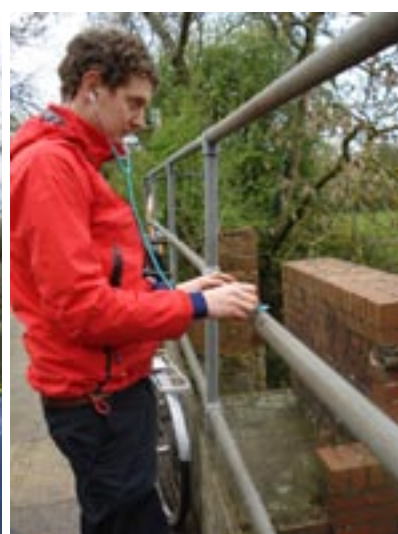


Final Report: Tranquillity is a State of Mind

WT086246MA

Liminal: Frances Crow and David Prior

June 2010



Foreword

In September 2008 liminal (architect Frances Crow and sound artist and composer David Prior) were awarded a grant from the Wellcome Trust for the research phase of their project *Tranquillity is a State of Mind: Listening Aids for a Listening Impaired Society*. Working in partnership with Sustrans, the sustainable transport charity, liminal brought together a research team comprising two acousticians, a computational neuroscientist and a clinical audiologist in order to develop a proposal for what we are describing as a 'listening aid' – a device that might encourage the listener to contemplate the act of listening itself. Of key concern in the development of the project was how an intervention on a site can create such a reflexive listening experience. Implicit in our research (and a driver to the constitution of our research team) was a desire to explore the relationship between unwanted sound in the ear (tinnitus) and unwanted sound in the environment. By getting a better understanding of the physiological and neurological causes of tinnitus and learning about audiological techniques used for its treatment, we hoped to be in a better position to understand the link between our physical response to unwanted sound and our environment.

This report offers a snap-shot of the research we have undertaken from September 2008 to end of May 2010 as part of the Wellcome Trust funded research project *Tranquillity is a State of Mind: Listening Aids for a Listening Impaired Society*. Pages 1-18 are largely unchanged from our Interim Report submitted on 23 July 2009.

Our original application to the Wellcome Trust identified three outcomes; a public sound cycle ride, a proposal for a 'listening aid' to be sited on the National Cycle Network and a public exhibition. This exhibition was to feature a 3D auralisation of the proposed listening aid in Arup's SoundLab. Over the course of the research a number of additional outcomes emerged which added value to this project. These outcomes have developed into a series of new projects, two of which are underway and a further two are seeking additional funding.

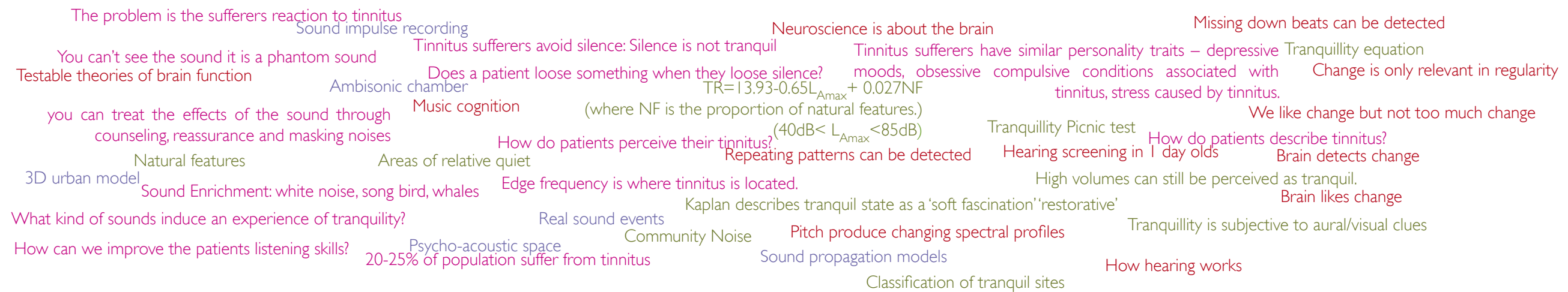


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(available at <http://vimeo.com/user4032896>)

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Introductions

On 30 September 2008 we met at University College Falmouth, Dartington campus, bringing the research team together for the first time. The team comprised: Sue Denham; computational neuroscientist, Greg Watts; environmental acoustician, Amr El Refaie; audiologist and Seb Jouan; acoustician and a principal of Arup Acoustics. Katy Hallet; Sustans Arts Coordinator and Lesley Greene; Curator. Each participant presented a project they felt relevant to the theme: 'Tranquillity is a State of Mind'.

Amr El Refaie is an audiological physician and programme director of the BSc Audiology course at the University of Bristol. Before starting work at the University in 2004, he worked as a research associate in the Institute of Hearing Research, Nottingham and then worked in Plymouth as an Audiological Scientist in Derriford Hospital. He studied medicine and graduated from Cairo University (M,B,B,Ch) in 1988. He also trained at Manchester University between 1993 to 1994. He was awarded an MSc in Audiology in 1991 and an MD in Audiological medicine in 1996. He has written several peer-reviewed publications on the subject of tinnitus and neonatal screening and has co-authored a chapter about the epidemiology of tinnitus in: *Tinnitus Handbook* (Singar, 2000)

Sue Denham is Professor in Computational Neuroscience at the Centre for Theoretical and Computational Neuroscience at the University of Plymouth. Her research is aimed at developing theoretical and computational models of auditory perception. She is interested in how the acoustic environment is processed, represented and organized into perceptual objects in the brain; i.e. how we make sense of sounds. In this work she combines insights gained from detailed modelling of the auditory system, with efficient implementations for practical applications, and perceptual experiments.

Greg Watts is Professor of Transportation Noise at the University of Bradford. His current research interests include the development of practical models to aid the construction of tranquil spaces in urban and rural spaces, the use of water sounds to enhance tranquility, the definition and protection of quiet areas, modelling sound propagation and the design of traffic noise mitigation measures.

Seb Jouan is a Principal of Arup Acoustic Scotland and an acoustician at Arup's responsible for the development of projects using Arup SoundLab in Europe. The SoundLab is an innovative design tool developed by Arup Acoustics to allow them to listen to designs using auralisation techniques. Auralisation is to sound what visualization is to sight. Arup uses SoundLab to auralise performing arts and public buildings, soundscapes and sonic arts installations. Seb worked closely with Bill Fontana for the Harmonic Bridge Installation in the Tate Turbine Hall in July 2006 and with Hans-Peter Kuhn for the Leeds Dark Arches project.

TRANQUILLITY IS A STATE OF MIND: listening aids for a listening imparied society

“This project takes the metaphor of the hearing aid as a point of departure. When individuals suffer hearing loss, a range of prosthetic devices and therapies are available to alleviate the symptoms. As a society we have been gradually devaluing our ability to listen in preference to seeing. We would research contexts in which the act of listening itself might be contemplated: the listener might listen to herself listen. Using the idea of the listening aid as a central metaphor, the project will investigate notions of noise, tranquillity, health and wellbeing in relation to the perception of sound in the environment.”

Summary of original proposal submitted to Wellcome Trust in June 2008

RESEARCH TEAM



Dr. David Prior - Liminal
Artist and Musician



Frances Crow - Liminal
Architect



Dr. Amr El-Refaie -
University of Bristol
Audiologist



Dr. Sue Denham -
University of Plymouth
Computational
Neuroscientist



Professor Greg Watts -
University of Bradford
Acoustician



Seb Jouan - Arup Acoustics
Acoustician and Director of
Arup's Soundlab



Katy Hallett - Sustrans
Arts Manager/Commissioner



Lesley Greene
Curator

INTRODUCTORY MEETING AND SOUNDWALK: 30 September 2008







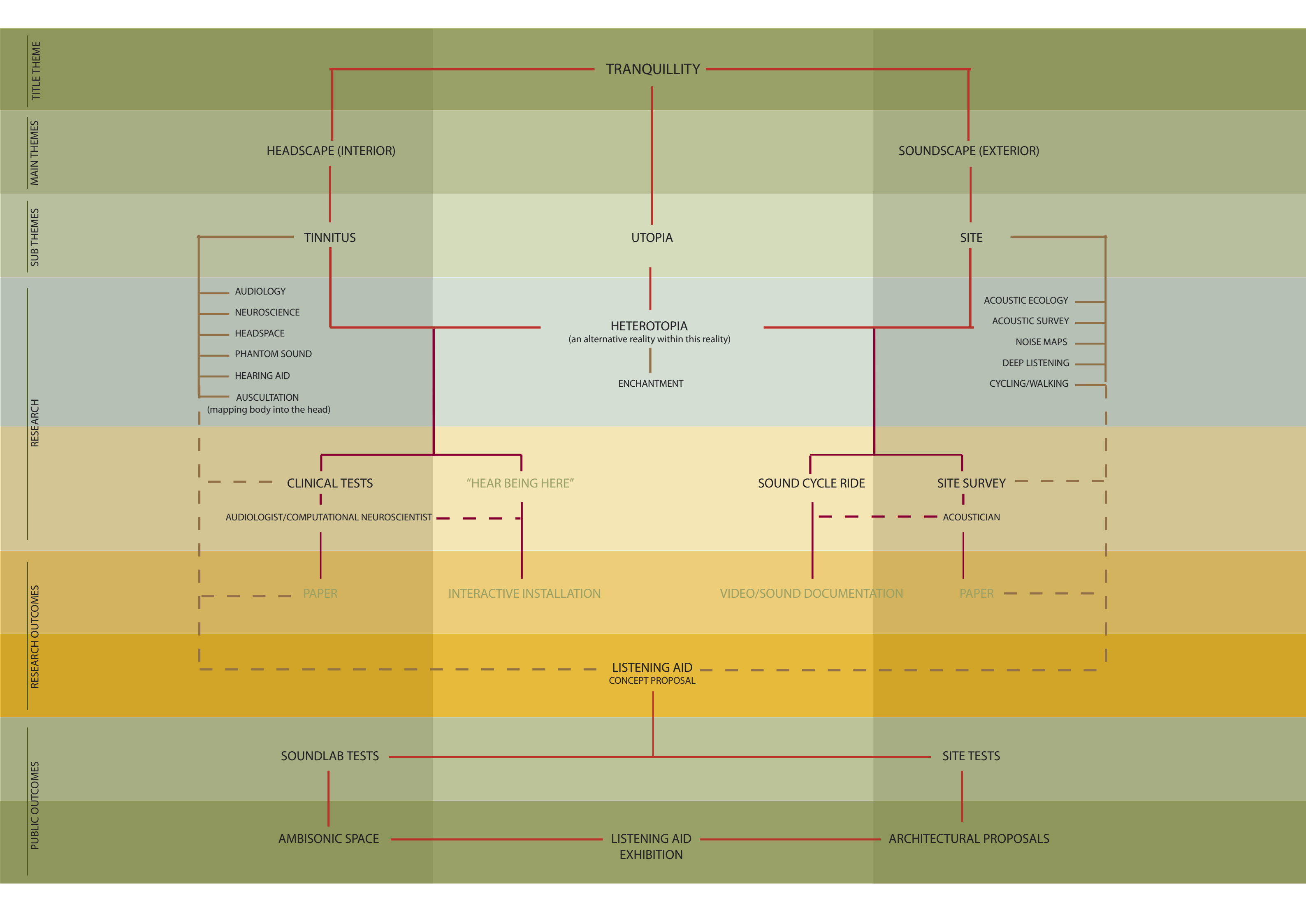




The Mind Map

Our initial team meeting in September 2008 opened up a number of avenues for research. In an attempt to draw these many themes together we produced a mind map (see page 4) through which we were able to outline the scope of our research. The map outlines the three main strands of research that we have been pursuing.

1. Firstly, the notion of tranquillity as a utopia; something essentially unattainable.
 2. Secondly, an exploration of the internal 'headscape' of tinnitus which would draw on the biomedical disciplines within the research team.
 3. Lastly, a survey of the exterior soundscape, using the analogy with tinnitus as a lens through which we might consider unwanted sound in the environment.
- This last theme would be informed to a great degree by the experience of walking and cycling as methods for immersing ourselves in the places we visited.



Ebenezer Howard



Ebenezer Howard's Garden City idea



John Betjeman's Metro-Land



Quainton Road Station, September 2006, taken by IXIA



William Morris

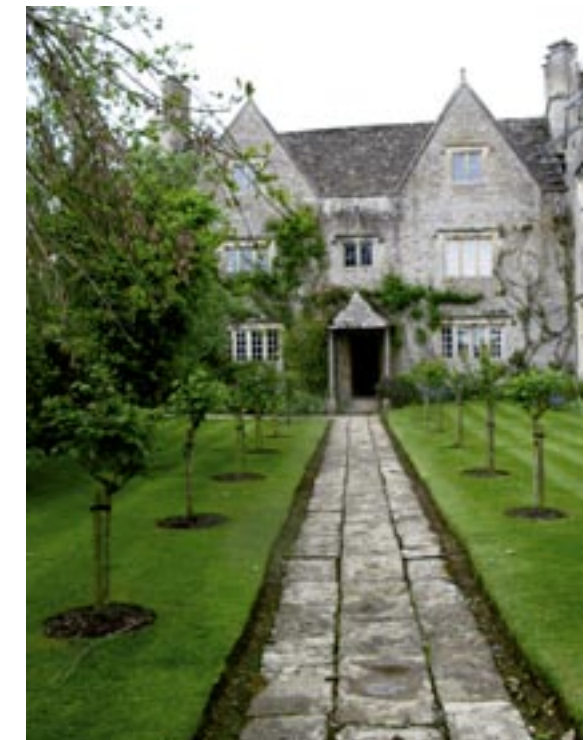


'Spring'. Breugel Painting hung in Kelmscott Manor



Utopia

The Garden City movement was born out of a proposition for new ways of living in the Victorian city. Along with the work of the town planner Ebenezer Howard, a series of utopian novels were written at the time describing idealised harmonious societies. In both William Morris's novel *News from Nowhere* and Edward Bellamy's *Looking Backwards*, the protagonist falls asleep and wakes in a utopian future. In both cases a journey ensues in which the protagonist attempts to make sense of the world in which he finds himself, only to return to 'the real world' (waking from a dream) at the point of a personal epiphany. This association of utopias with the passage of sleep and journeying through space has proved to be a useful matrix of connections to explore, affording us a metaphorical device by which we can 'travel' through different notions of tranquillity. In keeping with this theme, John Betjeman's 1973 BBC documentary *Metro-land* offers an affirmation of suburban life, tracing the emergence of a 20th century 'garden city' inspired suburbia which developed along the route of what is now the Metropolitan line. However, the anarchic idyll imagined in *News from Nowhere* or *Looking Backwards* is shadowed by a sense of the necessary cessation of desire and individuality on the part of its society's members. The social engineering necessary for real-world attempts at the realization of utopian ideals - be they manifest in garden cities or anarchist cults - usually require a good deal more hierarchical control. Imagining tranquillity as a utopian ideal, it has been interesting to reflect upon the respective connotations of the words *Tranquil*, *Tranquillity*, *Tranquilizer* and *Tranquilized*.



