Silent Light, Luminous Noise

Photophonics, Machines and the Senses.

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THESIS CONTAINS

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Abstract

This research takes the basic physical premise that sound can be synthesized using light, explores how this has historically been, and still is achieved, and how it can still be a fertile area for creative, theoretical and critical exploration in sound and the arts. Through the author's own artistic practice, different techniques of generating sound using the sonification of light are explored, and these techniques are then contextualised by their historical and theoretical setting in the time-based arts. Specifically, this text draws together diverse strands of scholarship on experimental sound and film practices, cultural histories, the senses, media theory and engineering to address effects and outcomes specific to photophonic sound and its relation to the moving image, and the sculptural and media works devised to produce it.

The sonifier, or device engendering the transformations discussed is specifically addressed in its many forms, and a model proposed, whereby these devices and systems are an integral, readably inscribed component – both materially and culturally – in both the works they produce, and via our reflexive understanding of the processes involved, of the images or light signals used to produce them. Other practitioners' works are critically engaged to demonstrate how a sense of touch, or the haptic, can be thought of as an emergent property of moving image works which readably and structurally make use of photophonic sound (including the author's), and sound's essential role in this is examined.

In developing, through an integration of theory and practice, a new approach in this under-researched field of sound studies, the author hopes to show how photophonic sound can act as both a metaphorical and material interface between experimental sound and image, and hopefully point the way towards a more comprehensive study of both.

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Chapter 1:

Introduction

I discovered that sound could be synthesized using light, almost by accident. One wet morning in the spring of 2000, on a British Council sponsored trip to Moscow, myself and a few others were invited on a visit to 'an unique Soviet synthesizer' by a fellow traveler, Simon Crab. Simon had spent a number of years pursuing a personal project – using various archives in the U.K and Europe, he was researching what he hoped would become a comprehensive chronological survey of electronic musical instruments from 1870 up until 1990.[1] This inevitably led him to our hosts that morning, Andrei Smirnov, director of the Theremin Centre for Electronic Music, and a composer named Stanislav Kreichi. It is no exaggeration to say that the encounter I was about to have would influence my creative endeavours for years to come.

At that time, the ANS synthesizer was languishing almost entirely forgotten in an ancient recording studio, at the end of a warren of basement corridors in a university building just north of Red Square (Fig.1). Today it languishes, not quite so forgotten, behind a velvet rope in the Glinka State Central Museum of Musical Culture; an accolade bestowed upon this peculiar machine because of its part in Russian electronic music and film in the late 1960's and early '70's. Used in Eduard Artemyev's soundtracks to Tarkovsky's films Solaris, Stalker and The Mirror, the synthesizer has a unique 'cosmic' sound, and an equally unique way of generating it. Using a variety of improvised tools, one scratches through opaque, thick black mastic smeared on a glass plate, which is then scanned across a band of sonically modulated light, so that those marks allow specific luminous tones to emerge, producing a soft, microtonal beauty; in essence, it plays what you draw. The very idea that light could be modulated using sound was something that I was aware of, but until then hadn't properly comprehended until I watched and listened to the ANS perform its elegant, alchemical work; the essence of that convolution of mediums sits at the heart of almost all of my artistic practice examined in this thesis.

When one considers everyday images from the unusual standpoint that they could be converted into sound, a subtle change in thinking concerning one's visual environment takes hold. At first, every type of complex movement seems to hint at some kind of sonorous possibility – the movement of shadows cast by foliage, for example, or a cloud of midges seem as though they ought to produce interesting sound, if only the right combination of factors can be employed. Usually, these factors for me have been a photo-voltaic cell (a solar battery charger from Maplins),[2]

[1] You can see the results online: Crab (2005)

[2] A UK high street retailer specialising in electronic goods and components

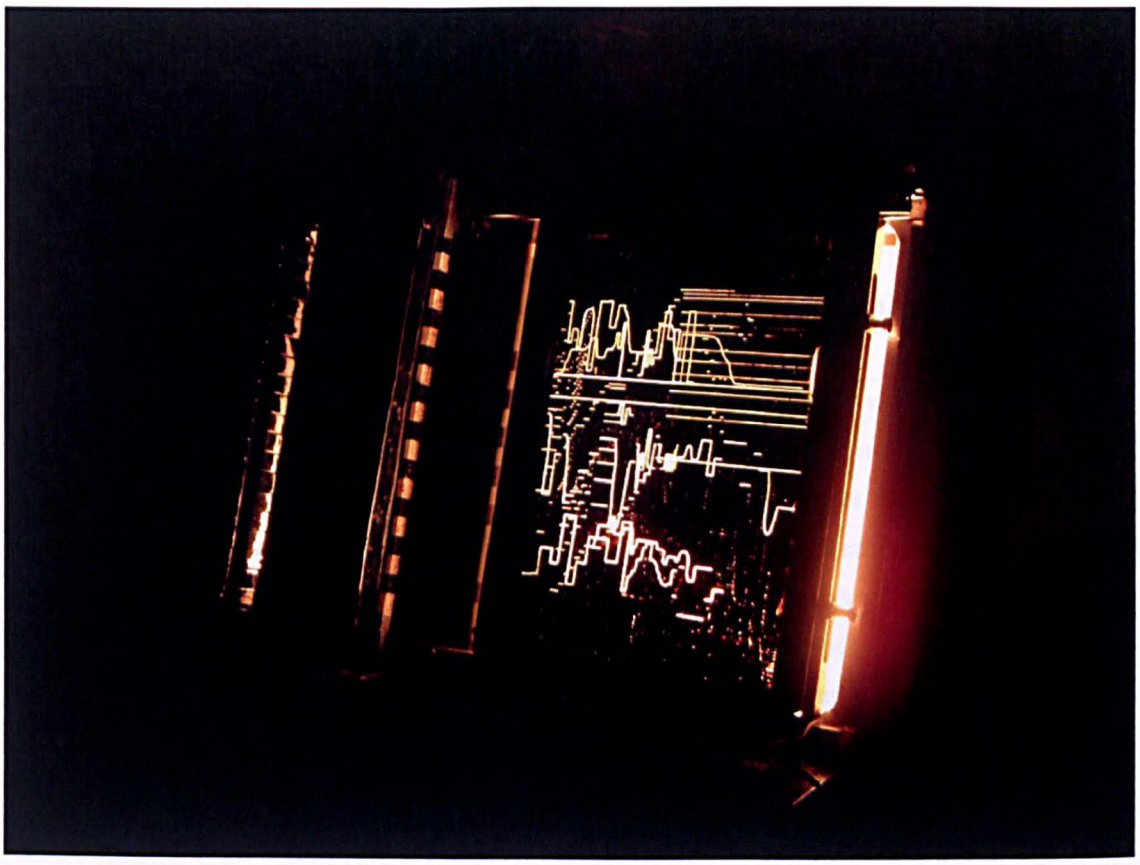


Figure 1
The ANS Synthesizer in 2000, showing a drawn score by the author illuminated.
Photo: the author

plugged into the microphone socket of either a portable sound recorder, or digital video camera. In this way, the fluctuations in voltage caused by the differing levels of light falling on the solar cell are treated as sound recordings. Sometimes something interesting is produced, but most often the expectations that the eye raises are not satisfied by the ear; the poetry is lost. Events which can be visible might, when turned into sound, just not contain enough detail, or simply be too low frequency to be interesting.

With man made light sources, the obverse is often the case. Our technologies commonly run on electrical currents which fluctuate, or alternate, and this is detectable almost everywhere that artificial lighting exists; paradoxically, the most direct and simple form of detection involves our ears. Whether it is the 100Hz hum of a domestic filament lightbulb, the harsh crackling buzz of neon, or the complex and sometimes beautiful tones which can be derived from digital lighting systems and LED displays, the events which occur at rates above our eye's ability to register, can nonetheless be listened to.

The natural correlate to this act of exploration is to try to invent new ways of introducing these modulations as a form of creative sound production, and my efforts at producing these devices will be discussed at regular intervals throughout this thesis. Almost without exception, the technical strategies I use have been re-invented many times before by others; indeed that most basic act, of wielding a device that converts fluctuations in light levels into corresponding fluctuations in electrical current, has gone on since at least 1880, with the advent Alexander Graham Bell's Photophone. A less basic strategy, but one that is nonetheless successful, is to enable ways for light to interfere with itself, in order that interference patterns be produced that can be scanned to produce sound – a technique termed 'interferometry'. Because of light's particular properties, when successful this method is incredibly sensitive to vibration, and I will go on to discuss my construction of an interferometer which partly reproduces A. A. Michelson's 'Aether Drift' experiments of the late 19th century, but with photocells incorporated to transform it into a listening device.

Michelson did not have the luxury of lasers to use in his work, but I have made fairly extensive use of them, not least in my interferometry piece. They can be reflected off of, or shone across vibrating surfaces and edges, transporting the resulting modulations across distances to the waiting sensor, to be re-coded into sounds which have their own peculiar properties – dry, airless, close, internal; two examples of my practice involving a laser's interaction with vibrating wires are discussed in detail. These and other light sources may also have audio pumped into their power supply, so that the resulting light may be subject to other environmental factors as a form of audio synthesis – the rumble of smoke and heat haze being examples that I will go on to discuss – turning

the difficulties that Bell encountered with the Photophone into an asset; noise into signal.

It became clear early on during this research that when documenting my artistic practice, sound recordings would not be enough on their own. The digital video recordings of my experiments with light sources have played an essential part of this research, by generating a central plank of the theory which I go on to develop. Hence they breach the problematic and seemingly fluid boundary between documentation and practice, and in what follows I have treated them also as works in themselves: indeed in one piece entitled Spectra, video is co-presented with sculptural work as integral to an overall whole which requires both to be understood.

I came to 'sound art' (if such a thing can be said to exist) through an interest in constructing new sonic timbres, textures and dynamics using unusual methods. But of particular interest has always been sounds which allude in some way, but which don't necessarily explain; or rather that the possibility of elucidation is latent within them. A lacuna between perceiving and knowing, and how it becomes resolved, seems structurally native to sound, insofar as it is a perceived event whose source may be unknown. That simple fact – that we may hear something that we cannot see – lurks behind many creative acts that involve sound production, and is complicated and compounded by the numerous technologies which began to emerge around the middle of the 19th century, which were designed to capture and reproduce it. For a sound recording, this condition is fundamental.

The film sound theorist and historian Rick Altman characterises this simple order of things, whereby the visual tends to validate the auditory, as the 'sonic hermeneutic', reminding us that 'Whereas images rarely ask: "What sound did that image make?" every sound seems to ask, unless it has been previously categorized and located: "Where did that sound come from?"[3] After the advent of the optical soundtrack in the cinema, that sound recordings came from anything 'real' at all was no longer a certainty, since sound's encoding as an image on the film meant that new sounds could be invented, or synthesized within the visual register – drawn to be sonified by the sound projector. Put simply, the chain of causality leading from the real was broken. Variously called 'ornamental', or 'animated' sound, these sometimes complicated, usually geometric glyphs play an important role in what is to follow, since they form a crossing in the different strands of thought concerning how sound and image might interrelate, and because of their visibility, or readability, what sound might be.

Optical film soundtracks notwithstanding, the practice of generating sound from light has remained a backwater in sound reproduction, and to this day, machines like the ANS (only one of which exists) are relatively rare. The reasons for this are a mixture of technical, economic, and where more experimental works are concerned, aesthetic. I've found that, issues of personal taste

[3] Altman (1980:74)

aside, making photophonic sounds that might be considered 'pleasant', 'harmonious', or even 'sonorous', is not easy. Put simply (and this is perhaps not surprising), when exploring simple, direct ways of turning the visual world into sound, I discovered that there is something about images that is not sound-like. They buzz, distort, crunch and scrape in ways that never fulfill one's expectations. A shadow passing completely over a photocell generates two thuds – first as it arrives, and then as it leaves. A scene of startling visual complexity and clarity may just generate a sonically tedious buzz. As I mention above, what the eye may find promising, the ear often rejects as disappointing.

The strategies behind what makes an image, or light source 'work' as sound, and how that sound gets made, all to some degree resolve themselves around the central issue of time, since time is one of sound's essential properties; perhaps its most essential. This basic attribute expresses itself as movement within the machines and systems that have been contrived, or abused into performing the processes I have mentioned. Film spools and un-spools, lights flicker, glass discs spin, interference fringes shift, and mirrors vibrate. All of these activities are there to render information carried on an energy that is specific to our visual needs more amenable to our auditory ones, and so our sensual biology (as many media theorists have reminded us) is mirrored in the machines that are there to serve it. These devices, and some of the artists, inventors and engineers that are associated with them, will be discussed in depth, but not chronological order – they are

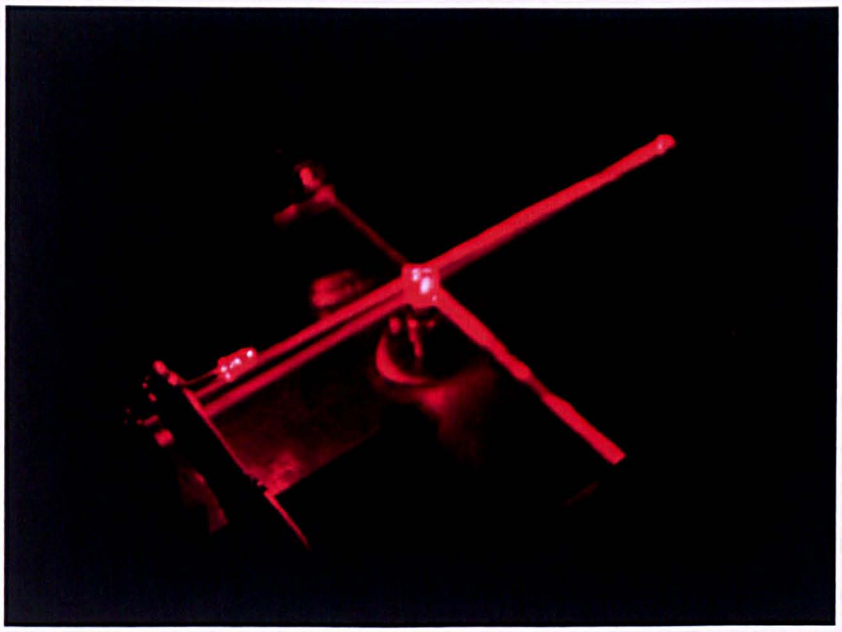


Figure 2
Rob Mullender & Mathew Chadwick (2006)
Interferometer beam paths articulated by smoke.
Photo: the author

dealt with roughly thematically, according to the sorts of processes that are used to produce the effects I discuss.

Firstly, the review of literature and artists' practices will set out certain basic terms which I go on to use, and describe the terrain within which both my practice, and this writing (which serves as its counterpart) operate. Then in 'Sonic Distortions in the Field of the Visual', I discuss perhaps the most experimental and vital exponent of post war sound-on-film experiments – Guy Sherwin. I describe (among other films) *Railings* and *Musical Stairs*, both pivotal works in this field, and then go on to delineate what I consider to be the relationships and tensions between his works, and Tony Conrad's *The Flicker*, using this as a device in conjunction with Laura Marks's remarkable invocation of the possibilities of 'haptic visuality' within the moving image. This is in order to begin developing what is a crucial theme of this thesis – how hearing and vision may be thought of as related, or operational only through other senses; specifically that of touch. This theme is picked up and expanded into broader issues of proximity and orientation within the first section of 'Further Strategies for the Production of Sound from Light', which deals with light's ability both to articulate vibrating surfaces, and to interfere with itself, so that patterns may be generated which can be used to produce sound. Here I describe two pieces I have produced which make use of lasers to read vibrating wires, and examine and contextualise the unexpected effects produced on video documentation.

A.A Michelson's 'Aether Drift' experiment will be discussed through its possibilities as a sound generating device, and further to that, a potential system for eavesdropping and orientation. My own interferometer works will be introduced to frame these arguments (Figure 2), and Alexander Graham Bell's pivotal Photophone is first brought to bear upon proceedings, by virtue of how this device might have been combined with Michelson's experiment to pre-empt certain notorious electromagnetic spectrum-based eavesdropping technologies (listening at a distance by sensing vibrations using infra-red light) which emerged from Russia in the 1950's.

