EVALUATING SOUNDSCAPES AS A MEANS OF CREATING A SENSE OF PLACE

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ABSTRACT

We report an empirical study into the creation of, and response to, a soundscape of a computer centre. We contrast the use of presence questionnaires, as means of assessing the sense of being-there, against a more phenomenological approach. We conclude that we have been able to create a strong sense of place but uncovered a number of experimental / procedural issues.

1 INTRODUCTION

We report initial empirical work into establishing the value of soundscapes in creating an artificial sense of place. This work contributes to the BENOGO project which is part of the newly funded European Union initiative researching Presence – that is, creating a sense of *being there*. The issues of *presence* and *place* are complex and subject to much research, debate and disagreeing, so for the purposes of this paper we simply define a sense of place to mean the direct, everyday experience [phenomenology] of that place and one of the measures of a sense of place is *presence – being there*. This contrasts with other explorations of sound in relation to presence, for example [1] who use a presence measure as an index of audio quality. To date most virtual reality / presence research has focused on creating predominantly visual environments augmented by sound. Our interest is in the application of VR technology (in its broadest sense) to create a sense of place of which a soundscape is a pivotally important element in its makeup. We begin by briefly introducing the BENOGO project and our work in creating a sense of place. We next introduce research into the phenomenology place which we contrast with empirical measures of presence before turning to the work we undertook and the insights we can draw from it. We conclude with indications of further work.

2 SOUNDSCAPES

The term 'soundscape' is derived from 'landscape' and can be defined as the auditory environment within which a listener is immersed. This differs from the more technical concept of 'soundfield', which can be defined as the auditory environment surrounding the sound source, which is normally considered in terms of sound pressure level, duration, location and frequency range. The concept of the soundscape is not new: Grano first differentiates between the study of sound and noise in 1929 [2]. The principle then lay comparatively dormant until 1969, when Southworth [3] tried to establish how participants perceived the sounds of Boston and how this affected the way they saw the city. Schafer [4] and Truax [5], as part of the World Soundscape project, attempted to formalise the concept using visual representations such as soundmarks rather than landmarks. The soundscape surrounds us, as well as being an individual experience, with each sound signifying an auditory event. Schafer has argued that all soundscapes should display high-fidelity where sounds are distinct so that inhabitants can interpret them easily, rather than low-fidelity where usually a single sound dominates, such as traffic, and it is difficult for inhabitants to distinguish individual sounds, or perceive sounds at any distance. We now turn to a brief description of the BENOGO project.

3 THE BENOGO PROJECT

The BENOGO project brings together a mixture of novel technologies that will enable real-time experience for an observer of recorded real places. The aim of the research is to develop new tools for empirical and theoretical studies of presence based on the concept of the observer's embodiment in the computationally created virtual environment. Furthermore, as real places (possibly known to the observer) with man-made and/or organic objects (like trees, foliage etc.) are otherwise hard to represent in a virtual environment, the objective is to bring about new insight into presence through comparison with the sense of presence experienced in the real world. The empirical research will exploit the possibilities to investigate the experience of 'being there' with respect to real places and objects The theoretical framework will be based on the concept of embodiment in conjunction with presence and sense of place. This will be investigated in terms of fidelity of experience and presentation as compared to equivalent real-word places, and physiological and neurological aspects like consistency of sensory-motor co-ordination. The framework will be developed in close interaction with, and as a guide for, technical development by focusing on the particular strengths that the technology offers as well as on its weak points. Feedback from empirical studies will form an essential part of the project. The research iterates through 11 demonstrators to achieve these goals. In order to structure the research, four main themes have been identified. These are: (a) the acquisition and real time rendering of places; (b) the augmentation of this rendered images with synthetic virtual reality images and 3D soundscapes; (c) an investigation in to the psycho-physiological aspects of presence and finally, for us the most important, and last but not least, (d) establishing a sense of place.

The authors work as part of team addressing the issue of establishing a sense of place by experimenting with soundscapes.