Kelmscott Manor William Morris's home in Oxfordshire



Tranquil scene at Kelmscott Manor

Headscape

The second theme we explored was the relationship between sound and medicine. This theme encompasses both the study of hearing as represented in our research team by audiologist Amr El-Refaie and computational neuroscientist Sue Denham, as well as the use of sound in diagnosis (auscultation) and therapy. Conversations with Amr and Sue were complimented by reading lists provided by both of them which helped augment our understanding of their respective areas of expertise. We were also able to draw upon the growing body of research associated with auscultation as a listening practice; perhaps best represented by Jonathan Sterne's excellent book *The Audible Past*. In making connections between the stethoscope and the subsequent invention of the microphone, Sterne makes the case for stethoscopy being a pre-cursor to microphony and phonography. Seminal 'microphonic' musical pieces such as Stockhausen's *Mikrophonie I & II* or Cage's *Cartridge Music* make this link explicit. As much of our own work is essentially 'phonographic', the theme of auscultation was immediately seductive. However, rich as it is, it is one of the many avenues we have decided not to pursue for the time being. Instead, we have decided to concentrate our research on the interface between the domains represented by Amr and Sue respectively, opening up dialogues between the acoustic and neurological, both literally and metaphorically.

Time spent in the Wellcome Trust Library brought to light early texts by Thomas Buchanan, a surgeon based at the Hull dispensary of the Diseases of the Eye and Ear. He wrote extensively about the practice of the 'Aurist' and the causes of hearing loss, or, as he described it: the "diminution of hearing". His research was limited to the outer and middle ear as the technology of the day did not enable him to see further than the tympanic membrane. In his 1825 publication *Illustrations of Acoustic Surgery*, he describes his own invention, the 'Inspector Auris', an early version of the Otoscope Specula used by clinicians today to look into the ear. He believed that tinnitus was caused by a build-up of cerebrum or wax in the ear canal and his treatment for the 'ringing noises in the head' was gentle exercise to "promote the action of the glandular system" and therefore the production of good quality wax. Buchanan's detailed instructions for the design of ear trumpets (which include specifications on how to treat the lining of the trumpet to replicate the acoustic characteristics of wax in the ear) have influenced experiments we have done with ear trumpets, some of which we used on the sound cycle ride.

Tinnitus has always been a significant area of focus for this project and we were keen to learn more about the relationship between both hearing loss and tinnitus, and the relationship between both conditions and the soundscapes which might contribute to their onset. The relationship between hearing loss and tinnitus became a particular point of interest. Given that hearing loss is nearly always focused to a particular band of frequencies, it was interesting to learn that one of the causes of tinnitus is the hyper-activity of the frequencies either side of the damaged band. This notion of a hyper-active or even 'phantom' sound, somewhat akin the pain experienced by an amputee in a missing limb, opened up some interesting areas of discussion around the relationship between tinnitus-sound and pain, both experientially and neurologically. As it is not possible to treat the source of tinnitus, treatment is concentrated on relieving the symptoms, either by masking the tinnitus-sound or through habituation; a process by which the sufferer learns to distract themselves from the unwanted sound. In the 1960s, the *Tinnitus Handicap Inventory* was developed, which sets out a series of questions for the tinnitus sufferer to rate the impact of their condition on their lifestyle. Based on the responses to this, a clinician can then propose treatments that help the patient learn to habituate themselves to the sound over a period of time or to mask it with other noises. A successful treatment is one where the patient no longer hears the sounds as they have learnt to distract themselves from it. It could be argued that if tranquillity is a state of mind, so too is tinnitus.

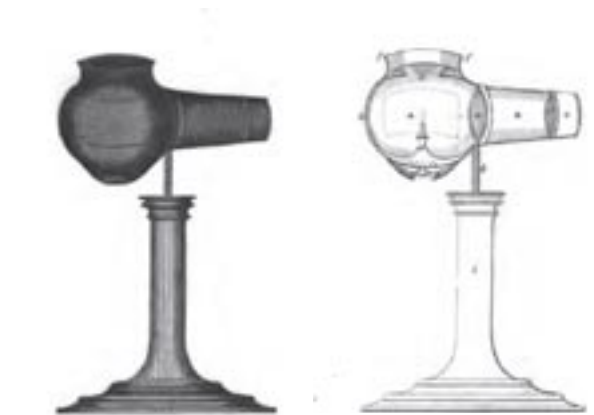
Following our conversations with Amr and Sue, it occurred to us that the theme of 'journeying', first drawn from the utopian novels we had been reading, now had a parallel in the journey we were tracing of a sound making its way through the auditory system. It is this journey that we have illustrated overleaf. Amr helped enormously with our understanding of the journey from the outer ear to the tympanic membrane, the three ossicles and the cochlea. We were intrigued by the etymology of the names of the components of the ear and began to attribute characteristics to them and integrate them into our evolving journey narrative. Of particular significance was the organ of Corti, our metaphorical gate-keeper between the mechanical and the neurological. We were also fascinated to learn about 'tonotopic mapping'; the process by which sound is physically mapped according to its spectral content across the length of the basilar membrane in the cochlea, up through the brain stem via the cochlear-vestibular nerve, ending at the primary auditory cortex. This idea of the mapping of sound into physical space has informed a number of the ideas on which we are now concentrating our attention. Similarly, Sue's interest in the way in which the brain picks out patterns in sound and identifies changes is these patterns that become significant as spatial and temporal cues, has now become one of our central concerns in the development of the *Listening Aid*.



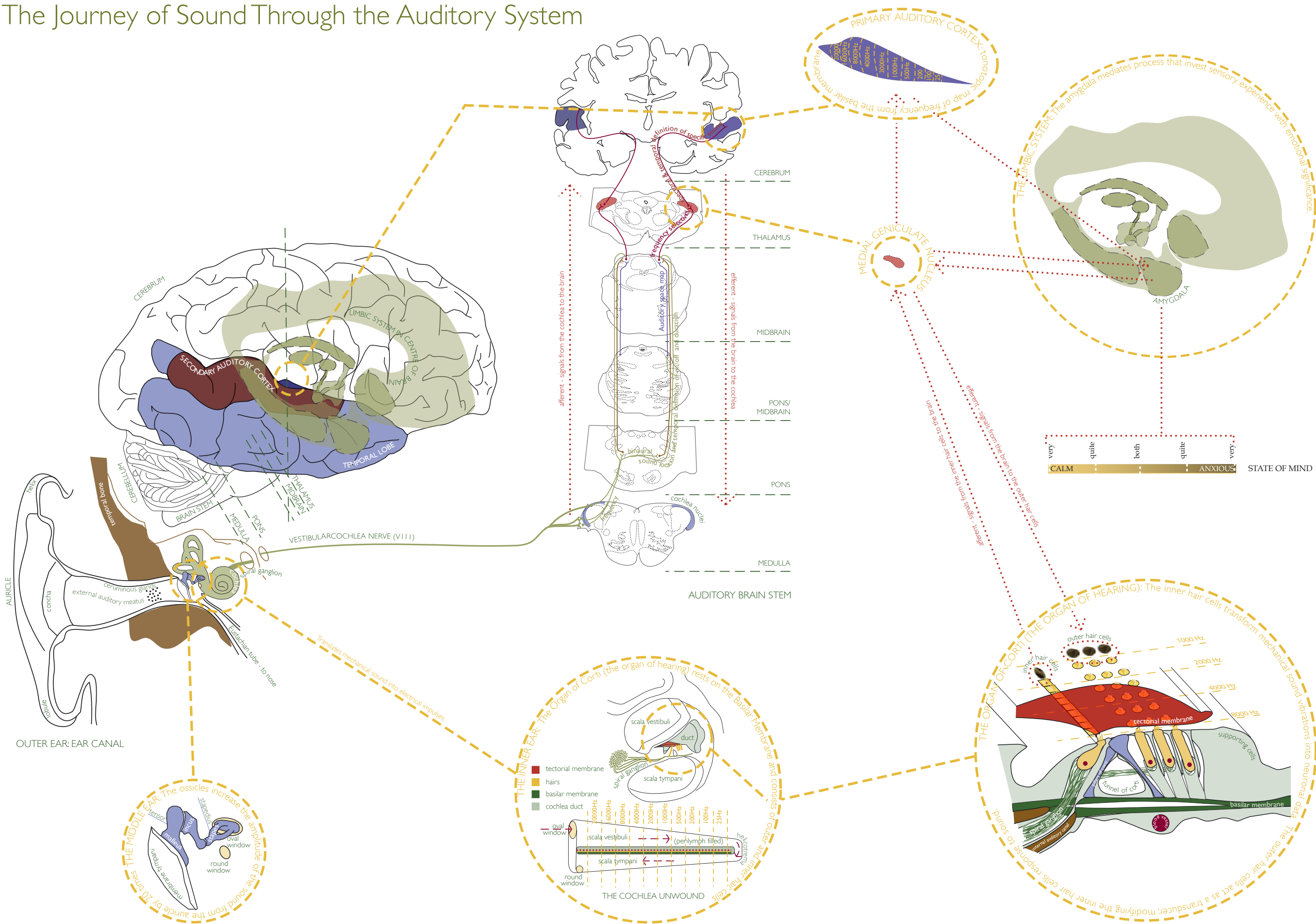
Amr El-Refaie



Sue Denham

'Inspector Auris' from Buchanan's publication
Illustrations of Acoustic Surgery

The Journey of Sound Through the Auditory System



Soundscape

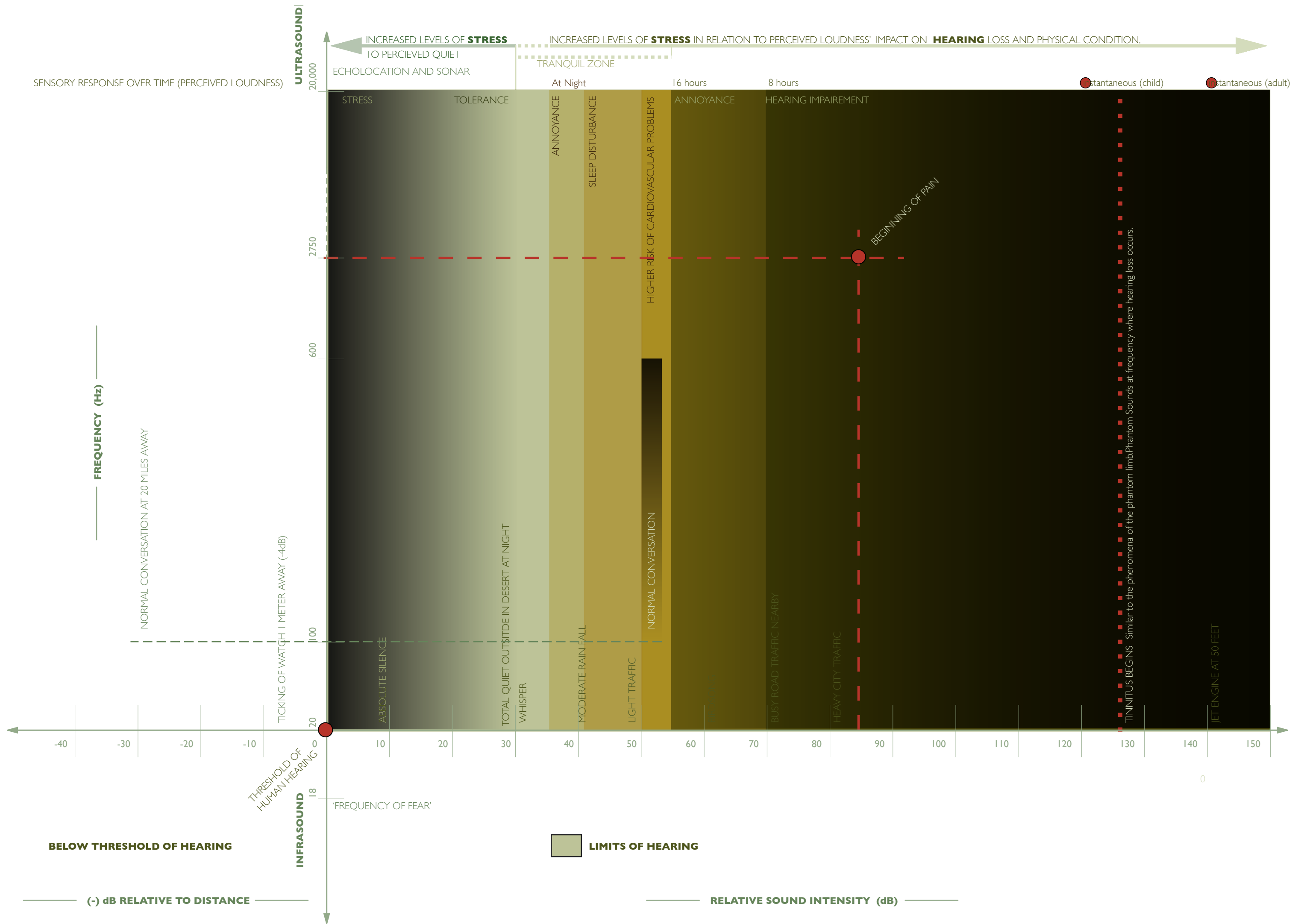
Tranquillity has been defined recently by the European Union (EU) as a place of relative quiet. The Campaign to Protection of Rural England (CPRE) has extended this definition further through its extensive survey of places in the countryside that participants in their review considered to be tranquil^{1&2}. It was found in the CPRE studies that particular elements could be identified as contributing to a tranquil place but that tranquillity itself was a state of mind. In both the context of the EU directive⁴ for places of relative quiet and the CPRE's tranquillity mapping project³, there is an underlying desire to preserve these places. For us, this was a romantic notion and we wondered if it was possible to reach a tranquil state of mind in a place that would be defined as non-tranquil or whether the link between place and state of mind is inseparable. With this theme in mind, we produced the *Decibel Level Chart* (see page 8) which collates the published data available on community noise sound levels from the Institute of acoustics here and in America as well as information from the British Tinnitus Association. The chart then maps this data to World Health Organisation data on annoyance, stress, hearing impairment and cardiovascular problems. This decibel chart demonstrates that what we might consider to be a sound that actively contributes to a tranquil state of mind, such as bird song at 65dB, is in the annoying band if heard for more than 8 hours. We felt that the contradictions between what we perceive and what is measured to be a theme worth pursuing.

