VISUAL AND ACOUSTIC FACTORS AFFECTING THE ASSESSMENT OF TRANQUILLITY

R Pheasant School of Engineering Design and Technology University of Bradford, West Yorkshire
B Barrett School of Life Sciences University of Bradford, West Yorkshire
K Horoshenkov School of Engineering Design and Technology University of Bradford, West Yorkshire
G Watts School of Engineering Design and Technology University of Bradford, West Yorkshire

1 INTRODUCTION

The ever increasing speed and intensity of modern life is placing unprecedented pressure on areas that have traditionally been valued for their peace and quiet. As more greenfield sites are brought into development and areas of inner city green space lost, the ability of people to seek out the type of environments that aid recovery from the sensory overload of everyday urban life becomes compromised. Such restorative tranquil environments have been described as providing 'soft fascination'[1], which is deemed to occur when there is enough interest in the surroundings to hold attention, but not so much that the ability to reflect and relax becomes impeded. In comparison, locations that provide 'hard fascination', or sensory overload, are so intense that they leave little or no room for reflective thought. Therefore, protecting existing, and creating new tranquil environments, becomes an important aspect of landscape management and design. However, we can only begin to move towards an engineered solution to this challenge by understanding both the objective and subjective qualities that make these environments so valued in the first place.

For the purposes of this project, the extent to which a place is considered to be tranquil is defined by how much individuals think a particular setting is a quiet peaceful place, i.e. a place to get away from 'everyday life'[2]. When constructing such 'tranquil space', people draw upon a complex array of emotional, experiential and sensory inputs. However, despite considerable research being undertaken to determine how visual and auditory modalities work together it is still uncertain how they combine and interact to bring about a state of tranquillity. This is supported in part by findings from the field of acoustics, which has established that there is a link between the perceived degree of noise annoyance and specific visual settings [3,4,5,6,7]. These studies significantly contribute to the current understanding of tranquillity assessment and link directly to this multidisciplinary project, which seeks to investigate in a real world setting how the auditory and visual modalities influence the construction of tranquil space.

For these reasons although defining Quiet Areas in accordance with the Environmental Noise Directive (END), using purely acoustical measures is an important step in protecting tranquil spaces[8] there is a need to go further and integrate both aural and visual factors into an overall descriptor that will be more precise and fit for purpose.

The work undertaken so far in this study has involved a ranking exercise of perceived tranquillity and the use of audio and video footage to provide sensory stimuli in an exercise designed to assess the soundscape quality of a variety of different landscapes. The video footage collected is being used in a series of subjective assessment exercises where both visual and auditory stimuli are presented. These experiments will be reported on at a later stage in the project.

2 DATA COLLECTION

The 100 images which were ranked from the most to the least tranquil by 105 subjects, utilized scenes selected from a database of 360 photographs that were taken from across England during the summer

of 2005. The data set included 20 colour images from each of the following five generic landscape classifications: mountainous and wilderness; coastal; parks and gardens; rural; and urban. These 15cm x 10cm images were randomly selected to cover a range of tranquillity ratings and included a broad spectrum of landscapes that were identifiable, if not familiar to, the subjects taking part in the experiment. The chosen angle of view was generally suitable for taking typical landscape views, i.e. telephoto shots were avoided.

2.1 RANKING EXERCISE

The primary aim of the ranking exercise was to develop a systematic approach to identifying landscape types which, through engineered solutions, have the potential to facilitate tranquillity, in order that they could be filmed and used as representative samples during the main subjective assessment experiments. This comprises the current phase of the study. This filtering process may be novel as previous papers [2, 5], that have used still images to determine how quiet a particular scene is perceived to be, have not provided sufficient details of the selection criteria. The secondary aim was to use the photographs to calculate the percentage of natural and anthropocentric space occupied in each image, in order to determine if an inverse correlation exists between this and the image's ranked position in terms of its perceived tranquillity.

The ranking exercise involved subjects ranking 100 photographs in terms of tranquillity; however, it was left to each individual participant to decide upon the value judgements they made and the sorting process they adopted. The instructions were as follows: "Please examine these photographs and sort them in terms of your assessment of the tranquillity of the area where the photographs were taken". The results were statistically tested by calculating the degree of agreement between the subjects using Kendall's coefficient of concordance and a score of 0.47 ascertained. This correlation is statistically significant at the 0.1% level and clearly indicates both a good measure of agreement between the participants and that the subjects were using similar criteria in assessing tranquillity.

