects a stance of *tool users* rather than *visitors*. *Visitors* of digital environments can accept or reject environments on grounds beyond the horizon of traditional usability. The analytical perspective inherent in *user orientation* is suitable only to a limited extent for digital environments. So far three user studies have been conducted. In these studies users were assigned to learning tasks in 3D ActiveWorlds-environments.

Study One

In this study a simple web site with materials from a course on conceptual modeling was produced. The site contained texts, conceptual modeling examples, photos and video clips. Twelve subjects participated and six were assigned to a learning task using the web site (in this case only one monitor was used). The remaining six were assigned to the same learning task, but with a basic 3D environment with few features (fig. 1) constructed around the web site.

Figure 1: The 3D environment from study one

After the subjects within each group had performed the learning task they were given a questionnaire. The main part of this questionnaire contained propositions to which the subjects could indicate their level of acceptance or rejectance on a scale ranging from 0 to 1. Propositions such as “To learn from the exhibition is easy” and “The exhibition is engaging” were used to probe for attitudinal responses. Open-ended questions such as “What is your opinion of the esthetics of the exhibition?” and “What did you not like about the exhibition?” were also included in order to give a richer picture of the way users felt about the environments. Such comments were used when the initial 3D environment was redesigned for the second study. Using an identical web site in both conditions allowed exploration of the impact of basic 3D encasing. The users in the 3D condition clearly perceived the learning

materials to be more engaging as well as easier to understand when we compared them to the users in the web site only condition. This was despite the fact that they were exposed to the same content in both conditions.

Study two

Eleven subjects participated in the second study. Based on how users perceived the first basic environment an attempt was made to build a compact, pleasant and less sterile environment (fig. 2). The course content was perceived with still greater positive regard than in any of the earlier conditions.

Figure 2: The redesigned 3D environment in study two

Study three

No direct enhancements of the accommodative determinants of the environment from study two were made, but the environment was equipped with navigational links (teleports) for efficient and precise navigation. Five subjects participated in this study. Some users had expressed a desire to move around in the environment by clicking on the places they wanted to go to and our hypothesis was that efficient navigation would yield more positive attitudes towards the learning materials. With teleports, the content within the environment was used more efficiently and the users went through the materials in record time. Although visitors could access the learning materials more efficiently, the materials were perceived with less positive regard than in the previous study. One hypothesis to investigate is whether this had to do with an experienced loss of control. Although the subjects themselves made the choice to teleport to the different content areas and initiated the action, they were still *being teleported*, i.e., *transported*, and as such the *locus of control* appeared to have shifted by degree from internal to external. Another hypothesis is that when user attention shifts from the 3D environment to the learning materials the impact of accommodative influence of the 3D environment weakens.

Conclusions

As this paper presents work-in-progress these conclusions are tentative. Our first finding is that encasing learning materials within even the most rudimentary 3D environment has a positive impact on user attitudes to those materials. A rudimentary environment, however, is not the best environment for promoting positive attitudes to such content. Nor is it necessarily the most efficient environment. Creating a 3D environment for promoting positive attitudes to learning materials should involve research pertaining to how users come to develop attitudes of rejecting/accepting the environment, i.e., how they accommodate. So far the following determining factors for promoting positive attitudes are emerging. First the environment should be designed so as to not be perceived as sterile. The environment should also be perspicuous and designed in a compact way. Finally teleports should be used with caution or avoided in small environments.

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Visitor Oriented Design

From Users To Visitors

In *Proc. of NordiCHI 2000* the 1st International Conference on Human-Computer Interaction, Stockholm, Sweden, Oct. 23-25, 2000

Visitor Oriented Design

–Three Studies of Visitor Accommodation and a Call for Action

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ABSTRACT

This paper proposes and describes a visitor-oriented perspective emphasizing the unique needs of visitors of digital environments in contrast to the user-oriented perspective that emphasizes the needs of users. To do so the term accommodation is introduced in a technical sense and given a brief explanation. Results are also reported from three explorative studies of desktop virtual reality environments. In these studies the visitor-oriented perspective was adopted and allowed for analyzing how subjects perceived the environments as places rather than artifacts for use. In comparison to a web site, it was found that even a rudimentary virtual reality environment can have a positive impact on visitor regard for information content. Implementing teleports increased the efficiency of one test environment but it was not found to have a positive effect on user attitudes to the environment. Many subjects felt that first the environments was sterile. Another common complaint was about the amount of walking required in the first environment. Five suggestions are given for building desktop virtual reality environments that are better received by visitors. In closing, the visitor-oriented perspective presented here is briefly discussed in relation to Terry Winograd's writings on software inhabitants.

Keywords

Digital environments, visitor-oriented design, accommodation, user-orientation, usability, design guidelines.

1 PLACE AND ACCOMMODATION

The starting point for this paper is a description of a proposed design approach that centers on *visitors* of digital environments rather than *users* of digital environments. In order to explain this approach and to have a working terminology, the term accommodation is introduced in a technical sense. The term digital environment is also used, and for the purposes of this paper it should be understood as referring to any digital artifact that can be experienced as a place. This paper, however, centers on user studies conducted within a particular kind of digital environment: the desktop virtual reality system. This kind of system runs on an ordinary personal computer. With desktop virtual reality systems, environments are rendered on a standard CRT monitor producing convincing representations of 3D space. The subject interacting with a desktop virtual environment can move about within the environment, typically by using the arrow keys of a standard keyboard or by moving a mouse. Kulwinders usability thesis (Kulwinder 98) is largely about usability issues pertaining to such

systems. While Kulwinders work focuses on the design for *users* of virtual environments the focus here is on the design of environments for *visitors*. The unique needs visitors have are here characterized as accommodative needs.