1. Jackson, S., Fuller, D., Dunsford, H., Mowbray, R., Hext, S., MacFarlane R. and Haggett, C. (2008). Tranquillity Mapping: developing a robust methodology for planning support, Report to the Campaign to Protect Rural England, Centre for Environmental & Spatial Analysis, Northumbria University, Bluespace environments and the University of Newcastle upon Tyne.

2. Campaign for the Protection of Rural England, The Countryside Agency, North East Assembly, Northumberland Strategic Partnership, Northumberland National Park Authority, Durham County Council. Mapping Tranquillity, Defining and Assessing a valuable resource. March 2005.

3. <http://www.cpre.org.uk/campaigns/landscape/tranquillity>

4. Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and the management of environmental noise. L189/12 Official Journal of the European Communities 18.7.2002





Sound Cycle Ride

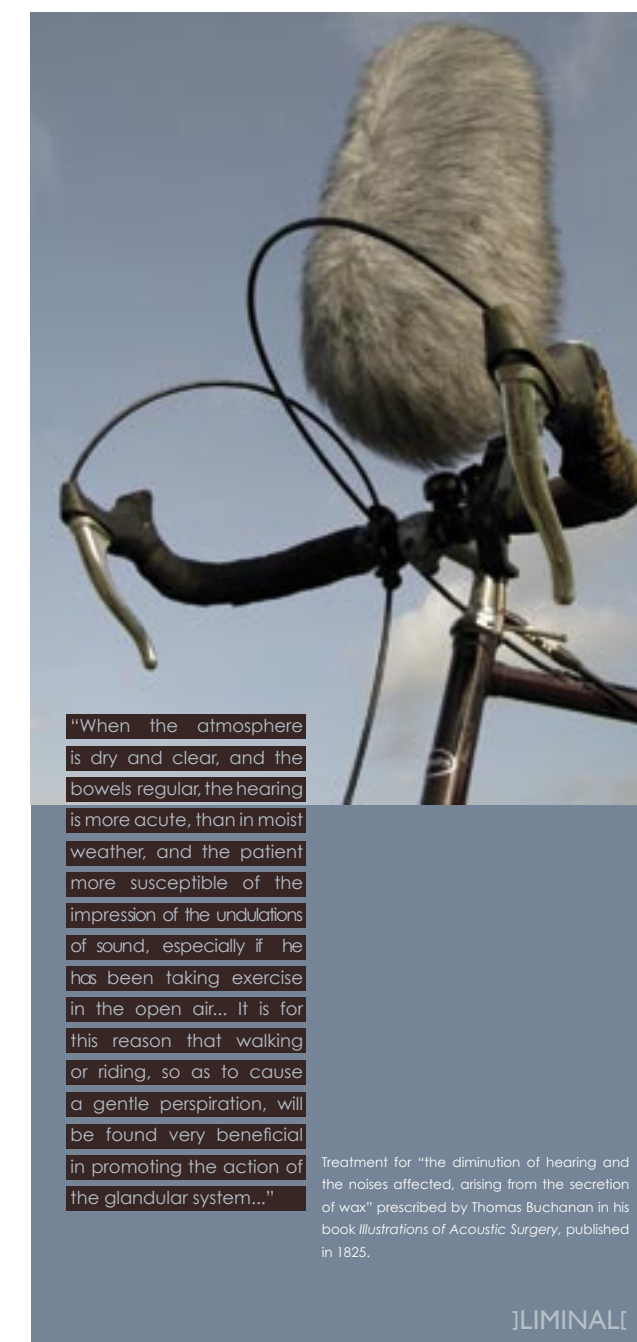
Having identified bio-medical themes that interested us, we undertook a four-day cycle ride along the National Cycle Network starting in Worcester and ending in Cricklade, Wiltshire. We hoped that the process of cycling would contribute to our understanding of the links between notions of tranquility and the ideas that we had developed during discussions with Amr and Sue.

Additionally, the ride provided us a way to identify a site for the proposed *Listening Aid* and a context in which we could test our ideas. Day 1 was spent in and around Worcester looking at potential sites for the *Listening Aid*. Henry Harbord, regional manager for Sustrans and Ed Dursely, cycling officer for Worcestershire County Council introduced us to a series of sites on the National Cycle Network and also on the new links that formed part of Sustrans National 'Connect 2' project.

Days two & three were spent cycling from Worcester to South Cerney. We used these two days as a form of experiential research. On-route, we stopped at places that presented us with questions about tranquility. We documented these sites using a *Sound Summary* sheet, 3D sound recordings, photographs and video. (See the DVD and CD appended for the sound recordings and videos).

As part of the research process we have been developing an 8 speaker, 3D ambisonic cube array in our studio so that we can work with the 3D sound recordings we have been making as part of the research process. A DVDROM was submitted as part of the Interim Report and included 5.1, 7.1 and B-format interleaved sound files of some of the sound recordings we had made. These recordings were played in Arup's SoundLab as art of the *Lost Frequency* presentation on 31 March 2010.

On Day four, members of the public were invited to join us on the last leg of our journey from South Cerney to Cricklade. The purpose of the public sound cycle ride was to engage the public in the questions surrounding the research project. We chose to site the ride along a visually tranquil disused railway in the Cotswold Water Park, part of Route 45 of the National Cycle Network. Running parallel to the route but not visible, is the A419; one of the noisiest roads in the area. As the landscape is flat, the noise from the road is audible along the cycle route to varying degrees. We used ideas developed in conversation with Sue and Amr in combination with 'ear cleaning' exercises based on those devised by acoustic ecologists R. Murray Schaeffer and Barry Truax to create a series of activities for the participants of the ride.



Invitation to Sound cycle ride

Diagnosing the Sound of the Landscape: A Sound Cycle Ride

11.30 am, Good Friday, 10th April 2009, South Cerney to Cricklade via Cotswold Water Park (National Cycle Network, Route 45)

Just as a doctor listens to the body of a patient through a stethoscope to diagnose their health, so participants in a sound cycle ride will use listening aids to listen to the landscape in new and exciting ways.

The ride is part of a research project *Tranquillity is a State of Mind* which is funded by the Wellcome Trust. The project looks at the condition of Tinnitus and the affect that unwanted sounds have on a sufferer's psychology. Using this as a metaphor for society's relationship to sound, the artists suggest that listening aids may work as diagnostic tools to investigate our health and well-being in relation to our soundscape.

This event is the culmination of a four day cycle ride from Worcester to Cricklade by Liminal, a partnership between sound artist David Prior and architect Frances Crow.

To book a place on the cycle ride:
email: alessia.macdonald@sustrans.org.uk ph: 0117 915 0220



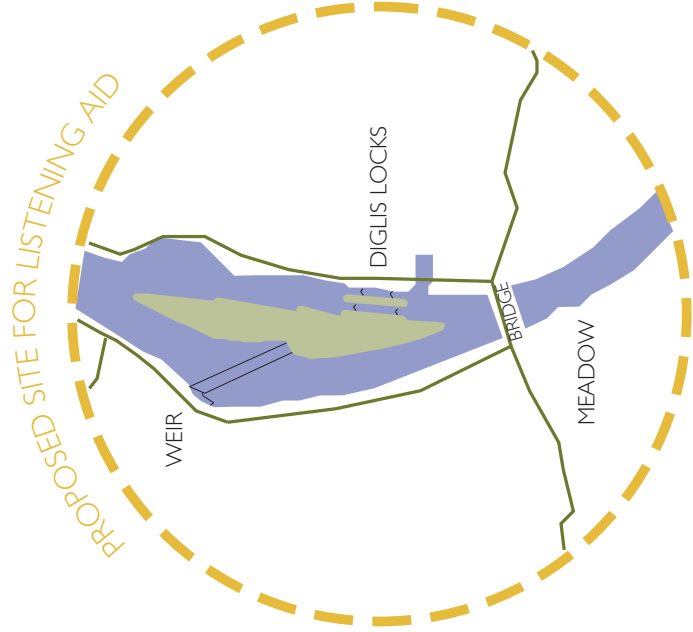
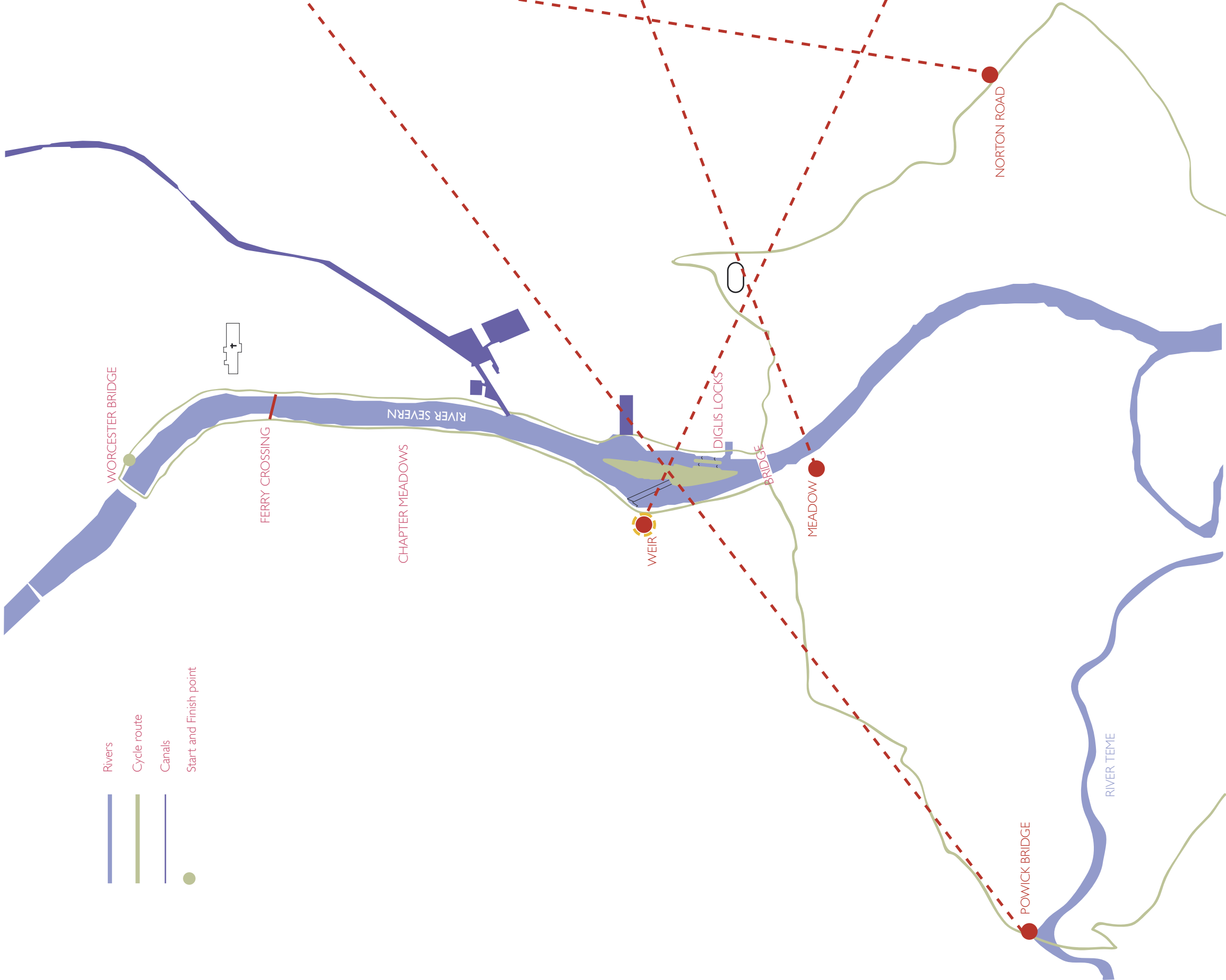
Sustrans is the UK's leading sustainable transport charity, working on practical projects so people choose to travel in ways that benefit their health and the environment. For more information, visit www.sustrans.org.uk or phone 0845 113 00 65. Registered charity No. 328562

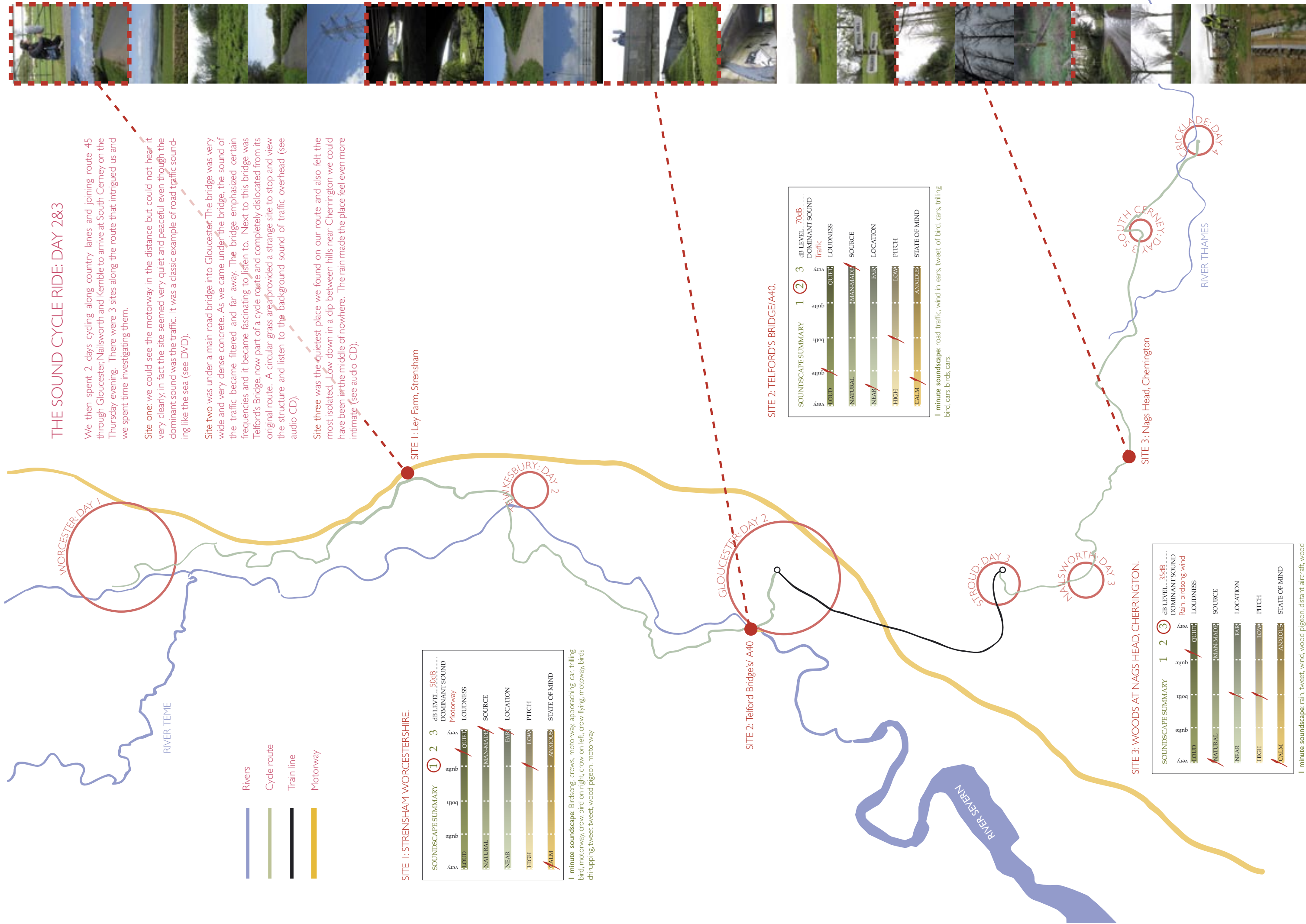


THE SOUND CYLCE RIDE: DAY 1 – WORCESTER

“We started the route by cycling along the River Severn down past the Diglis locks, past the site where the new cycling and pedestrian bridge will spring from, over scrub land that was made from the tipping of the dredged River Severn, through old landfill site now a playing field with a model engineers working miniature railway. We then rode through suburban housing estates and alongside busy A-roads, across the main floodplains to Powick bridge. Powick mills then led us to back-routes and pathways via an industrial estate back onto the river to arrive on the other side of the new, yet to be built, pedestrian and cycle bridge.