2.2 OBJECTIVE MEASURES

In addition to the ranking exercise, objective measures of the scenes reproduced on the photographs were also taken. Figures 1 and 2 show two of the images included in the exercise and Table 1 provides a breakdown of the percentage of space occupied in each image by natural features, the number of people present and the percentage of space occupied by them. The percentage composition of each photograph was determined by overlaying a 10 x 10 grid and manually estimating the area occupied by each of the categories, whilst the number of people present in any scene was simply counted. A rank of 1 indicates the image which on average was assesses as most tranquil.

Figure 1 North Cornish Coast

Figure 2 Chatsworth House - Derbyshire

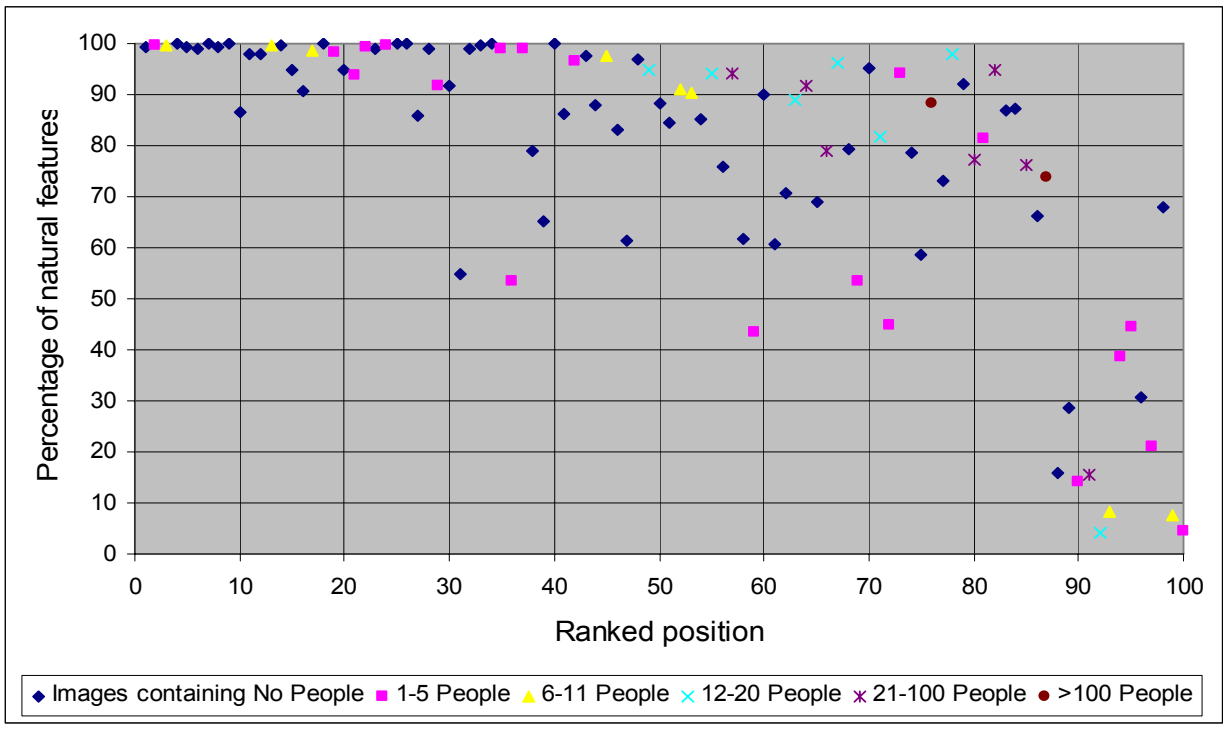
Table 1- The percentage composition of natural features, number and percentage of space occupied by people in Figures 1 & 2

Fig No	Ranked Position	% of natural features (Including agricultural land)	Number of people present	% of space occupied by people
1	1st	100	0	0
2	80th	77.25	64	10

By using data from all 100 images, it has been possible to indicate graphically the perceived tranquillity as a function of naturally occurring and manmade features. This is shown in Figure 3. This graph shows that one aspect of an engineered solution to creating tranquil space might be as simple as increasing the percentage of natural features in any given scene, which in turn could bring about a perceived noise benefit, though further work, is required to test this hypothesis. This is an important factor as 89% (Figure 5), of the subjects taking part in the ranking exercise, recorded on their questionnaires that the imagined type of soundscape at each location had significantly influenced the order in which the images had been ranked.

