INVESTIGATING AMBIENT AUDITORY INFORMATION SYSTEMS

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ABSTRACT

This paper discusses an exploration using a concurrent auditory displays for awareness and lightweight interactions. The design of this type of system and comparisons to existing awareness tools are discussed. The auditory display system in this exploration was designed to explore, using concurrent auditory icons, the issue of group awareness. The sounds used in this auditory display where selected based on their identification derived from individual's personal constructs using the Repertory Grid Technique. The system was designed to create a 'soundscape' of concurrent ecological sounds mapped to the individual's availability and to the group activities, respectively.

In this paper we present an auditory display using auditory icons to create an interactive soundscape that support opportunistic interactions and awareness. Presence and activity are conveyed by changes in the soundscape. Our goal in this work is to explore the potential of this type of system for supporting awareness and lightweight interactions.

[Keywords: Ambient Display, Auditory Icon, Awareness, Opportunistic Interactions]

1. INTRODUCTION

Our work has been influenced by prior systems such as Mauney et al's [1] work on stock market monitoring, Peep [2], WISP [3], Bovermann's et al work on Ambient Data Displays [4] and Audio Aura [5]. Mauney's system concentrated on dynamically rendering sonifications of real-time stock market data. It used an immersive soundscape consisting of natural sounds with threshold values mapped to trigger certain sounds based on the stock market data. Peep created a network monitoring system using auditory icons to represent network events. WISP or the Weakly Intrusive Ambient Soundscape as envisioned by Kilander allows the states and events in the particular computational and physical environment to be presented as subtle and non-intrusive distinct sound cues that conveys information through intuition rather than through interruption. Ambient Data Displays combine ideas from earlier systems with concepts from Tangible Computing [6]. The most influential of these previous systems on our work was the Audio Aura system. This was designed as a serendipitous soundscape for peripheral awareness using background auditory cues.

Presence and place are complex and loaded terms. In this paper we have adopted the definition of place as meaning the direct, everyday experience (in the phenomenological) sense of that place and use the group awareness system to investigate one aspect of place, that of *presence - being* in a similar manner as described by Turner et al [7]. Basso [8] described how '*places possess a marked capacity for triggering acts of self-reflection, inspiring thoughts about who one presently is, or memories of who one used to be, or musings on who one might become*', that complements our thinking behind a group awareness system as a mechanism for supporting awareness and lightweight interactions. Our exploratory group awareness system examines the use of auditory representations using auditory icons as presence indicators, in order to better understand presence indicators and their overall usefulness for conveying a sense of presence.

Awareness is yet another loaded term from psychology and it is easy to get lost in circular arguments. We have adopted the prevailing concept from the area of ambient / peripheral displays for use within these studies. Awareness has been defined by Dourish and Bellotti [9] "*an understanding of the activities of others, which provides a context for your own activities*" and expanded by Wisneski et al [6] as "*the state of knowing about the environment in which you exist; about your surroundings, and the presence and activities of others*". Lightweight interactions are the type of interactions that are triggered by informal, spontaneous interaction between people. These lightweight interactions or *opportunistic* interactions are the kind that happen when people meet one another when they have something to discuss, such as in the corridor or at the coffee pot. Studies have shown that these informal interactions are useful for getting work done [10, 11, 12]. Encouraging *awareness moments* as discussed by Nardi [13] which "*produce a certain feeling in people, rather than accomplishing information exchange ... Awareness moments argue for a richer notion of communication than current media theories allow. Even when no direct information exchange is taking place, people want to maintain connection with others, outside the context of specific events of information exchange*" was one concept that inspired our explorations and the design of our systems.

Designing auditory interfaces for awareness and lightweight interactions that function within existing work practices and the existing workplace soundscape [14] requires new approaches to explore the technologically rich modern work environments which are burdened with high information and interaction loads. Auditory interfaces are one mechanism for increasing the potential bandwidth for communication in these types of environments.