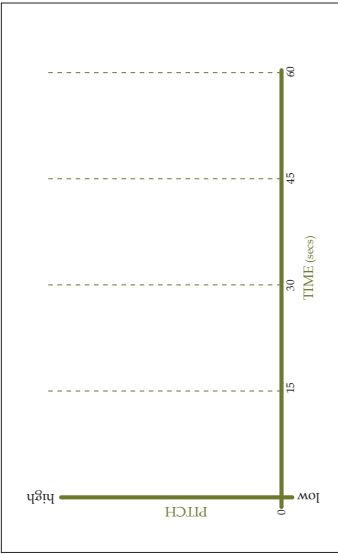
Next to the site of the bridge was an open meadow with long views back to Worcester and a defined soundscape where both distant and intimate sounds could be distinguished. We stopped here for a while to listen chat and take in the view. Heading upstream from the meadow we soon came to the weir which gradually masked out the sounds of the meadow until next to the weir we had to raise our voices to be heard. Henry or Ed, (I forget which) said that the flow of water over the weir changes depending on whether the locks are open or closed. Leaving the weir behind we passed the Chapter Meadows and then came back to the main road bridge over the River Severn where our ride ended.”





WRITE DOWN ALL THE SOUNDS YOU CAN HEAR...

NOTATING THE LANDSCAPE



NOTATING THE LANDSCAPE

NOISE HANDICAP INVENTORY

Because of the noise is it difficult to concentrate?

Does the loudness of the noise make it difficult for you to hear people?

Does the noise make you angry?

Does the noise make you confused?

Do you feel as though you can not escape from the noise?

Does the noise make you upset?

Do you feel that you have no control over the noise?

Does the noise make you feel anxious?

	yes	no	some times
Because of the noise is it difficult to concentrate?	☐	☐	☐
Does the loudness of the noise make it difficult for you to hear people?	☐	☐	☐
Does the noise make you angry?	☐	☐	☐
Does the noise make you confused?	☐	☐	☐
Do you feel as though you can not escape from the noise?	☐	☐	☐
Does the noise make you upset?	☐	☐	☐
Do you feel that you have no control over the noise?	☐	☐	☐
Does the noise make you feel anxious?	☐	☐	☐

NOISE HANDICAP INVENTORY

SITE 1: NOTATING THE LANDSCAPE

SOUNDSCAPE SUMMARY

1 2 3

dB LEVEL...52dB

DOMINANT SOUND
Birdsong

LOUDNESS

SOURCE

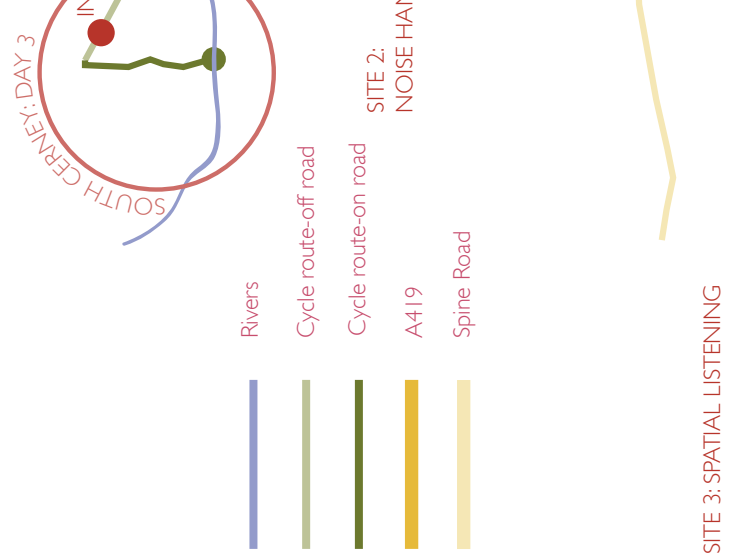
LOCATION

PITCH

STATE OF MIND

	very quiet	quiet	both	quite	very loud
LOUDNESS	very quiet	quiet	both	quite	very loud
SOURCE	NATURAL	MAN-MADE			
LOCATION	NEAR	FAR			
PITCH	HIGH	LOW			
STATE OF MIND	CALM	ANXIOUS			

1 minute soundscape: Birdsong, traffic, dog, little boy, boat engine, voices



SITE 3: SPATIAL LISTENING

SOUNDSCAPE SUMMARY

1 2 3

dB LEVEL...48dB

DOMINANT SOUND
Tractor at work

LOUDNESS

SOURCE

LOCATION

PITCH

STATE OF MIND

	very quiet	quiet	both	quite	very loud
LOUDNESS	very quiet	quiet	both	quite	very loud
SOURCE	NATURAL	MAN-MADE			
LOCATION	NEAR	FAR			
PITCH	HIGH	LOW			
STATE OF MIND	CALM	ANXIOUS			

DAY 4 – DIAGNOSING THE SOUND OF THE LANDSCAPE

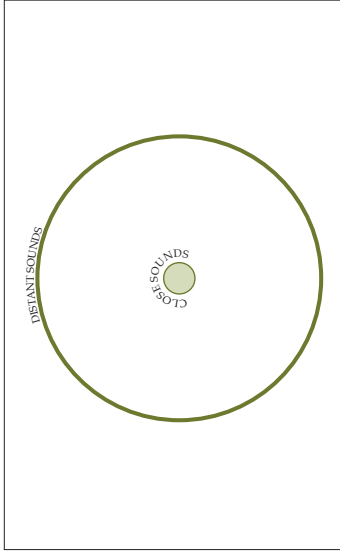
On the fourth day of our cycle ride we were joined by 15 members of the public for a 3 hour ride between South Cerney and Cricklade along the national cycle network route 45. We found out along the way that a number of participants suffered from tinnitus or some form of hearing loss.

The ride was lead by David who took the participants through a series of exercises as we stopped at 4 different sites along the route. These exercises were broken down into four different types which we describe here as: notating the landscape, 'Noise Handicap Inventory', spatial listening and prosthetic listening.

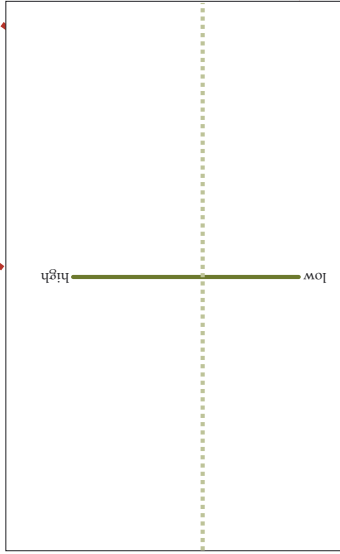
At the start of the most Northerly section of the off-road route 45, each participant was given a pack which included exercise sheets, pencil and lint pads. The group were then asked to cycle in silence, listening till we reached the first stop. When the group stopped they were asked to listen for the dominant sound that they could hear at that moment and then fill in the first sheet 'Soundscape Summary'. Once this was completed a megaphone was used to read back a summary of the site and also the decibel reading for the site. This process was completed at the start of each stop.

"When the atmosphere is dry and clear, and the bowels regular, the hearing is more acute, than in moist weather, and the patient more susceptible of the impression of the undulations of sound, especially if he has been taking exercise in the open air... It is for this reason that walking or riding, so as to cause a gentle perspiration, will be found very beneficial in promoting the action of the glandular system..."

Treatment for "the diminution of hearing and the noises affected, arising from the secretion of wax" prescribed by Thomas Buchanan in his book Illustrations of Acoustic Surgery, published in 1825



SPATIAL LISTENING



SPATIAL LISTENING

SITE 2: NOISE HANDICAP INVENTORY

SOUNDSCAPE SUMMARY

1 2 3

dB LEVEL...66dB

DOMINANT SOUND
Traffic

LOUDNESS

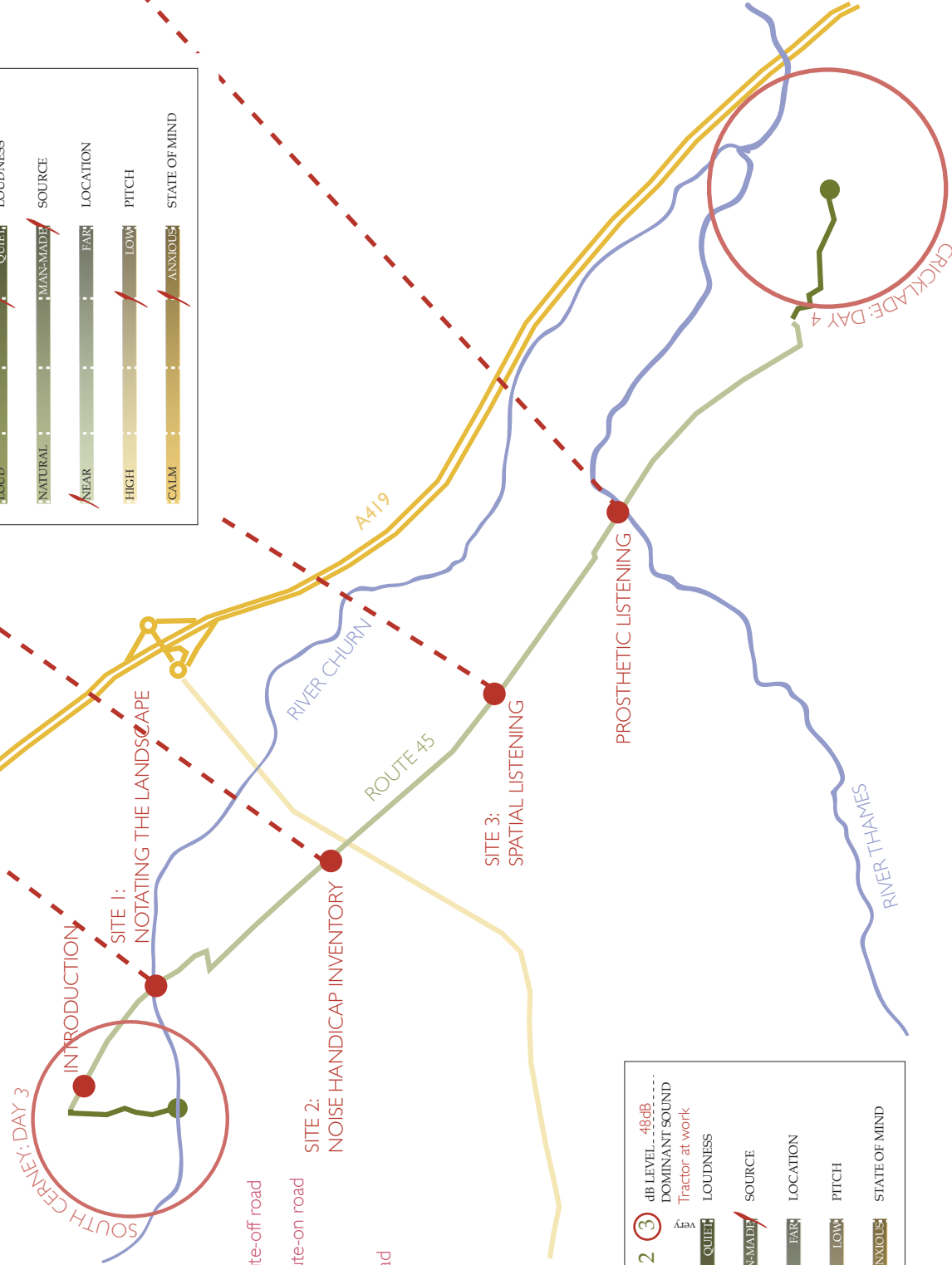
SOURCE

LOCATION

PITCH

STATE OF MIND

	very quiet	quiet	both	quite	very loud
LOUDNESS	very quiet	quiet	both	quite	very loud
SOURCE	NATURAL	MAN-MADE			
LOCATION	NEAR	FAR			
PITCH	HIGH	LOW			
STATE OF MIND	CALM	ANXIOUS			



The site

On the cycle ride we had come across a number of locations that presented us with ideas for the *Listening Aid*. However, the site we kept coming back to was the weir on the River Severn in Worcester, next to Diglis island. The site is defined by its broadband noise and we were attracted to the idea that with this full range of frequencies present, a huge variety of new sounds could be made by filtering out bands of frequencies. The weir is a constant source of noise in the landscape and acts as an effective mask to all other sounds occurring in the vicinity. It is for this reason that water features are often used as acoustic masking devices where other sources of sound are deemed even less desirable. Here, the weir acts like J.G. Ballard's *Sound Sweep*, mopping up the surrounding sounds. We wondered if it might be possible to 'sweep the sweeper', neutralizing the sound of the weir; a source (water) often associated with tranquility, in order to make way for the other; indigenous sounds of the meadows near by. It was in response to the site that we came up with our initial proposal for *The Tranquillizer*.

