The Experience of Space in Full-Scale Models and Virtual Reality

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Abstract

Do we experience the size and character of virtual spaces in the same way as real spaces? What impact has the meaning of a space, i.e. furniture and other clues to the use of a space, on our experience of it? This paper describes an experiment where the participants could navigate through a room, first on desktop-VR, then in full-scale VR (in a CAVE) and finally in a full-scale model. In a first phase the room was empty and only defined through walls, windows and doors. Later on furniture was added as well as colors and textures. The experiment was a pilot study and threw light on some questions which we intend to develop in further investigations. It showed that the participants used building components like doors and windows and furniture in the presentation on desktop VR for their estimation of the size of the room. In the CAVE and in the full-scale model the participants' bodies were the measure for their estimations. The experiment also hinted at that color and texture had an impact on the experience of size.

Introduction

The experiment described in this paper was carried out within a research project called *Design@Work*, which contains a group of researchers and designers with a background in architecture, systems design, work psychology, educational drama and physical work environments. The project aims at developing design methods and techniques for participatory design. The common ground is that the methods and techniques should visualize aspects of present and future work situations and allow active user involvement. However, the main interest is not to develop new design tools but to test and combine existing ones. Various complementary tools are used like full-scale models, pedagogical drama and virtual reality. The research sheds light on how the tools should be combined, their main characteristics and qualities as well as their suitability for participatory design. The project is carried out through experiments and implementations in case-studies.

The main question addressed in this particular experiment was whether people experience a room in the same way on desktop VR, in immersive VR (here a CAVE1) and in a full-scale model. What cues do they need to be able to determine the proper size? Do they use building components, furniture and other cues differently in the three media? What impact has the meaning of a room, i.e. a known use of a room, on their estimation of the size? Does color and texture contribute to the experience of accurate size?

Design Tools in Participatory Design

Design@Work has its theoretical mooring within several research areas, one of which is design theory, in particular, the theory that describes learning and the design tool's role in participatory processes. According to Ehn (1988; 1995) the chief merit with participatory design lies in the fact that it is a learning process for all the participants. On the way, new knowledge is created and refashioned, aided by the designer's tacit design knowledge and augmented by the participant's tacit knowledge, which originates from the use of the environment.

The participant's experience is an essential ingredient in the design profession's development (Mitchell, 1993). The designer's task is to help the participants to specify their intentions and to clarify their choice of solutions in a shared discussion. The participants are aided in gaining insight about situations that are difficult to specify verbally. These experiences become a link to deployment and anticipation (Jones, 1978; Mitchell, 1993). The usage of a design tool is, according to Ehn, enlivened with its activation. The tool is a part of the design activity, a help in the verbalisation of the participant's expectations and to stimulate their creativity (Ehn, 1995; Stoeckli, 1995). The tool must allow both the contemplation of the design problem in an abstract way as well as being able to relate solutions to reality (Hornyánszky Dalholm, 1998). In the participatory context, this means that the design tools the participants use should help them distance themselves from the environments being used as the experimental backdrop as well as giving tools to build associations to them.

The insight that the tool gives depends mostly on how transparent they are, that is, how easily they can be understood. Ehn underlines the importance of the design tool in having a family likeness to the devices that the participants use in their daily lives. The success that has been achieved in projects where full-scale objects, mock-ups and prototypes have been used can be explained by this similarity. The deployment of this type of design tool means that the situation and environments which are forged are not merely attempts to

verbally describe and picture a future usage of an environment, but rather a method of experiencing them through direct physical involvement. In the experiment described in this paper, the design tools were not used for design but for presentation. All the same the tools' qualities investigated were also adequate for this situation. Phenomenology underlines the great variety of people's perception and the impact of our bodies on how we experience the world. The body as the subject of perception implies that all our senses, not only sight, are important for our experience. The presence of our body gives the measure for the impressions that the surrounding supplies us with. The experience of architecture and space is complex and can't be represented fully by any tool/medium. Only when we enter the real space, move along in it, sense it with our body, we get the real conception of it and understand the nature of architecture. However, a combination of tools can give a more accurate view than each tool separately [7].