2. AMBIENT INFORMATION SYSTEMS

"Ambient displays", "peripheral systems" or "notification systems" are some of the labels given to the study of systems that "*present* *information within a space through subtle changes in light, sound, or movement, which can be processed in the background of awareness*" [6]. As the exploratory system we are discussing is an ambient information systems, we will use Pousman's and Stasko's [15] definition of ambient information systems characteristics for the behavioral characteristics[1] of our system:

- Display information that is **important but not critical**.
- Can **move from the periphery to the focus of attention** and back again.
- Focus on the **tangible**; representations **in the environment**.
- **Provide subtle changes** to reflect updates in information (should not be distracting).
- **Are aesthetically pleasing** and environmentally appropriate.

In Pousman's and Stasko's [15] taxonomy of design patterns of ambient information systems, there is one pattern which relates to this research. The ambient group auditory display (see Section 6.1) can be seen as a **multiple information consolidator** which is concerned with displaying many individual pieces of information about people and their presence in a consolidated manner. The existing classifications of these types of systems concentrate on the visual aspects and often neglect or relegate the auditory aspects. This provides opportunities for explorations of ambient information systems using auditory displays either as the sole element or as an aspect within a multimodal ambient information system.

3. SOUNDSCAPES

Natural sounds are more easily recognised in an office environment when compared with recognition of artificial tones [5]. Our previous research in concurrent auditory icons [16] supported the ability of users to identify several distinct but concurrent auditory icons. For these reasons, we designed a system that would use natural sounds such as birdcalls, electro-mechanical sounds, and animal calls to create an immersive soundscapes to sonify the presence of group members. This approach aims to create an auditory display that can be easily distinguished from the background whilst remaining in the periphery of attention and "non-intrusive" whilst ensuring that the group members could have a distinct sound personality within the soundscape.

In designing the soundscape, we decided to employ natural sounds to serve as event signifiers, which have a direct mapping per event to sound. The user-defined gradients use thresholds taken as the percentage change above or below a set value. Event notification of the user-defined gradients items are sent to the system allowing for the calculation of the current change with regard to the set value and to turn on the sounds that represent the particular threshold once it has been exceeded. These thresholds are controlled to allow either continually looping, single play, or a random number playbacks for the sounds, as specified by the user. Sound quality is a critical factor in both the realism and aesthetic quality of a pleasing soundscape. Continually looped sounds were edited to ensure that the endpoints were not distinguishable. Ideally, we would have used dynamic parametrically synthesised sound models for the sounds within the soundscapes but given the difficulty in their creation, specifically the accurate identification and synthesis of their salient features, we have initially used sampled sounds as it was the best solution available to us at the time. We hope to identify the success sounds within our initial exploratory application and use these sounds to create sound models. The sound files used where monophonic and had a CD audio quality rate (44.1kHz) to ensure high sound quality.

The design of the soundscape used in our system is generic and is modifiable to accommodate additional applications or data sources being added, with only minor reconfiguration to a simple textual (XML) configuration file. The random selection of a particular clip representing an event from a pool of clips, concurrency issues such as onset, latency as well as event priority issues as discussed in Papp's [17] "Computational Auditory Scene Synthesizer" provide heuristics that create a more natural soundscape. These heuristics ensure that a soundscape will never sound exactly the same twice, even when encountering the same set of data and events, but these sounds will still be perceived as having the same meaning. The events, mappings, and sound designs for this study are discussed in further detail in Section 6.

[1]Their emphasises are shown in bold.