Accommodation occurs with digital artifacts capable of being experienced as places (Hedman 99, Hedman 99-2). In places (electronic or not) subjects as visitors reveal feelings, attitudes and dispositions that indicate how well accommodated they are. Arguably the needs of visitors are different from the needs of users. The subject *as user* has needs in order to work *easily* and *efficiently* with her/his digital *tools* such as the accountant adding a new formula to a spreadsheet, the writer tinkering with a word processor or the correspondent rearranging the folders of an e-mail application, i.e., usability needs. Similarly, the subject as visitor has needs in order to feel accommodated in her/his digital *environment*, i.e., accommodative needs. For example, a visitor of a desktop virtual reality environment may find it uninviting unless some elements are included that make it appear less sterile. Adding elements such as trees and walkways may serve the needs of the visitor, but it may not do anything to make the environment easier to use or more efficient. In fact, adding such elements may have a detrimental effect on usability. The environment could become less responsive because the machine on which it is displayed must work harder to render those trees and walkways on the visual display unit. In terms of sheer usability, the environment has become less usable, although it may at the same time be more accommodating to the visitors needs.

So far, it may seem that accommodative issues are actually about form. Form, however is purposeless in itself. To give something a form does not say much about how it will be received. We need to know more about the relation between what the form is supposed to communicate and what the subjects are like that will perceive the form. Moreover, form is always given to something. Without knowing what that something is, it is difficult to get started to work on form. Also to have a complete environment (in terms of elements, whatever they may be) with an unappealing form could be more suitable to a visitor than an incomplete environment with appealing form. Appealing form is not the goal of accommodative design, although it is likely to emerge through the design process. The goal of the design process is to make adjustments so that the visitors feel pleased with the environment. This does not mean that the visitor is always right. Some suggestions that they give may prove unsuccessful when implemented. It is i.e., reported later in this paper from one study in which teleports were implemented because visitors wanted them, but they proved to be problematic. However, through testing with visitors, the accommodative designer will be able to adjust the environment for the better, what does not work is simply deleted from the environment or modified. This process of design becomes both organic and evolutionary. The design emerges through interplay between designers and visitors, yet neither the designers nor the visitors are in full control.

There is little guidance from the human-computer interaction (HCI) literature with respect to how to design for visitors as opposed to users. When this paper was written a title search among the over fifty thousand articles in the ACM (on of the largest organizations for computer related research) digital library for the word stem "visitor" yielded 0 records, while searching for the word "user" yielded well over 800 records. This may seem satisfactory or challenging depending on ones outlook. It is satisfactory to the one who holds that HCI should not bother with visitors, but challenging to the one who thinks that visitors have a place in HCI in their own right. The literature of HCI is largely about users as cognitive agents using tools (Baecker 95, Helander 97, Dix 98, Shneiderman 98). Indeed the tradition of user-orientation in HCI is strong, and builds on a vast amount of research. But, at the same time it is visitors that many organizations should be interested in understanding if they wish to construct pleasing or suitable digital environments, and not only usable environments.

Ease of use is the blinding light of HCI that obscures a truly visitor-oriented perspective. It is easy to forget about how subjects *feel about being in* an electronic environment and instead emphasize how they *use its features*. The issue here is about scope and general approach more than subject. While there are many broad studies of subjects as *users* each involving broad ranges of usability issues there is a lack of similarly broad studies of subjects as *visitors*. Nielsen takes on a broad usability perspective (Nielsen 93, Nielsen 99). In many cases he reports from studies were as many as possible of the usability "bugs" in a software artifact are to be found. Nielsen can be said to advocate user-oriented "debugging" by letting expert evaluators or regular users discover usability problems during experimental trials. There is no obvious reason for why it should not in a similar vein also be possible to do visitor-oriented "debugging". Research on visitors in digital environments, however, generally focus on particular and often highly theoretical topics such as *presence* (Slater 98), *navigation* (Norman 99)*, embodiment* (Benford 95), and *realism* (Carr 93).

The accommodative approach is broad and emphasizes the feelings, attitudes and general dispositions of visitors that might lead to the rejection or acceptance of an environment. By researching accommodative needs it should be possible to develop general design guidelines for the construction of accommodating environments. At the end of the paper, five suggestions are offered as a starting point of such a guideline. Note that the term accommodation (as used here in the proposed technical sense) is derived only roughly from one everyday use of the term meaning a place to stay or work in. It should not be understood in the Piagetian sense, i.e., the modification of internal representations in order to mentally accommodate a changing knowledge of reality (Bringuier 80). Accommodative design does not concern changes that occur over periods of time in users as they adapt to an environment, but rather changes that can be made to an environment so as to please its visitors. Thus the designer struggles to change the environment so it better accommodates its visitors. Also, the term accommodation as used here should not be confused with the term referring to the automatic adjustment of the lens of the eye to obtain distinct vision.

