Re-creating the Botanics: towards a sense of place in virtual environments

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Abstract

The EC funded project BENOGO seeks to re-create real places using photo-realistic immersive virtual reality technology and in so doing investigates the nature of presence and sense of place in such environments. We discuss the first stages in our work investigating how far a sense of place can be created in a virtual environment and benchmarked against the real world. This paper reports early studies which investigated sense of place in a real-world location – a glasshouse in a botanical garden – and the first in a series of planned experiments with its virtual equivalent. The results provide preliminary indications of which elements of sense of place manage to penetrate the considerable constraints of the current virtual environment and how the virtual experience might be redesigned in future. We also discuss techniques for investigating sense of place in this context and briefly describe the next steps in the work.

1   Introduction

This paper describes the early stages of an empirical investigation of sense of place in virtual reality (VR). The work is part of BENOGO, a recently funded project under the European Community's Future and Emerging Technologies 'Presence' initiative.

This paper first very briefly reviews concepts and studies of sense of place relevant to this context. We next introduce the BENOGO project and identify the particular flavour of sense of place which we are adopting in this work. This leads us to reports of

> a preliminary study of sense of place in retrospective accounts of places of the type to be recreated in BENOGO;

> a first experiment exploring sense of place in a glasshouse in the Edinburgh Botanical Gardens and in its virtual equivalent.

The extent to which any sense of place has been created is then discussed, and we conclude by reviewing the investigative techniques used and making suggestions for the redesign of the virtual experience and experiments exploring it.

1.1   Sense of place studies in real and virtual worlds

The nature of sense of place has been considered extensively in many academic disciplines. To take the most salient for the current paper, environmental psychologists have typically developed models of place, (e.g. Gustafson, 2001), have studied how place is engendered through long term associations with a particular locale (e.g. Hay, 1998) and through the design of the man-made environment (e.g. Stefanovic, 1998), and rather more rarely, how place may be recreated through artificial environments (e.g. Rohrmann and Bishop, 2002). Many environmental psychologists take an explicitly phenomenological stance in writing about place,

though this does not always deter researchers from attempts to identify and quantify component dimensions of the phenomenon.

Outside the sciences and social sciences, much other work has focussed on how sense of place can be created in virtual worlds, whether the medium be text, the visual fine arts, drama, or film. However, place – or at least the recreation of specific real places – has been relatively little explored in the context of computer-mediated virtual realities. Such research as exists tends to focus on the generation of a sense of place in such arenas as meeting places which belong only to the virtual medium. The current work starts to explore some of the concepts of place developed by environmental psychologists in the VR context.

To make a very broad generalisation, much environmental psychology literature characterises sense of place along three dimensions. While terminology and emphasis varies between authors, and sometimes the dimensions are further subdivided, they are generally something of this form:

> physical features and properties of the environment – not just buildings or natural features, but also light quality, sounds and so on;
>
> activities and experiences afforded, such as movement, interaction with other people or non-animate objects;
>
> affect engendered or meanings attached, such as feeling at home, being moved, impressed, interested, reminded of other places, of events in our own history or historical events…

Relph's monograph (Relph, 1976) is one of the earliest and most cited expositions of such an approach .The monograph takes an explicitly phenomenological and therefore holistic stance, but nevertheless defines three components of 'place identity' along the lines outlined above. He explicates these elements thus…

> "…the static physical setting, the activities and the meanings – constitute the three basic elements of the identity of places. A moment's reflection suggests that this division, although obvious, is a fundamental one. For example, it is possible to visualise a town as consisting of buildings and physical objects, as is represented in air photographs. A strictly objective observer of the activities of people within this physical context would observe their movements much as an entomologist observes ants, some moving in regular patterns, some consuming objects and so on. But a person experiencing these buildings and activities sees them as far more than this – they are beautiful or ugly, useful or hindrances, home, factory, enjoyable, alienating; in short, they are meaningful." (p.47)

Space here does not permit a review of later work, but this tends to fall into two categories: the holistic, exemplified by Stefanovic's discussion of the sense of place in two contrasting residential locations (Stefanovic, 1998) and Downing's (2003) treatment of memory and sense of place; and those that delineate empirically based dimensions. Gustavson's model of sense of place, for example (Gustavson, 2000) draws on an interview survey and builds on a review of earlier models. Jorgensen and Stedman (2001) propose that sense of place may be treated as an attitude, thus drawing on classical psychological theory. Just as any other attitude, sense of place then has cognitive, affective and conative components.