Bell and the Photophone become the main object of study in the third chapter, 'Signals From Nature', which engages critically with Jonathan Sterne's privileging of the 'tympanic' function in the ear, and its mirroring in sound's recording and reproduction, and consider the status of Mary Watts-Hughes's Eidophone voice figures as a composite of the Photophone and optical sound recordings. Through Bell and Blake's Ear Phonautograph I discuss the trope of deafness in such technologies, and how this notional void can be considered as an 'opening up' to vision, and more expansively image, as a source of energy to be sonified. As I have mentioned already, and as I will show in the chapter discussed here, the Photophone is a seminal device within the field of ideas that relate to synthetic sound's ontology, and my own works with 'environmental

photophonics' are again brought to bear, including observations on recordings I have made using light captured from smoke, insects, and the sea. I conclude this section by discussing *Spectra* – a two part video and installation work which I produced in 2009, and by examining the interrelations between the video and sculpture, show how photophonic techniques can be described as paracinematic, or possessing cinematic attributes despite the lack of any filmic apparatus.

The final section in this chapter deals with (and is entitled) 'Scanning', and is a more in depth look at two important photophonic synthesis machines from the mid 20th Century – the ANS Synthesizer, and the Oramics machine. I discuss my first-hand experiences of them, and what I consider to be the network of desires, ideas, and influences that went into their conception and construction, and how this may or may not have a bearing on the type of works that were produced on them. Through the ANS, I briefly discuss synaesthesia and its relationship or otherwise to intermedial arts, and consider how the machine might be seen as a condensation of concepts related to transcendentalism, noise, instrumentation through touch and gesture, 'synaesthetic myths' and the body. The different scanning operations of the machine are discussed and compared with Daphne Oram's 'Oramics' system, and further to that, how modes of input peculiar to Oramics compare to other types of drawn sound, particularly optical soundtrack experiments, and Alexander Melville Bell's 'visible speech' system. From here I draw on Thomas Levin's genealogy of synthetic sound, and discuss critically the sets of relations as he proposes them, between the works of two early pioneers in the optical sound field – Rudolph Pfenninger and Oskar Fischinger, before recapitulating the thread of esoteric phonography and the Photophone already discussed. This section then concludes with some ideas concerning the return, or mirroring into the mind of the processes and interrelationships between sound and light, proximity, time, touch and violence, and the potential of a denatured, denuded consciousness.

In attempting to get to grips with the simple irrationality of listening to light – something which I consider to be driven, in part, by the ultimately irreconcilable nature of the two modalities of seeing and hearing – I eventually decided to approach the problem by employing, or consulting irrational models. As I have already mentioned, a property common to both senses, and a theme which I maintain throughout this research is that of touch. In several of the sources concerning light, and particularly vision, that I was consulting when trying to navigate this unusual territory, I found discussion of what has been termed the 'material power of the gaze';[4] a concept that is understood to have existed from antiquity until surprisingly recently. Further to that, I discovered within the Atomist (and later, Epicurean) model of vision, a striking fusion between seeing, hearing and touch, in the form of the 'Simulacrum' or 'Eidolon', in which images were thought to consist of atom-thin skins which fly off of the surface of all objects, and enter the eye. The very idea that

4 The title of a chapter in Gonzalez-Crusi (2006)

images could, in this particular conception of the world, materially consist of the objects that gave rise to them, tied together previously un-reconciled aspects of my theory and practice, concerning the senses, orientation, the moving image and time. I will discuss in the chapter 'The Somatic Optic', how this crystallises into one aspect of my practice; that of making rubbings, or frottage of objects, in order to move towards an analogue of this concept.

That sound can be generated from an image (which is after all, a potential property of light), asks that we consider, conversely, what the visual depictions of sound may really indicate. The common trope of sound's representation – as a waveform of amplitude (or power) expressed vertically, strung along a horizontal time-line, is born from mechanical and electrical strategies devised for the purposes of its capture (indeed, I would suggest that without sound recording per se, this method of display would be unthinkable), rather than a reflection of how sound is processed by the brain or perceived. In the final chapter of this thesis, I discuss in detail my recent work *Said Object* (which gives the chapter its title) using it as a device to meditate further on some of the issues developed already, concerning the voice and touch, sound's image, and further to that, memory and loss. *Said Object* remains in many ways an unresolved work, and a sense of this will emerge during this discussion, particularly since the work itself involves the verbal interpretation by others of a piece of my sculpture practice that was itself of uncertain status.

This thesis, then, is about the intertwining, or collision of different sensory stimuli and registers, and how we may perhaps come to a different attitude towards those senses, through the devices that enabled these collisions to happen. Perhaps then it is fitting that its structure, as a written document, should contain different registers itself. As the writing that goes into what you will read was developing over the past three or so years, so was its relationship to my practice, and relatively early on I began to include entries from my note books in italicised sections to show how the theory had influenced me in my artistic work, and vice versa.

My practice and my writing have fed back into one another throughout the whole span of this research; sometimes in rapid, direct and reflexive switches, at other times, one seemingly providing an atmosphere or environment for its companion to work within. At each stage my approach to my practice has been heuristic in spirit, while simultaneously an attempt to walk the line between the production of a piece of work which fulfils the research requirements of the moment on the one hand, and one which I consider aesthetically acceptable on the other. In this sense, each of the works I describe is intimately related to the writing, and is often a manifest attempt to resolve some theoretical consideration, or in some cases a way of attempting to connect on a personal and practical level to the more historical aspects of the research. In this sense, the practice and the writing are an integrated entity. Accompanying this writing, the reader will find a

DVD containing all of my time-based works, and documentation of the sculpture work which I go on to discuss. These are clearly referenced in the footnotes, and arranged alphabetically on the DVD for easy reference.

Throughout the writing process, right up until the work on this final document began, I entitled my writings 'Saccades', and this choice has been apt for several reasons. Saccades is the name for the characteristic jumps and twitches which the eye makes when mobile... and in fact the eye is always mobile. Normally elided by our consciousness, saccades exist to allow the fovea (the relatively small part of the retina that generates our detailed vision) to gather the information required for the brain to build up a picture of an object or scene. Without these movements around and about a scene or object, our knowledge is incomplete.

In this sense, the jumps between the italicised notebook entries and the more standard expository text, might be thought of as saccadic movements between different registers; likewise the two short sections of speculative (or even surreal) historical fiction which I have included. These are intended to make jumps across time periods and conceptual spaces, which in the normal academic register would have seemed either inappropriate, contrived or simply long-winded. It is my hope that the ideas brought out by these saccades between the different modes of writing and their interrelationship with my practice help build an integrated picture of my research as a whole. Saccades is also the name of the 'Blogspot' address which I have been updating ireegularly throughout the life of this research, and where much of the material discussed here can be viewed, alongside other pieces which were not thought to be necessary to include in this text, but which nonetheless help give a broader picture of my overall practice.[5]

In his pioneering work on the subject, the Russian ophthalmic researcher Alfred Yarbus describes how he expanded upon a method of recording the eye's motion: anaesthetizing his patient's cornea, he would apply a suction cup, attached to which was a small arm, with an equally small mirror affixed to its end. Light reflected from this mirror was then captured on photographic paper, providing a record of the patient's eye movements as he or she looked at different images (often paintings), and producing the first examples of vision maps - which have since become familiar in articles on the psychology of seeing. Being asked to provide different types of information about the paintings would provide different patterns of saccadic movements over the picture. My hope is that as this thesis unfolds, different questions in the mind of the reader may similarly bring out different aspects of the research for them in the same way.

I hope it is not stretching the analogy too far, to mention Yarbus's discovery that when the eye is held completely still artificially, the very quick result is blindness...

[5] See: <http://silentlight.blogspot.com/>

Chapter 2:

Contextual Review

In this I will discuss the various materials, whether written, visual or auditory, that I think define and contextualise this research, and organize them according to general themes that have emerged over its course. In order to begin to break down and analyse some of the complexities involved, I will begin by looking at the basic technical processes, and develop different ideas concerning how the interplay between light and sound may alter our understandings of each medium respectively. Of particular importance here, are certain aspects of film sound theory, concerning syncresis and timing, the materiality of film, sound and image (through avant garde film practices), and the status of the spectator. I will offer a brief historical context, as well as a survey of contemporary practitioners, and also describe my work's theoretical positioning with respect to sound art, experimental film, and media. As I have mentioned above, certain passages within this text are italicised, and these are re-written texts from my sketch books, which also act as research diaries and stores for my reading notes. I hope the reader will build a picture of my methodology from these descriptions, and how they work with the rest of the text, since they are illustrative of the reflexive nature of the practice and theory components of this project.

The Sonifier

To begin at the beginning – what is a sonifier, and what does sonification mean? In its broadest sense, a sonifier is an object, or system that converts some form of energy or information into sound, and sonification is the activity of making this happen.[6]

A moment's reflection will suggest 'sonifiers' to be a class of objects which is rather large and disparate (from a bassoon, to a line of washing; from tap-dancing shoes, to an artillery battery), and some focus is required. For the purposes of this research, we will deal with the transcription of light into audio, and use the term 'photophonic' when referring to this type of sonification. As I will go on to show in a later chapter, photophonic sound communication was present before radio, and close to the inception of re-playable sound recording. The devices that I use for much of my own practice, in fact differ little from the one that was being devised in the late 19th century as a supposed improvement on the telephone.

[6] This should be distinguished from the use of the term to denote the auditory display of data for scientific or analytical purposes. See the International Community for Auditory Display website: www.icad.org Accessed 10.4.08.

I have become somewhat perturbed by the description of the 'very thin concave mirror' which served as the photophone transmitter in the literature I've dug up so far. If I'm to build one, it sounds like I may have to get one of those made up, which would be costly. And how thin does it need to be to be deformed by the voice enough to work? It occurs to me to test this notion of a focusing mirror. I take the silvered plastic wrapper from the packet of chocolate biscuits I finished earlier in the day, and then using an elastic band, wrap it over the bell of a 'marching band kazoo' (a kind of kazoo/trumpet hybrid) to form a transmitter. I set up the minidisc and solar panel combination which I use for all my test recordings and wait for the sun to break through the clouds. As soon as that happens, I begin recording, then reflect some sunlight across the room using my scratch built transmitter onto the solar panel, and speak a couple of sentences. On playback, my speech is perfectly clear, with a tin-can-like resonance (the membrane perhaps?), and peaking on the plosives, which flex the mirrored membrane too violently...[7] (Figure 4)

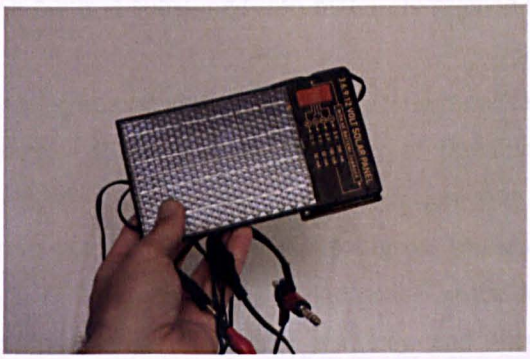


Figure 3
Photovoltaic cell
Photo: Isobel Clouter

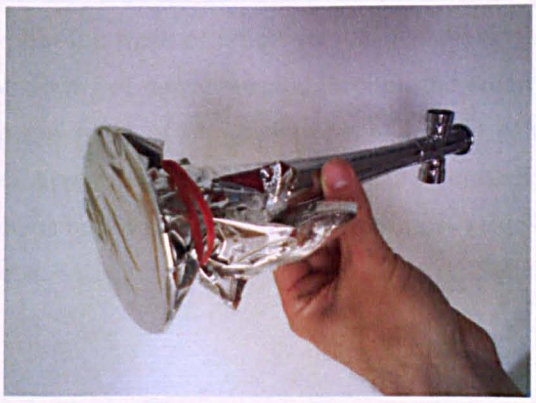


Figure 4
Experimental Photophone transmitter
Photo - The Author

[7] Author's personal sketchbook entry (April 2008)

In December 1880, Tainter Sumner and Alexander Graham Bell submitted several U.S patents pertaining to an 'APPARATUS FOR SIGNALING AND COMMUNICATING, CALLED "PHOTOPHONE."'[8] This, in its basic form, was a transmitter consisting of a thin glass concave focusing mirror connected to a mouthpiece via a speaking tube, which modulated a reflected beam of sunlight directed at a receiver. The receiver in this instance (although it took several subsequent forms) was a parabolic collector which focused the modulated beam onto a selenium cell (a substance which varies its resistance in accordance with the amount of light that falls upon it), thereby transducing the modulations into a voltage which could be amplified. Although this apparatus marks the genesis of photophonics, it remains unusual for several reasons.

Firstly, it does not modulate light using periodic occlusion, scanning, graphical marks, or masking. Systems since then with very few exceptions, have relied upon different kinetic and mechanical scanning strategies to modulate (vary) the strength of a light source.[9] Secondly, it was a system for interpersonal communication along the lines of the telephone – one which proved impractical because of the peculiarities of the visible spectrum; we are absolutely bathed in the stuff from dawn until dusk, which immediately presents noise problems for any light-based analogue communications system. Thirdly, much of Bell and Tainters' work on the Photophone pursued their discovery of the fact that to hear modulated light, one does not need electricity at all, but a glass receptacle containing a dark material – a method subsumed into materials science, all but forgotten to the arts and media since.[10]

There is an alternative, photophonic history to synthetic audio production, which does not for the most part involve oscillators, magnetic tape, voltage control, or many of the things ordinarily associated with electronic sound. This history's most common manifestation may be unremarkably commonplace, but its effects have been extraordinary – those being the sounds to most of the cinema of the 20th century. The arrival of the optical film soundtrack[11] in the late 1920's represented for some artists, a possible consummation of the auditory and visual relationships that had been so eagerly explicated in late romantic and symbolist painting, poetry and literature.[12] A strong 'synaesthetic' tendency within the work of artists such as Kandinsky and Scriabin suggested access to more privileged, purer forms of consciousness through the union of seeing and hearing, and can be traced through to the work of early pioneers of optical sound experiments such as Oskar Fischinger and Arsenei Avraamov. However, two distinct classes of interrelationship were apparent from this onset, perhaps best understood by their physical vehicles: the soundtrack itself, and what happened on the screen.

[8] See: Audio Annals (2008)

[9] For an introduction to photophonic musical tone production in 20th century electronic musical instruments, see: Douglas (1957)

[10] This phenomenon is known as the 'photo-thermal-acoustical transformation cascade'. See: Euler, et al (2000)

[11] Developed by Eugene Lauste, and patented in 1907 see: Allen (1997)

[12] Strick (2005:19). Those wanting a synopsis of the interplay between the early modern and avant-garde within the context of experimental film may wish to refer to the introduction of: Rees (1999)

This schism inheres in how the respective physical natures of sound and light themselves differ, and one uncovered by the emerging media technologies that exploited them. The cinema screen afforded a supposedly full access to this 'synaesthetic' arts paradigm, through form, rhythm, and eventually colour, whereas the images operating within the soundtrack quickly established their own particular regime by virtue of the simple realities of its mechanical operations. As I go on to discuss in chapter 4, early practitioners of sound on film experiments quickly found the correlations between graphical shape and auditory tone to have their own logic, introducing a new, and not necessarily 'musical' set of auditory aesthetic possibilities.

Jeremy Strick has suggested that abstract film developed in part as a response to the inability of painting to properly interface with perception in the temporal realm, adding that a degree of control unavailable to painting was now becoming realized: 'And while it is true that a viewer might take considerable time to apprehend fully a complex painting, the painter still has little or no control over the sequence or order in which the viewer's observations are made. Abstract film developed as if in response to these shortcomings."[13] A.L Rees alludes to this in establishing the origins of the moving image '...at the end of a century which was fascinated with the art and science of vision'[14], and convolves its birth with the 'moment of cubism' – aligning with film the cubist fragmenting of time through the introduction of multiple view points in the same frame.[15] It is this issue of time which links, but renders irreconcilable the two streams of production mentioned above – revealing, within the cinematic medium, one almost to be dependent upon (or a subset of) the other. In Gramophone, Film, Typewriter, Friedrich Kittler, writing extensively on how the advent of new media have helped us construct ideas about perception touches on this, remarking that: "The fact that cuts stood at the beginning of visual data processing but entered acoustic data processing only at the end can then be seen as a fundamental difference in terms of our sensory registration. That difference inaugurated the distinction between the imaginary and the real."[16] The film soundtrack's readability enabled an analysis of sound's properties, producing the possibility of the synthesis of entirely 'new' sounds through a better understanding of what sound was.

As I discuss in chapter 4, hints of this new epistemological paradigm – of sound as a stream of visible information held in stasis within a recording – had already made themselves apparent in the ruminations concerning the nature of the inscriptions generated by Scott's 'Phonautograph' (the direct antecedent of Edison's 'Phonograph')[17] – were they scientific measurement, or were they a newly discovered ur-language, or writing system? Scott was a

[13] ibid.

[14] Rees (1999:15)

[15] I have extracted a small but important thread from Rees's complex snd concise history – a detailed explication lies outside of my remit here.

[16] Kittler (1999:117-118)

[17] Hankins & Silverman (1995:137)

typesetter, and harboured a desire to 'write' language directly by sound capture, thereby imposing the condition of text upon aurality. Had he had a chance to properly examine optical film-sound, he may have adopted a different strategy.