4. SOUND DESIGN

Sound design has long been addressing the issue of concurrent presentation of everyday sounds, as sound designers are not recreating "real" sounds rather they are attempting to create the impression of the real sound in the mind of a listener. The listeners cultural and physical experience form part of the users expectations and contribute to the listeners mental model. An essential part in creating an effective design is easing the identification of a given sound or combination of sounds. People often create stories to explain a sound or set of sounds but these stories may not always be the story/stories intended by the sound design [18]. A sound in isolation can be very ambiguous in its meaning but by putting it in context with other sounds, its meaning can be made clearer. In designing with everyday sounds it is important to establish which sounds are ambiguous and either place them in a contextual relationship with other sounds to clarify their meaning or remove them and select a sound with a clear meaning that still suits the particular context[2].

The auditory display we discuss in this paper aim at establishing sonic narratives and exploring their use in a real world context. Maribeth Back [19] used a sound-based approach with narrative and well-chosen sound allowing for cultural meanings to be evoked. Back's approach deals with micronarratives where small events are stories with identifiable elements and each small event can be combined to create an ecology and used to evoke a higher-order schema. The auditory display we discuss in this paper aim at establishing sonic narratives and exploring their use in a real world context.

Adding more and more sounds to an auditory design is not always the best approach. The research by Schaeffer [20] and by Truax [21] in examining, recording and analysing real world soundscapes led to the development of categories for classifying semantic sound. Three important concepts from Schafer are:
keynotes, signals, and soundmarks. Keynotes are ambient, background sounds that form the backdrop of the soundscape. Sound signals are sound events which occur in the foreground of the soundscape and that present information. Soundmarks are unique sounds and the auditory equivalent of landmarks. We asked group

[2]There are several levels of context, the sounds themselves as the particular union of events in a soundscape, the listeners, the current state of mind and environmental factors.

members to listen to a set of sounds and used a verbal protocol analysis technique to derive their personal constructs for the sounds. They were then asked to select their individual sound or soundmark for use in the group awareness auditory display. Each group member was encouraged to personalise their individual sound or soundmark for use in the group awareness auditory display.

5. DERIVING PERSONAL CONSTRUCTS

The Repertory Grid Technique (RGT) [22, 23] is a method which can be used to elicit and structure information from a participant. The method can be used to reveal the structure of a person's classification of experiences in a manner that encourages personal reflection upon the qualities of the stimuli under examination. These stimuli or elements as they are also know are derived along with the definition of a personal set of constructs that differentiate between the elements, or sounds in the case. Triads of sound stimuli were presented to each subject, who were asked to describe in which way two of the stimuli were alike and how they differed from the third stimuli. The next triad is then presented and the same question asked. The results of this method is a set of bipolar constructs (verbal descriptors). The constructs are created out of opposing pairs of terms, such as loud – soft or animal – mechanical. The final stage, used a rating method for each stimuli where the participant rated along the elicited descriptors.

5.1. Elicitation of verbal descriptors

The verbal descriptors were elicited from participants in the following manner, each participant was presented triples of stimuli, and asked which of the three sounds differed the most from the other two sounds. They were then asked to describe the way in which the particular sound differed from the other two sounds. These descriptors where used to create the bipolar constructs, these words or phrases where later used as the poles of a rating scale. Participants were allowed to re-use existing descriptors and there was no limits on the number of times a sound could be replayed by a participant. This approach seeks to *implicitly* elicit descriptors with opposite meanings from participants. In order to prevent salient differences being found between two sounds when always presented together with a more dissimilar sound, each participant was presented with a randomised set of triples from the stimuli set being evaluated for the experiment.

5.2. Rating

The rating process of the stimuli was carried out by the participants after all the triples had been presented to the participants. The aim of the rating process was to indicate the degree to which each construct was stimulated or excited by each stimulus, and to generate numerical data for pattern matching between the constructs. This was accomplished by instructing one subject at a time to rate each of the subjects own personal constructs on a five-point scale for every stimulus in the rating sequence. The end points of the scale where bipolar constructs (verbal descriptors) given by the particular participant, each set of bipolar constructs where used to rate the entire set of sounds.