Accommodative design is simply the design, which brings to the foreground the unique needs of subjects as visitors. What is unique about those needs is that they go beyond those of users working with tools. Such needs can for example be aesthetical, cultural or simply related to what it means be a visitor. Accommodative design is a form of visitor-oriented design meant to complement user-oriented design rather than replace it. The term accommodation allows for classifying environments by how well they are satisfying visitors needs. Thus the terms usability and accommodation stand in contrast. An environment can be said to be more or less *usable* to its subjects as *users*, and more or less *accommodating* to the same subjects as visitors.

2 ACOMMODATION STUDIES

In the spring of 1999 a series of studies was started at the Royal Institute of Technology in Sweden with the goal of exploring accommodative needs. The subjects were students with mixed backgrounds. The ages varied between late teenagers to middle aged, and the sexes were approximately evenly represented. Trial environments had to be designed and implemented. Although it would have been possible to start out with theoretical design ideas such those inherent in Alexander's pattern language (Alexander 87) or Hillier and Hanson's social logic of space (Hillier 84) a less ambitious route was taken. A minimalist approach was adopted, and the first design was very simple. This approach allowed the visitors to strongly influence how the environments should evolve from rudimentary to more sophisticated.

ActiveWorlds (a desktop virtual reality system accessible over the Internet through PC compatibles) was used to construct the 3D environments. ActiveWorlds was chosen because the technology lends itself well to the designer who wishes to construct trial environments for empirical studies. Trial environments can be produced quickly and run well, with few problems such as software "crashes". Moreover, ActiveWorlds is also simple to navigate in, and allows inexperienced visitors to start exploring environments with minimal guidance. In the trials it was sufficient to provide the subjects with a simple map of the keyboard keys used for navigation along with a short verbal explanation. Lastly, as long as the trial environments built with ActiveWorlds are not overly complicated, navigation is swift and smooth. To render complicated environments (containing many objects per area unit, and/or with detailed surfaces) on the visual display unit takes more processor time, and generally makes interacting with the system sluggish. In the studies described here, such complicated environments were avoided. The environments were also optimized in various ways for better performance.

A between-groups design was used for the studies and no subject participated in more than one condition. In the first study a rudimentary 3D environment was constructed and compared to a web site with the same content. The 3D environment was built out of a concern for design minimalism and allowed for incremental design adjustments in study two and study three. In study two, comparisons were also made with a complex *navigational* environment that was designed and implemented by Rod McCall from Napier University, Scotland.

3 STUDY ONE

In this study, a rudimentary web site containing content for a course on conceptual modeling was constructed. Conceptual modeling is an abstract subject that centers around the use of diagramming techniques for modeling relations between objects, and the way those objects can be part of processes (figure 1). An object can be physical or abstract, and there is no predetermined domain for it. In the course, a variety of organizational settings and processes were modeled. Access was given to the course materials, and the teaching assistants were filmed as they explained key issues of the course. The finished web site contained course texts, images of conceptual modeling examples, photos and video clips.

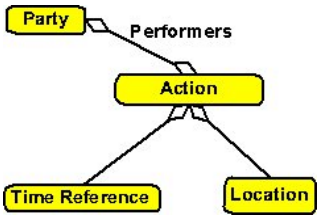


Figure 1 – A conceptual model

Twelve subjects participated in the study. Six subjects were assigned to a learning task using the materials within this web site. Another six subjects were assigned to an analogue learning task, within the 3D environment constructed using ActiveWorlds (figure 2). The ActiveWorlds environment contained the web pages of the web site, hyperlinked through images within the environment.


Figure 2 - Minimalist environment

The exhibition was organized around stations with three components each: a section heading, a sketch of a conceptual model and a link to a page within the web site. The subjects walked (using arrow keys) through the exhibition and stopped at the stations to examine each concept discussed. At these stations they could click on hyperlinked images using a standard mouse. Although some subjects had not explored 3D worlds prior to their participation in the study, they revealed little difficulty in getting around in the environment.

After each subject had completed the task, s/he was handed a questionnaire consisting of three main sections:

1. Propositions on a lickert-style scale to reject or agree with by placing an x on a line ranging between the alternatives "agree" to "not agree"
2. A section where the subjects were asked to diagram the exhibition from memory
3. Open-ended questions

It took the subjects roughly 45 minutes to finish their assigned task and to complete the questionnaire in both conditions.

3.1 Results From Study One

The subjects preferred the ActiveWorlds environment (despite its rudimentary nature) to the web site. From an information retrieval viewpoint, the web site is far more efficient. It is a simpler and faster process to go through the content of the exhibition using the web site directly, than to access the content through the ActiveWorlds environment. The way in which the subjects accessed the materials differed markedly between the groups. Subjects in the 3D environment relied on the spatial properties of the exhibition and did not (with one exception) attempt to go through the content using only the web browser.

All in all, the ActiveWorlds environment was received with greater positive regard and held as more engaging (figure 3). The results also indicate that the content was easier to understand in the ActiveWorlds condition (figure 4) although the content was the same in both conditions.