The differences inherent in how time governs the relationship between the auditory and the visual have dictated how the various engineering processes for rendering light into audio have arisen. Within these machines we can detect morphological themes which recur both as mechanical strategies, and occasionally in experimental works, as abstract or metaphorical *content*[18]; visions of space flattened, scanned, folded, spooled and stretched. Sound's essential temporality dictates that, if recorded as an analogue trace, it is most easily stored in linear fashion, which is then expressed as movement. The requirements that our vision imposes upon the artificial moving image are entirely different; our flicker threshold elides events which occur above a certain frequency, hence the development 24 frames-per-second of static images upon a clear substrate transforming into movement upon the screen. The soundtrack that would usually sit alongside it must be smoothly processed through the projector, since the ear would clearly detect intermittent movement.

To be practical for a moment, any audible signal, including those which have been derived from a light source, must exist within a particular 'window' of fundamental frequency for it to be audible. Typically, an adult will be able to hear sound who's frequencies range from 20 Hz to around 17-18 kHz. This sits completely at odds with the fundamental frequencies of the visible electromagnetic spectrum – around 540 Terahertz for green light,[19] which if it were encoded into sound based on this frequency, would produce similarly high ultrasonic energy. For audible sound to be generated, modulations in sonified light must therefore either be found, invented, or rendered somehow into this auditory frequency 'window', and this is a challenge elemental to the act of photophonic synthesis. Colour attributes however, cannot be directly translated into audio without a vast temporal shift, as it is a function of light's fundamental wavelength, and therefore, frequency.[20] In this way, the time/frequency specificities of light – or rather, the human biology that exploits their properties – forms a barrier to the direct audition of colour using pitch. The putative 'synaesthetic' relationships between visual colour, and auditory pitch and form, therefore exist in a different class of production to the transcriptive ones mentioned above; having been negotiated and synthesized though complex cultural assemblages, bleeding into and out of different disciplines such as colour-music, sound poetry and experimental film. As Paul Hertz (!) states: 'Abstract painting arose in part as the plastic arts sought to imitate musical art, but the physical parameters of

[18] We will go on to see this in Tom Levin's account of Oscar Fischinger's experiments with the relationships between different drawn shapes in the visual frame and how they sound on the optical soundtrack. Also, see Connor (2004a) for discussion of the trope of the spool in writing and audio in audio, and Kahn's (2001) use of the trope of 'the line'. This aspect will be discussed more fully later in my thesis.

[19] Van Heel & Velzel (1968:20)

[20] Certain optical illusions notwithstanding, such as 'Fechner Colours', which appear from spinning black and white patterns.

visual and auditory media provide us with no clear system of correspondences. This suggests that correspondences among media are arbitrary, conditioned only by fuzzy cultural practices and psychological preferences.'[21]

We can further articulate this apparent distinction between the cultural and the mechanical in terms of consumption: with only a few exceptions, wherever light and audio are deliberately convolved, this happens within the technological enclosure; hidden within the apparatus of its making. Light manipulated into the service of sound has always been isolated from other signals (AC mains lighting, sunlight), and directed as accurately and un-fussily as possible to the waiting photocell. Where consumers of mainstream cinema become aware of its processing, it is perhaps only dimly through the imperfections or degradations of the optical media, and this is subsumed into the front of house culture – a scyncretic manifestation of scratches and holes in the film image. Thus the cinema of, for example, Oskar Fischinger and Norman McLaren, is a peek inside the box – an explication of the photophonic optical soundtrack process, where within the cinematic construct, what you see is also what you hear.

Both Fischinger and McLaren worked on optical sound experiments in the 1930's and 40's in Germany and Canada respectively, and have become strongly associated with what is generally termed 'Animated Sound' – although McLaren, beginning a few years after Fischinger, was considerably more prolific and successful in this regard. Fischinger began exploring time-based abstraction after attending a screening of Walter Ruttmann's Licht Spiel Opus 1 in Munich in 1921, after which he produced a series of 'visual music' films, sometimes using unorthodox methods such as the application of coloured oils onto the celluloid, and unusually, stop-frame animation of thinly-sliced organically shaped wax solids, for which he engineered a bespoke guillotine.[22] These were often accompaniments to existing classical music, and were sometimes commercially and critically successful. Then beginning in 1932 in Berlin, he began to work extensively with optical sound to reveal what he thought to be putative meaningful relationships between graphical morphology and sonic timbre; a project which resulted in a number of short experiments, but ultimately no finished piece of film. He embarked on this process after having studied some optical sound recordings, observing that '...the kind of "ornaments", abstract designs that he used in his films, were not substantially different from the sort of patterns that were generated by sounds on the optical soundtrack.'[23] Filing out the camera shutter so that he could photograph directly onto the soundtrack, Fischinger then used a rostrum setup to generate short bursts of synthesized tones with specific fundamental musical pitches, which can be seen in the experimental short film *Tönende Ornamente*, which displays the waveforms on the screen as they are played out on the soundtrack.

[21] Hertz (1999:400).
[22] Moritz (2004:8-10)
[23] Moritz (2004:42)

Beginning in the late 1930's, Norman Mclaren's forays into 'animated' sound were more extensive, both in the volume of finished material he produced, and in the techniques he employed. Initially painting marks onto the soundtrack (for example with Dots from 1940), or scratching through opaque black film header (much of the soundtrack on Blinkity Blank,1955), to a system of indexed and pitch annotated cards with a comb-like pattern which when photographed, generated square-wave tones; a method which most closely resembled Fischinger's methods of photographing of graphical 'ornaments'.[24] These however, were more inspired by Fischinger's contemporary, Rudolph Pfenninger, who had also been working in the 1930's on the systematic analysis and synthesis of graphical sound, but from the perspective of acoustics, as distinct from the morphological, physiognomic correlations between shape and sound that preoccupied Fischinger. As I will go on to discuss in a later chapter, this distinction – between audio, and audio-visual, altered the nature of the graphical soundtracks in question, since they were intended to be 'consumed' differently by the audience in the cinema.

Some years later, for Norman McClaren however, this method of photographed optical soundtrack production would result in what is often thought of as a technical high point of graphical sound synthesis – *Synchromy* in 1971 – which utilised multiple exposures of his waveform index cards for the purposes of polyphony, gradated areas for changes in volume and dynamics, and onscreen, a vibrantly coloured visual component consisting of carefully composed and choreographed displays of what the soundtrack looked like as it progressed.

McLaren was no conceptual purist when it came to synthesis using optical sound, and made extensive use of re-recording with reverb and echo (unavailable in recording until after the war), remixing with other music, and used graphical sound synthesis for less abstract animation works such as *Neighbours* from 1952; indeed, graphical sound works generally from the mid 20th Century onward could be said to have been assisted in quality by the advances in photochemistry driven by a hugely profitable and innovative motion picture industry. As with almost any form of sound recording, however, the technology of its production may be heard embedded in what it produces. In *Cinesonica: Sounding Film and Video*, Andy Birtwistle points out that the noise of film's material – its 'optical rumble', or ground noise, has always been interpreted as a negative backdrop, or a problem for film theorists and historians, out of which a 'foregrounded' sound must be engaged with. However, this ignores the ways that we understand technology as embedded, or inscribed in all forms of recordings, and correspondingly, denies film's grain (and its changing nature with advances in film stock quality) as a signifier of materiality and historicity.[25] The importance of this class of sound, and its consequence for works which engage specifically with film's materiality will be examined later.

[24] These techniques can be seen on a short film of McClaren's called 'Animated Sound Test', from DVD No. 5 of: McClaren (2006)

[25] Birtwisle (2010:85-87)

Hearing, Seeing Machines

The photophonic musical instruments to have emerged since Tainter and Bell's Photophone, have sat across this divide of technicality and representation to varying degrees – that is to say, the divide between the mechanics of photophonic sound production on the one hand, and aesthetic strategies concerning how sound and music might be visually represented (and by inference, manipulated) on the other. Perhaps the most cinematic of these is paradoxically one which did not utilize adapted cinema technology – the ANS synthesizer. Developed over twenty years from about 1938 by Yevgeny Murzin (an optical engineer)[26], it occupies an interesting position because of this amalgamation of mechanical procedures for producing pitches (waveforms photographed onto spinning glass discs), and the compositional (or acculturated) x-y axis to time-pitch relationship of the drawing interface, echoing the 'top equals high pitch, bottom equals low pitch' relationships which have proved so enduring to those wishing to express a static image sonically.[27] As I go on to discuss later, it sits at the confluence of many different ideas concerning sound's relationships to vision, the body, noise and gesture.

The spinning translucent disc or drum has made numerous appearances in electronic music – from the A.N.S, and Theremin and Cowell's 'Rhythmicon',[28] to various experimental attempts to produce an equivalent to the electro-mechanical tone wheels of the Hammond organ (such as the 'Superpiano')[29], which have found themselves used relatively recently in the toy manufacturer Mattel's 'Optigan',[30] and Jaques Dudon's experiments with hand painted patterns and polarization filters. The other main strategy in photophonic experimental instrument construction has been in the use of 35mm film projector mechanisms, and specifically its optical sound track reader to generate audio. Although it is not a sound-on-film system per-se (as I go on to describe in a later chapter) the most notable and advanced example of the use of film as a medium for drawn sound is Daphne Oram's 'Oramics' system, which she developed over a number of years, and would eventually use drawing to control all of the various pitch, timbre, attack, decay and sustain characteristics of conventional analogue synthesis.[31] (Figure 5)

For Oram (as well as for others), the gestural immediacy of drawing was the primary route to control over sound's parameters. Jo Hutton remarks in her paper on Oram: 'The concept of drawn

[26] Interview with Andrei Smirnov and Stanislav Kreitchi, conducted by the author, April 2001.

[27] Probably the best example of this is the software 'Metasynth' <http://uisoftware.com/MetaSynth>. Trevor Wishart systematically critiques what he calls the 'pitch-duration lattice' in: Wishart (2002).

[28] Schedel (2002)

[29] Douglas (1961:237), and Douglas (1957:132-135)

[30] This is effectively a budget photophonic Mellotron (a keyboard instrument which used magnetic tape cartridges for each key). See: <www.optigan.com>. Accessed 16/2/2009

[31] Oram (1971)

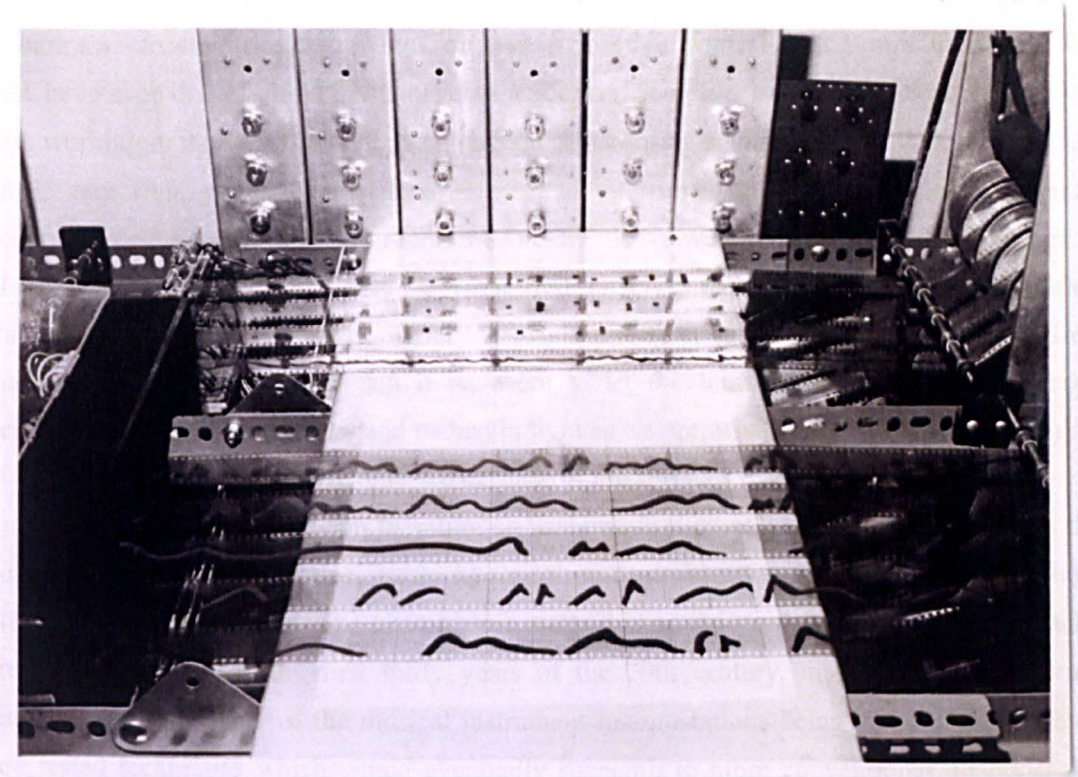


Figure 5
Oramics Machine
Photo © The Daphne
Oram estate
Courtesy of the Daphne
Oram Archive

sound was not new...Russian film-makers Arseny Avraamov and Yevgeny Sholpo created soundtracks from intricate drawings on thin strips that were 1.93-2.5 mm in width. Norman McClaren used drawn sound in many films...South African Electronics engineer Johannes van der Bijl, working in the 1940's developed a method of recording sound using photographed waveforms on 35 mm film, which were passed across and interrupted a steady beam of light, and thus generated a electronic impulse to represent sound.'[32] If we were to look inside the workings of any of the machines mentioned above, we would find ourselves pondering a light source, rectified and stabilized so as to provide a flat signal – a blank undifferentiated material to be chopped up and manipulated. What would happen if we were to let the luminous world into this necessarily hermetic world? Surrounded by and bathed in light as we are, what can we find out about this flood of energy – much of which we only see because of the surfaces that it articulates?

In searching for relevant literature on listening to light, it has become apparent that there is no body of practice or writing, either historical or contemporary, no culture of 'photophony' to draw upon in its own right. The photophonic method of sound synthesis seems to have reached its creative high point in the first thirty years of the 20th century, mostly through experimental cinema, and with many of the musical instrument manifestations being variations on a few tried and tested techniques which would eventually succumb to more conventional methods, such as voltage control additive and subtractive synthesis. The optical soundtrack in the cinema has survived for so long on account of it simply being made of the same stuff as the image, and therefore embedded temporally, with the attendant advantages of synchronization in editing, and further to that, economic factors in production, distribution and projection. Other examples are few and far between – a notable, although workaday one being optical compressors, which are still highly regarded by some sound engineers.[33] Why should this be the case? Undoubtedly, technology has played its part, notably problems with stability in the emulsions, dyes and substrates on photographic transparency materials, and issues with noise in opto-electronic components.[34] But further to this, the essential characteristics of light and images, when converted into sound directly (outside of the musical instrument/engineering of tones paradigm), often produce harsh, noisy results, seemingly uncomfortable with the transformation from one register to the other. Pre-digital domestic electrical light sources, when sonified, give a 100Hz hum – a flash for every half cycle of the mains frequency. Natural modulations in sunlight (trees or water, for example) are intermittent and contain a large element of low-frequency noise,[35] which may not have been seen as something

[32] Hutton (2003). This rundown of drawn sound devices is from Hugh Davies's (1984) entry in New Groves Dictionary. To this list we may add the drawn and photographed sound work of Hans Richter, Lazslo Moholy-Nagy, Walter Ruttmann, N.V Voinov, B.A Yankovsky, Arthur Hoérée, Jack Ellit, Rudolf Pfenninger, and later, the harmonic pendulum sound-track printer of John and James Whitney. See: James (1986). A large collection of Sholpo's 'Variophon' works has recently been found in a film archive outside Moscow, and has been digitised by Andrei Smirnov at the Theremin Centre

[33] See: <www.sweetwater.com/expert-centre/techtips/d--03/20/2002.> Accessed 27/08/2008

[34] Douglas (1957:132-134)

[35] Observations from my personal archive of photophonic recordings.

to be listened to at all not so long ago – just a 'noise'. What conditions would need to be in place for someone to think of environmental light as a possible sound source? As I discuss later when discussing Bell's work, the practice of 'esoteric phonography' – sound produced from non-sonic energies and phenomena – begins around the time of the Photophone's inception, and is indicative of changes in attitude concerning what sound could be produced from.