The form of the Listening Aid was to take its lead from its acoustic requirements and we began by pursuing two routes for its possible development: an innovative technology based on the phenomena of 'Sonic Crystals' as well as the more widely understood phenomenon of the Acoustic Tunnel. As part of the development of the proposal we worked with Arup Acoustics on the viability of the options and carried out a sound-site survey with Greg Watts.

2) Harmonic Bridge: coloured tracks run along length of bridge resonating at given frequency.



3) White out, white noise, white water
Sound from noise filtered into a space
and 'overdubbed' to produce immersive,
documentary 'white space'

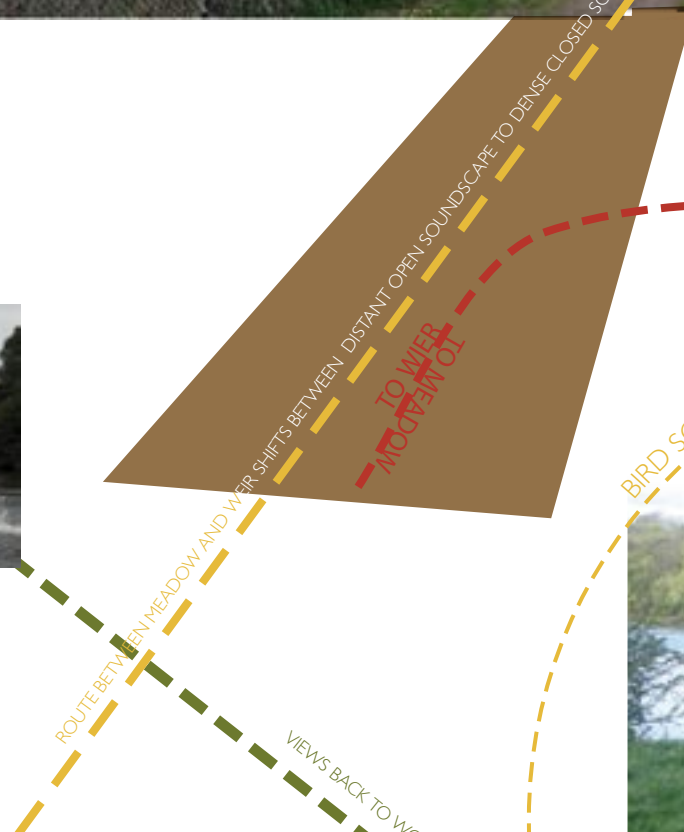


4) Filter Sweep:



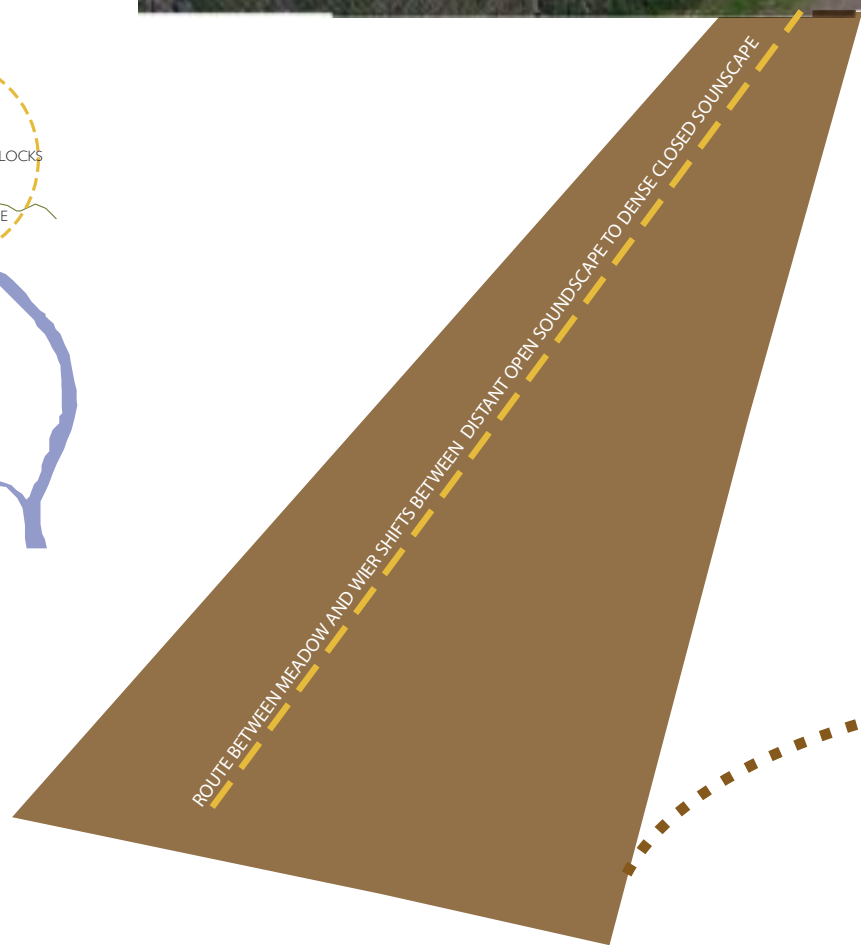
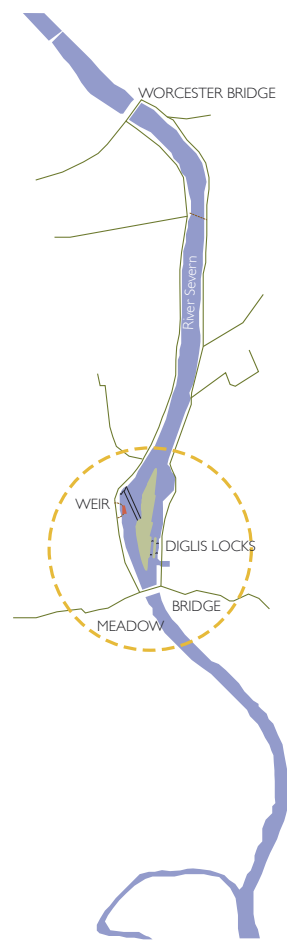
Knot form less gradually
under a diameter than
making the personal frequency
of the sound coming out of
the slit. As the liquid
presses through the space, the
approximate a better sound
there would be a still or
other side with sound coming
in opposite directions

Series of ideas developed on the sound cycle ride

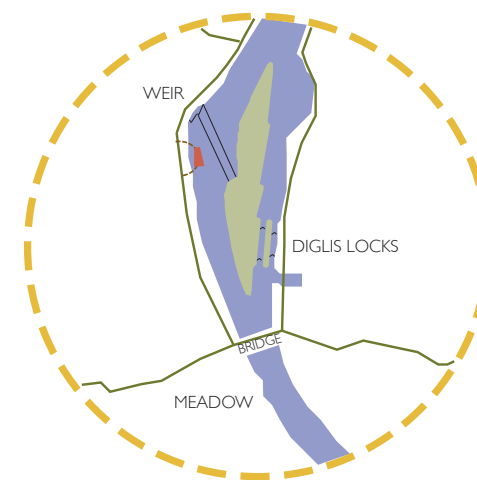


THE TRANQUILIZER

As the cyclist or walker travels towards the weir the amplitude of the dense broadband noise increases. The route takes the traveller through the 'Tranquillizer' and physically closer to the weir. As they move through the tranquillizer space, the soundscape is filtered so that the frequency (pitch) and the amplitude (loudness) decrease until at one point all sound is removed. The experience will be uncanny as visually you will see the weir close by, but the sound will have been turned off, as though it has been sucked out of the environment.



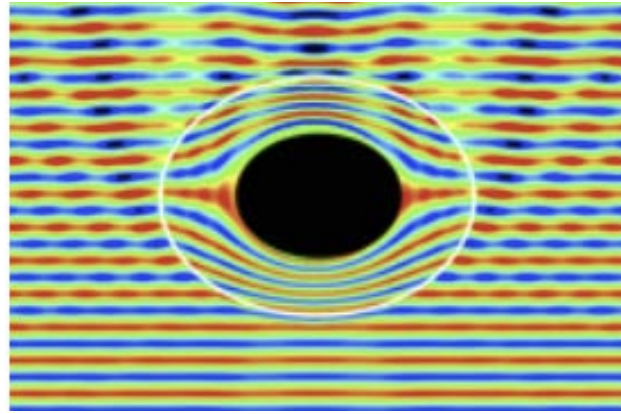
The cyclist or walker leaves the path and is taken over the water and through the Tranquillizer



THE TRANQUILIZER

Acoustic Tunnel: Initial Form

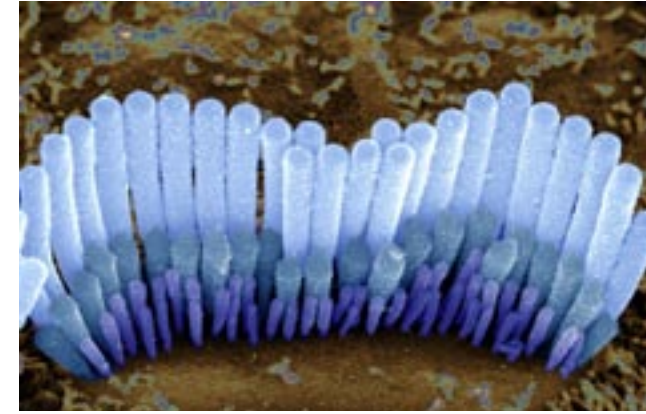
Representation of the sound waves effected by the acoustic cloak



Sonic Crystal sculpture, Eusebio Sempere, Madrid, Spain



A scanning electron microscope image of the inner hair cell from a guinea pig's hearing organ. Dr David Furness, Wellcome Images



Collapsible Victorian EarTrumpet, Wellcome Images



Tonotopic Landscapes and Listening Horns

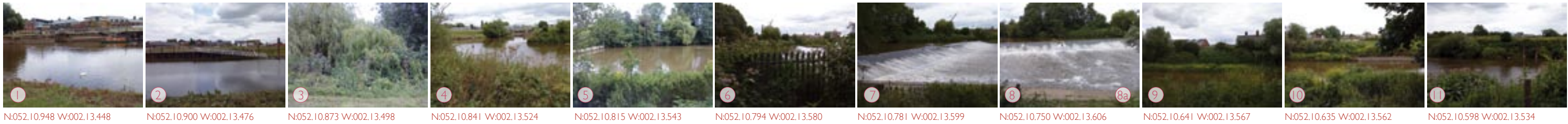
Tonotopic Landscapes: On 8 July 2009 we met with José Sanchez Dehesa of the Universidad Politecnica de Valencia and Seb Jouan at Arup's London Offices. José is the engineer responsible for the theory of an 'acoustic cloaking' material which it has been claimed, can make an object impervious to sound energy. We invited him to describe the technology in more detail. From the discussion it was clear that this technology was at a very early theoretical stage but had developed from a better known acoustic principle generically referred to as Phononic or Sonic Crystals. We continued to discuss the Sonic Crystal with Seb after José had left and decided that some form of this technology might provide the solution we are looking for.

Following our meeting with Seb and José, we met with Greg Watts at the Worcester site and spent an afternoon measuring the sound pressure levels, and taking sound recordings to analyse the frequencies present on the site. We also made a soundscape summary of each stop from the north of the weir opposite the canal to the meadow, taking readings where we perceived either a loudness or frequency shift in the sound of the weir.

Greg has been involved in the preparation of an EPSRC research project looking at sonic crystals as noise barriers with academics Keith Attenborough of the Open University and Dr Olga Umnova of the University of Salford. Greg also suggested that the sonic crystal idea may lead to some interesting effects on the site using a series of cylinders to alter the broadband frequency of the weir. The sonic crystal provides the potential for an installation which might be spread along a section of the cycle path, creating a structure which is designed to be experienced while in motion (walking or cycling) and thereby changing its effect upon the listener as they travel past it. Designing something which might be articulated through movement addresses Sue's suggestion that we explore the cognitive significance of changing states.

Another connection we have made is the visual similarity between the arrays of cylinders found in Sonic Crystals and some of the images of inner hair cells we have collected from the Wellcome Trust archive. The links between the frequency bands in the Sonic Crystal and the tonotopic mapping in the auditory system were at this stage, tentative but informed the basis of the next stage of our research with Amr and Sue and the development of the proposal for our 'listening aid', the *Cochlea Unwound*.

Listening Horns: Another solution for the *Listening Aid* we considered was the acoustic tunnel; a structure that is wide open at the end the visitor approaches and with the other end narrowed, pointing towards the weir. This would be filled internally with an acoustically absorbent material so that although the view is directed to the weir, the sound is significantly attenuated when you are inside the structure. We first became interested in this idea reading early audiology texts by Thomas Buchanan and we experimented with listening horns on the sound cycle ride. We have also been exploring various active noise canceling technologies as a way of augmenting the acoustic performance of such a horn.



SOUND SITE SURVEY



We began by walking from the Worcester bridge down towards the weir and started our sound survey just opposite the canal. We stopped at each point where we perceived a difference in the soundscape, these differences included the change in the dominant sound, the increase in volume or a change in the dominant frequency we could hear. At each site Greg took a 360 panoramic video, a GPS reading and a decibel level reading. Frances made a 1 minute binaural sound recording facing the river; took a photograph of what could be seen in front; filled in a soundscape summary sheet and wrote down all the sounds she could hear.

There were a number of interesting situations:

- Site 3 was the last point at which we could not hear the weir. Just beyond site 3 we became aware of the weir sound but very quietly. Greg described this as the "tipping point"
- Between site 5 and 6 the frequency of the weir changed from being low pitched to having a more dominant high pitch closer to the weir; this was very perceptible as you walked towards and away from the weir. This phenomena is called the shadow zone and as you walk toward the sound source and pass the edge of the weir you move into the "illuminated zone"
- Between site 8 and 8a the sound of the weir changed significantly within the distance of a meter as you walked away from the weir. There did not seem to be any landscape feature that might cause this.
- The main path runs at a higher level than the river at site 7 the weir was incredibly loud. Below and next to the river; but closer to the weir at site 7a, it was slightly quieter however there were more high frequency sounds in the weir-noise as the path of the water sound to us was more direct.