5.3. Reduction to fewer attributes

The current method using both elicitation of verbal descriptors and rating produces a large number of descriptors. This approach generates a large number of attributes per subject for analysis, which we analysed using principal component analysis [24] and hierarchical cluster analysis [25]. These methods as they apply to the RGT method are discussed in greater detail in Berg [26] and in Choisel and Wickelmaier [27]. Cluster analysis was performed on the participant's ratings associated with each descriptor as proposed by Berg and Rumsey [28]. A matrix of distances between each of the scales was calculated. The distance between the two scales was: $d_{ij} = 1 - |r_{ij}|$, where r_{ij} is the correlation coefficient between the two scales. The correlation of scales will vary from 1 for uncorrelated scales to 0 or close to 0 either positive or negative for correlated scales. Cluster analysis creates a *dendrogram* from the distances, where the descriptors/scales are leaves and where the nodes are clusters. The more similar two scales are, the closer to the bottom their two respective leaves will be connected.

6. AN EXPLORATION WITH A CONCURRENT AUDITORY DISPLAY

The system was designed for portability, based on the Mac OS X system architecture using Ruby, Python and C and builds upon two existing open source applications, Growl[3] and Boodler[4]. The group auditory display is directed toward research group members who are co-located in the same office-space and displays information about the presence and availability of fellow research group members that it is intended for others to hear. Papp's "Computational Auditory Scene Synthesizer" [17], which allowed the centralised aspects of the system to take into account the entire state of all systems and applications running and through the use of heuristics and knowledge from auditory scene analysis provide a better "centralised sound dispatcher" that included concepts of concurrency, priority and masking. Simple heuristics such as preventing two sounds from having onsets occurring simultaneously (or nearly simultaneously) can prevent merging of those sounds, whilst staggering similar event sounds and ignoring multiple alerts based on the same event can help in establishing a less cluttered but still informative soundscape.

6.1. Exploring an ambient group auditory display

The motivation for an ambient group auditory display was to provide information about the *presence* and *availability* of co-located colleagues. In particular, we use Huang's and Mynatt's idea of the *Semi-Public Display for Small, Co-located Groups* [29] where the information displayed is used to support members of the co-located group within a particular physical space, the space being somewhere not frequented by passerbys. This display can be classified as a *Single Display Groupware* as defined by Stewart et al [30] as "*computer programs that enable co-present users to collaborate via a shared computer with a single shared display and simultaneous use of multiple input devices*".

The placement of the ambient group auditory display is an important factor and as such we positioned the system inside the door of our laboratory where it was activated by a pressure sensitive floor. We chose this space on reflection upon our group's space, its activities, and on comments by Nichols et al [31] where doors can

[3] http://growl.info/

[4] http://www.eblong.com/zarf/boodler/

"*serve as a medium for communication, where people can broadcast individual messages to passerby's*" and as "*physical barriers*". Our idea continues the approach of Nichols et al [31] whose LabraDoor used a door which was supplemented to function as a mediator and as a medium for communication. The layout of our laboratory includes a small waiting area before widening out into a larger cubicle area, we hoped that the system could provide people entering an *auditory gist* [32] as they enter this waiting area.

The system was aimed at encouraging *awareness moments* and facilitating lightweight interactions or "*opportunistic*" interactions. The display centralised the relevant *presence* and *availability* information about group members from several sources and we hoped this would reduce the effort necessary in gathering such information from various channels such as email or word-of-mouth. This information was taken from several sources including the individual peripheral auditory display, machine presence on the network, and instant message activity by the user where the primary sources. Additionally, several of the participants used the individual peripheral auditory display that had been modified to transmit a network presence message via Growl. The display was located in the coffee / dining area used by all the colleagues and was aimed at providing a short auditory gist of who was present and available at that time by using Sound IDs, similar to those in the Hubbub system [10] but designed with auditory icons rather than earcons. Another potential use for the system was to help identify when short term visitors to the laboratory where present. The mapping from message / event to auditory icon for the ambient group auditory display scenario is shown in Figure 1.

