A Method For Designing Virtual Places

Rod McCall, Shaleph O'Neill, David Benyon, Michael Smyth and Fiona Carroll
School of Computing, Napier University, Edinburgh, E10 5DT, United Kingdom
{initial.surname@napier.ac.uk}

Abstract

This paper discusses our experiences of using a range of methods and techniques to measure the sense of place in real and virtual environments. The paper presents a discussion on presence and how this is linked directly with our sense of place. From here we discuss the development of 'The Place Probe' a bundle of measurement techniques that allows for the direct comparison of real and virtual scenes. We show how the data gathered from the probe can be used to inform the design of virtual places. The whole approach is predicated on the premise that by understanding place we can improve our sense of presence in virtual environments

1 Introduction

The BENOGO project is a fifth framework project in the 'Presence' initiative of the Future and Emerging Technologies programme. The project seeks new ways to give people a sense of 'being there' without having to go there. Using photo-realistic image-based rendering of real scenes, the BENOGO technology provides a real time experience of the scene. Stereo images are generated from 2D photographs and rendered in an area such as a head mounted display or six-sided CAVE that allows for real-time rendering of the images as tracked by head mounted tracking devices. The overriding aim is to inform the design of these virtual places. In doing this there is a need to investigate what it is that gives a place its distinctive sense of place (as opposed to it being 'placeless' [1]) and how to produce an environment in which people feel a sense of presence; they have a feeling of 'being there'.

Our interest, then, is in (a) our sense of presence *in a particular place* and (b) how to compare real and virtual places effectively. These two problems led us to develop the 'place probe', a set of techniques that locates the idea of place at the centre of presence research.

In essence a physical environment is a space, or a setting, whereas a place is somewhere to which people have attached additional meanings, feelings and interpretations. For example a room has little or no significance for us when we enter it for no purpose. However, if we enter the same room when undertaking an exam it may take on additional feelings such as fear or success, which are purely personal but often related to other physical cues such as other people, silence and the sound of clocks. Different spaces may become different places for different people. For example, the design of city centre parks may provide convenient lunchtime seating for office workers but as night falls may also provide unforeseen challenges for the city's skateboarders. While the 'found space' [2] remains the same for each group it is contended that the sense of place is quite different. In order to provide people with a real sense of 'being there' (i.e. a sense of presence) there is a need for a method that allows designers of virtual environments to capture key points about both the setting (physical attributes) and the experience (meanings, feelings and other abstract properties).

The paper is organized as follows. Section 2 provides a brief discussion of place and presence. This is followed by a review of existing methods for measuring a sense of presence and of our experiences in using these methods. Section 4 introduces the place probe and explains the rationale for including the various components. These are illustrated with examples from the use of the probe in empirical work. Section 8 illustrates how the data from the probe is captured as a number of interacting patterns of place that can be used by designers and evaluators of virtual places. A brief conclusion provides insight as to how this work might develop.

2 The Link Between Presence and Place

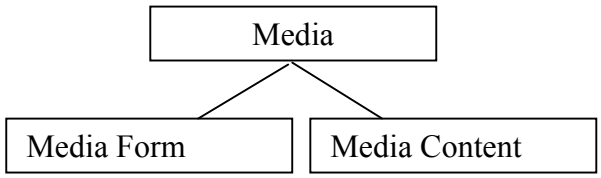

Figure 1 The form and content of a medium used in virtual environments has an impact

There are many definitions of presence. For example, Lombard and Ditton [3] describe it as the 'illusion of non-mediation'. Others prefer the notion that it is of 'being there'. For the purposes of the work contained here a definition of 'the feeling of being somewhere' (whether that be in a real or virtual environment) is used. As there is a need distinguish a sense of place as part of presence as opposed to a sense of placelessness. We want people not just to tick a box saying they had a sense of 'being there' we want them to tick a box saying they had a sense of 'being somewhere' (specific).

In order for people to ignore the media they are using (e.g. the head mount display or cave) and feel a specific sense of place there is a need to explore which aspects of presence are most relevant. At the basic level Sheridan [4] indicated that presence was derived from (i) characteristics of the medium and (ii) characteristics of the user. Of which characteristics of the medium can be broken down into media form and media content, the work here focuses primarily on the media content aspect. That is to say which aspects of the place we can utilize in order for people to feel they are in the specific place and thus experience a high degree of presence.