However, most authors stress that while generalisations about the components of sense of place are possible, it is intrinsically an emergent property of interaction between an individual and the environment, and while there may be some shared elements, the experience of place is fundamentally unique to each of us.

1.2 The BENOGO project

BENOGO investigates presence in virtual environments which provide photo-realistic representations of real places, and this gives us the opportunity to explore the aspect of presence which concerns the sense of being in a particular place. In brief, by the end of the three-year project the BENOGO technology will provide 360 photo-realistic visual representations of places which a participant can explore along certain pre-defined trajectories. The visual environment will be augmented by soundscapes, and there will also be the opportunity to place additional, computer-generated or real objects in the environment. Participants will be able to experience the virtual environment through a head-mounted display, inside a virtual reality 'cave', on a large flat screen or as a wide-screen panorama. The current state of technological development is described in section 3. BENOGO is a collaborative project between academic institutions[1] expert in VR technology, psychophysiology and the human factors of VR (ourselves at Napier). Although the current project is not required to have direct practical application, it is possible to envisage the technology being used for such purposes as 'visits' to remote or vulnerable historic, natural or cultural sites or for scientific exploration of environments such as the surface of the moon. The aspects of the project discussed in this paper aims to

> Investigate the phenomenology of sense of place in virtual environments and to benchmark this against real world equivalent places
>
> Develop qualitative techniques for such exploration
>
> Identify indicators for design for a sense of place in virtual environments

The places presented in the BENOGO environment may or may not be well known to the participants. This means that we are primarily interested not in the sense of place engendered by long-term dwelling in a place, but in that experienced in a more short term encounter, more akin to that conveyed by travel writing or letters home from abroad than the deep attachment to place discussed in much literature dealing with the phenomenon. Moreover, the places concerned are not restricted to the residential. As Manzo (2003) observes, much existing material on sense of place is focussed on such milieus.

2   Pilot study – eliciting descriptions of real places

This exploratory investigation elicited descriptions of real world places of the scale which could be represented in BENOGO – parts of city squares, or rooms in buildings, for example, rather than entire cities or castles. In addition to the general aims set out above, we were interested to discover how far the descriptions varied from individual to individual, and to trial investigative techniques.

Much existing work in both sense of place and presence research uses free-form self-reports or retrospective descriptions which are then subjected to qualitative content analysis. The study followed this paradigm. In this case the written reports were retrospective. There were two phases of data collection. In the first descriptions were elicited of a range of places. The second phase focussed exclusively on descriptions of the glasshouse complex in Edinburgh's Botanical Gardens, since a glasshouse

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[1] The partners are Aalborg University, Denmark, the Hebrew University of Jerusalem, Israel, the Czech Technical University in Prague, Napier University, United Kingdom, and the University of Bremen, Germany.

environment was to be used in the first of the series of BENOGO experiments with the technology.

2.1 Participants and method

The participants were 18 volunteers from the School of Computing at Napier University. None were directly involved with the BENOGO project at the time. A data collection instrument asked participants to describe a written description of a familiar place. It provided written instructions, collected basic personal data and provided space for subjects to supply their response. In the first phase, nine places were listed from which participants could choose one; in the second phase, participants (different from those in the first phase) were limited to the glasshouse location. The places were local to Edinburgh and both natural and built environments and interior and exterior settings were included.

Participants were asked to provide a 150-350 word written account of the place, as if telling a friend about the experience. They were further instructed "You want the friend to have as vivid an impression of the place as possible." It was hoped that this would elicit accounts which attempted to communicate a sense of place. Instructions otherwise were deliberately unspecific to avoid suggesting particular elements or a particular structure.