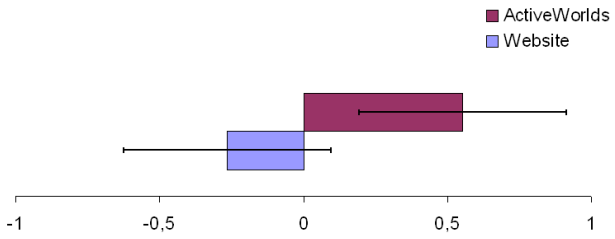


Figure 3 - "The exhibition is engaging"
(mean scores, scale ranges between -1 to 1, n=6)

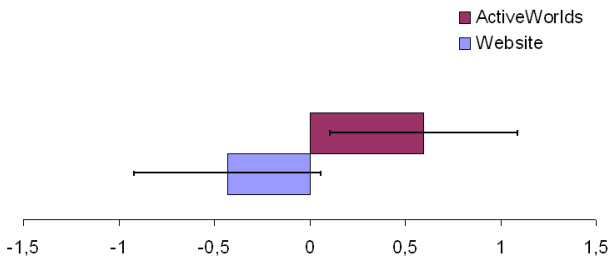


Figure 4 - "The content of the exhibition is easy to understand"
(mean scores, scale ranges between -1 to 1, n=6)

Not all subjects thought of the environment as aesthetically pleasing however:

> Boring - A big open courtyard with a fence of steel. It feels like a prison.

Altogether, the verbal reports on the aesthetics of the ActiveWorlds environment were mildly positive and not markedly more positive than those gathered from the web site only condition. Reflections from subjects were collected to serve as a foundation for improvements in study two. From a pedagogical standpoint, it is notable that the subjects in the ActiveWorlds condition reported positive attitudes to the difficult content of the exhibition. What is more, few had any prior experience with conceptual modeling, and those who did had worked with other notational schemas.

Since it was a faster and simpler process to access the materials directly from the web site, than from within ActiveWorlds, it is difficult to see any clear usability reasons for why the subjects in the ActiveWorlds condition should find the content easier to understand. The two groups used the same web pages to access information. Why should walking around in the rudimentary 3D environment before accessing the web pages have any effect on attitudes to the content? Nonetheless, being visitors in this environment appeared to have a positive effect on their regard for the content. When the subjects were e-mailed questions regarding the content about a month after the trials had been done, no knowledge retention differences between the groups were found. Both groups revealed little retention.

4 STUDY TWO

22 subjects participated in this study and were split into two groups with 11 subjects each. Two ActiveWorlds environments were constructed, one for each condition. Firstly, an enhanced version of the first test environment became the accommodationally enhanced environment (figure 5) for this study.

According to suggestions made by subjects from study one, five adjustments were made:

1. The exhibition was geographically compacted
2. A semi-circular shape was used
3. Navigational paths were constructed
4. Start and end were clearly marked
5. A backdrop of trees was built around the exhibition and flowers were put inside

These adjustments were made because (1) subjects had complained about having to walk around excessively in the first environment. A more compact environment served to reduce the amount of walking required. (2) Subjects raised concerns about not being able to overlook the exhibition from a single vantage point. Standing in the middle of the circular shape in the new environment allowed them to survey the entire environment by simply turning around. (3) Paths that would guide visitors through the environment had also been suggested. (4) Some subjects complained about not being sure were the exhibition started and were it ended. (5) Many felt that the initial environment was sterile.

Secondly, Rod McCall from Napier University designed and implemented an environment for testing navigation (figure 6). This environment was compared with the accommodationally enhanced environment (figure 5).

Figure 5 - Accommodationally enhanced environment

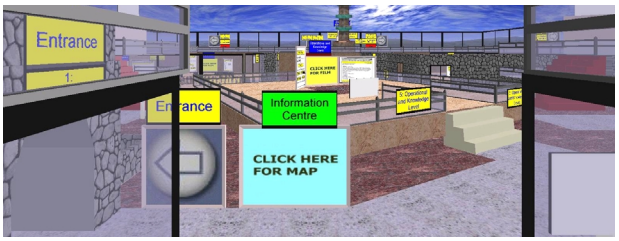


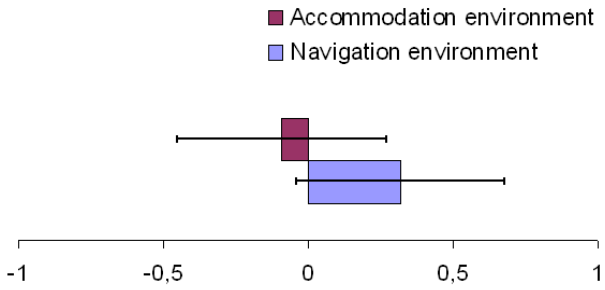
Figure 6 - Navigational environment

Figure 7 – Accommodational environment with teleports

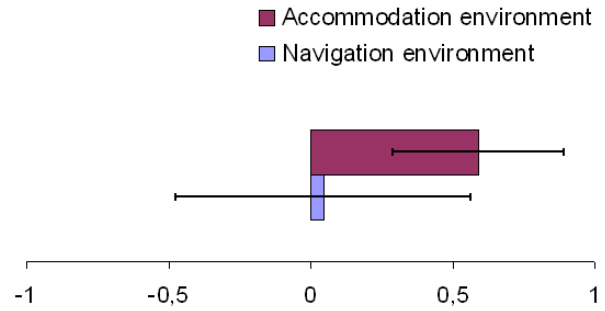
4.1 Results From Study Two

The two environments (figures 5 and 6) were compared with respect to accommodation, as well as to navigation. From an accommodative perspective both environments were better received in comparison to the web site only condition from study one, but we also found differences between our two later environments. The accommodative environment appeared to be perceived as less sterile and as more engaging (figures 8 and 9). The differences between the groups here indicate that not just any 3D environment yields a positive experience. However, the standard deviations are so great that the results cannot be taken as anything more than indications.