In terms of what constitutes place, a number of commentators have offered definitions. For example Relph's view of place [1] describes three properties; activities, physical properties and meanings (see table 1), a view shared by Norberg-Schultz [5] on his view of existential spaces (see figure 2). In many ways the Relph and Norberg-Schultz view of place share many aspects of the separation between media form and content. With content consisting of the aspects found in the Relph and Norberg-Schultz models, for example meaning and expressive space, when combined with the physical attributes such as layout.

Relph's View of Place	
Property	**Example**
Physical Properties	Buildings, furniture, other people
Activities	Walking, reading, sitting
Meanings	Fun, boring, sad

Table 1 The Relph model of place

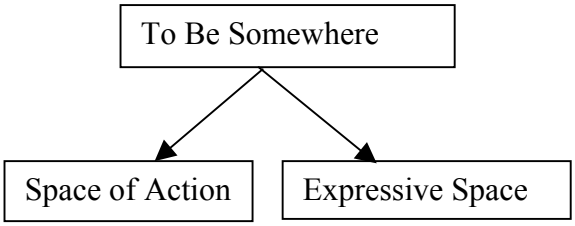

Figure 2 Norberg-Schultz model of existential space

Given the link between the definitions of place and presence it would appear logical to try and re-create as many of the *key elements* of a real world place as possible when building its virtual equivalent. This in theory should give a person a sense of presence similar to that experienced in the real place. Also from the perspective of those who develop virtual environments it would be advantageous to find out early on which elements of the experience to focus on, rather than those which add nothing or very little to the experience.

The idea of place has been extended by Gustafson [6] who places the person, and their relationship to others and the environment at the center of their experience of a place. The Gustafson model covers many of the areas found in other models, such as the importance of physical properties (such as environment) and a person's interpretation of it (through their feeling of self).

- **Self** - experience, memories, emotions and activities.
- **Environment** - natural/built /symbolic or historical /institutional environment.
- **Others** - characteristics, behaviours, traits of the inhabitants of these places.
- **Self/others**- places become meaningful as a result of people living there;
- **Others/environment**- atmosphere, climate and street life.
- **Environment/self**-respondents knowledge of the place, familiarity;
- **Self/Others/Environment**- themes that involve all three main parts i.e. traditions, festivals and anniversaries.

The work here makes use of both the Relph and Gustafson's models of place. However, the emphasis on experiences over a longer term that characterizes much of Gustafson's model is not relevant. It is also the case that the social nature of Gustafson framework while relevant for single user environments, probably lends itself more to work on collaborative virtual environments where there are issues of social and co-presence are more relevant. At present our focus is capturing the essential characteristics of an individual's experience of a place.

3 Experiences of Existing Methods

During 2003-2004 a number of studies of real and virtual environments were conducted [7], using a variety of investigative methods. The objective of these studies was to measure the sense of presence in virtual environments, and where possible to compare that to the sense of presence in real environments. Another objective was to explore the features that made people feel present in a particular location. From a methods perspective we were interested in exploring what measuring instruments were available and the types of data each method was capable of uncovering.

3.1 Questionnaires

Measures of presence have often focused on the use of questionnaires such as the one developed by Goldsmiths College (University of London) for the UK's Independent Television Commission [8]. It is a cross media presence questionnaire exploring four different measures; sense of spatial presence, the level of engagement, the sense of naturalness, and the negative effects experienced in an environment. There is no overall score for presence in this questionnaire as presence is regarded as a culmination of all factors.

While the ITC-SOPI questionnaire provides useful data on the levels of presence felt within an environment it is difficult to use the results for providing input into the design of a system or to highlight areas of weakness.

3.2 Video Analysis

The studies made use of video analysis with talk-aloud protocols as a means of understanding what people were doing while they experienced a real or virtual environment. Video analysis of the kind used provides vast quantities of data that were analysed from a semiotic perspective.