Contemporaries

Figure 6
Derek Holzer/Tonewheels, 2010.
Photo - © Amy Hope Dermont

Contemporary artists working with sonified light often use the audio generated as source material for manipulation within music projects, rather than presenting it in its raw form; perhaps because of the difficulties in synthesizing sound from light which might be considered 'musical' or 'sonorous' in its nature. Jacques Dudon has extended the technique of generating musical tones by directing light through patterns printed on glass discs to a complex and nuanced degree. His 'Disques Photosoniques' are arranged so that several can be utilized simultaneously, each affecting different aspects of the sound. The result of this arrangement (and the feature that sets Dudon's system apart from other spinning disc systems) is that timbre and pitch can both be altered in real time by changing the discs' speed manually. The sounds from Dudon's 'Photosonics' are presented for the most part within what might be best termed a 'New Age' setting, with flutes, percussion, didgeridoo and sequenced synthesizer arpeggios featuring heavily. In the sections where all these other elements are absent, the photophonic audio is still heavily treated with reverb and sometimes tremolo effects, creating a diaphanous, romanticized presence; somewhat conflicting with the scratch-built aesthetic of the instrument itself.[36]

[36] Meccano is visible in the construction of the instrument shown on the back cover of Dudon's 'Audible Light' recording: Dudon (1995).

Derek Holzer's Tonewheels project consists of a similar apparatus – this time, multiple spinning wheels sitting an overhead projector lit from underneath, enabling a projected image in real time for the purposes of a 'readable' performance (Figure 6). Holzer's sounds are much harsher and more industrial in their nature, and his exuberant performances (importantly, Tonewheels is fundamentally a live, improvised project) draw effectively on contemporary stage performance tropes, providing, one imagines, a rather different experience to seeing Dudon perform. .

Nicolas Collins is a chronicler of the scratch-built; the expanded chapter headings of 'Handmade Electronic Music' read like a layman's technical synopsis of much of the electronic sonic and visual arts practice in the west since the late 1950's,[37] and oozes humour and generosity in its opening up of the quotidian boxes, screens, transducers, sensors and chips which so often fall into the category of 'disposable'. Much of the expertise here is accumulated from experience, but contextual examples of other artists are provided in print and on audio CD, including, for our purposes, Norbert Möslang's recordings of flashing LED's and Steven Vitiello's World Trade Centre recordings.

As part of his residency at the world trade centre in New York in 1999, Vitiello made use of a photocell and a telescope to frame, and listen in to various light sources emanating from the cityscape below.[38] His approach differs from Dudon's in so far as the audio is gathered from the environment – a fact critical to how the work is to be understood. The signals heard within Vitiello's work are the results of systems designed for the visual modality exclusively, and the recording for audition of this 'spill' brings the work into the realm of esoteric phonography – seeming almost to treat the Twin Towers as multi-sensory antennae in extending the senses.[39] Again, as with Dudon's work, these particular raw recordings of Vitiello's are hard to come by as they usually seem destined as material to be used in improvisation and compositions.[40] Of all the works I outline here, these come the closest in sonic terms to my own recordings of man-made light sources, simply because the techniques used are almost identical. What differs is the context within which they are produced and presented: Vitiello's seem related to long-distance eavesdropping from a high vantage point, whereas I made my recordings while walking at street level while mobile. His are exclusively audio, and destined for inclusion in a broader work, mine audio-visual and, editing notwithstanding, left otherwise untouched.

[37] Collins (2006)

[38] For a post-'911' account, and how this event changed the reception of Vitiello's work, see: Kim-Cohen (2009:128-129).

[39] The other recordings were made using piezo-transducers configured as contact microphones which were attached to the windows were Vitiello was set up, thereby picking up the movements of the buildings as well as the city and its weather outside. Vitiello refers to them as stethoscopes – invoking a complex set of associations between himself and the buildings he was working with.

[40] A small excerpt of a recording of police car lights flashing is available on the accompanying CD to (Collins 2006)

Vitiello's treatments of these materials come from the digital aesthetic – temporal fragmentation, editing and spectral shifts to the Nth degree. We can, however, deduce within his approach a sympathy toward the condition of captured environmental photophonic audio; the instant onset and demise of a luminous source as it flashes past the photocell or is simply flashed on and off – a form of brutal sound editing in itself – and the unknowing repetitive duty of a buzzing sign in edits too fast for the eye to apprehend.

The repurposing of pre-existing visual apparatus to isolate and sonify environmental light signals finds a more satisfying and exploratory form in Eric Archer's 'sound cameras'[41], which not only benefit from the selectivity (framing) of good optics, but are beautiful objects in their own right. (Figure 7) Archer picks up old 8mm film cameras and mounts photodiodes in the gate, before fitting them with well designed circuitry and a headphone amplifier.
The visual metaphor of a pair of headphones plugged into a film camera is both direct and obvious in a satisfying way – and Archer has produced some fine recordings of both man-made and natural light sources with them, including notably, of noise produced by the filtering of the sun's light through the atmosphere at dawn.

The immediate luminous environment is likewise a concern with Edwin Van der Heide's 'Sound Modulated Light' installations – albeit one with corporeal proximity, and one which is constructed especially. Van Der Heide arranges halogen lights in otherwise bare environments, usually at about waist height. Convolved within these light sources are an ongoing series of computer generated electronic sound tracks (one for each light), which are then picked up by anyone navigating the space using a hand-held photocell sensor and headphones.

Figure 7
Trilux Lumicon 8-III camera w/ sound camera modification
2008. Photo - © Eric Archer

[41] Archer (2005-2011)

Two sensors produce stereo-like directional effects as the user finds themselves within the particular luminous fields of the different sources; an experience made more aleatoric by the differing lengths of each piece of audio/light source.

In a promotional video for one of these installations,[42] Van der Heide explains that the modulations present in the lights can be heard but not seen, (with the exception of an average dimming, apparent during a quiet interlude), but does not in any of the documentation on his website, mention how the 'content' of the light sources relates to the environment, the sonifying device, the user, or his/her navigation of the work, other than perhaps the fact that it is synthetically produced. The hand-held device takes the form of a metal enclosure with a sensing aperture on the front, and the lights themselves are domestic and quotidian in their presence; how we are to experience it in its entirety cannot be deduced from an online video, although we might speculate that Van der Heidr intends that the meaning or visual language of the lights is somehow being altered by the auditory codes present within.

> *In looking for some material to post on my blog, I dig out some old recordings of 'bulb voices' which I made in 2003. I made these by wiring up small krypton bulbs to the speaker terminals on an old amplifier and tuning through the radio dial to get some audio. I then picked up what happened on a standard photocell. The sound is remarkable – distorted but with a very strange soft quality, and what sounds like a ring modulator working at times. The signal is also heavily gated, with an odd backward dynamic, and reacts differently with bass frequencies than with mid-range or high. I recall blowing about ten bulbs making the half hour or so of audio I got from them, and the title from Artificiel's installations 'Condemned Bulbs' springs to mind.*
>
> *Further research suggests that the effects I'm hearing are the amplifier and the bulb reacting against one another – the amp in an effort to deal with a rapidly fluctuating impedance which it is not designed to deal with, and the bulb trying to keep up with the frequencies the amp is sending. I resolve to finding a reliable way of reproducing this effect so that I can incorporate it in other work – it sounds too good not to use...*[43]

[42] Grzym (2007)

[43] Author's personal sketchbook entry, February 2008. An Example of this is included in the accompanying DVD: *Bulb Voices*
This technique of pumping audio through a light source is used again with the video *Light Trap*

The domestic old fashioned filament lightbulb is transfigured in the French group Artificiels' Condemned Bulbs – notionally very similar to Van der Heide's installations, but crucially different for several reasons. Artificiel hang multiple large tungsten filament bulbs in a grid or field from the ceiling of the installation space in question, and then drive these using large amplifiers.[44] The bulbs produce sound simply as a function of the high power oscillating signal heating their filaments, producing a unique auditory environment, which can be experienced unmediated by sensors. The point here also, is that the bulbs are synthesizers of audio; their hysteresis (where the changes in the luminosity of a bulb filament lag behind the forces causing that change to occur), and resonant properties exploited to produce a unique audio-visual work which, on the evidence of the video documentation available, would seem to be powerfully affective.[45] While the signal sent through the bulbs is not produced in real time within the installation (it is pre-composed), it would seem to be generated to make the most of the peculiar characteristics of the bulbs as audio producing objects; there is a glassy, sometimes percussive quality brought into the acoustic space which expands the bulbs' presence, giving tangibility to their ephemeral material nature. All bulbs sing in unison, and auditory space and orientation is provided by the natural acoustic.

Paul DeMarinis explores, among other things, the interplay between sound and light producing objects – often by reproducing or modifying late 19th and early 20th Century experiments along the lines of those famously presented by John Tyndal to the Royal Society.[46] Particularly reoccurring is the use of flames in DeMarinis's work – both as indicators and generators of acoustic phenomena. 'Tongues of Fire' is a series of photographs of manometric flame capsule photographs – while 'Firebirds' is a group of ionic gas flame speakers in gold birdcages. Like Van der Heide, DeMarinis is interested in more than just the audio from his work and for him, inter-media functions become transformational in their symbolism as well as their utility: 'The scientific revolution threw away the idea that things were connected by appearances, and replaced it with the idea that things are connected with how they work...I think of technology of having a dual being. It is simultaneously a dream, or product of our dreams and the medium in which our dreams are exchanged and elaborated...'[47]

In giving these examples, I have consciously left out artists who explore the direct translation from the visual to the auditory in the digital arena, as I consider this to be an entirely different area of practice – one which must explore digital methods, tools, aesthetics and politics in a way which has only tangential relations to my own work, and with which I am not engaged as an artist. My present concern is with the materiality of the mediums and media concerned as they exist outside of the computational crucible, where the signal as an energetic force, or a vector of information, becomes quantized and modelled...

[44] Artificiel (2003).

[45] And, as we shall see later, another example of objects which sit obstinately outside of Jonathan Sterne's neat schema of all audio reproduction conforming to the 'tympanic' model.

[46] Tyndal (1867)

[47] Demarinis (2001) in Wilson (2002)

The Dial and the Paintbrush

In order to articulate how my own practice fits into the disparate field outlined above, I have begun by breaking down the work (as I understand it) into its basic components and identifying how they interrelate; both to each other, and the person experiencing them. What is the nature of the sonifying object? How is it perceived in relation to the light signal? What does the audio tell us about both of these? When considering the sonifier, where is the artist manifest in the relationship between the visual and its transcription into the auditory realm?

In his famous, and often quoted essay "Production-Reproduction: Potentialities of the Phonograph", Laszlo Moholy-Nagy presents a manifesto or call to arms – stating that it is imperative to extend the function of the apparatus to embrace a new 'groove-script alphabet' where 'an overall instrument is created which supersedes all instruments used so far' Moholy-Nagy perhaps suggests here that we examine the intentionality of the signal and our apprehension of the audio as reflexive components in our knowledge of the apparatus.[48] In his study of how artificial echo and reverberation construct cultural spaces, Peter Doyle reminds us that gramophone machines acted as more than just audio playback devices. In projecting a carefully constructed acoustic and cultural edifice into the home, they in effect 'territorialised' that space with those attributes – a power coded audio: 'The spatiality of the concert hall was virtually overlaid upon the space of the home; in a sense, it obliterated the domestic space. The home listener was granted a virtual access to the acoustic regime of the concert hall, an acoustic regime that already had embedded in it a whole ensemble of history and class and race politics, highly ordered codes of privilege and exclusion'[49] This power relationship was being notionally dismantled by Moholy-Nagy; by substituting the orchestra with the user-as-signal, the construct of the gramophone was transformed into a universal sound producer available to any devotee of the groove-script alphabet; a utopian ideal which re-aligns the apparatus of reproduction with the musical instrument and calls for a unified typology of all sound producers-as-sonifiers. Contrast this with Adorno's sniffy appraisal of the 'talking machine's' role in the parlour – confined to domesticity by its limited acoustic prowess: 'It is the bourgeois family that gathers around the gramophone in order to enjoy music that it itself – as was already the case in the feudal household – is unable to perform.'[50]

Systems of photophonic production moved synthetic audio to the realm of the paintbrush and the pen. This effectively rendered instrumentation into a space defined less by knobs and

[48] Moholy-Nagy (1923) In Cox & Warner (2004)
[49] Doyle (2005:58)
[50] Adorno & Levin (1927,1990)

switches, but more by the easel, the graphic artist's desk – or indeed the writer's. In his paper "Tones from out of Nowhere: Rudolph Pfenninger and the Archaeology of Synthetic Sound" Thomas Levin traces a genealogical line back from (amongst others) Rudolph Pfenninger, and Oscar Fischinger's experiments with photographing patterns onto the cinematic optical sound strip, through the manometric flame apparatus (Not only disinterred by DeMarinis, but also refigured as an litmus test of class by Alan Jay Lerner in the screenplay for My Fair Lady),[51] and Scott's Phonautograph, to Ernst Chladni's 'Tone Figures' – often considered to be the first successful graphic manifestation of sound through direct non-interpretational methods.[52]

Levin sets out basic prerequisites for the invention of synthetic sound, the first being '...the initial experiments that correlated sound with graphic traces, making it possible to "see" the acoustic...'[53] It is also with Chladni in 'Instruments and the Imagination' that Hankins and Silverman situate the 'starting point of modern acoustics'[54] and for them again, it is the new graphic language rendered up by instrumentation that makes the analysis and synthesis of sound a possibility; remarking that in the words of Jules Marey, 'instrumentation...had disclosed and corrected the limits of the human senses...'[55] Here we see a concept emerging which appears frequently in the professed motives of the engineers and musicians who have experimented with photophonics: to fix the unruly and diffuse auditory medium into a readable graphic index – sublimating the accuracy of the graph into what Varése termed a 'liberation from the arbitrary, paralyzing tempered system' of production, resulting in the paradox of freedom flourishing from control.[56]

Andy Birtwistle picks up on this point with specific reference to the Whitney brothers' production of the soundtracks for their Five Film Exercises, produced in the early 1940's. Theirs was a hermetic world of carefully orchestrated and systematic abstractions, consisting of basic geometric, coloured luminous forms, alongside a complex and, at the time, almost uniquely complex soundtrack recorded directly onto the film using a specially designed apparatus of

[51] Eliza Doolittle is exhorted by Henry Higgins to say her 'H's into the mouthpiece of the manometric flame apparatus, producing a theatrically 'cheated' leaping flame each time she gets it right. The mirrored box which spins in order to analyze the flame's modulations (and also enabling a quantized linear photograph) is here supposedly for ease of comprehension by Doolittle, and by extension, the cinema goers. Paradoxically, the movie camera takes up the task of the quantized analysis and fulfils the function of the apparatus – a task embedded in but hidden by the frame rate and the edifice of the narrative film. In Shaw's 'Pygmalion', the apparatus is a Phonautograph, which would have been unsuited to the demands of cinematic spectacle. Cukor (1964)

[52] There is documentation of Robert Hooke performing the same experiment with glass and talcum powder some 150 years previously. http://en.wikipedia.org/wiki/Ernst_Chladni. Accessed 19/09/2008

[53] Levin (2003: 38)

[54] Hankins & Silverman (1999:130)

[55] Ibid.