2.2 Results

The descriptions were analysed against (a) Relph's (1976) concept of place identity (b) the practical dimensions likely to be of immediate relevance for the design of BENOGO demonstrators and scenarios. The Relph concept suits our current purposes well because of its influential status, its strongly phenomenological bent and because the prominence given to affect and significance leant support to our championing of the need for attention to 'softer' aspects in the BENOGO design.

Individual differences

The most striking feature was the extent of individual differences in overall richness of description. For example, here are two accounts (in full) of Napier's computer centre, the JKCC. Both participants are computing lecturers with a similar degree of familiarity with the centre.

> **Description 4.** There is sunlight. It slants through the small windows and strikes the blank walls. The room is filled with about 500 computers, on benches of 12. There are ventilation grilles in the floor through which I can see deep holes. The walls at the far, high end have mysterious cabinet doors which open to reveal even more mysterious recesses. One day I'll climb in to one. Working there, there is as much isolation or contact as I need. The technicians' open-plan desk in the centre is a source of friendliness and sociability. They are always happy to chat. There is an open entrance area, carpeted but with no computers, which separates out those working from those passing through. It has a standing computer display of the system status, which itself is often faulty. The JKCC has a feeling of noise and disquiet, and it is difficult to concentrate fully.

> **Description 8.** The room is full of computers, about 500 of them on three levels. The computers sit in bays of about 10 computers. The monitors sit on benches. Each has a keyboard, mouse and mouse pad beside it. The box with disk drives etc, in sits on the floor. For each computer there is a swivel chair. In the centre is an area with a technician sitting behind a counter. There are a few students dotted around using some of the machines. The walls are blue, there are sky lights. The carpets are red.

There were also notable differences between participants in the relative depth and amount of description devoted to the dimensions described below. Participant

numbers were too few, however, to permit meaningful analysis against the places described and personal characteristics and background.

The physical setting

Numerous inanimate objects were present in all descriptions, people in most accounts, and other living beings (primarily plants) only in the Botanical Gardens.

> They are mostly coming and going to the refectory some with plastic cups of coffee in hand. (Description 11, Craiglockhart main corridor, Napier)

Comparisons with other places, or between different parts of the same place, were relatively common.

> Everything enclosed with the garden's walls is exaggerated when compared with what lies beyond. (Description 3, beside the lake in the Botanical Gardens)

The descriptions were overwhelmingly visual. Sound was mentioned in only six reports, touch/temperature in five and smell in two.

> There is a distinctive smell - a melange of wet earth, sweet rotting vegetation and the heavy non-odour of humidity. ((Description 13, Botanics glasshouse)

Activities

All descriptions had include some type of physical activity. Most were variants on bodily movement through the environment:

> …you have to dodge the shoppers and workers on their lunch break (Description 2, Princes Street)

Interaction with objects was less common and found in less than half the descriptions.

> …a few students dotted around using some of the machines. (Description 8, JKCC)

Social interaction is similarly rare, and with the exception of description 1 (quoted in full above) usually related to interaction between other people rather than the participant themselves.

> …technicians trying to help users (Description 14, JKCC).

Meanings and affect

Most descriptions attached some sort of meaning (in Relph's sense of the word) to the place or its features:

> There is an important looking control centre, it looks like a fortress… (Description 1, JKCC)

As will be apparent from this brief account, these short written descriptions provided evidence of all three aspects of place identity. Striking points from the data were the extent of individual differences, the predominance of the visual, and the relative lack of interaction with people and things in the places described. We now move on to the next phase, the first trial of the BENOGO technology.

3   Real and virtual botanical gardens

The place captured for the first BENOGO trials was a glasshouse in the Prague botanical gardens. (The partner responsible for image capture is located in Prague.) Project resources and linguistic skills precluded fieldwork with glasshouse visitors in Prague. However, we established with our colleagues that the layout, atmosphere and contents of the Prague glasshouse bore a sufficiently (and conveniently) close similarity to its Edinburgh equivalent for fieldwork to take place locally.