SOUNDSCAPE SUMMARY	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9	SITE 10	SITE 11
dB LEVEL	48.49	55.46	46.47	49.51	54.55	65.66	69.70	67.68	51.52	49.50	47.48
DOMINANT SOUND	Road traffic and boats	Road traffic	Road, wind	Weir	Weir	Weir	Weir	Weir	Weir	Weir	Weir
LOUDNESS	100	100	100	100	100	100	100	100	100	100	100
SOURCE	NATURAL	NATURAL	NATURAL	NATURAL	NATURAL	NATURAL	NATURAL	NATURAL	NATURAL	NATURAL	NATURAL
LOCATION	NEAR	NEAR	NEAR	NEAR	NEAR	NEAR	NEAR	NEAR	NEAR	NEAR	NEAR
PITCH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH
STATE OF MIND	CALM	CALM	CALM	CALM	CALM	CALM	CALM	CALM	CALM	CALM	CALM

1 minute soundscape: lock gate, birds, mens voices, boat engine, water wake, canal boat, road traffic noise, wind in ears.

1 minute soundscape: road traffic, distant talking, clanking metal, bike, birds, boat engine, road traffic, construction vehicle.

1 minute soundscape: construction vehicle, wind, bird song, traffic in background, birds, crow, barge engine slowing down, revving, traffic, water wake.

1 minute soundscape: ducks quacking, bird song, weir, distant rumble, birds to left, bird in front, weir, quack.

1 minute soundscape: weir, birds, crow, wind in trees, tweet, bird, closed in sound, motorbike in distance.

1 minute soundscape: weir, wind in trees

1 minute soundscape: weir

1 minute soundscape: weir, fishing rod, wind, trees.

1 minute soundscape: weir, birds, wind in trees, birds all around, aeroplane above, weir.

1 minute soundscape: weir, tractor, wind in trees, birds song, more wind, weir distant, wind in trees.

1 minute soundscape: police siren, aeroplane, weir in background, running dog in grass, plane, distant car, bird song, construction vehicle, bee in ear, man talking to dog.

SOUNDSCAPE SUMMARY	SITE 7a
dB LEVEL	65.66
DOMINANT SOUND	Weir
LOUDNESS	100
SOURCE	NATURAL
LOCATION	NEAR
PITCH	HIGH
STATE OF MIND	CALM

1 minute soundscape: weir, low rumble, shhhh of white water, distant aeroplane above.

SOUNDSCAPE SUMMARY	SITE 8a
dB LEVEL	57.38
DOMINANT SOUND	Weir
LOUDNESS	100
SOURCE	NATURAL
LOCATION	NEAR
PITCH	HIGH
STATE OF MIND	CALM

1 minute soundscape: bird song, weir, aeroplane, birds, plane above, weir, plane.

1:5 rapid prototype model of the 'Valencia Sonic Lens'



Testing the frequency band 5-10kHz affected by the 1:5 model of the 'Valencia Sonic Lens'



1:1 prototype of 'Valencia Sonic Lens' tested at the weir in Totnes on 21 March 2010



Visualisation of the 'Cochlea Unwound' sonic crystal listening aid for Worcester



The Cochlea Unwound: Sonic Crystal Listening Aid

The **Cochlea Unwound** is an idealised version of a sonic crystal array proposed for the site next to the weir near Diglis Island in Worcester. The **Cochlea Unwound** takes its cue from the audiological process of 'tonotopic mapping' that begins in the cochlea and travels up through the auditory system to the primary auditory cortex. Our proposal for the **Cochlea Unwound** provides a frame through which to listen to the tonotopic structure of sounds in the landscape, by making audible the frequency bands within the weir sound. It uses the acoustic principles of sonic crystal arrays to focus or attenuate particular frequency bands within the weir noise.

A sonic lens is a form of sonic crystal array that enhances or attenuates a particular frequency band. A 2D sonic 'crystal' or 'lens' is constructed using various dimensions of long cylinders in close proximity. The dimension of the columns and the spacing between them effect the frequency bands that are enhanced or attenuated, by bending and trapping sound. Professor Keith Attenborough from the Open University introduced us to what we have called the '**Valencia Sonic Lens**' which was developed by Hakansson and Sanchez-Dehesa from the Universidad Politecnica de Valencia. With Keith and his colleagues from Valencia University we have developed the proposal for the **Cochlea Unwound**.

To begin to understand the formal qualities of the sonic lens, we developed a 1:5 model of the '**Valencia Sonic Lens**'. The frequency band that this scale of sonic array will effect is 5-10 kHz. We then developed a 1:1 prototype of the '**Valencia Sonic Lens**' to test if the predicted effect of the sonic lens would be audible in an outdoor environment. At this scale the array affects sound waves in frequency bands between 1-2 kHz at 50cm away from the centre line of the array. Liminal tested the **Prototype** at the weir on the River Dart in Totnes on 21 March 2010. Although the materials and construction of the **Prototype** compromised the predicted effect it was still possible to hear a subtle change in the frequency bands of the weir. Having listened closely to the **Prototype**, listeners also noticed the subtle shifts in frequency caused by sounds bouncing off trees and local landscape features.

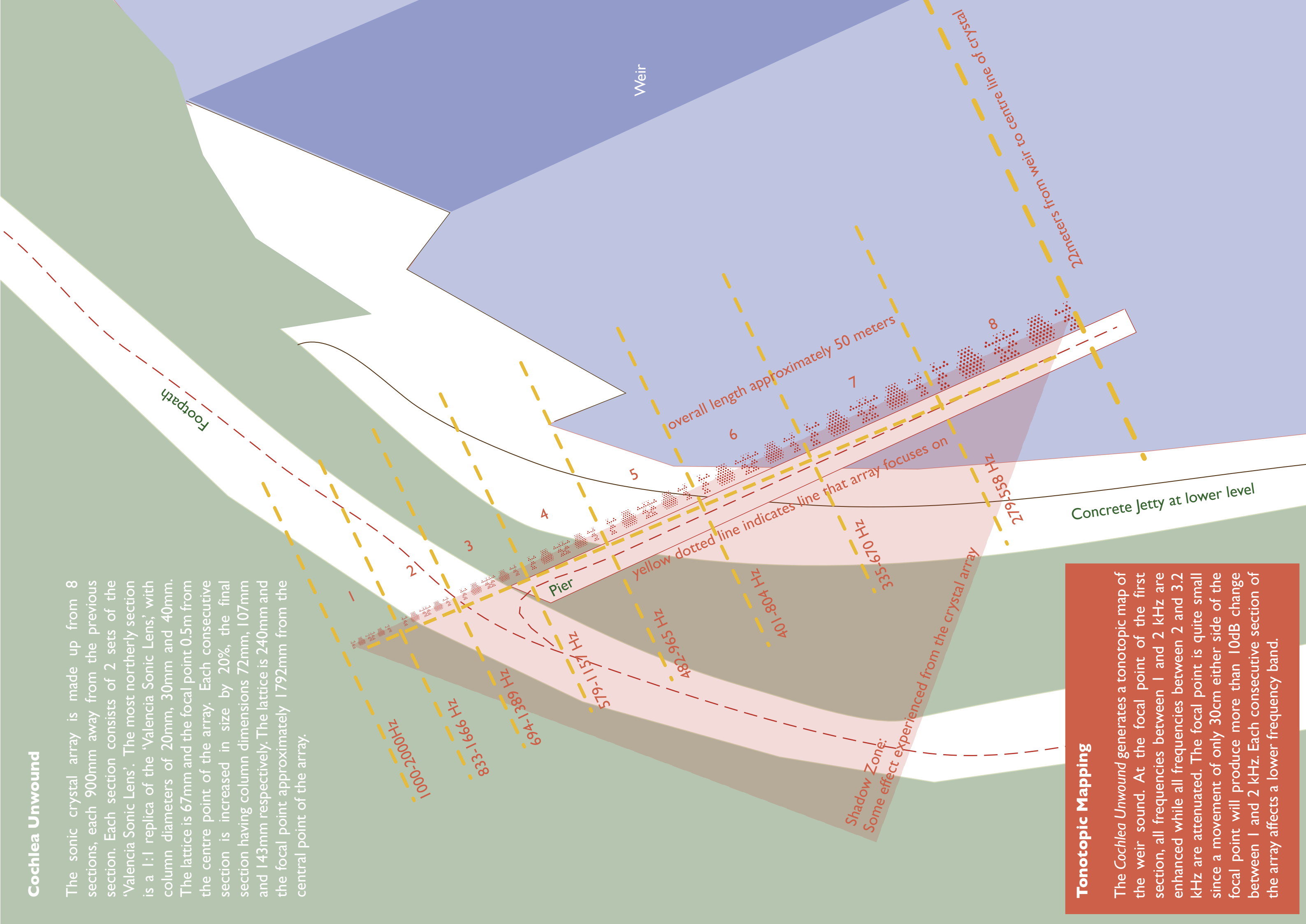
To communicate the effect of the **Cochlea Unwound** on the sound of Diglis weir, we commissioned an animated visualisation of the journey from the meadow at the southerly tip of Diglis Island to the weir, to which we created an auralisation sketch of the affect the sonic crystal arrays would have on the sound of the weir as a cyclist travelled past the structure. This was presented as part of the Lost Frequency presentation at Arup's offices in London.



Stills from the animated visualisation and auralisation of the journey from the meadow to the weir.

Cochlea Unwound

The sonic crystal array is made up from 8 sections, each 900mm away from the previous section. Each section consists of 2 sets of the 'Valencia Sonic Lens'. The most northerly section is a 1:1 replica of the 'Valencia Sonic Lens', with column diameters of 20mm, 30mm and 40mm. The lattice is 67mm and the focal point 0.5m from the centre point of the array. Each consecutive section is increased in size by 20%, the final section having column dimensions 72mm, 107mm and 143mm respectively. The lattice is 240mm and the focal point approximately 1792mm from the central point of the array.



Tonotopic Mapping

The *Cochlea Unwound* generates a tonotopic map of the weir sound. At the focal point of the first section, all frequencies between 1 and 2 kHz are enhanced while all frequencies between 2 and 3.2 kHz are attenuated. The focal point is quite small since a movement of only 30cm either side of the focal point will produce more than 10dB change between 1 and 2 kHz. Each consecutive section of the array affects a lower frequency band.

The Cochlea Unwound: Sonic Crystal Listening Aid



Exhibition in Atrium of Arup's © Sustrans



SoundLab with ambisonic recordings of Tranquil Places © Sustrans



The Lost Frequency presentation lecture © Sustrans



The Lost Frequency presentation lecture © Sustrans



The Lost Frequency: In Search of Tranquillity



Invitation to the Lost Frequency

We concluded the research phase of the *Tranquillity is a State of Mind: Listening Aids for a Listening Impaired Society* project with a performance lecture and exhibition at Arup's Shears & Emmerson conference suite, Fitzroy Street, London, on 31 March 2010.

The Lost Frequency: In search of Tranquillity wove together the two key journeys that featured in our research; the journey of sound from the ear to the brain and the journey from the meadow to the weir at Diglis Island in Worcester. The presentation integrated live performance and an eight channel sound diffusion based on the recordings of the site, interviews with the research team and an auralisation of our proposed structure, the *Cochlea Unwound*.

The Bike Show: Radio Broadcast on Resonance 104.4fm
Extracts from the final presentation and an interview with David Prior and Katy Hallet were broadcast on Resonance FM's The Bike Show on Monday 7th June at 6.30pm, repeated the following Sunday lunchtime and also available as a podcast.

The Bike Show is a weekly radio show about cycling. It is broadcast in central London on radio art station Resonance 104.4fm and is also available as a live web stream and podcast, to which there are currently around 5000 subscribers. The Bike Show won a London Cycling Award in the 'best media' category in 2005.



Seb Jouan welcoming the audience © Sustrans



Exhibition in the Atrium at Arup's © Sustrans

Inter-disciplinary Research Team



Journey of Sound Through the Auditory System and The Cochlea Unwound illustrations, presented at the final exhibition



Tranquil Places, presented in Arup's SoundLab



Diagnosing the Sound of the Landscape: A Sound Cycle Ride



Public Engagement

Tranquillity is a State of Mind lead to a series of outcomes that communicate the biomedical themes developed as part of the research process:

The inter-disciplinary nature of the research team worked well not only in providing a stimulating context for debate around the subject of sound, hearing, tinnitus and listening but also as a catalyst for new ways of thinking about our respective research areas.

The Journey of Sound through the Auditory System: (graphic presentation pg. 7) illustrates the interface between the domains represented by the clinical audiologist and the computational neuroscientist. It opened up dialogues between the acoustic and neurological, both literally and metaphorically. For example, 'Tonotopic mapping'; the process by which sound is physically mapped according to its spectral content across the length of the basilar membrane in the cochlea, up-through the brain stem and ending at the primary auditory cortex, became one of our central themes in the development of our 'listening aid'; The Cochlear Unwound.

The Cochlea Unwound (proposal for a sound installation) provides a frame through which to listen to the tonotopic structure of sounds in the landscape by making audible the frequency bands within the sound of the weir in Worcester. It uses the acoustic principles of Sonic Crystal arrays to focus particular frequency bands within the weir noise. The proposal for the Cochlea Unwound is a catalyst for debate around the Tranquillity is a State of Mind project. The proposal for the Cochlea Unwound will provide a context where the public can engage experientially with listening to sounds in the environment in a new way and encourage new ways of thinking about how we hear sound.

Diagnosing the Sound of the Landscape: A sound cycle ride was a four-day cycle ride along Route 45 of the National Cycle Network starting in Worcester and ending in Cricklade, Wiltshire. On-route, we stopped at places that presented us with questions about tranquillity. We recorded these sites and they were presented as Tranquil Places in the Arup SoundLab as part of our final exhibition. Members of the public were invited to join us on the last leg of our journey from South Cerney to Cricklade. The purpose of the public sound cycle ride was to engage the public in the questions surrounding the research project.

The Lost Frequency: In search of Tranquillity (live audio presentation) concluded the research phase of our project. Interweaving the journey of sound from the ear to the brain and the journey between a meadow and a weir; the performance lecture used sound recordings and a spoken narrative as a method of communicating the research process. The accompanying exhibition mapped out ideas and routes that we took as part of these journeys.

The public sound cycle ride and the Lost Frequency presentation and exhibition, provided a context in which the general public and a cross-disciplinary professional audience respectively, could engage with and discuss biomedical issues of hearing and tinnitus and consider the relationship that this has with cultural listening practices.



The Lost Frequency: In Search of Tranquillity exhibition



The Lost Frequency: In Search of Tranquillity Performance Lecture.