P15 Alan		
Time	Visual	Audio
02:58:00	Table (and camera legs)	Doors opening and closing
Transcription	-Right there's something not right here with the table -Uhuh It was kind of moving towards me, under me -Right ok	

Table 2 Transcript from a Video Session

The videos were first of all transferred from tape to hard disk for storage and easy access. They were then viewed a number of times to promote immersion in the data and a transcript of participants comments was made along with notes on aspects of visual, audio and timing of events. Along with field notes taken during the studies this amounts to the core of the data. The transcripts were then turned into text files and analysed using Atlas.Ti software, which is designed specifically for recording and managing qualitative data analysis. The purpose of this analysis was to explore the types of phenomena encountered by the participants in relation to the semiotic concepts of denotation, connotation, and metaphor. Code tags were built directly from participants' utterances and then further tagged as examples of either denotation, connotation or metaphor. Networks were then developed from these tags culminating in semantic trees of meaning clustered around specific events in specific locations examples of which are given below. Phenomena were classified in terms of the channel in which they occurred i.e. audio, visual, augmented, or physical. In the excerpt from the transcript in table 2 participant 15 has identified that there is something wrong with the table. In the demonstrator system used there were problems with the shadows generated by the table legs.

The video analysis provided a vast quantity of rich data that opened up some interesting questions. One area of particular concern was the appearance of imagined phonomena in response to an event within the environment. In one example a person saw broken glass shortly after hearing the sound of a shattering window, despite the fact that there was no broken glass in the virtual environment.

3.3 Structured Interviews

During early studies structured interviews were used to find out about the experience people were having of the real and virtual places. Such interviews allow questioning to be concentrated on specific areas of interest and to explore particular responses made by the participants. A list of sample questions used during one of the interviews is contained in table 3.

1. Initial open question 'describe the main features that you experienced while in the room'
2. Describe the sense of scale that you experienced while in the room
3. What were you aware of while you were in the room?
4. Describe your personal feelings about the room
5. Did you experience enjoyment while exploring the room?
6. Did you feel part of, or engaged by, the experience?
7. While exploring did you experience a sense of movement, either of the objects in the room or yourself? E.g. Differences in sounds, texture gradients etc
8. What in your opinion were the three most striking features of the room?

Table 4 Questions used in the structured interviews

From here an essentially enumerative strategy based on categorizing the data into various themes was used. For example how real/natural the environment/experience looked and felt to the participant, what they were aware of? How involved they were in the scenario? And what technical issues arose? To make analysis simpler each of these themes was represented with a code: realism, aesthetic, technical issues, involvement and physical objects. Each of these codes, permits the identification relationships and associations.

3.4 Repertory Grid Analysis

A repertory grid [9] is a method of analysing the meanings that a person has attached to something, for example an object, activity, location or the virtual world used in this study. A participant is first asked to provide a series of elements (or descriptions) of their experience, they are then asked to assign these elements along a series of bi-polar constructs (see figure 4). The bi-polar constructs are usually derived from the elements selected by the participant, or (as in the case of this study) they may be supplied by the evaluator. The constructs used were based on Relph's model of place (see table 1).

Constructs	
Permanent	Temporary
Colourful	Colourless
Noisy	Quiet
Still	Full of Movement
I could explore	I could not explore
I could meet my friends here	I could not meet my friends here
I would like to work here	I would not like to work here
I could touch this	I could not touch this
Surprising	Unsurprising
Attractive	Ugly
Interesting	Dull
Designed for Work	Designed for pleasure

Table 4 A list of constructs used in the repertory grids

In the example below a person is asked the question. They are then asked to place words they have chosen within the grid (table 5), based on whether they would like to work (a score of 1) or not like to work (a score of 5) within the environment.

3.4.1 Example

Question asked "Can you give me eight words which best describe the environment you've just been in?"

Elements (words) chosen: dark, pleasant, stressful, busy, grey, stairs, desk, people, signs

Construct:

1= I would like to work here

3 = No overall opinion

5= I would NOT like to work Here

1	*2*	*3*	*4*	*5*
Stairs				Stressful
Pleasant		Grey		Dark
	Desk	People		
		Signs		

Table 5. Words used to describe one environment

In the above example (table 5) the person has indicated that they find the stairs make them feel they would like to work in this environment. They were asked to assume they were a security guard. However the stressful nature and darkness put then off wanting to work within the space. Using the data above data is possible to see the relationships between feelings and properties of the environment.