It was also discovered that most subjects did not find the navigational paths useful in the accommodational environment. Yet, none of the subjects said they should be removed. This indicates that although the paths did have a role it was not obviously related to usability.



Figures 8 – "The exhibition is sterile"
(mean scores, scale ranges between –1 to 1, n=11)



Figures 9 – "The exhibition is engaging"
(mean scores, scale ranges between –1 to 1, n=11)

5 STUDY THREE

The information content was the same as in the previous two studies. No direct enhancements of the accommodative qualities of our environment from study two were made, but the efficiency of the environment was improved by providing teleports.

The teleports served five functions:

1. Go to a subject by clicking on its heading
2. Go to the next subject by clicking '>>'
3. Go to the previous subject by clicking '<<'
4. Go from to the first by clicking 'start'

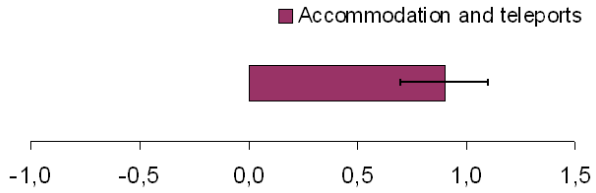
Throughout all three studies suggestions that teleports should be used had been made. Subjects did not use the term teleport, but described how one could move through the environment by clicking on parts thereof. One subject from the second study, with no previous experience of 3D environments put it in the following way:

> ..it is difficult to navigate…it is the fact that I go into walls…one would just like to click on a place and get there.

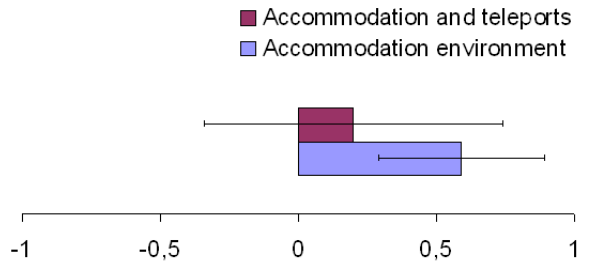
To implement teleports appeared warranted. However, they proved to be problematic.

5.1 Results From Study Three

With teleports, the environment could be used more efficiently and the subjects revealed no difficulty in understanding how they worked. Teleports worked well enough that the subjects often did not understand what was meant when questioned if they were difficult to use. Overall, the subjects went through all materials and still finished faster than in the earlier conditions. The teleports also helped visitors to get were they wanted within the exhibition (figure 10).



Figures 10 – "The teleports reflected where I wanted to go"
(mean scores, scale ranges between –1 to 1, n=6)



Figures 11 – "The exhibition is engaging"
(mean scores, scale ranges between –1 to 1, n=6)

Did such increased efficiency allow for changes in accommodation? The subjects did not report any increased positive regard for the exhibition (figure 11). Could this have to do with an experienced loss of control? Though the subjects teleported to the different stations by themselves, they were still *being teleported*,

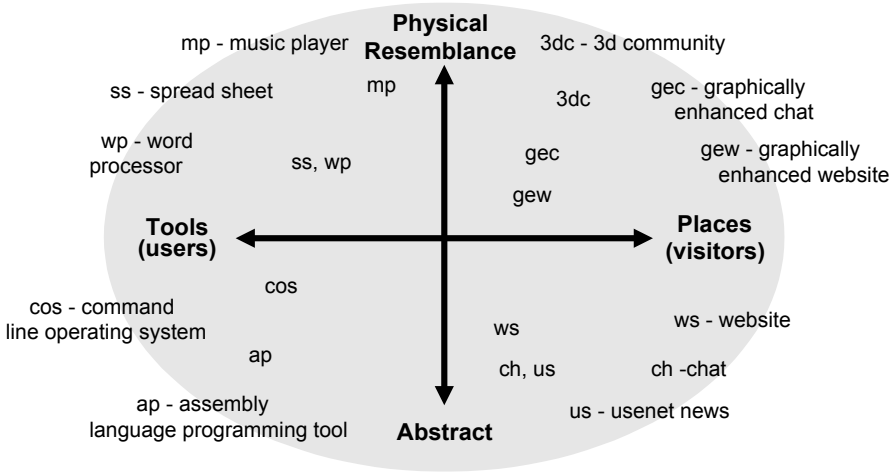


Figure 12 – A proposed ontology for HCI

i.e., *transported*. Thus the *locus of control* shifted by degree from internal to external. Moreover, it has been found that students with an internal locus of control are more likely to persist in distance education than those with external locus of control (Dille, 1991). Apart from the possible loss of autonomy, the subjects were also able to spend relatively more time with the content as opposed to walking in the environment than in the previous studies. This change implied that the subjects interacted less with the 3D environment and more with web pages, thus it could be expected that the purely accommodative effects of the 3D environment should be weakened.

As part of the experiment, subjects were also asked to go back into the environment and locate different information stations. In doing so they never used teleports. They walked slowly back into the environment as if they were "feeling their way back". In many cases they walked to the right information stations on the first try. It is difficult to characterize this situation correctly. If so many subjects knew were the stations were, then why did they not teleport to them? It would have been easier and faster to do so.