Performing the study in the real environment allowed us to benchmark the study in the virtual environment. The benchmarking element, a continuing activity throughout the project, is intended to help identify the characteristics of a real environment that might be important to the development of a sense of place in the virtual, and to

compare virtual and real experiences. In this instance, it also allowed the fine tuning of experimental technique.

Figure 1: Part of the virtual glasshouse panorama

At the time of this first experiment the technology permitted participants to experience a 360 panorama of the interior of the tropical glasshouse via a head-mounted display. A restriction of the image capture and processing process is that no moving objects – including people – could be included in the panorama. Participants could look all around them, but not move 'into' the environment, nor of course touch any objects therein. External speakers provided a soundtrack of sounds considered appropriate to the setting – primarily birdsong and moving water. There was no other sensory input beyond that incidental to the room where the experiment took place.

3.1 Participants and method

Thirty-three participants initially took part. Four took part in the benchmarking studies in the real environment and 29 in the BENOGO virtual environment of whom only 27 generated complete data. The participants varied with respect to their age, background and sex (22 male, 7 female) and for reasons outwith our control there was a strong representation from participants with a high awareness of virtual reality technology. All participants took part on a voluntary basis and were considered to have a good command of the English language based on our informal questioning. (The VR experiment took place in Denmark at the partner site where the VR hardware is currently located.) Data collection used three different modes:

Talk-aloud. Participants were asked to provide a running commentary on their experience as they explored the environment. It was hoped this would elicit phenomenological data with a minimal degree of cognitive processing. An experimenter prompted participants if they fell silent and an a video/audio recording of each session made.

Structured interview. The participants were given ten minutes to explore the real/virtual environment. They were then asked to describe it, as if telling a friend at home about the experience. The other questions were shorter and more specific, designed to probe specific aspects of sense of place and other aspects of the virtual experience. Again a recording was made

The think-aloud and interview questions aimed to probe the participants' experience of the phenomena identified in the literature as contributing to sense of place. A subsidiary aim of relevance to the more general issue of presence was the degree of perceived realism and the contributory factors to this. While we considered some specific questions were necessary to ensure that a comprehensive range of data were collected, it was crucial to elicit free-form contributions since we wished to discover which aspects of the environment impressed themselves on participants without our prompting. This part of the data gathering procedure mirrors the written descriptions obtained in the pilot study. Requesting written material was considered but dismissed in view of the extra burden on participants who were not native speakers of English.

Questionnaires. The project has an underlying interest in the overall phenomenon of presence, and we administered two quantitative instruments well-established in presence research which address overall immersive tendencies and perceived sense of presence. This data is not discussed further in this paper, since it is not of primary relevance to sense of place. Later work may however consider whether and how the quantitative data derived can aid the interpretation of the qualitative 'place' data.

3.2   Experimental procedure

Figure 2: Wearing the HMD

Each participant was required to complete an immersive tendencies questionnaires before any exposure to the environment. In the real environment, each participant then explored freely with a video camera capturing their experiences of the environment by talking aloud as they explored. They were then interviewed. Initially both the talk-aloud procedures and the interviews were carried out with all participants. Further reflection after this phase of the study suggested that the talk-aloud procedure might influence the descriptions elicited in interviews and the procedure was revised for the VR element of the trial.

In the virtual environment each participant was asked to stand in a central position surrounded by four speakers and to wear the head mounted display (HMD). They were informed that they could turn 360 in either direction and to look up and down but their physical movement would be restricted -to about two metres in diameter- by the cables supporting the HMD. In the talk-aloud group, participants then explored the virtual environment and their commentary was recorded. The camera captured a screen of what the participants were seeing from a static position while the participants 'explored' using the HMD. For the interviews participants were simply asked to explore and enjoy the virtual environment. They then took part in the interview immediately afterwards. Finally all participants were asked to fill out the sense of presence questionnaire and the study was concluded.