The group display uses an embedded computer, an Arduino[5] shown in Figure 2 to monitor the pressure sensor fitted inside the floor of the laboratory entrance. The pressure sensor uses a force sensitive resistor (FSR) [34]. We chose this sensor based on our earlier experiences with this type of sensor [35]. The Arduino was chosen because it is a open source computing platform which in addition to containing the micro-controller board also offers a development environment for writing software for the board. It runs on Windows, Macintosh OS X, and Linux operating systems and can be interfaced with many programming languages including Flash, Processing, PD, Max/MSP, Director, Ruby, and C. This embedded system allows for the group display to be activated when somebody enters or leaves the lab. The group display uses a standard PC to run the processes which poll the state of the members in our research group and creates the sounds for display. The group display PC contains the sound card whose output is activated by the pressure sensor linked to the PC by the Arduino, this PC also runs a web-server which offers audio files on-demand allowing iTunes, WinAmp, or other music player to request the group display sound files for playback on the particular group member's PC. This allows group members at their desks to determine the presence and availability of other group members.

7. EVALUATION

The group auditory display was installed in the entrance to our research group's offices as shown in Figure 3. The display was demonstrated to our fellow researcher. After a week, they were asked about their experiences through questionnaires and interviews which were supplemented with data from application logging. A study was conducted with 15 participants for the group auditory display.

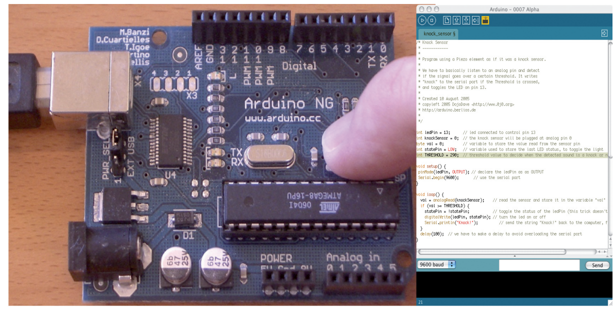

Figure 2: *The Arduino board and its programming interface.*

Figure 3: *The entrance to our research group's offices.*

7.1. Methodology for evaluating the sound design

In order to evaluate the sound choices for the scenarios as discussed in Section 6, participants were asked to consent to application use (not content) logging and were interviewed in a semi-structured manner after a week's usage of the display, they will complete a post use questionnaire, in addition to three questionnaires during the period of use of the individual display. Combining the use of interviews and questionnaires we aim to qualitatively explore rather than empirically measure or verify (see Slater [36]) the phenomenon of awareness or of lightweight interactions, as the possibility exists that these phenomenon were simply called into being by having been enquired about through post-event measures. The NASA-TLX [37, 38] measure was rejected as it may simply be called into existence post-event in a similar fashion suggested by Slater [36] to the evocation of presence. Our use of questionnaires aims to provide qualitative measures that can be combined with interview data, as an approach to limit the potential of phenomenon being called into existence through enquiry about the particular phenomenon.

The questionnaires were designed to elicit user responses to the following issues:

1. The user's satisfaction with the system
2. The user's judgement regarding the effectiveness of the system
3. The user's judgement regarding the disturbance / interruption of the system

[5] The Arduino contains a standardized "bootloader", 8 kBytes of Flash program memory, 1 kByte of RAM, runs at 12MHz, has 13 digital input/output pins, and 5 analog input pins. It is based around a ATMEL AVR ATmega8 processor [33] and uses a RISC type architecture.