6 DISCUSSION

How we regard the "human" in human computer interaction gives us different perspectives on HCI since users are provided with *artifacts to use*, but visitors with *places to reside in*. The perspectives should not be held as mutually exclusive. As a rule, the processes of use and accommodation are mutually interdependent. Concerned use of artifacts is subject to breakdowns and mishaps that will force the user to shift her/his attention from the subjective stance of being in an environment to that of using an artifact. Similarly as use becomes transparent, attention will shift back to the environment. As a user of an artifact or set of artifacts goes from being a novice to an expert this shift from focusing on artifacts of use to interacting gracefully with an environment becomes apparent. The philosopher John Searle gives an illustrative example of differently skilled skiers.

> …the beginning skier may require an intention to put the weight on the downhill ski, and intermediate skier has the skill that enables him to have the intention "turn left", a really expert skier may simply have the intention "ski this slope". (Searle, 92, p195)

Similarly, the novice visitor of a 3D environment may require the intention to "use the arrow key to move forward", the intermediate visitor has the skill enabling s/he to have the intention "move forward", and the expert may simply have the intention to "explore the environment".

When the use of artifacts is transparent because of well-designed artifacts, development of expertise or a combination of these factors, the human in HCI is enabled to engage more directly in the process of accommodation.

What makes the distinction between usability and accommodation difficult to accept is the "computer" in human computer interaction. It suggests a stance that rightfully belongs to the history of computing, when humans were subjectively absorbed with physical machines. Computers need not be part of human everyday use of digital artifacts, they could as become

transparent to humans (Norman 98), letting them focus on their tasks instead of on technology. HCI must widen its scope to fit the experiential realm of humans and what they do in fact interact with

The focus should be on what is part of human experience within digital environments, i.e., the ontology (figure 5). Within this suggested ontology, subjects engage in two primary roles: they are users and visitors. The digital artifacts they use can have a physical or abstract resemblance and the artifacts can be experienced as tools or places.

There is a potentially large set of features that determine how visitors accommodate to digital environments. Yet there is also a lack of guidelines that helps the designer to construct environments that work from a visitor-oriented perspective. The pilot studies conducted here indicate at least five such factors pertaining to the construction of 3D environments.

1. They should not force the users to walk long distances, because users do not like to walk excessively even if they expend little physical energy in doing so.
2. They should include elements that serve the function of making the environment non-sterile. In particular organic shapes and warm colors are sought.
3. They should be perspicuous so users easily can see what is in them. Note that this is not simply a question of informational perspicuity. The visitors simply like to see the 3D environment in its totality.
4. They should have paths indicating were subjects should walk. However, such paths may or may not fill a functional role. The subjects in the accommodationally enhanced environments were queried if they had used the provided paths, but generally responded that they had not. At the same time, none answered in the affirmative when asked if they should be removed.
5. Teleports appear to have a negative effect on visitor attitudes and should be used with caution. Efficiency of use appears to be in conflict with autonomy and/or the way visitors naturally cope with an environment.

For the educational organization, researching and taking accommodative factors into account could open up windows of learning opportunities. If a student reveals a more positive attitude to a subject much is won. The ramifications of a visitor-oriented design are not insignificant and should be taken seriously. If they are then we might come to speak of human or subject oriented design some day as an area encompassing both user-oriented design and visitor-oriented design.

Much of the work here is influenced by Terry Winograd and his book *Bringing Design To Software* (Winograd 97). Because of this influence, this paper will end with a short discussion of Winograd's view on design. In this book he advocates a broad perspective on design and he claims to think of users as *inhabitants* of software.

> Software is not just a device with which the user interacts; it is also the generator of a space in which he lives. Software design is like architecture: When an architect designs a home or an office buildning, a structure is being specified. More significantly, though, the patterns of life for its inbabitants are being shaped. People are thought of as *inhabitants* rather than as *users* of buildnings. In this book, we approach software users as inhabitants, focusing on how they live in the spaces designers create. Our goal is to situate the work of the designer in the world of the user. (p xvii)

There is a tension in the quote above. On the one hand Windograd argues that “people are thought of as inhabitants rather than users” and one the other hand he argues that the work of the designer should be situated in the world of the user. For Winograd the fundamental user ontology is still there. It is the user that is somehow primary. There is no obvious reason (other than following tradition) for why it would be wrong to take an extra step and dethrone the user from this position of primacy. Furthermore, the idea of being an inhabitant (though appealing to the metaphysician) seems to be going a bit overboard. Who can actually say that they are inhabitants of digital environments? Plenty are visitors (of web sites and virtual environments for instance), and in the future we might see more inhabitants, but people who actually live in cyberspace are still considered to be out of the ordinary. Especially the ones inhabiting their word processors or operating systems. The idea of viewing digital artifacts as places can be powerful, but if we carry it too far, it simply becomes misleading. Winograd’s view of software inhabitants should best be taken as a prediction of what may come. The mass of humans interacting with software as places today, are still mostly visitors rather than inhabitants.

Winograd’s view of users as software inhabitants is also problematic because he fails to bring in a discussion of different degrees of what may be termed “place-likeness”. In Winograd’s view, it appears that all software is on equal footing with respect to their accommodative capacities. Thus a blank screen saver can

accommodate inhabitants just as much as desktop virtual reality system.

Since Winograd makes a comparison with architectural design it is also odd that he chooses the terminology of inhabitants. There are many kinds of architectural works that are not constructed for inhabitants such as storage places, churches and libraries. In the previous quote he gives the example of office buildings as having inhabitants. In all these examples the word visitor would be more appropriate. People visit storage places, churches and libraries, and some work in them, but the ones who actually live in them are very rare.