[56] Hutton (2003:54)

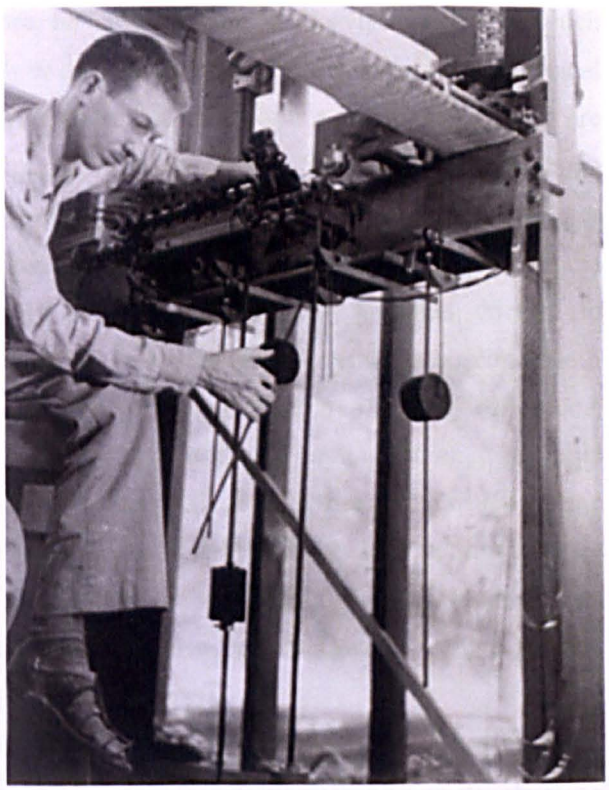


Figure 8
James Whitney with pendulum based optical soundtrack generator circa 1945
Photographer unknown
Photo: Courtesy of
The Centre for Visual Music

multiple pendulums linked to an exposure gate. (Figure 8) The Whitneys eschewed pre-recorded sound in order to maintain a supposed degree of control over how they felt the audio-visual dynamics of the film should be perceived by the spectator. Birtwistle notes that 'Running through the Whitneys' writing is the undeclared notion that sound is the Dionysian term of the audio-visual relationship, and must consequently be controlled' – a trope fully articulated by the bespoke instrument they developed to effect that control.[57]

The way that instruments may be read as cultural systems is a central concern to Jonathan Sterne, who robustly stakes out a terrain in which he examines understandings of sound and its physical traces through its interplay with the apparatuses that channelled it. In consonance with Kittler, Sterne eschews the technological determinism that he views as having held sway in histories of media – making the case for example, that the 'tympanic'[58] interfaces between media and users are cultural artefacts, only brought into being under numerous favourable social,

[57] Birtwistle (2010:148)
[58] Concerning the diaphragm or membrane as an interface between mediums.

economic and scientific conditions.[59] Furthermore, he critiques the 'audio-visual litany'[60] which he believes to have coagulated as articles of faith or dogma in writing on the senses: metaphysical or 'transcendental phenomenologies', and binary in character, they form a familiar list,[61] and are common currency with many of the sources below. In a broader sense, Sterne proceeds to frame and re-frame advances in auditory media through issues of economy, technique, and notably for this niche of history, class. For example, Lannaec's development of the stethoscope and the attendant technique of 'mediate auscultation' in the late 18th century enabled doctors to professionalize audition through a virtuosity of listening, a physical distance (the stethoscope itself, instead of an ear directly on the patient), and, through privileged technique, a class difference. Perhaps more pertinently for us here, this is then situated at the beginning of an inexorable commodification of sound through the individuated listening afforded by headsets (which Sterne identifies as intertwined with the emergence of the middle classes in the 19th century); since '...commodity exchange presupposes private property. Acoustic space had to be ownable before its contents could be bought and sold'[62] Hence, a relationship of privilege, or power as well as privacy might be said to have been coded into the headset (or headphones).

This research will explore whether sonification may be seen in the context of my practice as a form of expanded instrumentation, which enables a sense of 'listening in' to develop – a reading of information within a visible medium which was previously unknowable. Further to this, a model will be examined, whereby the sonifier acts as a point of leverage, or a fulcrum upon which light and its sonified auditory correlate can act upon one another – the sound acts upon the light source, and the light source the sound.

[59] Sterne (2006) and Kittler (1999) both cite (among other things) the change in understanding of sound from notions of pitch and harmony to frequency, medical understanding of the inner ear as a mechanism, as preconditions for the invention of the phonautograph, the ear phonautograph, and the phonograph – a refiguring of sound as recordable information or indices to be inscribed.

[60] The religious overtones here are rhetorically aimed by Sterne at Walter Ong's spiritual metaphysics of the voice – '...a sophisticated and iconoclastic antimodernist Catholicism' (Sterne 2003:17), and much more fundamentally at '...a set of religious prejudices' which have subtly influenced the weather in western intellectual developments.

[61] A list which I don't think it is useful to reproduce, since this is not a rebuttal to Sterne, but to summarize, it is a binary set of relations, where for example, seeing equals: objective, static, directional, spatial, distancing, and hearing equals: subjective, dynamic, spherical, temporal, immersive.

[62] Sterne (2006:155)

Phantom Positioning

In this research the term 'instrumentation' is employed in more than one way. Firstly, I use it in the conventional sense, as the physical enabling of control upon media – light and sound – by the devices that transform them, and the signal that they carry. But further than that, it can be understood in a sensory way as action at one place removed; or perceptual remote action through the reflexive influence of one medium upon another. This understanding of one medium's workings by the consultation, or perception of another is not simply physical, but an ideational gathering of territory; for example, a guide (through amplification) to the very faint, or more appositely here, through sonification of light, to the very fast. The question of how our senses receive the world – our concept of space and how we exist within it – is intimately bound up with the tools we devise for its reproduction and representation. This sense of place is constructed by subtle composites of different sensory data, rather than 'just' seeing, or 'just' hearing.

In writing on acoustic space, Marshall McLuhan suggests that our percept of visual space is not an inherited absolute (although its potential for existence is), rather that it is synthesized in the newborn, whose eyes are 'as perfectly developed a camera mechanism as they will ever be' from a mixture of inputs from the eye and hand.[63] This kinesthetic framing of space within time serves to orientate, or calibrate the visual cortex: 'Without motor movement and its attendant kinesthesis, it is hard, if not impossible, to believe that depth perception would develop at all.'[64]

Likewise, Oliver Sacks writes extensively on the articulation of, or as he puts it, 'linguisization' of space used in the sign languages that have evolved among deaf communities; something which the hearing can only understand in a secondary fashion. Sacks quotes the parents of a deaf girl, Charlotte – a fluent signer: "'All the characters or creatures or objects Charlotte talks about are placed.' her mother said; 'Spatial reference is essential to ASL [American Sign Language]. When Charlotte signs, the whole scene is set up; you can see where everyone or everything is; it is all visualized with a detail that would be rare in the hearing'"[65] The picture that emerges is of a four dimensional linguistic space of immense subtlety and complexity – "Speech becomes simultaneous, concurrent, multileveled in sign."[66]

This broadening of the territories of communication suggests new routes to an auditory identity through touch and gesture. Steven Connor has written extensively and persuasively on the communications, both physical and psychological, between audition and the skin. He suggests that

[63] McCluhan (1960)
[64] Ibid.
[65] Sacks (1989:74)
[66] Ibid.

the tactile and the auditory are emulsified into a temporary undifferentiated ur-sense within the womb's fluid, constituting a 'sonorous envelope'[67] to be separated into its components through the trauma of birth and its mitigating effects of the mother's skin and breast - wrapping this in Didier Anzieu's concept of the 'skin ego'. In this way, the foetus develops an auditory self-hood through the skin; "...Freud wrote in an elliptical way that the superego derives from acoustic roots...orders, injunctions and threats that the child has heard uttered are at the origin of the superego – in short parental voices"[68] (Mladen Dolar also remarks that the mother's voice is the original 'acousmatic voice', and that to listen and to obey share etymological antecedence in many languages.)[69]

However, Connor goes further here by linking the crying urge in infants to a vitalization of space, and by implication a projection of power. In vocalizing, and through this act, articulating its spatial place in the world, the infant expresses a 'desire to put its will into sound, to force sound into a permanent form; as though the amplitude of a cry would imprint it more firmly and permanently on the word, and give it the quality of manipulability that the child finds lacking'[70] – a sonic instrumentation in order to bring the world to within its grasp. Connor's use of Anzieu in the pursuing of audio as an articulation of notional bodily volumes and territories (and, as we see below, of Chion's Acousmetre) is a step toward his invocation of a 'vocalic body' which exists as a projected or remote animation of an object or space.[71]

That our sense of space through the acoustic is as primary as the visual is well known. In his co-work on aural architecture, Barry Blesser describes a conceptual experiment involving two environments. He asks us to imagine that we are in a box constructed of thick glass sides, but which is in the middle of an open meadow – so that our vision is unconstrained but our auditory space is a closed one. Next we are to compare this to sitting inside a box of acoustically transparent wire mesh, which is then draped with a visually opaque cloth, so that we are enclosed visually but our auditory space is unencumbered. Blesser's contention is that our sense of encapsulation would be much stronger in the glass box, adding that we would feel as though we could "leave the [acoustically transparent] space at any time."[72]

The spatial dynamics of hearing have been the subject of innumerable cognitive-hearing studies, and are often debated within music discourse, especially since the advent of electro-acoustic music, where spatiality became a tool for manipulation in its own right.[73] An interesting

[67] Connor (2000:28)
[68] Anzieu (1990:62)
[69] Dolar (2006:75-76)
[70] Connor (2000:30)
[71] Ibid.
[72] Blesser & Salter (2007:20)
[73] For an non-specialist scientific introduction to studies in cognitive hearing, see: McAdams & Bigand (2001). Although not a major heading, spatial cognition is examined in several chapters. An edition of 'Organised Sound' has been dedicated to auditory space in composition. See: Landy (1998)

take on this theme, however, is provided by Louis Guggenheim in his study of the morphological evolution of the ear. He notes the fact that the two organs with the function for hearing and equilibrium are housed next to each other in the temporal bone: "Seemingly unrelated, one's curiosity asks why nature has seen fit to have them so associated."[74] This, he states, is because our hearing and balance functions are effectively the same – that hearing evolved from balance. It is through the devices of movement or orientation and spatial perception that the auditory and visual senses can perhaps be related – and this research examines how the photophonic convolution of signals from both modalities can be seen to articulate this.

Towards the beginning of this research, I began to use video as part of my practice, both as a way of documenting and making readable the process of photophonic recording, but also partly to situate that practice within a certain theoretical framework; to make it in some way available to film sound analysis, and (less expectedly on my part), the discourses surrounding materiality and media within the experimental moving image. However, as I will go on to exlplain, the camera and therefore the frame are fugitive presences in my video work; not least of all because the work's effects can be experienced without a camera at all.

> *In my ongoing work, provisionally (and sarcastically) entitled 'Fun', I have been recording on digital video some of the light sources from what I perceive to be the dominant pursuits in the west end of London where I live – namely leisure and consumerism. I spend a few hours just before Christmas 2007 with a mini-DV cam and a solar battery charger plugged into the external mic socket, using it to sniff out interesting sounding light sources for filming, whilst wearing headphones. What I find spilling from the shops up and down Regent Street is surprising in its range of timbres and pitches – I surmise that each tone is attributable to different makes of digital dimming circuitry in different locations. The orbs strung above the street as part of the Christmas lights make strange mewling sounds as they fade from pink to blue and back, and the funfair in Leicester Square is a relatively disappointing wash of 50Hz hum by comparison – with the notable exception of phasing and rhythmic patterns on some of the rides. The real light show though, is Piccadilly Circus's giant LED adverts, which you can sense halfway up Regent Street, and which is akin to being bathed in an electrical storm. As I listen, the advertisements become meaningless – crumpling under the weight of the fizzing screeching audio and abstracted into shifting colour fields.*[75] (Figure 9)

[74] Guggenheim (1948:15)

[75] Author's personal sketchbook entry, December 2007. The video work referred to can be found on the accompanying DVD: *Photophonic Study No.2*

The original aim of producing this video was to document the recording of the audio component (or sonified light), but it became quickly clear that the sound and image combined to generate a powerful tool for the examination and elucidation of my practice. The status of the video I describe above is fluid, since it can be said to serve as both documentation, and as work in itself. This theme is recapitulated, and dealt with in the final chapter of this thesis, where I look at *Said Object* – a video which also operates in these two registers. However, the video documentation of light sources is different, since it serves in some ways to *efface itself*,[76] due to the interrelationships between the auditory frame generated by the photovoltaic cell, and the visual frame provided by the camera. In this sense, the camera is rendered obsolete by the photovoltaic cell's framing of space via light's transport of sound to the ear. The articulation of these volumes of space through sound is normally peculiar to the artificial moving image, and so it seems pertinent to consider sound theory which deals with this directly. Michel Chion goes some way toward this in his formulation of the *acousmetre*, a very specific set of audio-visual relationships where a character is constructed through audio, but whose "relationship to the screen involves a specific kind of ambiguity and oscillation".[77] Providing by way of example James Whale's *The Invisible Man*, Chion argues that a notional volume in space is constructed by the voice of the actor; 'The speaking body of Wells's hero Griffin is not invisible by virtue of being offscreen or hidden behind a curtain, but apparently really in the image, even – and above all – when we don't see him there.'[78]

Figure 9
An LED display board in London
from - Rob Mullender (2007)
Photophonic Study No.2

[76] A common theme in theoretical writing on film. See Altman (1980) and Lastra (2000) for a sonic perspective on this.

[77] Chion (1994:129)

[78] Chion (1994:127) Importantly, this character is distinct from the *acousmatique* voice which is not involved with the events onscreen – as is the case, for example, with the narrator's voice.

Chion asserts that the cross fertilization of properties between modalities is inherent to film. For our purposes, however, this concept becomes more problematic in the power relationships that he goes on to ascribe to this particular class of character – omnipotence, omniscience, and ubiquity. We are, after all, not necessarily thinking of the articulation of character through voices, or synthesized audio which uses them as its source, but any number of sounds with potentially any number of meanings.

More Distant than the Stars, and Nearer than the eye

When examining the video of sonified light mentioned above, which I eventually entitled Photophonic Study, it is possible to draw a few basic conclusions, primary among which is that the audio and its visual source are exactly synchronized, and from this fairly simple fact some interesting possibilities can be explored. In his paper "What is Sound?", Robert Pasnau attempts to clear up what he considers to be inherent contradictions within the 'standard model' of how sound is propagated and perceived. He essentially states that we understand sound to be a property belonging to the object that we perceive to be making that sound, and that therefore sound waves supervene upon that object's vibrating properties. His main analogy is that of colour being a property of an object we see: we 'hear birds' rather than hear the sound waves that they generate, claiming that for both cases to exist would be internally inconsistent.[79] I hope it will become clear as this writing progresses, that such rigid delineations do poor justice not only to the fluid and dynamic experiential realities of listening. Cinema's audio-visual interrelations, or rather, how they have been theorised, serve as more useful examples.

Rick Altman provides a more cinematic (and more straightforward) perspective, remarking that: 'The image in terms of sound always has the basic nature of a question. Fundamental to the cinema experience therefore is a process – which we might call the sound hermeneutic – whereby the sound asks where? and the image responds here!'[80] Through this perceptual assignation of sound to source, contradictions arise when experiencing a distant photophonic signal: our auditory instincts tell us that a short circuit has occurred somewhere, brought about by the audio seeming to hitch a lift on the emanations from its luminescent progenitor. Because of our auditory sense's role in articulating space (and distance), the more distant the signal, the more this 'telescoping' becomes apparent – an effect essentially cinematic in character.[81] Through a shared lineage of audio and image, a plasticization of space is affected, brought about by the decoupling of the

[79] Pasnau (1999)

[80] Altman (1980)

[81] Chion deals with this when outlining what he considers to be the difference between cinematic sound and televisual sound. A loud, or close-up voice from a distant figure is common in the cinema, whereas a close-up of a figure with distant, or ambient sound is a hallmark of television, and particularly sports events. Chion (1994:159-161)

acoustic from its normal spatial, and therefore orientational imperatives; there seems at times to be a sense of visual flattening, or proximal ambiguity, which is never stable, but oscillates in unpredictable ways.[82]

As has already been suggested, the status of the audio sonified from a light source has a paradoxical existence. While it is the product of an energy that articulates space, it has almost nothing in the way of spatial attributes in itself (except for some correlation between distance an amplitude), or at least none of those that we expect to be present in audio – for instance the time lag, filtering and reverberations we come to understand as articulations of space. Experientially, this acoustic is most closely related to what one might hear with elbows resting on a vibrating surface with fingers jammed in both ears. This form of transmission is most commonly encountered as a component of one's own voice, or perhaps with tinnitus (one is reminded of Cage's famous, and often told encounter with his own nervous system in the anechoic chamber at Harvard – certainly the most space-less space for the ear); it could be described as, along with more traditionally synthesized electronic sound, internal in character.[80] Unlike more standard electronically synthesized sound, the photophonic signal can be bi-modal, or presented aurally and visually, thereby contributing by association to the spatial instability outlined above. Through the use of headphones, the monophonic signal is placed spatially within the head – generating a privately available audition of events. A sense of listening-in arises; an apprehension of a space heard at a distance as well as seen, a shop window heard on this side of the glass as well as seen through it; a position of influence at a distance from privileged knowledge.

Projections

In 'Light Moving in Time', William Wees characterises cinematic image as a metaphor for, or more expansively, a 'visualization of sight'[81] which in its 'avant-garde' manifestation destabilizes accepted conventions of the classic visual 'net' of vision as exemplified by the renaissance conventions of vanishing point perspective. By expanding into the realms of, for example, peripheral vision, phosphenes (or closed-eye vision) and saccadic eye movement, the avant-garde film more faithfully interrogates our sense of our own vision. Wees notes that '...[usual cinematic

[82] These observations are from repeated viewings of the video, and from occasional reflective flaneuring with my photocells and headphones around London at night.

[83] Christof Migone's essay on the ontology of internal/external acoustics from the perspective of sound art addresses this notional space-lessness. For example quoting José Gill's 'referral to self-hearing as "an act of 'absolute reduction; of space"'. See: Migone (2003).