It is clear from the graph that several of the images comprise a high percentage of natural features yet rank quite poorly and this may be because they contain people. Figure 3 also indicates the number of people in each image. The types of landscapes that typify those images falling into the upper right hand quadrant of the graph are of most interest, as they offer the greatest potential to develop an engineered solution to increasing the amount of tranquil space.

Figure 3 – The influence of the natural features and people on ranked position



Previous studies[7] have indicated that the presence of people disrupts tranquillity, more than any other factor, however, it can be seen from Figure 3 that approximately 1/3 of the top ranked images contain between 1 and 11 people. One explanation for this apparent contradiction relates to the percentage of space occupied by people within a view, rather than just the number of people present. Figure 4 shows that the higher the percentage of visual space a person (or persons) occupy, or are perceived to occupy, the less tranquil an environment is considered to be. Whilst this can be attributed to the proximity of the intruding source to the viewer, a deeper understanding may lie in how we construct and maintain personal space, which is generally accepted to range from between 45 – 120 cm[9], in a potentially tranquil environment. Therefore one step in developing an engineered solution to managing tranquil space is to acknowledge that tranquil environments are complex constructs, which rely on both a high percentage of natural influence and a low percentage of human visual intrusion.

Figure 4 –The percentage of space occupied by people in each image

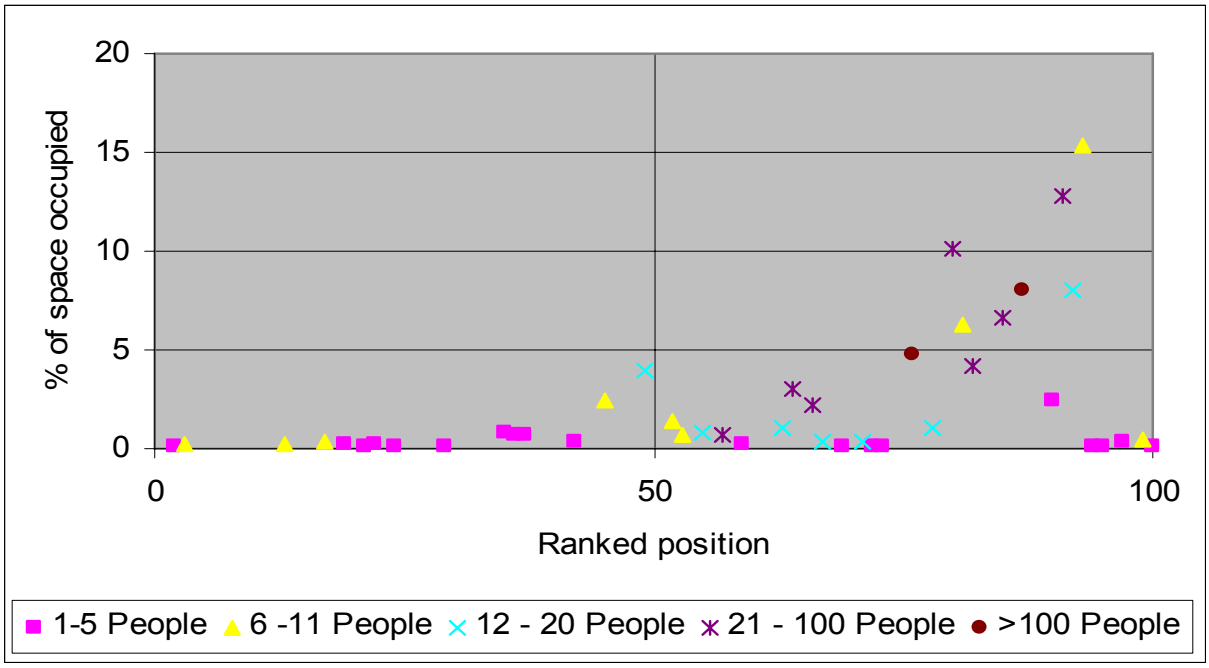
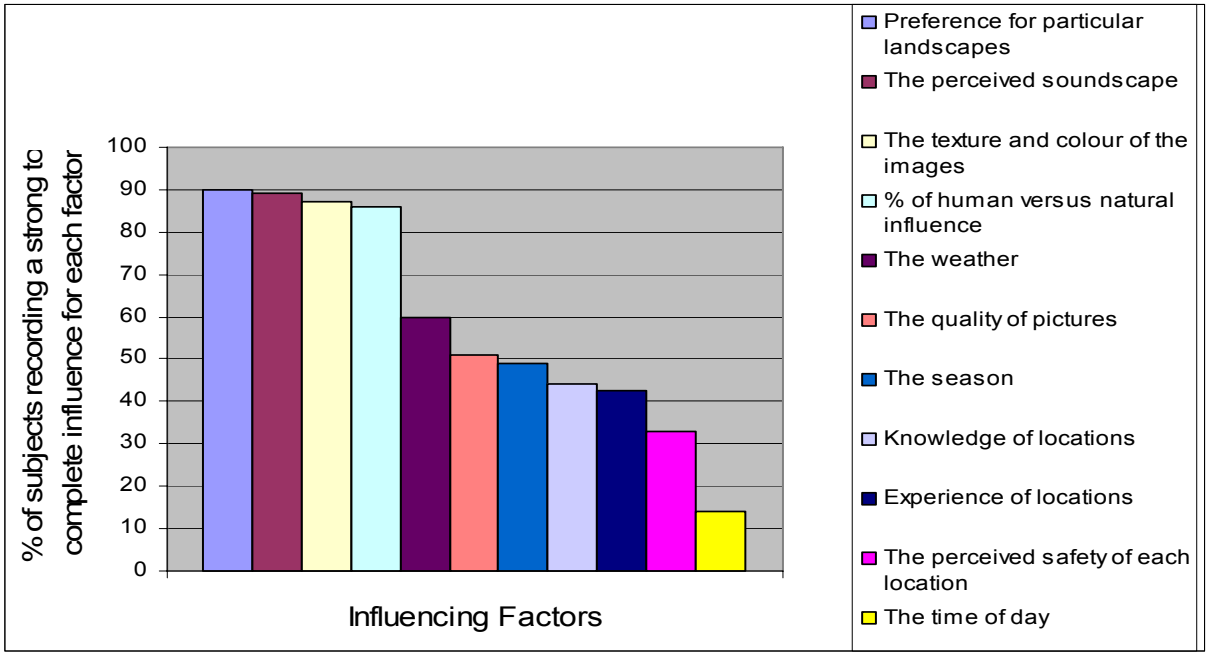


Figure 5 - Factors that most influenced the ranked position