4 Comments on Use of Methods

In using a combination of methods the studies were able to uncover themes and issues that appeared across multiple sources. However methods such as repertory grids and interviews both require the evaluator to be present and are time consuming to conduct and in the case of interviews also take some time to analyze.

5 The Place Probe

A key factor in developing a new technology is to provide useful feedback in the design process. While all the methods mentioned above proved to be useful in exploring participants sense of place, they all took a considerable time to administer and provided little useful information for the technologists working on the project in terms of how to enhance the sense of place in the VE. For the BENOGO project it became paramount to devise a method that was both quick and easy to administer in various locations, both real and virtual, and that provided essential benchmarking information that could be used by the technologists to improve the VE. Based on the experiences of the methods discussed earlier a new way of capturing core aspects of real and virtual places was devised. This new method called 'The place probe' [10] was designed to be more flexible in its approach to capturing data, to produce results relevant for the virtual reality technology being used and to be easy to administer while basing itself around the key ideas of the existing methods.

The concept of the probe drew on earlier ideas by Gaver [11] and Baillie [12]. The probe is designed to be used by visitors to the real or virtual scenes, where they can complete it either in the presence of the evaluators or on their own, as it is easy to read and understand. This allows it to be used on locations where the evaluators may not be present. It has also been designed to allow for relatively quick data analysis, for example by asking for keywords or scores, through to more complex data such as those found in sketch maps and written descriptions.

The probe is designed to capture key information about real scenes so that they can be incorporated in to the virtual equivalent. It is also intended to allow for a comparison (a process referred to as benchmarking) between a real and virtual version so that evaluators can uncover areas of difference. The data ranges from specific information on a scene, such as that uncovered during written descriptions and sketch maps to high level data about the overall experience (in the semantic differentials).

Each data source (with the exception of the semantic differentials and photographs) were analysed by a member of the team using a grounded theory approach. This allows for themes to emerge that exist within the data rather than adopting a series of pre-set categories. In order to verify the data samples are then chosen at random from each data source and given to the other evaluators who then note down any themes. The data found and emerging themes were then compared.

Prior to selecting a real world location a checklist was used to decide if it is was suitable. The checklist was developed to accommodate a number of technical considerations which effect the choice of locations used for the virtual environments for example; lighting, the amount of movement offered to the participant and the geometry of the space. As the project evolves it is

expected that the criteria will change, moreover others using the probe will no doubt need to alter the probe to suite their own requirements.

5.1 Profile

Basic profile information is obtained to permit easy comparison between people, for example males, females or different age ranges. An example from a navigational perspective is that of children who were asked to find their way around a university campus [15]. The children all remembered features at their eye-level or below for example dogs and bins, however they become lost when these features were removed. While navigation is not the only task which people undertake in virtual and real environments, the example illustrates the variation in the types of features remembered by different groups of people.

5.2 Descriptions

This part is similar to a visitors book and asks people to write down a short description of their experience . This approach allows for a totally free form response and is not restricted by asking for information on specific topics.

Atlas.ti was used to analyse the descriptive component of the probe. Atlas .ti was useful as it allowed certain quotes within the content to be highlighted and then to be easily organised and grouped into common codes/themes for example in the viewpoint real study, a quote like '*we can pick out landmarks we know – the castle, Tyn Church and St. Nicolas'* and '*a good point of view. St Vitus is a marvellous church'* can be categorised into a theme like physical location. The themes /codes were chosen as a means of best representing/categorising a group of quotes. These individual themes/codes were then discussed and compared with the themes of the other researchers and an agreement was reached on whose theme/code was most appropriate for the situation.

5.3 Sketch Maps

Sketch maps (see figure 3) can be used to assess which aspects of an environment a person recalls, and areas where they stood and walked around. The objective being to uncover the most salient aspects of the environment and if required concentrate any computing resources on them. The sketch maps may also prove useful in identifying which areas of the environment people are most likely to visit and hence support for allowing avatar movement in these areas of the virtual environment can be provided. A method of analysis from Billinghurst and Weghorst [16] was chosen, however the procedure was simplified the by not looking at aspects such as overall sketch map accuracy and orientation, instead the emphasis was on how many times a feature was drawn in by all the participants.