[84] Wees (1992:31)

images] are relevant to a very small part of what we actually see: not much more than two degrees of the approximately 200-degree angle that our eyes encompass as we look at the world around us.'[85] and in refuting or expanding on the conventional cinematic view, the avant-garde film turns against the camera obscura trope of the retinal image prevailing since Descartes – a bright field projected onto the back of a dark interior. Furthermore, a case is made for more 'receptive' modes of viewing to be a virtue in certain varieties of avant-garde film making; to '...abandon goal-oriented "looking" in favour of receptive "seeing"'.[86]

Within the relations proposed here, the most stark manifestation of such a dynamic is the flicker movies of amongst others, Paul Sharits and Tony Conrad, which utilise either patterns of solid black and white frames, or alternate ones of different colours to induce various effects on the viewer – both phenomenal and intellectual. In Sharits's words: 'Light-colour-energy patterns generate internal time-shift and allow the viewer to become aware of the electrical-chemical functioning of his own nervous system.'[87] We begin to sense a model emerging of the apparatus of representation being turned against itself, or being forced to reveal its own workings by recruiting the viewer's perception, and the viewer being forced to consider their perception by the projector. Wees: 'In normal film viewing situations, the projector-pistol also fires discontinuous impulses of light at the viewers' eyes but usually at a sufficiently rapid rate to disguise their discontinuity. What the projectors are designed to hide, the flicker effect restores to visibility'[88] In the photophonic synthetic space, these pulses can be heard rather than seen, and no radical refiguring or abstraction of the source signal is needed. By interrogating our threshold of visual perception by recruitment of the ear, can the sonification of environmental light be seen as a cousin of the structural film movement – further expanding the visual through, and out of the cinematic, to remove the need for the camera and projector?

Writing on endeavours in the UK, David Curtis delineates the structural and material film terrain as a place free of narrative and representation, a space to understand 'film as film'.[89] If the flicker movie induced comprehension of visual thresholds by firing light into the mind of the viewer, Anthony McCall's *Line Describing a Cone* (1973) left them in no doubt about how it got there. As Curtis describes: 'Over half an hour, a white dot on a black screen was animated to move through 360 degrees, slowly becoming a circle. Projected into a smoke filled room, a hollow cone of 'solid light' was formed, with its apex at the projector lens.'[90] Taking McCall's lead, Lis Rhodes

[85] Wees (1992:43)

[86] Wees (1992:126)

[87] This is quoted by Wees from Sharits (1969) and refers to his film *Ray Gun Virus* of 1965. Concerning the film's title, Sharits is also quoted in this same source, asserting that: 'The retinal screen is a target. Goal: the temporary assassination of the viewer's normative consciousness'. Ibid.

[88] Wees (1992:151)

[89] Curtis (2007:205)

[90] Curtis (2007:215)

integrated this into her film *Light Music* (1974) which extended directly printed black and white lines from the projected frame onto the soundtrack. This was projected onto two screens from different locations, resulting in '...an overwhelming but orchestrated aural-visual assault.'[91] Although the film itself does not possess a sound track, McCall's articulation of space through smoke and light is also not a silent affair;[92] it might easily be asserted that the acoustic emissions of the projector's mechanism are concomitant with, and pertinent to the luminous emissions of the lens. Could we continue even further down this line of disassembly by remarking that the projector is incidental?

The notion that cinema, or it's conditions, can be separated from the technologies that bring about its production and reproduction, has been examined by Jonathan Walley. Ruminating on avant-garde film's modernist tendency toward a foregrounding, often under the banner of 'anti-illusionism', of its own materials and apparatus, Walley pinpoints a paradox. In establishing the essence of cinema to be independent of film itself (that is to say, that the elements of light, time, space, image and structure can be found independently), avant-garde film and its attendant field of scholarship has at times found itself examining its own material conditions, while simultaneously rejecting them. This ability of cinema to permeate, or exist outside of itself, Walley defines (after Ken Jacobs) as 'Paracinematic', and he provides us with McCall's Long Film for Ambient Light as a prime example of these works, which are '...an array of phenomena that are considered "cinematic", but that are not embodied in the materials of film as traditionally defined. That is, the film works I am addressing recognize cinematic properties outside the standard film apparatus, and therefore reject the medium-specific premise of most essentialist theory that the art form of cinema is defined by the specific medium of film.'[93]

In what follows I will call on the idea of the paracinematic relatively frequently, since it enables the identification, through mechanistic processes and sonic effects, of cinematic conditions within my own practice which would not normally be considered works of 'cinema' in the normal sense. This concept, as we shall see, will also be extended outward to encompass environmental phenomena which I have sought to document in my practice, and further to this, draw together seemingly disparate ideas concerning seeing hearing and the haptic.

[92] From personal experience – McCall exhibited this piece at the Serpentine Gallery in London, January 2008.
[93] Walley (2003:18)

Phantom Positioning - Part 2

In his extensive exploration of figurative ambiguity in modern art, Dario Gamboni briefly summarizes three models of vision from antiquity, where light is given radically different mechanisms in its transportation to the eye, and further inward, to the consciousness: 'Whereas Plato emphasized a channel of fire coming from the eye (extramission), coalescing with light and stretching to the visible objects, and Aristotle stressed the action of the objects and the intermediary air upon the eye (intramission), Lucretius, following the Greek atomists, thought such an action was brought about by thin films that detached themselves from objects (simulacra).'[94] According to David Park, the theory of the simulacra can be traced back from Lucretius, through Epicurus and Democritus to Leucipius, who understood eidola (the Greek term for simulacra) to be '...thin veils of matter, perhaps only one atom thick, which peel off and retain their shape as they fly with immense speed in every direction. Though they may be quite far apart in space, they arrive close together in time so that our view of a changing scene is continuous, like what we see in the cinema.'[95] We can further find a taste of this in Henri M Yaker's summary of concepts of 'Time in the Biblical and Greek Worlds'. Yaker excavates the sediments that inhered within the Greek term for time, chronos: 'It is determined as a parameter of the spatial kinematic motion of the planets...Aristotle refers to the elliptic motion of the celestial bodies as "eternal"...but in this sense "eternal" means periodicity, recurrence, or perhaps "perpetual present"...',[96] further adding that 'The Greeks used chronos as a parameter or secondary concept which was finally eliminated from the study of space and the universe – the planets projected their 'images' on the receptacle [the empty void] in constant recurrence.'[97]

It would be a stretch, I think, to claim that the Greeks invented cinema, but there is a sense here that existence is somehow paracinematically rendered, since it is interstitial or periodic. In Lucretius's simulacra we see an unwitting forebear of modern popular visions of the broadcast model – ghostly shells emanating out from a central position in space to be collected by a passive receiver. Compare this to Balzac's notion of the camera's action upon the soul, noted by Kittler: '...Balzac was already overcome by fear when faced with photography. If, (according to Balzac) the human body consists of many infinitely thin layers of 'specters', and if the human spirit cannot be created from nothingness, then the daguerreotype must be a sinister trick: it fixes, that is steals, one layer after the other, until nothing remains of the specter and the photographed body.'[98] The shells continue inward to where nothing else remains but a singularity, a co-ordinate for navigation

[94] Gamboni (2002:25)
[95] Park (1997:36)
[96] Yaker (1971:18)
[97] Ibid
[98] Nadar in Kittler (1999:10-11). Walter Benjamin found that what he termed the 'Epicurean' theory of vision suited his perception of history being a composite of finite moments and events. See Downing (2006).

in the world...

Lucretius's vision of vision is apt for us here, situated as it is in the middle of the two models of sound and light propagation that we now understand to be correct. In listening to light signals, we can see into that imaginary space of lightning-fast phantoms filling our waking vision, and our thoughts and dreams.[99] As I have mentioned in my introduction, and go on to discuss in chapter 5, the implications of the Atomist/Epicurean visual world expand seeing and hearing into the realms of touch, by virtue of the fact that they are not light as we now understand it to be – an energy articulating surfaces separate from itself – but rather, are materially indistinct from those objects. The image of the object is part of the object itself, only becoming rendered into immateriality by perception, even as its materiality is perceived...

The 'material power of the gaze' finds an unlikely modern analogue in neuroscience, where the perception of materiality is has been conjured prosthetically in consonance with effluvial theories of vision. Paul Bach-y-Rita's work with 'tactile vision substitution systems' (TVSS) conjures an embodied manifestation of the emission theory by enabling a short circuit of the senses – to touch at a distance through machine vision, or enabling touch without touch. A matrix of electrodes is placed on the tongue, where an 'image' computed from two cameras, typically mounted on the user's glasses, is constructed. The team found that '...a blind infant using the vision substitution system smiles when he recognizes a toy and reaches for it, and a blind 10-year old perceiving a flickering candle by means of a TVSS is enchanted.'[100] Paradoxically, the object touched from afar is literally brought within the mouth (although other parts of the body, such as the abdomen can be used), again suggesting an oscillation between perceived external and internal spaces, vision and touch. It is not recorded as to whether a transducer could be added to enable hearing through the teeth in addition to seeing with the tongue – since taste is there already, and smell not far away, we would have a microcosm of the sensorium...

In his essay 'Edison's Teeth', Steven Connor makes bedfellows of the auditory and tactile senses, reminding us that the two are mimetic. He writes that: "...touch accompanies, mimics, performs sound rather than translating or defining it."[101] Connor's evocation of the mouth as a composite of the senses is rich with overtones and textures, and now it seems with TVSS we can add visions to the list. As the point of ingress for the breath and egress for the voice, inseparable from hearing as an activity, the claim is laid for the mouth as a locus of self-hood, where the tactility of sound can best be understood, since it is the mouth's kinesthetics that articulate and mediate our projected sonic selves. The eponymous teeth mentioned were used by Edison as a tactile hearing apparatus – being hard of hearing he would bite on his phonograph for a private audition. I like to imagine that given a chance, he would have had a good chew on George Tainter

[99] Lucretius held that ghosts were errant simulacra, and dreams were similar, only entering consciousness through the eyes during sleep. I will examine this more in the penultimate chapter.
[100] Bach-y-Rita et al. (2003)
[101] Connor (2004a)

and Alexander Graham Bell's Photophone.

In quoting the sources above, I have outlined how this research examines the nature of the photophonic signal, and its components – the light source and the audio derived from it. I have also attempted to show how the sonifier, or physical component of my practice may fit into this picture as the object or system doing the work, and have examined how the nature of the space within which the photophonic source operates is entirely synthetic, and its effects elusive and personal. In this last section I have attempted to sketch out how orientation – as something common both modalities – may work as an intermediary to inform seeing and hearing, and further to this, show how the work's fluid effects concerning proximity may engender a sense of touch. But this is not just an examination of an act of transformation, as if it were occurring in some kind of vacuum – as we will see, the enduring interest in these processes is in many ways as much an object of study as than the processes themselves.

Chapter 3:

Sonic Distortions in the Field of the Visual

Guy Sherwin's Optical Soundtrack Films,
The Flicker, and the Emergent Haptic.

'Pitch' is a multi-sensory, intertextual term. Equally happy in the solid and in the insubstantial, it slopes roofs, angles propellers, persuades clients, and targets messages exactly; it is a field of activity. It transmits between the realms of the ear, the eye and the skin with a flair that rivals 'texture' in its intermedial invocations. Signifying the saw-tooth wave of a flight of stairs (or even saw teeth), or the thread of a machine screw, our auditory imagination can construct how 'pitch' might sound through experience. In our mind's ear we can run our nail along a screw thread to hear the buzzing it makes. The circular saw whines as each tooth chips away at its target; we find that time is now the key. So it is in photophonic systems, and particularly with experimental sound film – passing images are fleetingly read by the sensor to transmute the physical/visual into auditory pitch; but in doing so the associations that our sonic memories learn and maintain about materials, and their natural acoustic properties are stripped away, leaving us with absolute foreground abstraction. And so the harsh contrast of black and white becomes a square wave, a diffuse chiaroscuro becomes hissy and soft, a corrugated plastic roof literally sinusoidal. Luminous patterns become sonorous analogue data; the visual field becomes *denatured*...

In this chapter I introduce the area most commonly associated with photophonic experiments, and certainly the most fertile – experimental film. I discuss Guy Sherwin, whom I consider to be pivotal in my own understanding of what photophonic sound is capable of, and use comparisons of his work with other, ostensibly similar (although earlier) work from another artist in the genre – Tony Conrad's *The Flicker* – to explain how I consider an emergent sense of touch to operate within his films. Using Laura Marks's theories on 'haptic' visuality, I will then discuss how a notion of touch within sound and image can be used to articulate power within these films, through the concept of a dialectic of forces between the films and the spectator. In a broader sense, I will suggest that Marks's considerable contribution to expanding our understanding of how film can be perceived, is incomplete in her non-engagement with sound and its effect upon the image, particularly with respect to films which engage directly with this.

Between 1971 and 1977, Guy Sherwin produced a series of what have since come to be known as 'Optical Soundtrack Films'. Although only a part of his overall output during

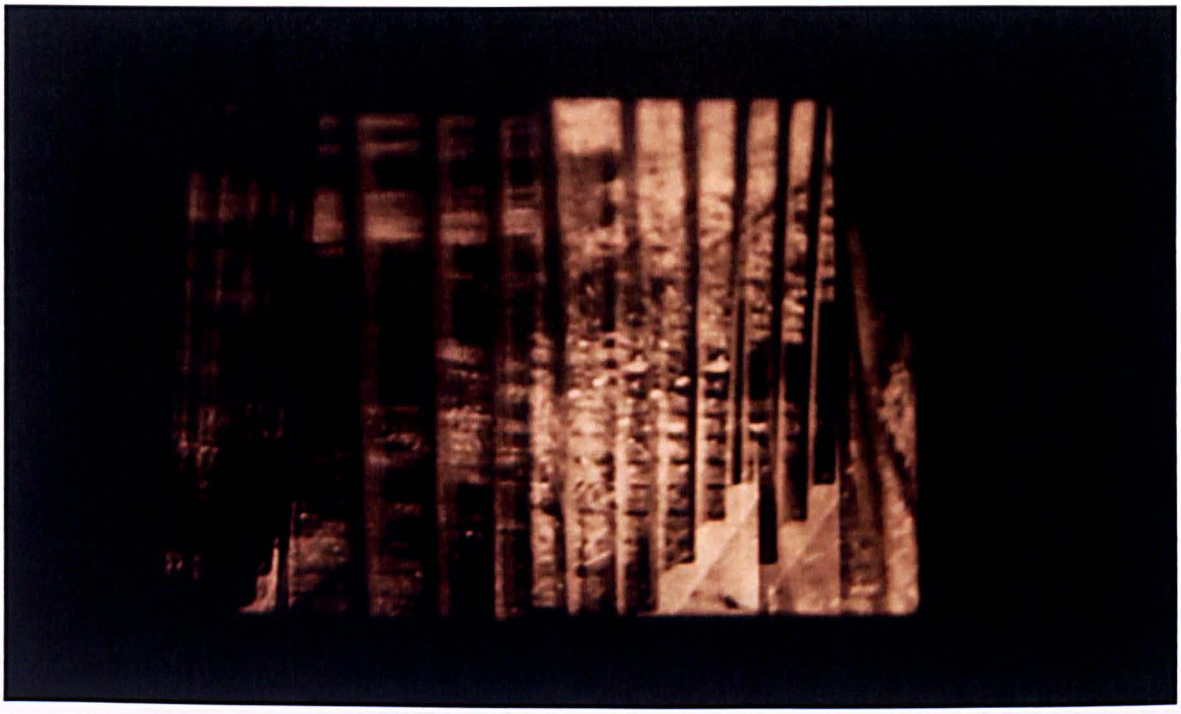


Figure 10
Guy Sherwin (2011) *Railings*
(live performance with 16mm projectors, A Coruna, Spain 03/06/2011)

this period, they are nonetheless exemplars of their type. Sherwin came to prominence during the 1970's as part of a loosely defined group of film makers who made what was then termed 'structural' or 'material' films, and whose work undertook an interrogation (or perhaps more accurately, an exposé), of the materiality of the cinematic apparatus – camera, film, projector – and hence set out to destabilise the spectators' habitual collusion with an 'illusionistic' conglomeration of sound and the image. One of Sherwin's methods of engaging with this set of ideas, was to bleed the images in the frame across into the optical soundtrack, so that what was seen was also what was 'heard'.