4 THE PHENOMENOLOGY OF PLACE

Phenomenology is concerned with describing experiences as they appear in consciousness, without recourse to explanation, theory, or other assumptions from other disciplines. Phenomenology has a long history, as noted by Dennett [6], Thomas Gilbert in the 16th century wrote of the phenomenology of magnetism but we had to wait 300 years before Faraday, Maxwell and others offered explanations of magnetism. Returning to experiences as they appear in consciousness, Dennett again usefully suggests that they have be divided or grouped into (1) experiences of the 'external' world such as sights and sounds; (2) experiences of the 'internal' world such as daydreams, talking to oneself and (3) affect – pains, hungers and emotional responses such as surprise or desire. While these very different experiences could be divided and partitioned in a dozen different ways we can (probably) agree that they are direct, subjective, personal and qualitative in nature and as such differ from what ever it is that questionnaire-based methodologies purport to measure. However in identifying these phenomena as being of value we are faced with the myriad problems of their elicitation. Giles [7] identifies a number of different methods for doing just this but few are suited to the study of place. Approaches to eliciting the direct / subjective experiences of individuals include the use of interviewing, observation, the use of content analysis of verbal protocols (think-aloud and speak-aloud), repertory grids and a number of other non-intrusive techniques.

5 'MEASURING' PRESENCE AND SENSE OF PLACE

Presence researchers continue to devote much academic energy to the quest for the holy grail, a true measure of presence. The field is bedevilled by a number of demons: the lack of an agreed definition of presence; the wish to have quantifiable results which can thus be subjected to statistical analysis; the unfortunate fact that asking about presence interferes with the phenomenon under study; and the desire for a standardised instrument which can be applied across media. A full analysis of this ongoing debate is beyond the scope of this short paper. In brief, most attempts to measure presence tend to take one of four forms:

- questionnaires (typified by [8], variants of the Slater-Usoh-Steed instrument [9] and the ITC-Sense Of Presence Inventory [10]
- observational behavioural measures [11]
- physiological measures of arousal [12]
- less frequently, concurrent or retrospective free-form self reports [13]

In practice, very many studies adopt questionnaires as a basic measure, even if the technique is complemented by other tactics. The appeal lies in convenience, the reasonable body of usage experience which has now accumulated, and the opportunity to gather quantifiable results. However, the limitations of presence questionnaires are increasingly acknowledged (as in [14]): for example the data gathering is necessarily retrospective, and there is a much more fundamental problem about exactly what is measured.

As for sense of place, much work is avowedly phenomenological, and largely draws upon the exploratory analysis of verbal accounts. These are most frequently obtained through interviews. Some authors have derived sense of place scales based on interview data as in the case of Jorgensen and Stedman [15]. Interestingly, Hay [16] makes a case for the derivation of such a questionnaire and the analysis of its results within a phenomenological approach.

In the current study we adopted a combination of a ready-made, well-tried presence questionnaire (Slater-Usoh-Steed) and concurrent verbal reports. The questionnaire items were adapted slightly to match our experimental conditions. For this early, exploratory work, trialling the methods used was just as important as collecting data.

6 CREATING THE SOUNDSCAPE

Despite the increasing popularity of 5.1 and 7.1 systems, it was decided to utilize a custom 8 channel digital system, this allowed participants to move their head freely without there being a front and back as normally associated with the more conventional surround systems. Recordings utilized 8 identical omni-directional tie-clip microphones, with subsequent speaker positioning matching the microphones in both floor position & height. These were positioned into an ellipse at approximately average ear-height when seated, in order to emulate the majority of the inhabitants' positions. Omni-directional microphones were chosen in order to maximize any natural reflections as well as to ensure that nothing was "off-axis" such as in the case of directional microphones. Please see figure 1 which shows capturing the sound of the Jack Kilby Computer Centre (JKCC) – the central computing lab at Napier University - during a typical afternoon. The recording was made in a single thirty minute pass onto eight separate channels, a separate Focusrite eight channel pre-amp was used to minimize distortion and ensure consistency in both dynamics and frequency. Each channel was recorded at 96kHz and 24 bits, which gave us an theoretical dynamic range of c. 144 dB and ensured that the full audible range was covered. The high sampling rate meant that not only could ultrasonic frequencies be recorded, ensuring that associated phase cancellation could be reproduced, but also that the short time delays, with an accuracy of c. fifteen microseconds, that we rely on in order to accurately locate sounds could be reproduced, something which is not possible at the standard CD sampling rate of 44.1 kHz. Calibration between the physical soundscape and its subsequent reproduction was achieved utilizing a sound pressure level (spl) meter. The meter was set to the C scale and recorded an average of c.48dBC, the A scale would have rolled off too much bass, whereas the C scale more accurately represents listening at such a comparatively low level. For reproduction eight compact monitors were supplemented by four sub bass units, whilst bass transmission can normally be considered omni-directional, the low spl levels made accurate positioning of low frequency sounds, such as people walking on hollow resonant floors, difficult. The use of four sub bass units solved this problem, achieving a more accurate representation, than that normally associated with a 5.1 or 7.1 system, where sub bass is normally located in front of the

listener. This also compensated from the reduced frequency transmission range associated with compact monitors.