The Experiment

The experiment was carried out with four people with different professional backgrounds. All of them were experienced computer users and one of them was a professional designer. They carried out their tasks individually. The number of participants was due to the fact that the experiment was a pilot study. The tools used in the experiment was a desktop VR (with computer screen), a CAVE and the full-scale model at the school of architecture in Lund. The desktop VR was performed on ordinary PC- equipment and the spaces presented were modeled in a programme called Superscape. A 3D-mouse was used for navigation. The CAVE represents a type of VR called immersive VR. This type of VR allows the user to see the world from his or her own perspective with a one to one size ratio. The CAVE used is a room with size of 3x3x3 meters. The walls consist of screens where 3D-models are projected as well as on the floor. The subjects wear special high-speed liquid chrystal shutter glasses which create an illusion of depth. Navigation is performed with a dataglove. The rooms in the CAVE were modeled with AutoCad and 3Dstudio.

The full-scale model is a flexible modeling kit with wall-, window- and door-panels. The panels are easily put together by small pieces of metal. In addition to the building elements the kit includes kitchen fittings, bathroom equipment and some basic furniture. The hall used for full-scale modeling is 18 x 15 m. The room presented to the subjects was L-shaped and irregular in order to encourage them to move around to be able to form an overview of it. It had the size of a large Swedish living room (31 sqm) and the height of a normal flat in Sweden (240 cm). The subjects entered the room through a door placed close to one of the corners. There were three windows in the room.

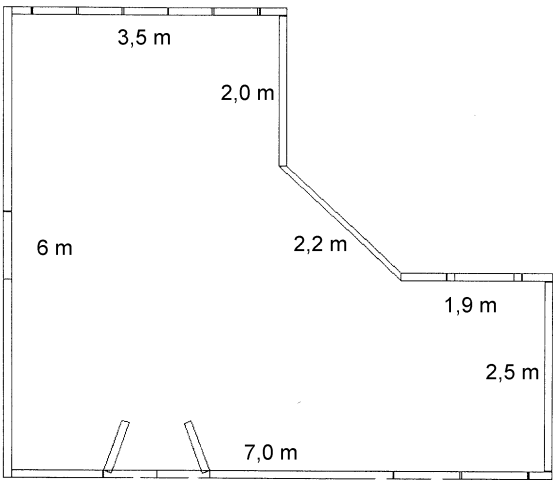

Fig. 1 The layout of the room used in the experiment.

The room-models in the CAVE were placed in an abstract environment which could be seen through the windows whereas no such view was visible from the rooms presented on desktop. The participants could experience the room first on the screen, then in the CAVE and finally in the full-scale model. The virtual presentations were made in four steps. In the first step the room was empty, in the second it was furnished for no obvious use (with a bathtub, a stove, a bed and so on) and finally furnished as a living-room with a dining table, sofa, TV and so on. In the last step color and texture was added both to the room itself and to the furniture. In the full-scale model this last step was omitted due to lack of time and appropriate material.

One of the researchers helped the participants to navigate through the room in VR. The participants could themselves decide the direction of the movement and when they should make a stop. They could also choose for how long time they wanted to remain in different parts of the room. Their movements were registered as well as their spontaneous comments throughout the experiment. Also the time the participants used to investigate the room was measured. After each step the participants were asked about their impressions and whether their estimation of the room's size had changed. Another question was how they decided the room size and what impact the furniture had on their estimation. They were also asked to indicate the dimensions of the room and the furniture in a simple sketch.

Results and Analysis

On desktop the participants tended to use building components like windows and doors as well as certain types of furniture (for instance the stove) to estimate the size of the room. Already at an early stage of the experiment they seemed to have a correct perception of the room's shape although their

estimations of its dimensions were not quite appropriate. In the CAVE the participants were still more successful in their estimations of the dimensions of the room but they found it hard to decide the heights as well as the distance between pieces of furniture. In general they didn't use the furniture but their bodies as a measure. Some of them estimated the dimensions of the walls by stretching out their arms, others lay down on the floor to get the proper measure of the size. Some of the participants also mentioned that they used earlier experienced real rooms as a reference for their estimation.

Most of the participants estimated the room as smaller in the CAVE as on desktop. They also perceived the furnished rooms as bigger as the unfurnished ones. The measures of small parts of the room as well as the height of the windowbacks were rather difficult to estimate correctly on desktop.