The definition of a 'structural', or 'material' film was at the time fiercely contested, and this tussle for intellectual and ideological territory plays out vividly in debates between some of the leading practitioners from the U.K and the U.S, in what was at the time, a relatively small field of activity. For example, structural film is identified by P. Adams Sitney in the U.S, as literally being defined by a hermetic structure; that 'The structural film insists on its shape, and what content it has is minimal and subsidiary to the outline', and which employs techniques which '...attempt to divorce the cinematic metaphor of consciousness from that of eyesight and body movement'; structural film is of the cinema's mind, not of its body.[102] This interpretation would be initially critiqued by the British film maker and theorist Malcolm LeGrice, on the basis that it bore no relationship to European structuralist concepts; his own interpretation being that for a film to be structural, it must articulate the processes of its own making, reflexively referring to the deeper structures of the mechanics of cinema. Further to that, a film could only move into the materialist realm, once it could be seen as being defined by a dialectic between human perception – which was subject to a 'bodily binding of our nervous system and by our relationship to experience' on the one hand – and the image of that experience as mediated by the cinematic apparatus on the other.[103] These discrepancies aside, it is fair to say that the label 'structural' pertained to a loose grouping of film makers in the '60's and '70's whose works played with the established codes of the normal cinematic interrelationships between sound and image, film and spectator, film maker and film, and presented these works within the milieu of the underground arts scenes of the time. Further to that, it is worth noting that many of these films were silent works, the emphasis being on a presented dialectic between image and eye, and Sherwin stands out in this regard.

The optical sound experiments produced by the likes of Sherwin (and also Lis Rhodes) can be understood as technologically closely linked the work of the 'Ornamental' or the 'Animated' sound works (to be discussed in chapter 4), for example, of Arsenii Avraamov and Oscar Fischinger from the 1920's and 1930's. By the 1970's, their emergence in opposition to the by then long established dominant cinematic norms, be they aesthetic, economic or ideological, places

[102] Sitney (1978:369-370)

[103] The differences I briefly outline here are discussed in a spirited debate between LeGrice and Sitney in 1977. See: Narrative Illusion vs. Structural Realism in LeGrice, (2001:137).

them in a very different frame. For while artists such as Leger and Vertov (to name but two) were critiquing cinema's 'natural' affinity to theatrical stagings and devices such as dialogue and narrative as early as the 1920's,[104] the advent of optical sound presaged a particularly focused line of experimental research concerning the soundtrack's graphical traces, and how they might be creatively utilized, both in and out of the image.

The 'stuff' of sound-on-film, and therefore film itself could become the legitimate concern of musicians and acousticians as well as film-makers; individuals who saw great potential in the visually readable, mutable and plastic nature of sound recording that was now available, and who made extensive and methodical forays into this new synthetic territory. Sherwin's work might be seen in part as a reexamination of this earlier terrain, but from within the ideological milieu of the 1970's independent film, and from an acoustic aesthetic standpoint which now had recourse to an established 'post-Cageian' set of conditions. But watching the raw alchemy of everyday objects being wrenched from the visual into the auditory in Sherwin's films, I am struck by the notion that, to paraphrase Cage, rather than letting sounds be themselves, he is letting the images be the sounds themselves...

In a piece of text to accompany the DVD release of *Railings* (1977), Sherwin states that 'Images of railings are converted into sounds as they pass over the projector's optical sound head. *I used the camera like a stick, clattering over the railings.*'[105] The camera is turned on its side so that the railings can be bled across onto the area reserved for the optical soundtrack, producing changes in pitch and timbre with altering perspectives and distance. This is achieved by splitting the film a-symmetrically along its length, and then turning it over, before reprinting. In dragging the combined forces of camera, printer, projector and observer across a set of railings (since the work can only be complete with these intermediate and final processes), the railings' metal is rendered into a tactile proximity using sound. Two divergent sensory scenarios arise within the onscreen construct:

1 If one were to transcend the corporeal realities of mass and velocity, and were to wield a contact microphone, running at speed across the visible/physical landscape twenty four times a second in mimicry of the projector's optical sound sensor (increasing velocity in consonance with vanishing perspective), one would perhaps reproduce this stark, percussive intensity. Perhaps Sherwin is really trying to tell us that sound is, in its true nature, about speed.

[104] See LeGrice (2001)

[105] Sherwin (2007:55). My emphasis.

2 If in the act of scanning the scene to realize these sounds, the camera anchors the artist (and viewer) in static scale, as the artist's apparatus's conspire to drag the filmed scene into a proximal space, simultaneously shrinking it to enable tactile events – the camera is equipped with a macro lens by the auditory function of the viewer. Changes in size of identical objects normally put down to increasing distance (perspective) become differently spaced embossed striations and figures upon an unstable two dimensional tactile surface. Far becomes near.

Both of these propositions are inherently fantastical, alluding to hallucinatory or hypnagogic states of consciousness. Both are concerned with the basic premise that the visual scene has been utilised to force the soundtrack into existence by some refiguring of its original 'purpose', and this has brought about an inevitable transformation of how it is perceived. In both, the proximity of the objects represented upon the screen are brought into notional contact with the spectator through the mediation of the projector's sound capabilities – if the conditions are right. As I shall discuss in the next chapter, divergent meanings within sound film experiments of this flavour can arise, depending on the spaces within which they are viewed or presented; the familiar scenario of a room with a projector being perhaps being just one. In Sherwin's films, especially *Railings, Musical Stairs* and *Soundtrack*, the essential nature of the work is suffused by the presence of the tools used to produce it, and the mechanical techniques they employ to do their job (according to the tenets of the more European flavour of 'structural'). However, as we shall see, these techniques can be liberated from the apparatus of cinema, in ways which also free the spectator from spectatorship in ways redolent of the structural/materialist film paradigm, but which go further by freeing them from film itself. I will describe in chapter 4, in the section entitled 'Scanning', a piece of my work, which is intended to transform its visible surroundings into an optical soundtrack, and which can generate sounds remarkably similar to that which can be heard in Railings and Musical Stairs. This technique of scanning a scene for its utility as materials for sonic synthesis may invoke the condition of film in more ways than in just the aesthetic properties of the sound produced. In effect, excising a technique from the film's apparatus is not a clean procedure; it brings a residue of its previous incarnations from within the cinema, which attaches itself due to the physical nature of the media (light, and hence, its optics) it uses to do its work.

Sherwin's sound films uncompromisingly speak to a tendency (deliberate or otherwise) toward aesthetic 'harshness' in sound/film experiments, and sit happily along side films such as Tony Conrad's *The Flicker* (first shown in 1968), Paul Sharits's *Ray-gun Virus* of the same year, or

perhaps more pertinently Peter Kubelka's *Arnulf Rainer*, which Sherwin describes as a profound influence on his experiments with optical sound.[106] Some of Sherwin's earlier works which fall into this category are sympathetic with what emerged as the flicker genre in terms of their simplicity of form, and internal formal coherence – strict schemas governing time, process and rhythm are applied, and a stark, stroboscopic, monochrome aesthetic pervades the image.[107] Perhaps the most Flicker-like of all is *Cycles*, which was produced using stick-on paper dots, and holes cut out of film leader (Figure 14). The projected image essentially consists of an alternately black and white flashing circle within a square, which itself fades between black and white at various rates. The soundtrack is comprised of pieces of stick-on dots, cut into quarters to present a soft saw-tooth wave to the projector's sound head; the maximum frequency available to Sherwin was dictated by the size of the dots; three half-dots per frame, or 72 hz. Sound and image cycle around each other, going in and out of sequence, with the seeming correspondence between the two gaining only momentary footholds in the ongoing action.

However, it is when in the traditional/pictorial (as opposed to exclusively abstract) realm of the everyday; of railings, train tracks and stairs, that Sherwin's works are at their most startling, and here lies an interesting interplay between his work and flicker films, despite them sitting to some degree on either side of the pictoral/abstract divide. In drawing links between Sherwin's work and the 'flicker' genre, my aim is not to attempt to align too closely entirely separate bodies of work, or indeed to simplify or gloss over the various complexities inherent to each, but to examine how they both generate ostensibly similar experiences for the spectator, while leaving distinctly different impressions.

The ideological ramifications of producing a film which only found itself completed within the eye and brain of the spectator (a fundamental maxim of the form), as well as its art-historical setting, are outlined plentifully, and in detail elsewhere, as is the flicker genre's history and context.[108] My wish here is to consider more closely something almost ignored the writing on Structural and Material film by LeGrice and Sitney; how the interrelation of sound and image generates and nuances the essential nature of these films, and furthermore, how this exchange might resonate with, or generate an emergent tactile aspect to the films' effects upon the spectator. Even when considering the deviation toward non-abstract imagery in Sherwin's later optical soundtrack works, lines of both repulsion and attraction operate between them and flicker films (and across a whole decade, and the Atlantic ocean); forces which allow for the opening up of a tactile, or haptic component to emerge as common ground between both.

In Sherwin's films which involve the use of a camera (as opposed to those which involved direct camera-less processes such as scratching or drawing onto the soundtrack), the sound's

[106] Interview with Guy Sherwin conducted by the author, 21/9/2009

[107] Le Grice refers to the flicker genre as 'the perceptual film', referring it back to its 'region of function'. Le Grice (2001:50)

[108] Joseph (2008)

generation by the film is rooted in the visible (and hence, audible) recording of recognisable scenes and objects, whose presence might ordinarily serve to suggest some kind of normative, or traditional representative arena within which the film might operate. This fundamental inclusion – of the naturalistic image as distinct from the abstract – sets these films apart from the vast majority of 'visual music' or 'colour music' works, be they film, video, or accompaniment to sound works.

It is the tension between the expectations placed upon the representative image, its expected relationship to the more traditional codes of diegetic or extra-diegetic sound, and the sound that the film actually has, that gives both *Railings* and *Musical Stairs* some of their power. This flirtation with the classic veridical image is put under further strain (almost to breaking point) by techniques seemingly designed to effect further audible changes in the optical soundtrack, and in accordance with materialist film principles, to draw attention to the physicality and presence of the medium and its apparatus, strengthening the direct transcriptive nature of the audio-visual turn. In *Musical Stairs* extremes of exposure and contrast are made use of to produce differing timbral qualities, and alternating sequences of varying distances to the stairs generate changes in pitch. Each shot is static, thereby locking each pitch and timbre in stasis for the duration of the edit. *Railings* employs a different visual style, and is more fluid and dynamic, with much of the film subject to a deliberate mis-registering of the frame in the printing process (in this case, frame by frame on an 'intermittent' contact printer),[109] thereby fracturing the image into separate but co-presented events, even to the extent where one side of the frame is static, the other might be in motion.

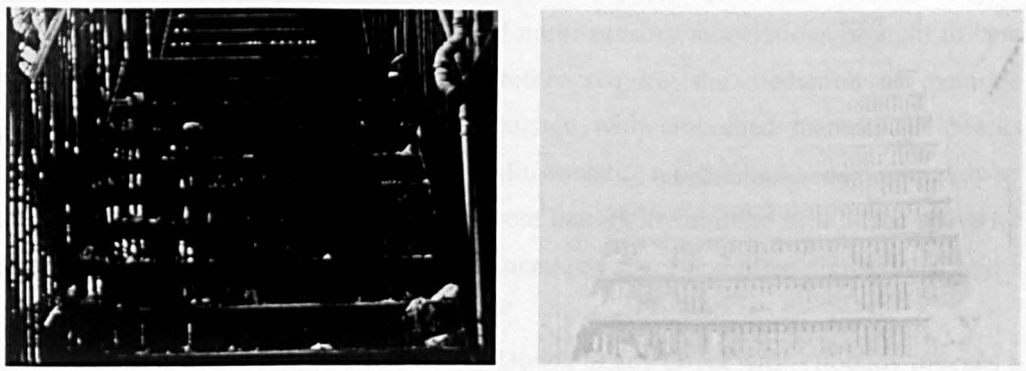


Figure 11
Guy Sherwin (1977) *Musical Stairs.*
Showing different levels of exposure/contrast to achieve different timbres when the image is printed across onto the soundtrack.

[109] Sherwin (2007:55)

While Sherwin was not unaware of the discourse concerning experimental film that had been developed by the likes of LeGrice, Sitney and Peter Gidal since the late 1960's, his optical soundtrack films were heuristically produced as material experiments in and of themselves, and not in direct response to any of the broader critical concerns outlined above: 'It was really a kind of intrigue about what this film strip would look like having done these various actions to it, whether it was sticking things onto it, or putting it through various processes. I didn't have a chance to repeat it, or, shall we say smooth it out... so if I made *Musical Stairs*, I had one stab at it... this would be interesting to try certain kinds of rhythms, you go through that, and it's available as a process to get it done... each one explores a different aspect of optical sound...'[110]

The net effect of these techniques is to destabilise the illusion of fleeting represented scenes, switching them in and out of their normative role; these objects are suddenly grabbed and flattened by the soundtrack that is of themselves. The sounds serve to denature the image; the screen reminds the spectator of its presence, simply because it rattles, whirs, pops and growls – fizzing with surface energy.

It is this telescoping and flattening of the image which preoccupies Laura Marks, as she lays out the case for a haptic visuality within cinema, a mode of seeing that is '...distinguished from optical visuality, which sees things from enough distance to perceive them as distinct forms in deep space: in other words, how we might usually conceive of vision... Haptic looking tends to move over the surface of its object rather than plunge into illusionistic depth, not to distinguish form so much as to *discern texture*.'[111] Marks's concern is chiefly that of 'embodied spectatorship'; that perception and apperception are not necessarily subject to the categorisation of the senses ascribed to them by their naming, but are blended of the totality of experience. For example, the image of a knife's blade has a weight of personal and multi-sensory associations brought to bear upon it: 'All sense perceptions allow for, and therefore require, the mediation of memory. Consequently, even the "mere contact" sensations engage with embodied memory.'[112] Marks contextualises this by offering up a model of western 'illusionistic' representation as a retreat away from the plane of the image, and consequently away from materiality and the skin of the spectator – quoting the antiquarian art historian Riegl: 'With an increased space and three dimensionality the figure in a work of art is increasingly dematerialized.'[113]

To be clear, what is being suggested here is not touch in any direct way – nobody touches a film as they watch it – but according to Marks, a condition of touch may be evoked by the nature of the image as it plays out upon the perception of the spectator. Attributes characteristic of this type of image, are of abstraction (since apprehension of the whole is an impossibility in close proximity), defocusing, to mimic the actions of the eye by the camera, and a scanning, searching

[110] Interview with Guy Sherwin, conducted by the author, 21/9/2009

[111] Marks (2000:162). My emphasis

[112] Marks (2000:147)

[113] Riegl (1927:74) in Marks (2000:165)

motion which may reflect the movements of the skin upon an object. With the invocation of a materiality within an image by virtue of a planar, haptic visuality, Marks's strategy of broadening the inventory of the viewer's receptive capacities and surfaces has a further implication for us here. It effectively establishes a dialogic flow of the senses, an exchange rather than a bestowal, and so a flexible model of spectatorship emerges which goes beyond the 'passive/active' binary; after all, within touch, an exchange of force takes place, the varying nature of which might subtly alter the way an event is experienced. If I might exaggerate to illustrate the point: trying to prevent a car rolling down an incline leaves behind a very different set of sense perceptions and memories to those generated by smoothing down a child's hair. Here, each action is a composite of emotions, gestures, and forces, operating at relative extremes of magnitude and direction – more usually, gradations of experience are at play, nuancing each tactile interaction with our surroundings. Intricacies of intentionality, feedback and reflection are intrinsic to the imprints of experience which constitute memory, and whose subtle networks of force might indeed be invoked between a spectator and the image, arising from under a model of haptic visuality – or even perhaps helping conjure it into being. Within this model of visuality, Sherwin's films seem to be scratched and scrubbed entities – percussively, and in some instances, violently playing out across the screen.

The great omission from this otherwise forceful telling of how cinematic touch arises, is sound. Marks admits as much, but does contend that sound is subject to the same dialectical intricacies as the image, along the lines of the optic/haptic model she has proposed: 'Of course we cannot literally touch sound with our ears, just as we cannot touch images with our eyes; but as vision can be optical or haptic, so too hearing can perceive the environment in a more or less instrumental way.'[114] Sound is, as we know, a prime agitator and articulator of space (perfectly effective within the proximal sphere where vision becomes useless), and when present, is as important as the cinematic image in establishing a spectator's spatial and conceptual relationships to both the on-screen construct, and the space within which it is projected.