Additional influencing factors recorded in the questionnaire that accompanied the ranking exercise showed that the amount of water present and the mood of the subjects at the time of ranking were also significant.

3 SUBJECTIVE ASSESSMENT METHODOLOGY

This aims of the subjective assessment exercise which is currently being run, are for subjects to determine how tranquil they consider various locations to be and how loud they gauge the associated soundscapes components when presented with video data.

Using headphones and a plasma screen subjects are being presented with audio only, video only and combined audio / video data streams and asked to score on a scale of 0 – 10 (Fig 6&7), how tranquil and how loud they perceive each location to be. The data being replayed was captured using a camcorder from the venues ranked at ten percentile intervals during the ranking exercise and is presented to each subject four times per data stream in an attempt to eliminate random chance. Each of the clips lasts for 32 seconds followed by a 6 second break which allows the subject's time to record their results. Prior to commencing the last set of repeat data (i.e. Tracks 34 -44) the subjects are told that in addition to assessing the tranquillity of each location they are also to assess the loudness of each of the soundscapes components based on the five generic categories of sound listed in Table 2. When the subjects are assessing the perceived soundscape from video images only they are instructed to estimate the loudness of each component based only on the visual information presented.

The intention is to correlate this information with the results of a laboratory analysis of each recording, in order to determine objectively the impact of various natural and manmade noises upon tranquil environments.