Fig. 2 Sketches made by two of the participants further to their visit to the room on desktop.

In the CAVE as well as in the full-scale model the participants' movement in the room turned out to be important for their estimation of its size. Also the empty space between pieces of furniture was more easily estimated whilst moving around. The individual pattern of movement varied. Some of the participants moved around in big circles while others remained rather stationary. Some turned around in the center of the room to get an overview while others stopped in certain spots for the same reason.

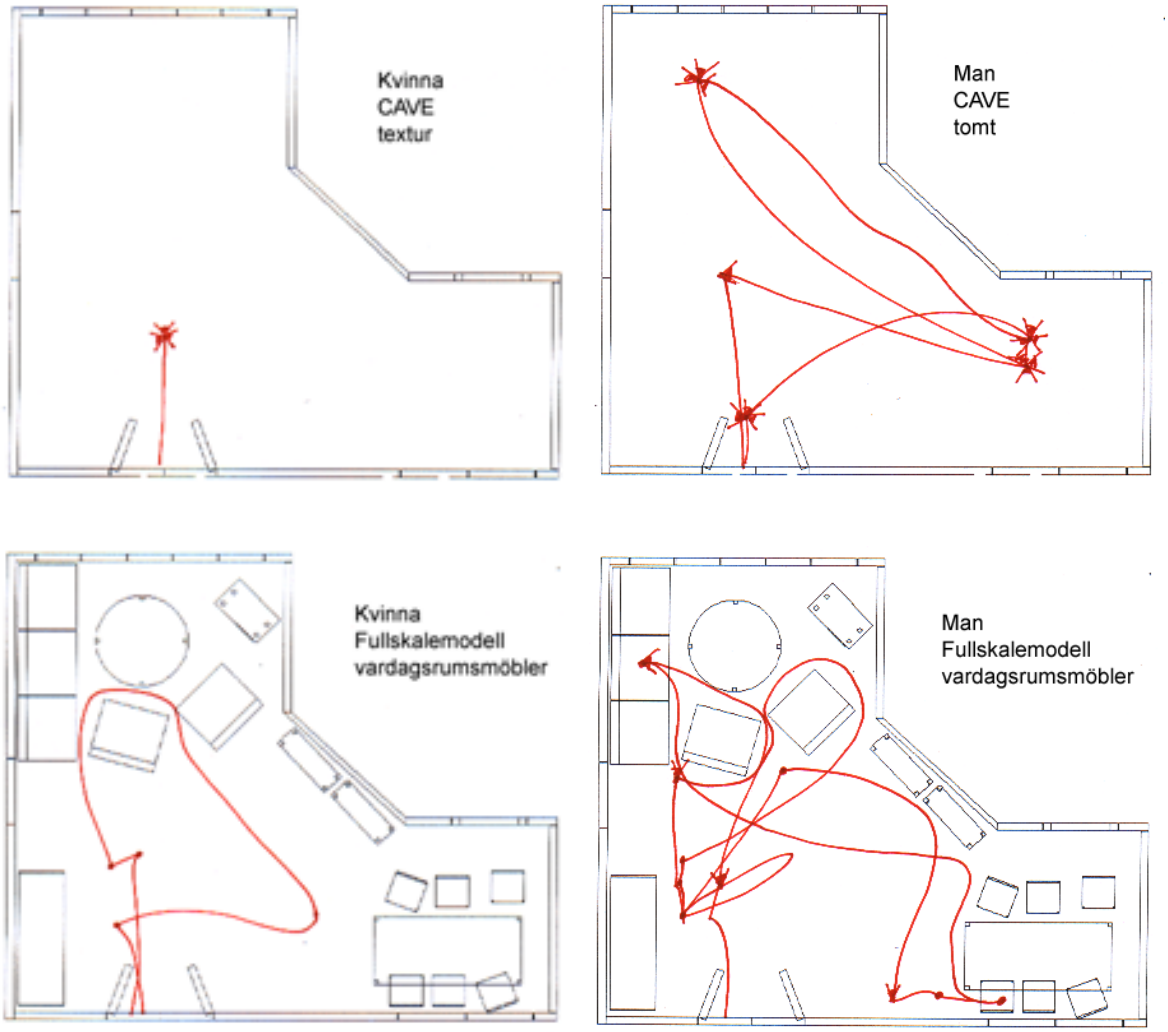

Fig. 3 Two of the participants' movement patterns illustrating the difference between individuals.