To sum up, Winograd could be said to advocate an inhabitant-oriented view of design, but in our age it appears that a visitor-oriented perspective is more readily applicable. Moreover, the visitor should be put on equal footing with the user. Humans are users as well as visitors and in many cases these two modes of interacting occur in parallel and to different degrees. Whether the artifacts of interaction are physical or not does not change this change this fundamental relation. The human subject is primary, not the user and not the visitor; those are simply roles we play.

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Questionaire for study 1

En studie av digitala lärmiljöer

Moment

I Scenariopresentation
II Problemlösning
III Frågor

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I. Scenariopresentation

Antag att du kommer till arbetet en dag och Sara, en person i din arbetsgrupp är sjuk. Nu måste du ta över en del av hennes arbetsuppgifter. **Hon har skrivit en anteckning till dig:**

> **Kan du ge en kort presentation av schematiska modeller? Du behöver bara säga några ord om ämnet på styrelsemötet senare idag. Se den elektroniska utställningen ..**

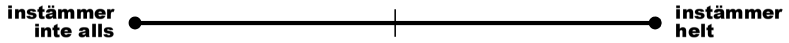
II. Problemlösning

Du behöver nu gå till den elektroniska utställningen som Sara pratar om och lära dig så mycket som du kan om "schematiska modeller". Din assistent visar dig var den finns.

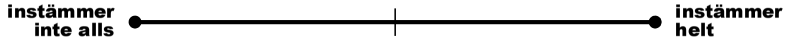
III. Frågor

Markera ditt svar med ett kryss på linjen

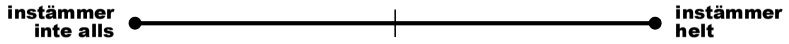
1. Det är lätt att orientera sig i utställningen



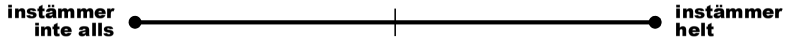
2. Det är lätt att förstå hur informationen är organiserad i utställningen



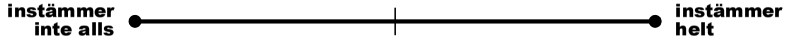
3. Jag upplever utställningen som vilken annan programvara som helst



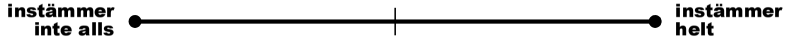
4. Att lära sig från utställningen är lätt



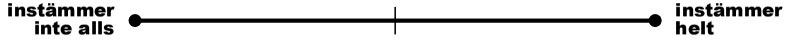
5. Utställningen är fängslande



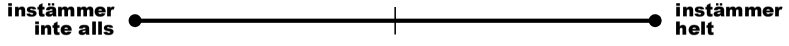
6. Utställningens organisation är lätt att förstå



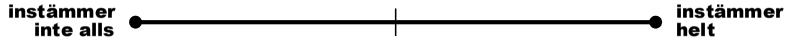
7. Utställningens innehåll är lätt att förstå



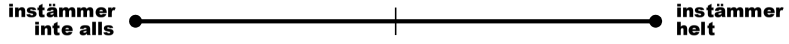
8. Utställningen är en form av databas



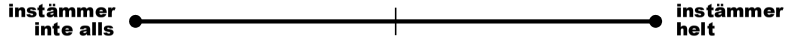
9. Utställningen stimulerar känslor



10. Utställningen stimulerar tankar



11. Jag kan lätt förklara hur jag upplever utställningen



Rita ett diagram över utställningen

Svara kort på följande frågor angående utställningen

1. Vad tyckte du inte om?

2. Vad tyckte du om?

3. Vilka svårigheter upplevde du?

4. Vad tyckte du om utställningen estetiskt sett?

5. Beskriv utställningen med dina egna ord

Bakgrund

Ålder

____

Kön

kvinna ☐ man ☐

Utbildningsnivå

gymnasium ☐ universitet ☐ akademiker ☐

Vilken arkitekturstil föredrar du?

Viktoriansk ☐ Funktionalistisk ☐ Modern ☐

Hur stor erfarenhet har du av dataspel?

ingen ☐ lite ☐ spelar varje vecka ☐ spelar dagligen ☐

Om du har erfarenhet av dataspel vilken typ föredrar du?

action ☐ äventyr ☐ strategi ☐

Questionaire for study 2

A Study of Digital Learning Environments

Parts of this study

I Scenario presentation
II Problem solving
III Questions

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Rod McCall – rmccall@dcs.napier.ac.uk
HCI Group, School of Computing, Napier University, Edinburgh, EH14 1DJ

I. Scenario Description

Imagine that you come to work one day and Sarah, a person in your work team is sick. Now you have to be her stand-in at a meeting later today. **She has written a note for you:**

> **Can you give a brief presentation of schematic modeling? You only need to say a few words about it at the meeting with the bord of advisors later today. See the electronic exhibition ..**

II. Problem solving

You need to go to the exhibition Sarah is refering to and find out as much as you can about "schematic modeling". Your assistant will guide you there. Sarah has asked you to explore the electronic exhibition for her, however she would also like you to take some notes.
"I'd be grateful if you would write down the names of the patterns you see in the order that you encounter them."