Figure 1 - Capturing the sound of the Jack Kilby Computer Centre (JKCC).

When participants were describing the virtual soundscape they were recorded using a standard stereo tieclip microphone onto a DAT set to 48kHz 16 bit, this allowed an accurate stereo image in order to emulate the participant's listening experience with reference to their own voice.

Figure 2: recreating the JKCC elsewhere.

7 METHOD

This study examines two factors in understanding a sense of place. The first issue concerns the importance of the sound in creating a sense of place. The second considers the practicality of adopting a phenomenological approach to eliciting the experience of place. The study had four conditions with 10 participants randomly assigned to each condition:

[1.] Physically present in the JKCC. The participants were asked to absorb themselves in either the real sounds of the JKCC and then complete the modified Slater-Usoh-Steed presence questionnaire.

[2.] While physically present in the JKCC participants were asked to speak-aloud what they could hear and then afterwards asked to complete the modified Slater-Usoh-Steed presence questionnaire.

[3.] Participants were blindfolded and exposed to the soundscape for 15 minutes. They were asked to remain silent (just listening) then asked to complete the presence questionnaire.

[4.] Participants were blindfolded and exposed to the soundscape for 15 minutes. They were asked to describe aloud (speak-aloud) what they were hearing then afterwards asked to complete the presence questionnaire.

The first and second conditions provide a benchmark against which we compare the experience of the artificial soundscape.

7.1 Participants

Forty participants were invited to participate in the study and were randomly assigned to one of the four conditions. The study was conducted over a period of three consecutive days. The participants varied with respect to their age, sex and background. All participants took part in the study on a voluntary basis and all were required to have a high command of spoken English.

7.2 Experimental procedure

The first condition require no comment. As for the second condition we attached a microphone to the collar of participant and recorded what they said using a DAT. They were informed that the task would last for about fifteen minutes and that they could ask any questions afterwards.

For condition 3, the participants were blindfolded and guided into a room and seated at a table. They were asked to listen to the recording we were going to play them for 15 minutes after which we would ask them some questions. They were also told that they could end the experiment at any point.

For condition 4, the procedure followed that of condition 3 except that we attached a small microphone to their collar. We also asked them to describe aloud what they heard during the recording. The participants were unaware that they would be seated in the midst of eight speakers and four sub basses. Please see figure 2. After fifteen minutes, they were guided back out of the room and their blindfold was removed (the microphone was also unclipped). At no stage during the experiment, could the participant see the room and its contents. The participants were then taken another room to complete a questionnaire.

8 RESULTS

The results take 3 forms, (1) three sets of completed presence questionnaires; (2) a number of free-form responses both written and in the form of comments from the participants to the researchers and (3) series of speak-aloud verbal protocols saved as MP3 files. Taking these in turn: firstly, the questionnaire data. Here only one of the questions, A8, yielded anything of interest. The question asked was, "During the time of the experience I often thought that I was really standing in the JKCC". The scale ran from 1. Not very to 7. Very much so. We found the following:

Actually in the JKCC, n=10, median = 4.5,
Blindfolded and silent, n=10, median = 5
Blindfolded and speak aloud, n =10, median = 2.

As the presence scale is a simple rating scale the median is quoted as a measure of the central tendency. These results indicate that we had succeeded in creating as least a good a sense of place (well, slightly better actually) using the soundscape as compared with the actual environment as measured by this instrument. However, asking people to

describe their experiences during the episode detracted from the sense of space quite dramatically. Space precludes a thorough treatment of the free responses, so instead here is a flavour [the notes in square brackets have been added for clarification]: "[it was like …] attempting to listen to a conversation shared in a daydream. [I] always knew it was not real but definitely [that is, especially] during the period between drifting off thinking about other things and coming back.", and "What helped give a sense of 'really being there' - continuous surrounding sound, - noises of people conducting their own work, i.e. nothing was strange or out of place."