The sketch maps provide useful information on aspects of the scene which people consider most relevant, for example they draw the Cathedral but not another large less prominent building next to it. They are also open to some issues such as drawing ability, subject exposure to the environment and the evaluators ability to recognise objects within the drawing.

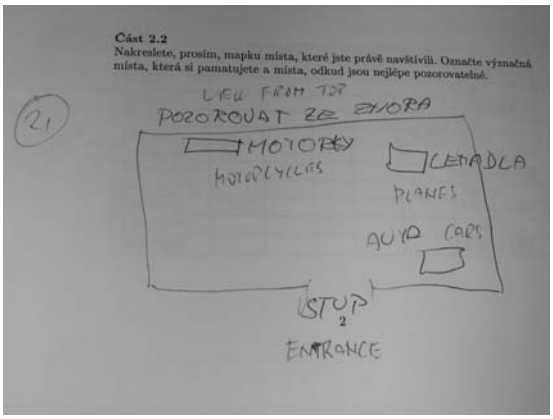

Figure 3 A sketch map drawn by one child of the Technical Museum in Prague

A number of evaluators would examine a series of maps to assess the level of agreement of categorising objects. In the example below there is some disagreement on the name of the marked object, however on checking travel guides for Prague it is possible to identify the correct name of the building.

The sketch maps from the real and virtual scenes are compared to see if people are drawing the environments in the same level of detail. For example the study of the hilltop location in Prague found that distant objects in the virtual environment were not accompanied by supporting information such as their name and tended to appear as collection of buildings rather then being drawn separately.

5.4 Semantic Differentials

The objective of semantic differentials is to uncover any connotative associations that people have with certain words and the environment they have just visited. To do this people are asked to rate their experience of the environment on a series of bi-polar scales, for example in the table below the person has illustrated that they found the environment 'very attractive' whereas they could equally have indicated that it was 'very ugly'. Semantic differentials produce a set of scores related to how people feel towards the environment and are easy to analyse.

The differentials were based on our work with Rep Grids mentioned earlier and are essentially a quick method of gauging participants responses to an environment in relation to Relph's three categories; physical properties, activities afforded and meaning. Within these categories themes that were uncovered from the repertory grid studies are used, for example within the physical features section we find attractive, big, colourful and noisy. Within the activities section, temporary, available, versatile, and interactive. Within the meanings section pleasant, interesting and stressful.

	VERY	QUITE	NEITHER	QUITE	VERY	
Attractive						Ugly
Big						Small
Colourful						Colourless
Noisy						Quiet
Temporary						Permanent
Available						Unavailable
Versatile						Limited
Interactive						Passive
Pleasant						Unpleasant
Interesting						Boring
Stressful						Relaxing

Table 2 The semantic differentials used

Results from the differentials are useful in providing information on the high level experience people have of a particular place for example whether it is ugly or attractive. It is also possible to quickly compare the data obtained for real and virtual scenes and uncover areas of difference. For example, results from one study found people in a virtual environment find less attractive than its real counterpart. Data from the semantic differentials is useful for corroborating results from other sources, and it can be used as a starting point from which to explore data found in other sources.

5.5 Photograph

A set of six photographs was taken at each real world location visited by the evaluators. These were then given to the participants in the study who were asked to select the one which best represented their experience of the location they had or were visiting. This approach is useful for finding which view people felt best represented the environment they had visited. In turn this provided the designers with information on the most common standing locations of people within the place. For example this could be used to indicate a starting location in the environment, a standing point (if the technology allows limited movement) or a location where images can be captured from (if the technology uses real world images e.g. photo-realistic VR).

5.6 Six Words

Participants are asked to write down the six words which best describe their experience.

The six words section involves counting the number of incidences of common groups or terms. In common with the descriptions the use of a dictionary and thesaurus was useful in pinning down specific meanings in cases where the evaluators were unsure.

6 Study

The first study which made use of the probe for design and evaluation was conducted during 2003. For this a number of locations in Prague were visited with a view to selecting those which were most appropriate for the technology. The locations were chosen based on a list of properties known as the 'The Place Suitability Checklist'.