III. Questions

Choose the best option from your viewpoint

1. It is easy to understand how the information is organized within the exhibition

2. To learn from the exhibition is easy

3. The exhibition is engaging

4. The content of the exhibition is comprehensible

5. The exhibition stimulates thinking

6. I don't feel tired at all

7. The exhibition is sterile

8. The paths made it easy for me to find my way around

9. The paths reflected where I wanted to go

10. I felt overwhelmed by the amount of information presented to me

11. I did not feel lost within the exhibition

12. On arriving in the exhibition I was able to comprehend the size of it

strongly agree	agree	no opinion	disagree	strongly disagree
☐	☐	☐	☐	☐

IV. Tasks

PLEASE DO NOT REFER TO ANY PREVIOUS ANSWERS.

PLEASE ASK FOR THE TASK CARDS, PRIOR TO ANSWERING THE QUESTIONS ON THE FOLLOWING PAGE.

13. The paths made it easy for me to find my way around

strongly agree	agree	no opinion	disagree	strongly disagree
☐	☐	☐	☐	☐

14. The paths reflected where I wanted to go

strongly agree	agree	no opinion	disagree	strongly disagree
☐	☐	☐	☐	☐

15. I did not feel lost within the exhibition

strongly agree	agree	no opinion	disagree	strongly disagree
☐	☐	☐	☐	☐

Please diagram the exhibition in the space provided below

Answer briefly the following questions

1. What did you not like about the exhibition?

2. What did you like about the exhibition

3. What difficulties did you encounter?

4. What is your opionion of the estethics of the exhibition?

5. Characterize the exhibition in your own terms

Background information

Age

____

Sex

female ☐ male ☐

Educational level

gymnasium ☐ university ☐ graduate ☐

Which style of architecture do you prefer?

Victorian ☐ Functionalist ☐ Modern ☐

How much experience do you have with computer ganes?

none ☐ a little ☐ I play weekly ☐ I play daily ☐

If you have experience with computer games, which kind do you prefer?

action ☐ adventure ☐ strategy ☐

Questionaire for study 3

A Study of Digital Learning Environments

Parts of this study

I Scenario presentation
II Problem solving
III Tasks
IV Questions

Study Environment 3

Anders Hedman -- ahedman@nada.kth.se, Sören Lenman – lenman@nada.kth.se
CID, Centre for User Oriented IT-design, KTH, NADA, Dept. Computing Science

I. Scenario Description

Imagine that you come to work one day and Sarah, a person in your work team is sick. Now you have to be her stand-in at a meeting later today. **She has written a note for you:**

> Can you give a brief presentation of schematic modeling? You only need to say a few words about it at the meeting with the bord of advisors later today. See the electronic exhibition ..

II. Problem solving

You need to go to the exhibition Sarah is refering to and find out as much as you can about "schematic modeling". Your assistant will guide you there. Sarah has asked you to explore the electronic exhibition for her, however she would also like you to take some notes.
"I'd be grateful if you would write down the names of the patterns you see in the order that you encounter them."

III. Questions

Choose the best option from your viewpoint

1. It is easy to understand how the information is organized within the exhibition

2. To learn from the exhibition is easy

3. The exhibition is engaging

4. The content of the exhibition is comprehensible

5. The exhibition stimulates thinking

6. I don't feel tired at all

7. The exhibition is sterile

8. The paths made it easy for me to find my way around

9. The paths reflected where I wanted to go

10. The 'teleports' made it easy for me to find my way around

11. The 'teleports' reflected where I wanted to go

12. I felt overwhelmed by the amount of information presented to me

strongly agree	agree	no opinion	disagree	strongly disagree
☐	☐	☐	☐	☐

13. I did not feel lost within the exhibition

strongly agree	agree	no opinion	disagree	strongly disagree
☐	☐	☐	☐	☐

14. On arriving in the exhibition I was able to comprehend the size of it

strongly agree	agree	no opinion	disagree	strongly disagree
☐	☐	☐	☐	☐

IV. Tasks

PLEASE DO NOT REFER TO ANY PREVIOUS ANWERS .

PLEASE ASK FOR THE TASK CARDS PRIOR TO ANSWERING THE QUESTIONS ON THE FOLLOWING PAGE.

15.The paths made it easy for me to find my way around

strongly agree	agree	no opinion	disagree	strongly disagree
☐	☐	☐	☐	☐

16.The paths reflected where I wanted to go

strongly agree	agree	no opinion	disagree	strongly disagree
☐	☐	☐	☐	☐

17. I did not feel lost within the exhibition

strongly agree	agree	no opinion	disagree	strongly disagree
☐	☐	☐	☐	☐

18.The 'teleports' made it easy for me to find my way around

strongly agree	agree	no opinion	disagree	strongly disagree
☐	☐	☐	☐	☐

19.The 'teleports' reflected where I wanted to go

strongly agree	agree	no opinion	disagree	strongly disagree
☐	☐	☐	☐	☐

Please diagram the exhibition in the space provided below

Answer briefly the following questions

1. **What did you not like about the exhibition?**

2. **What did you like about the exhibition**

3. **What difficulties did you encounter?**

4. **What is your opionion of the estethics of the exhibition?**

5. **Characterize the exhibition in your own terms**

Background information

Age

____

Sex

female ☐ male ☐

Educational level

gymnasium ☐ university ☐ graduate ☐

Which style of architecture do you prefer?

Victorian ☐ Functionalist ☐ Modern ☐

How much experience do you have with computer games?

none ☐ a little ☐ I play weekly ☐ I play daily ☐

If you have experience with computer games, which kind do you prefer?

action ☐ adventure ☐ strategy ☐