The participants identified the empty room on desktop differently. One of them suggested it to be an art gallery, others thought it could be a hotel room or a flat. As soon as the room could be identified with its use, the participants no longer used the pieces of furniture to estimate its dimensions but their knowledge about the reasonable size for that type of function, i.e. they used a conceptual idea of the space needed. Another experience from the experiment

was that the participants' feeling of presence increased in the CAVE compared to desktop VR. However, the illusion of the virtual world was disturbed when they were confronted with elements from the "real" world like the joints between the screens or the researchers observing their actions. Additionally, the CAVE seemed to be a trigger for the participants' imagination and helped them to reflect on the use of the room. Some of them mentioned that they experienced it as "more real" than the room on the screen. They could sense the space not only visually but also for instance by listening to the sound of their own footsteps. The full-scale model gave their experience further dimensions, a feeling of substance. The room was experienced as a "real" room where they could sense the space like in the "real world".

Pieces of furniture presented on the screen sometimes were misinterpreted. In the CAVE the furnished rooms were estimated as bigger as the empty one. The pieces of furniture were perceived as more material than on desktop and the participants even made way for them when they were passing by. In the full-scale model the objects were loaded with meaning. Texture was less important, the objects still had substance. The design of the stove for instance gave the participants associations to a certain period. The pieces of furniture became more obvious and for instance the chairs were also used to sit on. The furniture was more material and gave the a more cosy feeling. The objects in the 3D-world were more obviously recognized as mockups and the participants didn't pay so much attention to them. Color and texture diminished the room on desktop and made it easier for the participants to navigate. In the CAVE colors and texture didn't change the experience of size but impeded navigation.

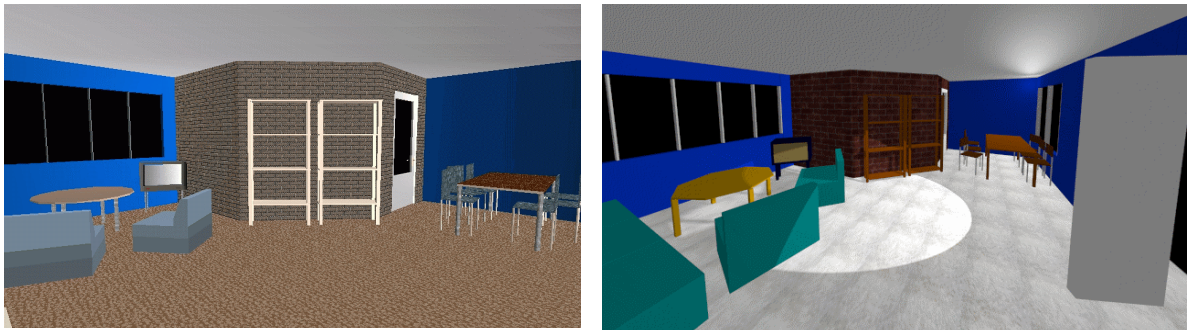

Fig. 4 The furnished room with colors and textures on desktop VR (left) and in the CAVE (right).

Discussion

Our conclusion from the pilot study is that the essential difference between full-scale modeling and the CAVE, on one hand and other design tools on the other is scale. They seem to allow the experience and usage of material and social space in a way that is very close to the experiences we have in "real" environments. Being physically present is not only vital for estimation of the room's dimensions, but also for comprehension of attributes such as proximity, connectivity and atmosphere. Participants have the chance to experience the modeled environments with "body and soul". Through visual experience and by moving through and acting in the environment, they tend to capture both the material and social aspects. In their judgement of the environments, the body can be used as a reference and the senses can be combined for the experiencing of various aspects of the environment such as form, lighting and roominess. If the design tool in participatory design shall promote experiences, action and reflection, we propose that full-scale modeling and CAVE ought to be combinable tools in these types of processes. Whether this is the case, we hope to explore in further experiments.

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