Finally, and for us the most interesting contributions, were the contents of the speak-aloud protocols. These varied dramatically from the sparse "Typing. People coughing" to – again we can only offer a flavour:

"There are a lot of people around me … There is a quiet buzz of conversation all over the place but I can't make out any words …"

It's a big place, it's a…. it's a…it could be outdoors. There is a sort of rumble, which might be rain…. Ah…low frequency content certainly, could be air-conditioning… could be rain…a lot of people …"

Participant M

"I feel a bit lost sitting still when everyone else is moving around getting on with their stuff …"

Participant E

"I can hear people chatting in the distance ……it is quite irritating that I can't hear enough that I can hear what they're saying .." "People in the distance doing something sitting, chatting…. but all very distant from me say fifteen… twenty…. or thirty feet away…it does feel like I'm in quite a large open space but indoors … Definitely indoors."

Participant R

9 DISCUSSION

At the outset of this paper we posed two questions, (1) could we create a soundscape which gave a strong impression or experience of place and (2) how do phenomenological measures compare with conventional presence questionnaires in practice. We have concluded that – yes, we can create a sense of being somewhere (as measured by the presence questionnaire) which compares very favourably with the experience of real places. As for the second research question the evidence requires a little reflection. There is no doubt that the questionnaires are a blunt though useful quantitative instrument: in contrast, the speak-aloud technique we employed yielded a wealth of rich and interesting qualitative data but their production negatively impacted on sense of place. It may be that the act of foregrounding ambient (background) sound interferes with the experience of being there and/or highlights the presence of contradictory cues. A number of participants in the speak-aloud condition remarked that they heard people walking on hard wooden floors while they could feel the office carpet beneath their feet. We have a daunting amount of work planned which includes:

1. The technique we used to create the soundscape could be expanded further through the use of HRTF (Head Related Transfer Function) (binaural) recording techniques in order that the physical listening experience could be further studied through monitoring head movements, as well as giving the opportunity to listen to the effect of the head movements upon the participant's perceived soundscape.
2. Creating further soundscapes being careful with the experimental procedure as not to give the participants any contradictory cues as to sense of place we wish to create.
3. The investigation of individual differences between individuals as to their response to the soundscape and their propensity to become transported to the places we create.
4. Finally, we are interested in creating a presence measurement instrument of our own but design to focus on the role of sound.

10 REFERENCES

[1] Freeman, J. and Lessiter, J. (2001) Here, There and Everywhere: The Effects of Multichannel Audio on Presence. *Proceedings of ICAD 2001*, 231-234

[2] Grano, J. (1929). Reine Geographie. *Acta Geographica 2*, 1-202.

[3] Southworth, M. (1969). The Sonic Environment of Cities. *Environment and Behaviour*. **1:** 49-70.

[4] Schafer, R. M., (Ed.) (1977). *European Sound Diary*. The Music of the Environment Series. Vancouver: A.R.C. Publications.

[5] Truax, B. (2001). *Acoustic Communication*. Norwood: Ablex Publishing Corporation.

[6] Dennett, D (1991) Explaining Consciousness. London: Penguin Books.

[7] Giles, D.C. (2002) Advanced Research Methods in Psychology. Hove: Routledge

[8] Witmer, B.G and Singer, M.J. (1998) Measuring Presence in Virtual Environments: A Presence Questionnaire, *Presence* **7(3)**, 225-240.

[9] Usoh, M., Catena, E., Arman, S. and Slater, M. (2000) Using Presence Questionnaires in Reality. *Presence* **9(5)**, 497-503.

[10] Lessiter, J., Freeman, E., Keogh, E. and Davidoff, J. (2000). *Development of a New Cross-Media Questionnaire: the ITC-Sense of Presence*, 3rd International Workshop on Presence

[11] Freeman, J., Avons, S.E., Meddis, R., Pearson, D.E. and Ijsselsteijn, W. A. (2000) Using behavioural realism to estimate presence. *Presence* 9, 149-153

[12] Meehan, M. (2000) An Objective Surrogate for Presence: Physiological Response. 3rd Int. Workshop on Presence.

[13] Neale, H. and Nichols, S. (2001) Theme-based content analysis: a flexible method for virtual environment evaluation. *Int. J. Human-Computer Studies*, 55, 167-189.

[14] Insko, B.E. (2003) Measuring Presence: Subjective, Behavioral and Physiological Methods. In G. Riva *et al.* (eds.) Being There: Concepts, effects and measurements of presence in synthetic environments. Amsterdam: IOS Press

[15] Jorgensen, B. S. and Stedman, R. C. (2001) Sense of place as an attitude. *Journal of Environmental Psychology*, **21**, 233-248.

[16] Hay, E. (1998) Sense of Place in Developmental Context, *Journal of Environmental Psychology* (1998) **18**, 5–29.