3.3   Results

Data from both real and virtual environments are reported in each section below. For reasons of space, material is restricted to that of most direct relevance for sense of place, and the results from interviews and talk-aloud have been combined. As in the pilot study, there were considerable individual differences in the richness of the accounts elicited.

The physical setting
In the both the real and virtual glasshouse participants commonly identified objects such as trees, plants, water and parts of the building. Fish, birds, signposts, heat, humidity and people were all noted (and actually existed) in the real world but were not present in the BENOGO environment. The only time any of these were mentioned in the BENOGO environment was to point out their absence. (Note: participants are labelled r-real, b-BENOGO)

> I see a garden with a bridge and an object, looks like coming from a leaf, staying in the middle, then I see the sun on the leaves. I hear some water. I see the roof. *Participant b2*

> There is no moisture in the air, in my breathing or sensing on my skin. That's one of the things I'm missing. *Participant b10*

Sound appeared prominent in both environments. In the BENOGO environment many participants commented on the sound, its realism and its match to the visuals. In the real environment comments were restricted to the water, the humidifier, and the sense of quiet. Every participant in the real environment commented on the sheer overall greenness and also the intense colours of individual plants. In the BENOGO environment, comments were confined to the lack of realism or depth of colour. Atmospheric quality was also a prominent feature of the real glasshouse. All participants commented on the pervasive heat, humidity and smell.

> The first thing that hits you is when you open the door and you get a whack of the humid air inside it…the heat and the smell which is the smell of the air… the smell of the plants… the smell of the flowers...the smell of the water… and that's the first thing that hits you cause its not like your everyday experience. *Participant r1*

In the BENOGO environment, many of the participants commented on the absence of these features.

> I have been to a botanical garden and some of the most distinct things about that is…the warmth and the water in the air and the smells that make a big impression when you are there and I needed that to make this seem more real. *Participant b5.*

Activities

Inevitably, participants in the real world had much more freedom of action. They spoke of wanting to run around, to touch (and in one case, eat) the fish and to touch a strikingly vivid red flower. In the BENOGO environment frustrated attempts to move and mentions of wanting to move were quite common across most participants. Note also the desire to pick a leaf.

> I get the feeling of being attracted to walking over the bridge or trying to step down on some other place maybe walk round, to explore it even more. *Participant b10*

> I think I would have liked to have taken a leaf or taken a walk around… *Participant r28*

Neither environment stimulated comments about interpersonal interaction.

Meanings and affect

The real world stimulated much more reference to significance and memory. Sometimes this was triggered by individual features, as in this case.

> And you remember how relaxing the sound of moving water is' *Participant r1.*

Participants were also often reminded of other places, such as other botanical gardens, gardens in general or places with hot climates. Cultural references to films such as the Jungle Book, Tarzan and other jungle films were mentioned together with memories of holidays, family and in the case of two Greek participants, home. In the BENOGO environment there were some mentions of memories of other botanical gardens and holidays but little that was as vivid as those in the real environment.

> "It reminds me of Kew Gardens I went there when I was younger, the other thing is the heat and the condensation it reminds me of a shower. Its very relaxing and quiet" *Participant r1*

> It reminds me of a place, a museum in Copenhagen which has a kind of indoor garden like this. It's not the same actually but it sounds very much the same. So it kind of reminds me of that place and I am associating, trying to drag on my experiences of being in a place like that… it reminds me of being on a holiday in a different place. Actually it doesn't remind me of a rain forest although it could be but there's too much light in here. *Participant b10*

Interestingly, more than one of the visitors to the real glasshouse also commented on the artificiality of the environment.

4 Discussion

The numbers involved in this study are small, and as noted above, subject to large individual differences, so we should be careful about generalising too far from these

conclusions. Some tentative suggestions can be made, however. The accounts of real places obtained in the pilot study and from participants in the real botanical gardens contained a good deal of material which suggests that existing concepts of sense of place, and in particular, Relph's characterisation of 'place identity' can be extended beyond places which are the subject of long association, and/or are residential. All three elements – physical setting, activity and meaning, appeared to be salient features in the accounts we obtained, although there was little mention of social relationships or interaction. Thus it would seem that such concepts should have utility in considering the re-creation of 'visited' rather than 'dwelt in' places.