Table 2 Five sound source components being used in the subjective assessment exercise

Sound Source	Definition
Human (H)	Sounds made by people including musical instruments
Mechanical (M)	Sounds emitting from anything manmade, excluding musical instruments and water features
Weather (WX)	Sounds made by the wind e.g. wind in trees, telegraph wires and thunder / lightening
Water (WA)	Sounds made by water e.g. rapids, waves, rain, fountains,
Biological (B)	Sounds made by living organisms excluding human beings e.g. farm animals, bird song, humming bees

Figures 6 and 7 show how the subjective assessment results are recorded. In order to provide visual context this data is accompanied by images taken from the video footage.

Figure 6 Little Germany - Bradford

Tranquillity Rating

0 1 2 3 4 5 6 7 8 9 10

	H	M	B	WX	W
Loud		●			
Mod Loud					
Mod Quiet					
Quiet	●		●	●	
Not Present					●

Perceived Loudness

Figure 7 Community Garden - W Yorkshire

Tranquillity Rating

0 1 2 3 4 5 6 7 8 9 10

	H	M	B	WX	W
Loud					
Mod Loud					
Mod Quiet			●	●	
Quiet		●			
Not Present	●				●

Perceived Loudness

4 CONCLUSIONS

The aim of the research undertaken thus far on the 'Noise and Tranquillity in Urban and Rural Environments' project, has been to gain a better understanding of the effect of a single modality on the perception and expectation of tranquillity, based on the use of still images and video data. The results of this work have enabled a more detailed experimental strategy to be developed that will explore the relationship between the subjective assessment of a soundscape and the objective measurements of aural and visual factors taken in the laboratory.

This research represents the first step to characterize the contribution and interaction of visual and auditory elements to the perception of tranquillity. It has shown that an inverse correlation exists between the perceived level of tranquillity and the percentage of natural and manmade influences within any given landscape and that as the percentage of space occupied by people increases the tranquillity level decreases. It has also shown that a significant influencing factor in the construction of tranquil space is the perceived soundscape. The data presented in Figure 3 shows that when the proportion of natural features within a landscape drops below 50% the perceived level of tranquillity falls significantly, and clearly shows that in environments that comprise a high percentage of natural features, the presence of other people does not necessarily disrupt tranquillity especially if the visual angle they subtend at the observer is relatively small. The subjective assessment study which is currently underway has demonstrated that subjects are able to make a reasonable estimation of the soundscape of a location based only on visual data and this work is currently being extended to a much larger sample.

5 REFERENCES

1. Kaplan R., Kaplan S., *The Experience of Nature: a psychological perspective.* New York: Cambridge University Press 1989
2. Hertzog T.R., Tranquillity and preference revisited, J. Environmental Psychology. **19,** 171-181 (1999)
3. Heron J., Whitaker D., McGraw P., Sensory Uncertainty governs the extent of audio-visual interaction, Vision Research. **44,** 3119-3130 (2004)
4. Bangjun Z., Lili S., Guoqing D., The influence of the visibility of the source on the subjective annoyance due to its noise, Applied Acoustics. **64,** 1205-1215 (2003)
5. Watts G., Chinn L., Godfrey N., The effects of vegetation on the perception of traffic noise, Applied Acoustics. **56,** 39-56 (1999)
6. Viollon S., Lavandier C., Drake C., Influence of visual settings on sound ratings in an urban environment, Applied Acoustics, **63,** 493-511 (2002)
7. MacFarlane, R., Haggett, C., Fuller, D., Dunsford, H. and Carlisle, B. Tranquillity Mapping: developing a robust methodology for planning support, Report to the Campaign to Protect Rural England, Countryside Agency, North East Assembly, Northumberland Strategic Partnership, Northumberland National Park Authority and Durham County Council, Centre for Environmental & Spatial Analysis, Northumbria University. (2004).
8. Watts G, Morgan P and Abbott A. A proposal for identifying Quiet Areas in accordance with the Environmental Noise Directive (END). Proceedings of IOA Autumn Conference Vol. 8, pt 7 (2006)

9 Cassidy.T. (1997) Environmental Psychology: Behaviour and experience in context, Psychology Press,