Dissemination

The resources and outcomes from the research phase of the Tranquillity is a State of Mind project have been disseminated in the following ways:

- Presentations at University of Plymouth and the University College Falmouth.
- Presentations at three conferences:
 - The Applied Soundscapes Conference on 16 September 2009, University of Salford.
 - A Place for Creativity?, The second annual public art conference organised by RUDI, 17 June 2009, The Lowry, Manchester.
 - Public Art Symposium, De Montford University, 2 December 2009.
- David Prior's paper *The Cochlea Unwound* will be published in the peer reviewed journal Performance Research, Volume 15, No. 3 (September 2010) 'On Listening' published by Routledge.
- Max Dixon has proposed writing an article about the issues surrounding Tranquillity is a State of Mind for IXIA's new journal "Art and the Public Sphere"
- This report is available as a PDF download via Sustran's and Liminal's websites
- The short films are available online on vimeo
 - Diagnosing the Sound of the Landscape: A Sound Cycle Ride
 - Tranquil Places 1
 - Tranquil Places 2
 - Tranquil Places 3
 - The Tranquillizer - a concept sketch
 - Sonic Crystal Prototype 01
 - Cochlea Unwound: Sonic Crystal Listening Aid - animated auralisation and fly through
 - The Lost Frequency: In Search of Tranquillity - final presentation at Arup.
- Extracts from the final presentation and interview with David Prior were broadcast on Resonance FM's The Bike Show on Monday 7th June at 6.30pm, repeated the following Sunday lunchtime and also available as a podcast. The Bike Show is a weekly radio show about cycling. It is broadcast in central London on radio art station Resonance 104.4fm. The Bike Show won a London Cycling Award in the 'best media' category in 2005. Through the internet it reaches listeners all around the world – there are currently around five thousand subscribers to the podcast.
- The PRS Foundation have shortlisted our proposal The Organ of Corti for their New Music Award. The Organ of Corti proposal comes directly out of our Wellcome Trust funded research and has received media attention including interviews so far with,
 - The Times newspaper, 18 June 2010.
 - Sound and Music's magazine INTO
 - Feature on Radio 4's Start the Week with Andrew Marr and PRSF panelist Paul Morely.
 - Short films have been made of the shortlisted pieces and these will be distributed on June 18th online via the Times website and the PRSF website and in a number of Art Centres across the UK.

Evaluation

Tranquillity is a State of Mind: Listening Aids for a Listening Impaired Society has been a successful project that brought together experts from a number of fields, stimulating new ways of thinking about the relationship between sound, the environment and their relationship to health and wellbeing. Members of the team commented on how the project has been a catalyst for new ways of thinking about sound and its relationship to their own disciplines and the public outcomes have already communicated elements of this to both general interest and professional audiences. Liminal's short listed project the *Organ of Corti* for the PRSF New Music Award, Sustrans/Liminal's successful Arts Council bid and David Prior's forthcoming publication in *Performance Research* are just three examples of the ways in which the project will continue to have an impact on thinking within the field.

Working as part of a multi-disciplinary team proved to be one of the most enjoyable and valuable aspects of the project as well as one of the most logistically challenging. The collaborative process took more time than anticipated and during the project, the team wanted to have more opportunities to develop a dialogue between disciplines. This was addressed by extending the project programme allowing the project to emerge collaboratively and integrate the diverse themes that resulted from the different disciplines involved.

A formal evaluation of the contribution and engagement of the core team was undertaken by Sustrans at the beginning, part way through and at the end of the project. This process was based on the Ixia evaluation tool for public art projects. The research team experienced a high level of engagement with the project and felt that the most enjoyable aspect was working with people from other disciplines. There was clear indications of cross-disciplinary learning, not just between art and science but also across scientific disciplines. At the end of the research project liminal asked each member of the team to contribute a short statement. Their responses can be found on the following pages.

The response of the public to the sound cycle ride was identified through an informal questionnaire, devised by Sustran's and the presentation at Arup was gauged through informal discussions. The overall feedback for both events was positive.

Research Team's Personal Evaluations

Dr. Amr El-Refaie: Clinical Audiologist

I come from a medicine / Audiology background and my initial interest in the project stemmed from my work with people with hearing loss and tinnitus. Being involved in tinnitus management, the main goal is to reduce the effect of tinnitus, or the “internal noise” on the patient’s well being. The statement “Tranquillity is a state of mind” sounded exactly like what we try to achieve. From the first time we started to discuss the project with other member of the group from different backgrounds, I understood that we, in the tinnitus field, are looking at the problem from a very narrow angle. The inter-disciplinary team approach made me re think some of the concepts and beliefs I had about tranquillity and how we interpret it differently. I believe now that management of the “internal noise” can’t be separated from the environment that we live in or the “external noise” and probably looking at the concept of the “Listening impaired society” as a whole, would be essential if we are managing individual’s problems. I also found intriguing the concept of “silence” and how it relates to tranquillity and well being, while actually, it differs with different people. It is a standard practice in tinnitus management to advise our patients to “avoid silence”, as this might contribute to making the tinnitus sound louder. I now have to re think about that, and probably investigate what silence actually mean to individual patients before discussing it as a part of the counselling process. I hope I was able to provide a clinical / medical angle to the discussion, especially with understanding how the hearing mechanism work at the level of the ear and the central auditory system in the brain, and help in reshaping the final outcomes of the study. I am now very enthusiastic to get involved in further work regarding the concept of listening aids rather than hearing aids. I believe that the way I approach management of tinnitus in general has changed as a result of my involvement in this work and I can see clearly new pathways to look at the problems of tinnitus and hearing loss

Professor Susan Denham: Computational Neurologist

When the principal investigators, Frances Crow and David Prior, first contacted me describing their ideas of creating a sense of tranquillity in landscapes impaired by noise, through transformation of that noise, I was very intrigued. The questions they were asking started off a whole train of, sometimes crazy, ideas in my mind. So I was very pleased when the project was funded.

My role in the project was as scientific advisor on auditory perception and the neural mechanisms underlying the transformation of atmospheric pressure waves into the rich world of sound that makes up our conscious perception of these waves. In this sense I think tranquillity, like perception, is a state of mind, a mental construct which results from our brains trying to make sense of and interpret the external and internal world in which they are immersed.

In an age where technology allows and encourages the saturation of the environment with a wide range of sounds, it is interesting to consider how we can learn to listen ‘better’ and become more sensitive to and aware of the subtleties and beauty of (some) sounds. The problem is of course that our sensory systems adapt to the prevailing levels of stimulation, and so constant exposure to sound inevitably deadens ones sense of sound in a very real way. The idea of creating interesting listening aids is thus challenging and inspiring.

I found the interactions between the diverse set of investigators and contributors at the project meetings to be very stimulating. Despite coming from a range of backgrounds we were nevertheless able to find ways to communicate and bridge what is sometimes seen as an unbridgeable science-arts divide. I think the end result and the ideas which flowed from the interaction were and are valuable, and I look forward to seeing at least some of them pursued in a more concrete form. From my own point of view the idea of understanding how we perceive soundscapes continues to interest me, and is in fact a topic of a new EU research grant which began last year and will run to 2012.

Professor Greg Watts: Acoustician

I provided the background to our studies of tranquillity at the University of Bradford which involved a presentation of the major features of our work i.e. the development of a novel tranquillity rating prediction tool. I also sampled traffic and water sounds at the proposed site for the art work at Worcester and suggested the use of sonic crystals as an interesting method of engaging the public. I was also interviewed for the final public presentation of the project, though regrettably I was not able to attend the event in person.

We have discovered through our studies involving fMRI (functional magnetic resonance imaging) that for tranquil scenes (beach scenes) the medial pre-frontal cortex of the brain makes significantly stronger connections with the auditory cortex than for non-tranquil scenes (motorway scenes). This added connectivity suggests a greater involvement of the conscious part of the brain in reflecting on sensory information in tranquil states. Further studies are planned which should reveal more about the "state of mind" when tranquil scenes are perceived. Perceived tranquillity is clearly a response to both sensory information and mental and physiological states. However, looking at external factors that contribute to tranquil spaces we can say that an environment is considered tranquil if we expect most people to rate the area peaceful most of the time and where there is an obvious connection with nature.

Many soundscapes in cities and towns are coloured by mechanical sounds from transportation. This noise can easily mask other more satisfying sounds which as a consequence we can easily miss. A case can be made to educate people to attend more to the sounds around us particularly natural sounds. When fully attended to, such sounds produce a direct positive emotional response. A listening aid in the form of artwork that actually draws attention to the soundscape through its interesting manipulation is a potentially valuable approach. I am passionate about the idea that tranquil spaces can be designed using an engineering approach and in an important sense can be restorative i.e. they aid recovery from the stress of modern life, improve wellbeing and have positive health consequences. Using sonic artwork can be a step in the education process of making the public more aware of soundscapes which is an important determinant of perceived tranquillity. Involvement in the project has broadened my knowledge base and reminds me of the different approaches that can be used in the education process. It is possible that one or more colleagues I have met as part of this work will be useful in bidding for future research work in this area.

Seb Jouan: Consultant Acoustician

We provided support to the team as soundscape adviser and acoustic consultancy input – in particular for the appropriateness and technical relevance of several artistic proposals. We also contributed by hosting the final evening in our Arup facilities in London with more than 100 guests attending. Our SoundLab was also used for demonstrating some of the soundtracks produced for the final evening at the end of the project.

As soundscape designers, we work on improving the urban soundscape for the public realm which usually means reducing overall noise levels. This artistic project was interesting in the sense that it was focusing on the paradox that some of the sounds that the human ear like are not necessarily quiet ones. And attempting to reduce their noise levels not necessarily a pleasant one – the concept of the 'tranquilliser'. We found this idea very interesting – which indeed confirms that Tranquillity is a State of Mind. Our society is driven by sight. Advertisement, television, video-games, etc are all visual more than sound experience. As acousticians, we too concentrate on the perception of sound. We recently did an artistic installation for the Edinburgh International Science Festival called Sonic Dreams where people were exposed to 3D sound in total darkness. We want to help people use their hearing more. In Arup, we always want to push the boundary whilst bringing closer together Arts, Engineering and Science. This project was exactly

that. Also, whilst the SoundLab was meant to be used, the project investigated the possibility of auralising the effect sonic crystals. Interestingly, the only way to auralise them was by using a technique still under development – wave propagation prediction which includes sound diffusion - currently not feasible with ray tracing techniques. We suggested the intervention of Dr Damian Murphy, from the AudioLab at the University of York to attempt to resolve this point.

We in Arup work in inter-disciplinary teams. Part of our reputation is our ability to approach projects in a holistic manner. We believe we brought this experience to the project, more than learnt from it. This project challenged the current auralisation techniques, and our practice gained a link with the University of York investigating the possibility of using wave propagation techniques and consequent auralisation. Finally, we believe that the most interesting aspect of the project is the quality of sound not the quantity (ie noise levels). Indeed you can have a pleasant experience if you are near a loud sound created by a weir. This project is a reminder that the subjective experience is more important than the objective target. Modern cities are often designed with very objective targets in mind (quantitative – ticking the box) – but in fine lack aesthetics (arts) and cohesion (multi-disciplinary) (i.e. qualitative). This is an aspect we are approaching with planners.

Katy Hallett, Sustrans: Project partner

Sustrans new Art Programme focuses on commissioning artist led interdisciplinary collaborative teams to develop ideas and new artworks of particular relevance to Sustrans and our remit to encourage people to travel in ways that benefit their health and the health of the environment.

Sustrans role in this project was as project host taking a deep interest in the development of the research and assisting with project as appropriate. I was particularly concerned to contextualise the concept and locate it within Sustrans core activities, to find links with Connect2 - Sustrans major Lottery project. This was achieved during the Sound Ride when Liminal cycled from Worcester to Cricklade - a site at Worcester along the National Cycle Network was identified with input from Sustrans regional manager and our Worcestershire Local Authority partners.

Particular aspects undertaken by Sustrans;

- Co-ordination of the project partners including networking with Worcester contacts
- Attending project meetings
- Project evaluation through Ixia evaluation forms plus gathering information about the project
- Production of project flyer for Worcester
- Assisting with design of invitations for Sound Ride and Final presentation
- Undertaking printing for flyer and invitations
- Compiled mailing lists for mailouts and emailing for Sound Ride and Final presentation
- Provided photographer for Sound Ride and presentation – plus additional staff to these events

Tranquility is a State of Mind raises questions about what constitutes Tranquility and how much of ones life is based on ones attitude and state of mind. A sobering thought with far reaching consequences.

The idea of listening aides for a listening impaired society was inspiring - I envisage something quite literal that could punctuate a section of the National Cycle Network giving travellers a chance to experiment using the 'aide' to listen anew to the environment and with their own listening attention - encourage a more perceptive listening public. We were interested in taking part in the research project as we were excited to see how artists and other specialists would work together and what this might produce.

By working as part of an inter-disciplinary team, we have gained by observing the process – the research potential and seemed to expand becoming enormous with too many potential avenues to pursue – they had to be defined with many possibilities noted for another day. Sustrans new Art Programme has involved four commissions to date each completely different - We have gained confidence in process and are committed involving multidisciplinary teams with future commissions. This Tranquillity is a State of Mind project has been inspiring and unpredictable - if rather slow moving. We look forward to seeing practical results from this research process – auditory proposals for permanent auditory experience along the river Severn in Worcester realised and installed over the coming year.

Lesley Greene: Independent Curator

In this research project the curatorial role was essentially supportive of both the artists and host, and consisted of mediation and facilitation rather than traditional curatorial work. I worked with liminal at the Cotswold Water Park Society and was extremely interested in their approach as artists alerting people to the qualities and subtleties of sound in the environment and also transforming noise in the environment. I am particularly interested in the impact of liminal's work on our awareness of the natural sounds around us, as part of my ongoing interest in birds and wildlife and their 'roles' in our world; that we are a 'listening impaired' society for me is additionally of interest in relation to our ability to attend to the crisis of biodiversity especially in this International Year of Biodiversity.

I have always worked in multi disciplinary teams but this research project was especially interesting as it was following a unique exploratory path. I was pleased to work with Sustrans on their new programme as it looks forward in many different ways to, and raises questions about the contributions that teams of artists, scientists and others can make to a society in transition. The Sound Cycle Ride through the Cotswold Water Park was a particularly inspiring public event. It engaged members of the public in a thought provoking way, inviting a variety of fascinating responses of which perhaps the most poignant was from one individual who did suffer from tinnitus. Another person on the ride was able to identify individual bird song and that added richness to my experience.