As for the virtual glasshouse created for the Benogo experiment, there are indications that some vestigial sense of place may just have survived the considerable restrictions imposed, at least for one or two participants. Aside from some degree of audio-visual correspondence, there is the desire to move about – as in the real glasshouse – and to pick a leaf. There is also one account where associations with other places are triggered. Although there needs to be a much more weighty body of evidence before we can be convinced that a sense of place has been created, it is worth at this point recalling the accounts of place obtained in the pilot study. These described the experience of real places, yet in some cases were almost completely devoid of significance and meaning. It would not have been surprisingly to be told that these accounts were of virtual environments. Individual differences in relation to the experience of place may prove to be an overwhelming factor in the results we obtain. We are currently considering ways of exploring this in the experimental work.

There are a number of practical routes to enhancing the effectiveness of the experience in future. One simple change is to select a place with less striking qualities of heat, humidity and smell, some of which are difficult to reproduce under current technological constraints. It should be possible to render colours more accurately, and the next iteration will take place in a virtual reality 'cave', thus allowing participants more freedom of physical movement. Much richer soundscapes can be employed (for an example of this, see Turner *et al.*, 2003). Other possibilities include the addition of real objects to the virtual environment. Perhaps more interesting is the scope for enhancement in other ways – embedding the visit to the virtual place in a convincing narrative, for example, or providing participants with appropriately realistic tasks – for example identifying plants, in this instance.

As for experimental technique, the procedures were satisfactory in that they provided us with a large amount of qualitative data to analyse. There are however significant issues to reconsider for the future, some more easily remedied than others.

Coding reliability is always a vexed question when dealing with qualitative data. So far the data has only been coded by members of the team working individually. Clearly we need to establish procedures to ensure inter-coder consistency and also to avoid coding drift. Adopting qualitative analysis software which permits sharing of coded material should help to support this.

The talk-aloud technique and interviews were dominated by a preoccupation of most participants with the technical properties of the virtual environment. This problem is likely to have arisen from the fact that most – for reasons beyond our control – were members of VR laboratories and hence had considerable levels of VR knowledge. We will seek a more balanced population in future. A further issue with the talk-aloud is the tendency for some participants to 'dry', occasioning heavy prompting which may have influenced the content elicited. This we intend to counter by providing a more strongly motivated reason for the commentary in the next experiment.

A more difficult issue is to ascertain how far we obtained data pertaining to participants' direct experience and how far this was (a) shaped by people's exposure to conventional accounts of place and (b) stimulated and directed primarily by our instructions, however neutral we intended these to be and (c) shaped by the language available to participants, many of whom were not using their mother tongue. We necessarily use language to describe our experience of place. But language is much more than just a descriptive tool, as the work of cognitive scientists, philosophers of language and developmental psychologists have shown who have in their different ways convincingly argued that language may also affect our very cognition (e.g. Clark, 1997, Dennett, 1991 among many). It may be that language may both constrains our description of place and our cognition (and/or experience) of that place, cf the Whorf-Sapir hypothesis (Whorf, 1956). While this may be an unconscious inevitability of our everyday lives, it needs to be understood, quantified and qualified when we are faced with creating a sense of place using VR technology. The issue is one which will continue to preoccupy us as the project progresses.

Finally there question of whether a sense of place can be experienced without a concomitant sense of presence, of being there. BENOGO is part of the EC's Presence initiative, so this is not without interest. For example, many of us will have had the experience of feeling familiar with a place from photographs, films or travel writing encountered before a real visit – Venice being one city which commonly evokes this impression. We suspect that Relph's concept of the various degrees of insideness-outsideness (Relph, 1976) may be afford some help in investigating the issue in later experiments with more sophisticated versions of the virtual environment.

5   Acknowledgements

6   References

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