7 Themes Workshop

After analysing each source of data a workshop is held. This is a forum where all evaluators gather to discuss the themes which emerged within the data with a view to agreeing on a common set of templates. In order to do this each evaluator is asked to discuss the main themes which emerged within their data (e.g. the descriptions), in some cases noting them on a whiteboard (See figures 4 and 5). The themes are then checked against the samples chosen from each data type to ensure that similar items are being identified and to discuss any discrepancies.

Figure 4 A group of themes on the left being situated within the Gustafson model

During the next stage the evaluators begin to explore which themes appear across the range of data sources (e.g. within the descriptions and six words), with a view to retaining those which appear in more than one data source and possibly eliminating those which appear in only one source. They also look for links between themes in different data sources so that any which refer to the same feature or phenomena can be grouped together.

The ultimate objective of developing the themes is to provide designers and evaluators with a series of templates which can be used to describe a given location. This is similar in many respects to the idea of architectural design patterns by Alexander [17] which are sets of high-level common description of architectural features such as paths & goals and café's. However as documented later there is need to develop in a way which is relevant to the technology which will be used to operate the virtual environment.

The final stage of the data analysis involves grouping the range of themes within a chosen model of place. To date the studies have used the Gustafson model (see figure 2 with descriptions), which is drawn primarily from a sociological perspective and Relph (see table 1 with descriptions). The Gustafson model of place seemed unduly complex for the task which was primarily communicating results to technologists who were building the virtual environments, where as the Relph model provided three distinct and readily understandable categories.

Figure 5 A further refinement of the model

8 Place Model

The place model is the result of the final stage of the analysis (see figure 6). In the example model derived from a technical museum in Prague there are three main levels, which are based on Relph's model of place and the technical aspects of the VR system. The top area (dark) represents the meanings people have attached to their experience, the central area physical properties of the environment they have noticed and the lower (dark) area represents the technical issues which affect the environment. The central circle represents an activity people undertook while in the museum that should be encouraged within the virtual environment.

In addition to the place model designers and evaluators can view on-line supporting documentation. At present this take the form of a webpage which contains a definition, links to related templates and relevant data from the studies.

The place model represents a tool for communicating information to the developers of virtual reality systems. The aim being to allow for such information on the real environment to play an important role in the early design stages of a project. For example in the above place diagram the technical requirement that there should be sufficient resolution is linked with the need to be able to clearly identify exhibits within the