A great deal of my time was spent trying to find an appropriate venue in which the sound piece could be properly performed. This was frustrating – the combined requirements for an ambi-sonic chamber; publicly accessible, in central London and relatively inexpensive proved impossible until Arup offered their facilities. I found the discussions between the research team members thought provoking although but team meetings were fewer than had been originally anticipated due to the difficulties of getting very busy people together. I was also disappointed that the whole research team could not be present at the final event due to an unexpected venue problem. That said liminal pulled off an exemplary and compelling performance and I am proud to have had the opportunity to work with them.

The experience confirms my commitment to interdisciplinary practice as a fruitful methodology in the arts. I hope to continue to work with liminal in the Cotswold Water Park as it will be a venue for the 'Organ of Corti' if the PRS Award is successful.

Potential Future Developments

Listening Aids for Worcester: The proposal for the 'listening aid' is being developed for the Worcester site as part of Sustrans' successful funding bid to the Arts Council for a public engagement project surrounding the themes developed in the *Tranquillity is a State of Mind* project. We are looking into working with the local RNIB school and the George Marshall Medical Museum. Alongside the development of a permanent listening aid we are working with artist Rob Colbourne who will be developing a series of public engagement events around the themes originally developed in the research process.

The Listening Aid project Partners

On 10 July 2009 Katy Hallet and Frances Crow met with Chris Dobbs, the cycling officer for Worcester City Council and Henry Harbord, the Sustrans regional manager, to discuss what needed to be done to build the project on site. Chris Dobbs was very supportive of the proposal and provided a number of links to begin the lengthy process of negotiating the use of the site for the listening aid.

The Organ of Corti: As part of the development process for the 'Cochlea Unwound' we constructed a 1:1 prototype of a sonic crystal array. This has led to the PRSF New Music Award short-listing our proposal for the 'Organ of Corti'. For further information please see www.prsformusicfoundation.com

EPSRC Sonic Crystals: As part of the development of the Cochlea unwound and the acoustic phenomenon of sonic crystals, we developed a strong working relationship with Professor Keith Attenborough from the Open University. With him we will seek partial funding from the EPSRC to fund a version of the 'Cochlea Unwound' that can be used to engage the public with the science of sonic crystal arrays. This may contribute to the 'Organ of Corti' or a permanent version of The Cochlea Unwound. We may also apply for match funding to the Wellcome Trust to develop this aspect of the project as the Cochlea Unwound would provide a physical context where the public can engage experientially with listening in a new way and encourage new ways of thinking about the way the auditory system tonotopically maps the sounds that we hear.

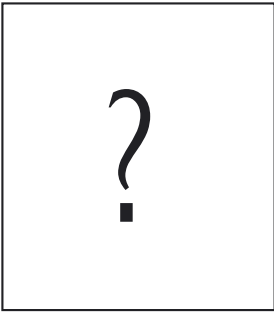
The Tranquil: We are currently developing a proposal that will combine the narrative we began in the 'Lost Frequency' and the journey illustrated in 'The Journey of Sound in the Auditory System' into a piece for radio and live performance that we would take to medical museums and institutions. Based on the radio version, the performance would become a vehicle for live debate and we would seek funding for this stage from the Wellcome Trusts public engagement awards. This proposal came from our original idea for an intimate listening space for the narrative, see the following illustration [The Tranquil: A journey in search of tranquillity](#).

The Tranquil; The Tranquillizer; The Tranquilized

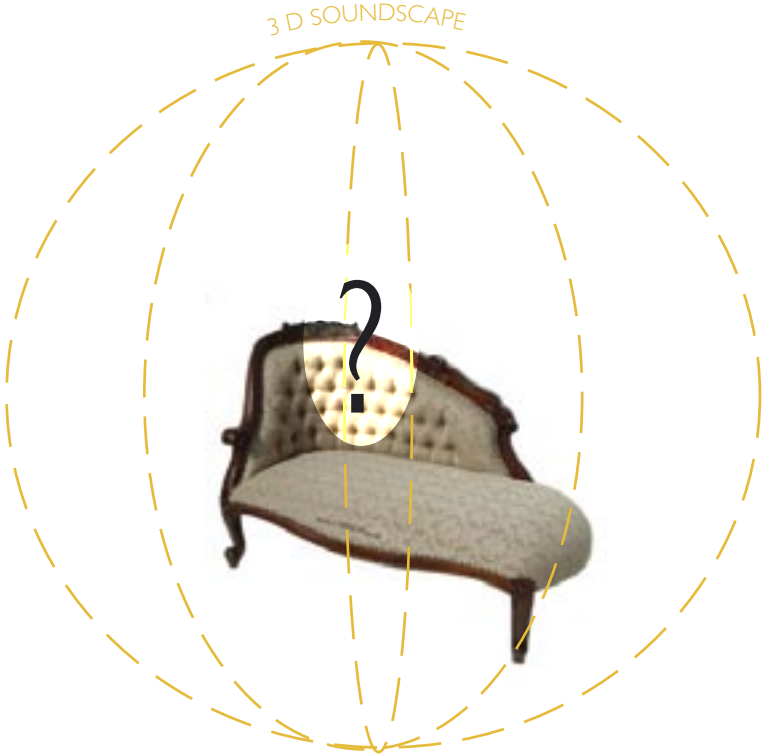
This is a proposal for a public engagement event that developed through our research into the Utopian nature of journeying. See the following illustration

THE TRANQUIL: A JOURNEY IN SEARCH OF TRANQUILLITY

The exhibition will consist of a visual display of proposals for the *Tranquilizer* including drawings, models and contextual information on the research process and a 3D audio presentation for one visitor (or Guest) at a time. As our 'Guest' enters the intimate ambisonic (3D) sound space they will be invited to recline on a *chaise longues*. As they rest they are taken on a utopian journey in search of tranquillity. Just as 'Guest' in William Morris's utopian novel 'New from Nowhere' is transported through a dream state to another time, so our 'Guest's' journey will take them out of their immediate soundscape on an imagined journey which will take them from the outer ear, passing through the various stages of the auditory system and ending in the auditory cortex. In the final stages of the journey, our Guest arrives at the *Tranquilizer*: her utopia. The *Tranquilizer* will be represented by an auralisation (an aural equivalent of a visualisation) of the structure we are designing for a site on the National Cycle Network in Worcester. The auralisation will be designed in collaboration with Arup Acoustics SoundLab. The purpose of the narrative journey is to place the *Tranquilizer* proposal in the broader context of the research we have carried out and to consider the impact of noise on health and wellbeing in our urban environment.



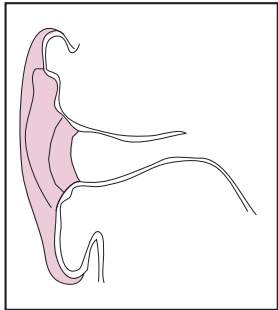
Guest



CHARACTERS



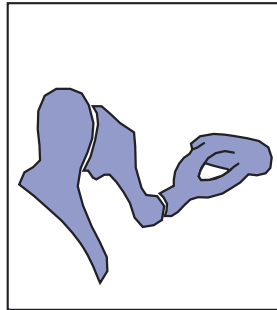
The Aurist



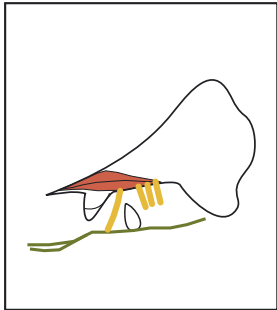
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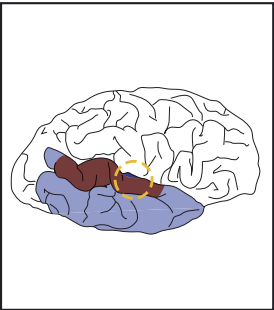
Inspector Auris



The Three Ossicles -
Malleus, Incus and Stapes

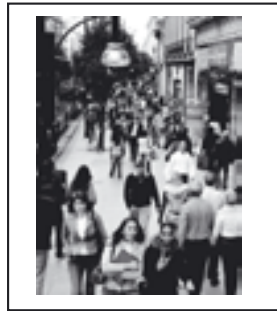


Corti - The organ of
hearing

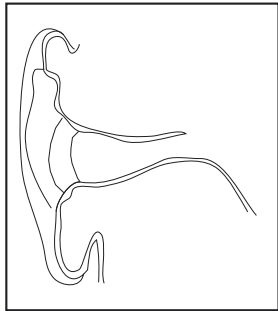


Dr Wernike

LOCATIONS



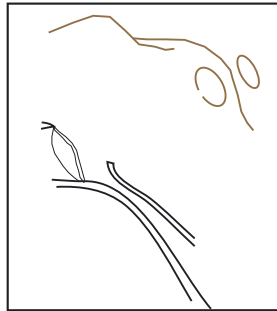
Soundscape



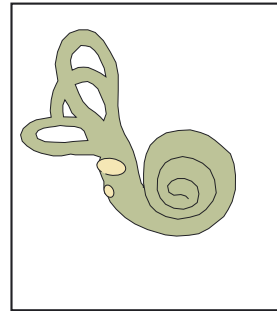
Ear Canal (Meatus)



Membrane Timpani - (Ear
Drum)



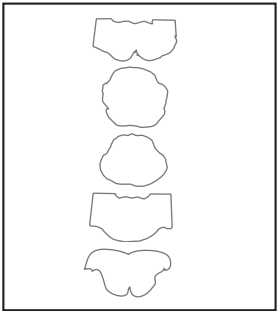
Petronous portion of the
temporal bone



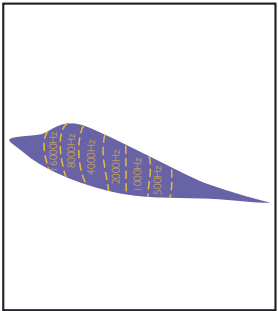
Cochlea - oval and round
windows



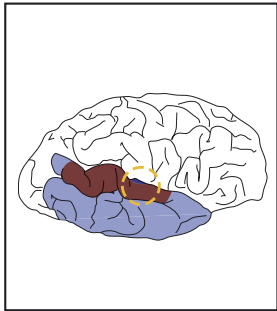
Spiral Ganglion and Basilar
membrane



Brain Stem - Medulla, Pons,
Midbrain



Primary Auditory cortex -
Cerebrum

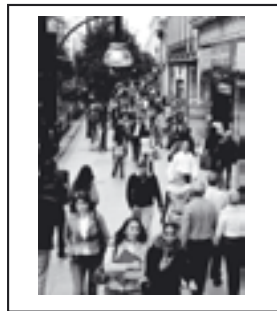


Secondary Auditory
Cortex - Cerebrum

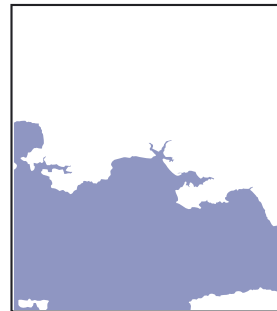
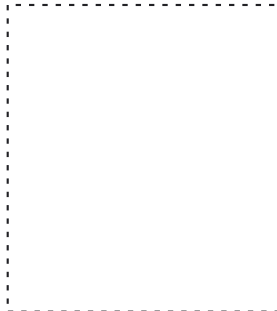
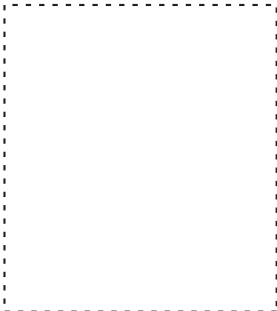
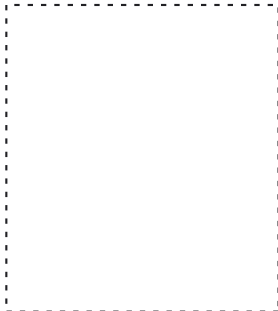
ATMOSPHERES

AIR

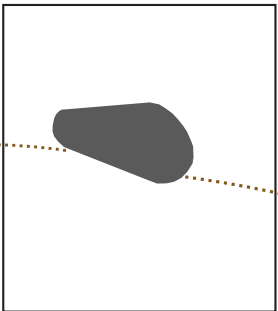
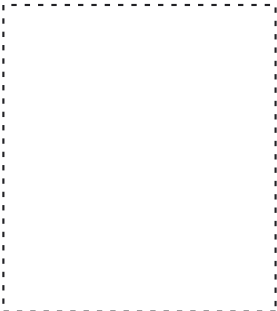
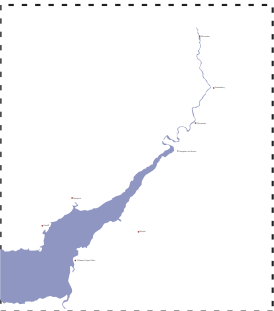
JOURNEY



Urban Soundscape



The River



The Tranquiliser



Urban Soundscape

TINNITUS - PHANTOM SOUND

THE TRANQUIL, THE TRANQUILIZER, THE TRANQUILIZED

The Tranquil is a live sound-cycle event with an open invitation to the public to join two characters, both called William Morris as they journey up the river Severn, one by bicycle the other by boat. The piece will encourage cyclists of all ages to take part in a collaborative live performance as they ride along the banks of the River Severn, finally ending their journey at the Weir in Worcester and the site of a proposed new public art structure “The Tranquillizer”.

William Morris, the inventor of the Morris motorcar, who was born in Worcester and started life as a bicycle mechanic, will accompany the cyclists. Guest (a fictional character from the other William Morris’s utopian novel News From Nowhere) who has travelled by boat to the upper reaches of the River Severn will meet them on the way. The cyclists and their fictional companions will discuss notions of tranquillity, noise and health and wellbeing as they journey in search of Tranquillity.

The narrative for the piece will be generated from our current collaborative research project Tranquillity is a state of mind, which has been supported by Sustrans and funded by a £30,000 grant from the Wellcome Trust. It will culminate in a proposal for the Tranquillizer in February 2010.

In the months leading up to the Tranquil, a Morris Minor car re-sprayed with a William Morris print will travel around the region engaging the wider community in participatory workshops. The community will propose utopian visions for future societies based on their relationship to the bicycle and car and consider the impact these forms of transport have on our health and wellbeing. The results will contribute to a travelling exhibition in the Morris Minor.

By using cycling, we will raise issues of environmental sustainability, health and well-being and as a result bring together culture and sport in an exciting live experience of a public space. The legacy will be The Tranquil: a pre-recorded, down-loadable, cinematic sound piece that takes its direction from the live event but can be listened to by individual cyclists on their MP3 players, The Tranquillizer: the permanent structure and The Tranquillized: a traveling exhibition in the Morris Minor.



William Morris - (1834-1896). An English architect, furniture and textile designer, artist, writer, and socialist.



William Morris (1877 – 1963). Founder of the Morris Motor Company and a philanthropist