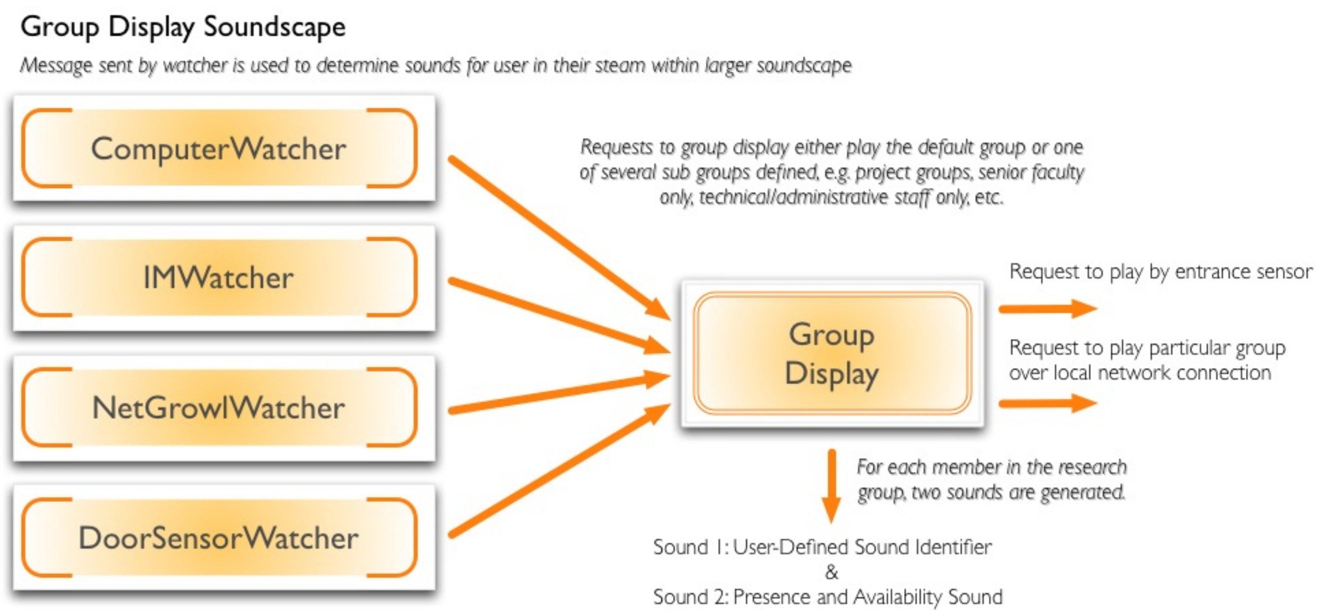

Figure 1: *Soundscape mapping between events for the ambient group auditory display scenario.*

4. The user's judgement regarding the aesthetic quality of the system
5. The user could easily interpret the availability/presence of colleagues
6. The user could easily distinguish other colleagues' sound identifiers

In this questionnaire, elements 5 to 6 are better suited for a quantitative research experiment. Therefore the results are indicative rather than statistically robust or significant. The questions used in the study are given in Table 1.

The interview consisted of a small set of open-ended questions aims to provide the opportunity to discover themes and issues about the users experience, such as asking questions related to determining good elements of the design, problems, and whether the designs met the users expectation. Qualitative analysis of the interview data will provide interpretative accounts of the users experience and identified help in identifying successful design elements.

7.1.1. Phase 1 Training With The Group Awareness Display

The first stage of this study involved the familiarisation of the participants with the group awareness display and the auditory icons that represented group members and how these represented the group member's presence / availability are shown in Figure 1.

7.1.2. Phase 2 Exploration With The Group Awareness Display

The participants are asked to list the people who they could determine where present using the group awareness display on three randomised occasions within the period of use. The particular participant would be prompted by an email to fill in a matrix type question containing a list of people within the group and a set of presence / availability categories as shown in Table 2, in addition to the questions shown in Table 1.