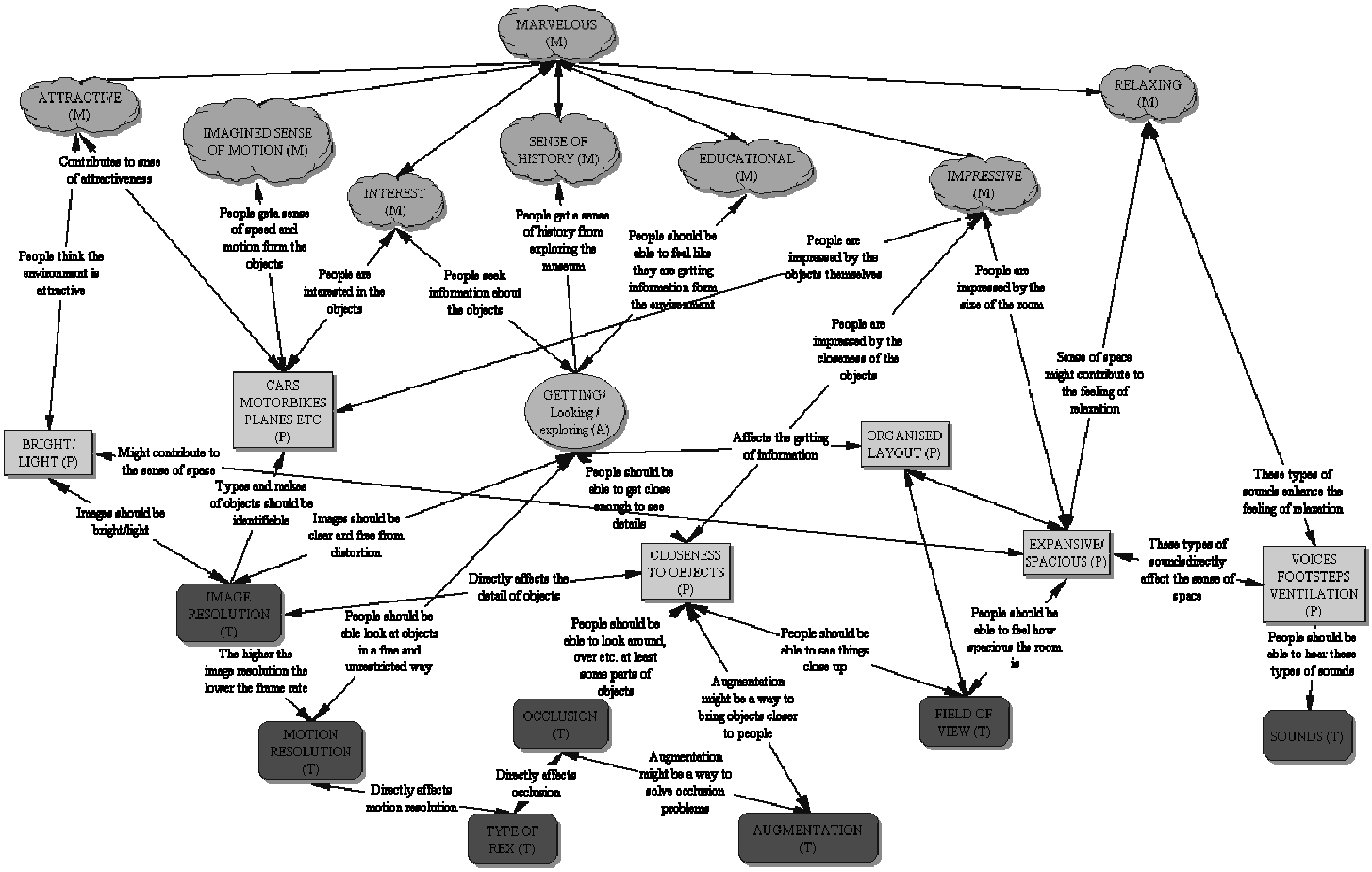

Figure 6 The Place Model of the Technical Museum in Prague

museum. This could be interpreted not only as providing a sufficiently high resolution for the entire environment, but also augmenting certain objects at higher resolutions so that people can get close to them and still be able to recognize them. The issue of closeness is highlighted as a desirable property on its own but is also linked to a range of other features such as the occlusion of objects within the space. While occlusion of objects is a natural property of the real environment, the ability to provide it within photo-realistic virtual environments is problematic and there are limitations on how and where it can be provided. As a result it is important to indicate this is an important issue of the environment which if possible should be addressed within any implementation of the space.

From an evaluation perspective the issues and links between the topics in the place chart provide a method of finding out whether people are having similar experiences within the real and virtual environments, for example are they able to look at objects which are close-by without the resolution causing problems. Also the data from semantic differentials can be used to find if people are having the same views on the experience.

9 Conclusions

The concept of presence is open to much discussion and debate, not only on whether it exists but through to definitions and how systems can be better designed to support it. However it is clear when comparing place and presence that there is a degree of overlap and that the idea of place is rarely fully explored by the presence community. This paper explores the link between presence and place and how that can be exploited to provide relevant design and evaluation advice for developers of virtual environments. In contrast with certain other methods this results in a situation where specific properties can be discussed and ultimately included in a virtual environment, on the premise that if these features are provided then a higher degree of presence will occur. Rather than abstract notions of presence which produce scores but provide little or no indication of what is right or wrong with a particular environment.

The 'Place Probe' discussed in this paper is in development but provides a quick and reliable method of capturing information about real and virtual scenes. While the method builds on aspects of place from literature the results are not tied to any specific models of place and adopt a grounded theory approach, with specific frameworks (e.g. Relph or Gustafson) only being used in the final stages of analysis. This permits the data to be framed in specific contexts, for example designers and evaluators of collaborative systems may chose the Gustafson framework as it places emphasis on the relationships between people, their environment and others. Where as if this is not relevant then the Relph model may prove useful.

In conclusion this paper presents a review of our experiences of using existing methods of capturing place and presence and how based these a new method 'The Place Probe' was devised. The 'place probe' has been used in a variety of studies of real and virtual scenes and provides relevant information and can be applied to a range of environments and contexts.

10 Acknowledgements

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