Questions
Phase 2
1. The group awareness display proved an aid in determining who was present (Strongly Disagree [1] . . . Strongly Agree [6])
2. The group awareness display allowed me to determine when people where last present (Strongly Disagree [1] . . . Strongly Agree [6])
3. The sounds associated with people in the group awareness display were easy to distinguish (Strongly Disagree [1] . . . Strongly Agree [6])
4. The group awareness display was not disruptive (Strongly Disagree [1] . . . Strongly Agree [6])
5. The group awareness display and its sounds were pleasant to listen to (Strongly Disagree [1] . . . Strongly Agree [6])
6. The group awareness display was easy to learn and recall (Easy to Learn [1] . . . Hard to Learn [6])
7. My current method of tracking people's presence and available is (Good [1] . . . Bad [6])
8. The auditory method of tracking people's presence and availability is (Good [1] . . . Bad [6])

Table 1: The questionnaire for the study.

7.2. Results

The preliminary results from our exploratory study found some interesting results, it is however important to remember that the repertory grid technique results from a participant are their own world view and their related constructs. Each participant will have their own distinct viewpoint and as such results whilst potentially similar, are not always aggregable across all participants.

7.2.1. Repertory Grid Technique

A sample of the verbal descriptors elicited from participants are shown in Figure 4. The full list of verbal desciptors can be found

Person	*Present Free*	*Present Busy*	*Not Present >2 hrs*	*Not Present >24 hrs*	*Not Present >7 days*
P1	☑	☑	☑	☑	☑
P2	☒	☒	☒	☒	☒
P3	☑	☑	☑	☑	☑
P4	☒	☒	☒	☒	☒
P5	☑	☑	☑	☑	☑

Table 2: An example result of the presence / availability - person matrix question.

online as discussed in Section 11.

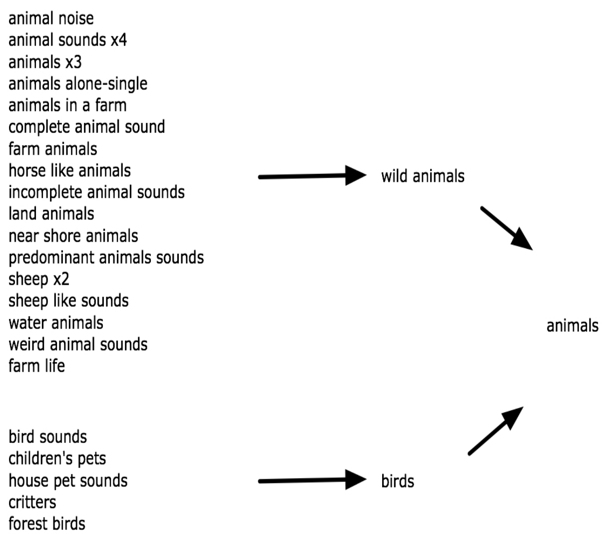

Figure 4: *A sample of the verbal descriptors elicited from participants with category reduction carried out in a similar fashion to Brazil and Fernström [16].*

In order to reduce the number of descriptors, cluster analysis was performed on the ratings associated with each descriptor. The cluster analysis was performed individual for each participant and the result for one participant is shown in Figure 5 and the resulting clusters for the same subject is shown in Table 3.

Full results, subject data (anonymised), software source code and results are available for download as discussed in Section 11.

8. DISCUSSION

The use of the triadic elicitation in the repertory grid technique, does not require that the participants opposite words or expressions and as such some rearrange of the words was necessary, this was followed by a verification from the participant that the two word of each study had an opposite meaning in their view within the context of the sounds under study. The large number of descriptors obtained per participant (up to 14 per participant), and given a certain redundancy within the descriptors, we used cluster analysis to reduce the number of attributes. Although synonymous or semantically related word often grouped together in the same cluster, this was not always the case, and this difficult choice was left to the experiment to label the cluster. The difficulty in this choice

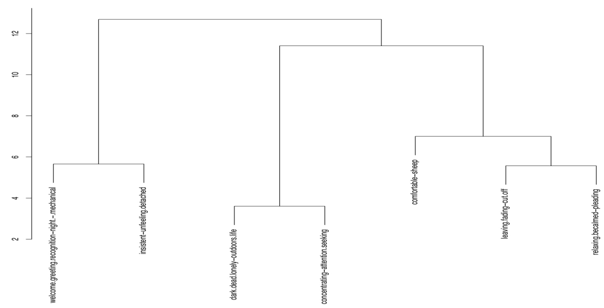

Figure 5: *Cluster analysis of the RGT construct for participant 5. The clusters corresponding to the latter case are detailed in Table 3*

	Emergent Pole	*Implicit Pole*
1	welcome greeting recognition	night / mechanical
2	comfortable	sheep
3	dark / dead / lonely	outdoors life
4	leaving / fading	cut off
5	concentrating	attention seeking
6	relaxing / becalmed	pleading
7	insistent	unfeeling / detached

Table 3: Clusters obtained for participant 5.

was that the same word or descriptor could be used to convey different intentions by the participant. This could cause reliability issues but these could potentially be avoided through several repetitions of the ratings stage. The repertory grid technique proved a useful technique for elicit verbal descriptors. This type of study can provide guidance by improving what a user's interpretations of a set sounds are and in creating designs based on these results where possible metaphors can be extracted from the participants descriptors. More studies are needed on what people hear when they listen to sounds to increase our understanding of the perceptual and cognitive processes involved.

Based on the analysis of the system's logs available from our exploratory studies we can now begin the next logical step in the evaluation of the sound choices made by carrying out listening tests of the sounds using the same methodology and rationale presented in our earlier investigations of concurrent auditory icons [16]. The system and its logs allow us to note the commonly occurring events and patterns that populate the soundscape. These can be used to generate listening test conditions with the particular auditory icons for those events. Sounds that were difficult to identify can be discovered through use of the systems and through the final semi-formal interview, these difficult to identify sounds can be further tested with listening tests to confirm identification issues and to test alternative sounds.

Our system used multiple pressure sensors to recognise when a person is either entering or leaving the lab, as this would allow the display to play the soundscape only when somebody enters the lab. This raised another issue which arose the hidden use of these pressure sensors and was related to the ambient aspect of the system. Several participants asked about a less ubiquitous and more prominent switch for the display to act as a trigger so people could choose to activate the display or to avoid its use. The '*footswitch*' which we are currently investigating is shown in Figure 6.

Figure 6: *A more obvious 'footswitch' to activate the display, this would be place above rather than below the carpet in the hall.*

The evidence from this type of exploratory studies is never conclusive. We hope the results of our research will lend further support to the idea that awareness and lightweight interactions can be supported by auditory feedback.

9. FUTURE WORK

This applications began as single distinct project, but as work has progressed, it is becoming increasingly apparent that there were many opportunities for providing a useful infrastructure which could be used by other applications for sharing information between them. A goal for the near future is to find a common configuration profile for the application that can be easily modified by users. The system needs to be tested on larger groups in an effort to determine the social impact of this type of ambient group display. We are planning to collect social networking data to see how awareness and use of the ambient group display impacted on the members who used it. Privacy issues were a major issue raised in initial design discussions and again in participant interviews, as several users expressed worry about issues regarding the history information available from the systems.

10. CONCLUSION

We have created an application that allowed us to explore peripheral displays using auditory display. We are eager to expand this application and its user base, as well as conduct further development and deployment of the application. Although we are still far from a truly ubiquitous deployment of auditory peripheral displays, we hope that others can learn from our experience and be more inclined to experiment with their own auditory peripheral displays in this, and other, contexts.

11. ONLINE INTERNET RESOURCES

The software source code and non-commerical sounds used for this study are available for download at http://richie.idc.ul.ie/eoin/icad07/, along with the interview and questionnaire results. The details about commercial sounds will be included (in the format devised by Shafiro and Gygi [39], see Appendix C in their paper for an example.) but due to copyright issues, the sounds themselves will not be available for download.

12. ACKNOWLEDGMENTS

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