This is not to infer that film sound must obey any specific rules concerning what it may or may not carry, and it should be mentioned here that Marks's main area of study is international and diasporic film and video, rather than the kind of experimental artist's moving image produced by Guy Sherwin. However, a non-engagement with sound seems a missed opportunity, produced perhaps in part by a misunderstanding. We do indeed 'literally touch sound with our ears', as well as with the rest of our body, and so this leaves the issue of a 'haptic cinema' incomplete, since it can equally considered to be as much an audio-visual possibility as an exclusively visual one. After all, sound's capacity to transform or undercut the spectator's understanding of the image can originate from what is understood to lie outside of the frame, as well as what lies within it. One

[114] Marks (2000:183)

need only watch works which deliberately play with the expectations and codes operating within film and video which transform the pro-filmic event into a specific, credible spatial whole. A fine example of this should surely be Janet Cardiff and George Bures Miller's *Berlin Files*,[115] which skillfully disorientates the viewer with its exploration of cinematic norms pertaining to the soundtrack's diegetic function. Specifically in one scene, a view notionally shot from within a helicopter flying serenely high over water is vertiginously rescaled, as the camera pulls back to reveal that the water is a close up of a dirty puddle. The scene which up until moments ago had held the viewer aloft with the sound of the helicopter's rotors, was now re-framed, confronting them with the knowledge that they had been watching exactly the type of shot with which Marks invokes haptic sensibilities – a slow, deliberative scan across a proximal surface. The paradox of course is, that until the revelation of the camera pulling back, they effectively hadn't been…

Crucially, in Sherwin's *Railings* and *Musical Stairs*, with sound's flattening and fastening[116] of the image onto the screen, the boundaries within which the haptic operates are expanded out of the narrow confines proposed by Marks, and those images which do fit her proximal, abstract ideal, are provided an extra tangibility. As we have seen, Guy Sherwin's optical soundtrack films are equally works of sound (or perhaps music) as they are vision; the succession of concretised images only reach their proper potential only through the optical sound sensor's simultaneous, indifferent translations. When fully engaged, the spectator's perception oscillates unpredictably in and out of the notional bodily 'envelope' accordingly; the screen's surface, articulated by the film's photophonic construct, enables an exchange of force through the tactility of sound and image combined; the moment-to-moment shifting from the optical to the haptic reined in by the soundtrack's insistence of spatial proximity. The spectator is both subject to the film's effects, but simultaneously invokes this emergent tactility; counterbalancing subjection with instrumental perception, and engaging in a way which fluctuates between Sherwin's images of 1970's London, and the apparatus that conjures it into the world again – the film projector and the surface of the projected here-and-now.

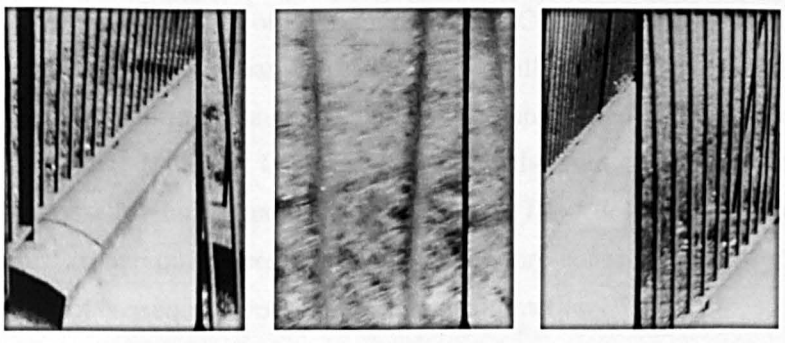


Figure 12
Guy Sherwin (1977)
Railings

[115] Cardiff (2003)

[116] 'Haptic' is derived from haptein, meaning 'to fasten'

The laying bare of the apparatus was one of the professed desired effects of flicker films at their initial inception (Sitney considered the genre to be archetypal in the 'structural' canon), but perhaps not the primary one. In 1972, Tony Conrad outlined three possible receptive scenarios with respect to *The Flicker* and its effects upon spectators:

> 'Either they accept the experience as a new type of spectacle, or they ask themselves questions about the very functioning of cinema, through the demystification of the apparatus of projection...or they create their own mental experience and come out of their passivity'[117]

In his formidably researched overview of the aesthetic weather that made *The Flicker* a possibility, Branden Joseph goes to considerable lengths to stake out a territory for this singular work, where not only are the shibboleths of structural film in force – and as such, a repositioning of the film as fundamentally a set of recursively referential, material events within a given time envelope[118] – but also a further disentanglement from any specific aesthetic context per se. He points out that initially, Conrad gave little credence to the film's status as a cinematic work at all: 'Instead, Conrad consistently discussed it within a much broader context that included op art, psychedelia, popular happenings and rock concerts (particularly those staged in Brooklyn by Murray the K), medical research, and even the 'treatment of battle neuroses'[119] Clearly, the reception and understanding of the work has altered since its creation, not least of all by Conrad, but it is worth noting that as recently as 1989 he referred to the film as simply 'a library of peculiar visual materials, referenced to the frame-pulse at 24 frames per second.'[120] This de-coupling from cinematic contexts is further reinforced by the piece's frequent presentation as a schematic, or chart – the film laid out for us to read whichever way one wishes (Figure 13) With such a breadth of contextual possibilities to choose from, how are we to understand the work's effects – what the film wants, so to speak? If we are to take away the projector and the screen from the work, or rather, if we are to discard the cinematic wrapping of the experience (as Conrad seems to imply we should, since it is but one context among the many possible), so that all that remains are its effects, then interactions between the raw materials of audience, light and sound would seem to be our chief concern. It was in these terms that Malcolm LeGrice understood the film to be 'conceived entirely in terms of retinal response',[121] and is quoted as remarking on *The Flicker*: 'Action on the autonomic system seeks to create a nervous response which is largely pre-conscious, the psychological reactions sought being a direct consequence of the physiological function.'[122]

[117] As related to Gérard Langlois. Joseph (2008:300). (trans. Joseph).
[118] To use Sitney's flavour of 'structural' rather than LeGrice's
[119] Joseph (2008:301)
[120] Joseph (2008:291)
[121] LeGrice in Joseph (2008:297)
[122] LeGrice in Joseph (2008:298)

The ascription of passivity to the spectator is perhaps the most interesting part of Conrad's above assessment of how the work might be received; more so when it is considered that one of the key influences in the milieu influencing its production was a book on experimental neuropsychology entitled *The Living Brain* by W. Grey Walter. Walter would go on to be a pioneer in the then nascent field of artificial intelligence and cybernetics, but cut his experimental teeth working on how the human brain's autonomic functions could be affected by extreme visual stimuli, and what could be read from the resulting changes in the resulting cerebral electrical activity. In a chapter entitled "Revelation by Flicker", Walter outlines his research into alpha brainwaves in particular, and describes how stroboscopic lights, when tuned to the approximate frequency of alpha waves, sometimes produce significant and debilitating effects upon the patient. He goes on to provide several anecdotal accounts of individuals who suffered from various types of blackouts and seizures when exposed to stroboscopic light under everyday circumstances, prominent amongst which were traveling along tree lined avenues on sunny days.

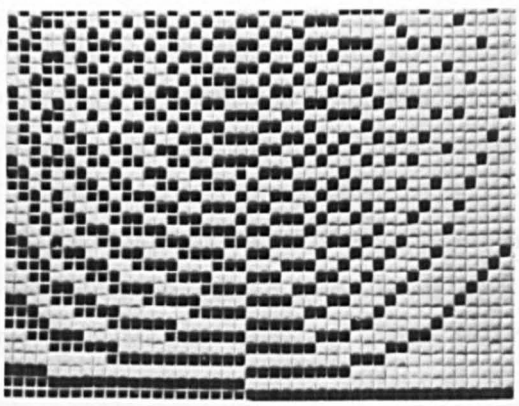


Figure 13
The Flicker exposure timing sheet showing the film's frames laid out in sequence.
Cornwell (1979:81)

This trope of experimentation of the 'patient's' brain as a reactive device that could be affected by bypassing the gatekeeper of conscious perception (that is to say, the parts of us which apperceive, or respond as sentient minds to an experience) finds its direct expression in *The Flicker*, but is obviously denuded of any medical/experimental context – the spectator is cut adrift, and left to construct a cinematic one for themselves. That Conrad's intentions fell into this one-sided power relationship, would seem to be recapitulated in the reports on the first screenings of the work, as recounted by Joseph: 'Early audiences' reactions to the film ranged from disorientation, temporary hypnosis, and intense experiences of colors, patterns, and even hallucinogenic imagery… to

headaches and violent bouts of nausea, all seemingly caused by the pulsating light's interaction with the brain's alpha waves.'[123]

My own experience of *The Flicker* is different. I will be cautious here, since it was shown using a digital projector (albeit one of high quality and brightness), and so it might be argued that the sub-perceptual, or autonomic effects generated by this different technology may be weaker.[124] However it is worth noting that none of the reactions (that can be observed) that Joseph lists seemed to be in evidence amongst those present. Nobody vomited, fainted, ran from the room, or suffered seizures. I personally found the film to be compelling, but felt no strong involuntary effects, except for a sense that the screen developed an uncertain proximity to myself – and even then I found that this could be defused by a little perceptual re-focusing.

How do we account for the differences in experience and reactions between an audience in London in 2008, and New York in 1966? A clue might be found in a comment from Jonas Mekas, in an article from just a year and a half later, entitled 'On the Changing Eye': 'When I first screened The Flicker, two-thirds of the people walked out. Today they ask for a repeat screening. It still provokes some heated discussions, but the objectors are being fought down by their own colleagues – there is nothing for me to do.'[125]

Clearly, the avant-garde film goers of New York had not neurologically altered or evolved in such a short space of time (nor indeed, over thirty one years by 2008), and it would be a stretch, I think, to suppose that only those who knew they would sustain no involuntary ill-effects were attending the later screenings that Mekas recounts. The implication here is that either the reports of *The Flicker's* early screenings have become amplified in part through a kind of cultural feedback mechanism – an extrapolation of, perhaps a few adverse effects, in order to meet a set of needs or understandings on the part of the milieu of the time – or if this attenuation was indeed as it has been reported, and that a screening went from a mixture of vomiting, seizure, hysteria and mass exodus, to general enthusiasm, that these early effects were heavily acculturated. If this is the case, they were not for the most part autonomically induced. The project of firing pure light directly into the nervous system of the spectator unmediated, or under the radar of consciousness, was not easily excised and transferred from the laboratory; it was always going to be a shock – but it was a culture shock – and one that was not entirely visual.

The Flicker's soundtrack is not generated by the same materials that constitute the stroboscopic visuals (I refrain here from using 'image'), as was the case with Conrad's *Articulation of Boolean Algebra for Film Opticals* from 1975, but was recorded separately using an electromagnetic 'gizmo',[126] which was then subject to echo and panning. Conrad describes the sound as an attempt to destabilize the spectator's understanding of their acoustic environment

[123] Joseph (2008:283). Also see Walter (1953:52-73)

[124] I do not have the details of the codec used in the version I saw, or the make and model of the projector. However frame rates in digital projectors do exceed those of film, so visual information is unlikely to have been lost.

[125] Jonas Mekas quoted in Ibid

[126] As described to the author by Conrad, Tate Modern, London 2008.

creating an 'unexpected birth to a sense of aural vastness',[127] and is at heart a rapid, metronomic, clicking buzz, which over the length of the film is overlaid with itself at changing rates, producing an echo and phasing effect, in turn generating secondary pitches through harmonic interactions. The phasing is also audio-visual, since the sound's 'flicker' is a-synchronous to the image, inducing further dislocation, or perhaps enabling a sense of fluid proximity between the spectator and screen. Primarily though, the sound is strongly reminiscent of that made by a film projector, but transported through the electro-acoustic spaces being articulated by composers of the day across the U.S and Europe. If Steve Reich had made *Come Out*[128] using the sound of a 16mm projector for his source material instead of a voice, then something similar would have emerged...

In one sense, I am reiterating much of what Joseph has to say on *The Flicker*, in terms of the lines of power that reach through the work from Walter's book to the cinema's audience, and the nature of the sound track.[129] However, I do so in order to get to why the character of ostensibly similar works such as Sherwin's optical soundtrack films leave very different impressions when viewed. That Sherwin's *Railings*, *Musical stairs*, or *Cycles*, and others have emergent, notional 'surfaces' might be a simplistic way of putting it, but there is a strong sense of their possibility, and this possibility defocuses and refocuses as each event progresses within the film; progressions which adhere to strict temporal values.

That time within these films is rhythmically marked is a key attribute – to hear the films without their image is akin to listening to a sort of proto-industrial techno. Sherwin citing Kubelka's *Arnulf Rainer* as a formative influence is significant, since it was conceived not only as a distillation of cinema's primary materials – white light, and darkness, white noise and silence – it was also a structural re-articulation of twelve-tone music (Joseph is a little dismissive of the film, despite its apparent similarity to *The Flicker* – choosing to recall Conrad's characterisation of it as 'extending the infinitely anal art-style of Anton Webern into 'the cinema'')[130] and such, "Just as Webern reduced music and the interval to the single tone, so Kubelka reduced film to the film frame and the interval between two frames."[131] This 'pollution' of cinema seems conceptually an anathema to both Sitney and LeGrice's concepts of structural film, for different reasons respectively. It not only ruptures the hermetic barriers that a structural film ought to maintain, but distracts from the reflexivity that pertain to LeGrice's ideas. Sherwin, however, states that he has tried, and indeed still tries to aim for the condition of music with his films, and in this regard he has succeeded, but by employing simple frame-based 'counting' time structures rather than Viennese formality – demarcating the changing treatments of audio/visual materials with the projector's clock. However, rather than just considering these broader formal structural characteristics, we may find that at much smaller temporal values – at thresholds where the

[127] Joseph (2008:285)

[128] Considered to be a founding work in the American minimalist canon.

[129] There are other key players here that Joseph talks about, and that I have left out – Gysin, and particularly Burroughs.

[130] Conrad in Joseph (2008:292)

[131] Weibel, (2003)

perceived auditory visual begin to coalesce or smear discrete momentary events into the state of becoming continuity, pitches and movement – we can detect a further line of attraction between the works of Sherwin and Conrad.

The contiguous zones of tonal pitch and a consecutive repetition of events, or rather, their shared shifting and fluid boundary, has proved a fertile ground for exploration with Conrad. Beginning with the influence of Stockhausen, he would go on to collaborate with, among others, La Monte Young and John Cale, on works which explored the extremities of duration and volume, as well as the almost limitless microtonal tonalities afforded by the layering of pitches in 'just intonation' tunings:[132] 'Once Conrad and Cale were "inside" the dream syndicate, alternate tunings, in particular just intonation, would play a major part, as would the threshold relationships of pitch and rhythm, how and where the two phenomena might meld or transform into one another.'[133] It is within this fluid state that *The Flicker's* soundtrack operates; the rhythm, phasing and pitches of the output from Conrad's bespoke 'gizmo' all at once hovering between a procession of clicks within which one may discern much higher pitches, and an overarching buzzing pitch constituted of the clicks themselves. This peculiar threshold would similarly interest Sherwin, whose typically straightforward description indicates a move toward exploration of these in-between states:

> ... I knew about flicker and persistence of vision, at certain frame rates things would start to fuse together and that below that you get these separate visible pulses, and I knew that in a sense, sound does that too, because I had access to this vcs3 synthesizer and I knew that if you took a tone and you just dropped that lower and lower it would start to break up, and you'd think 'wow – sound is just clicks'. So I was curious about what this 'persistence of sound' threshold would be... so the way *Cycles* is organised, is it moves from these separate moments of sound and picture and moves through both of those thresholds...[134]

In his analysis of 'the sound of technology' with respect to film and its optical soundtrack, Andy Birtwistle brings together lines of association between the auditory event/pitch continuum and the 'optical rumble' or ground noise of the soundtrack. The image that constitutes the soundtrack's waveform is made of the same light sensitive emulsion as the frame of the film – and therefore possesses the same attributes of grain resolution (an indicator of the film's quality). Hence it is vulnerable to the same degradations as the image; scratches and abrasions in the emulsion pass by as clicks, pops and crackle, and experimenting with multiple exposures, solarisation, and other

[132] A system of tuning based around mathematical ratios, as distinct from equal temperament.
[133] Joseph (2008:72)
[134] Interview with Guy Sherwin, conducted by the author. 12/7/2010

interventions into printing processes produce audible results.

For Birtwistle, the 'basso continuo' or 'un-pitched drone' which constitutes the noise floor of the optical soundtrack is a signifier of the materiality of the film itself – and in this respect, he reiterates a more sound-oriented version of a central tenet of the structural/material film movement. The drone of the film's emulsion wells up out of the thousands upon thousands of silver halide grains passing under the photocell's eye as the soundtrack progresses. This mass of individual granular events – more demure than the hiss embedded in magnetic tape recording – is essentially the aural equivalent to the grain of the film's image.

Birtwistle points out that advances in photo-chemistry have, over many years, yielded less noise and an increased frequency bandwidth: 'According to Belton, the frequency range of sound on film in 1928-30 was approximately 100Hz to 4 kHz, but by 1938 this range had increased to 30Hz-10kHz'[135] and goes on to note that this change can be viewed according to the familiar trope in film theory, whereby the cinematic apparatus in its ideal form seeks to efface itself. Hence the contiguous states of singular event and pitch can be understood, within the auspices of micro events such as optical rumble, as a focussing in and out of the films material presence, where '...we move from sound to source, from material to meaning.';[136] and since Sherwin's optical sound experiments operate squarely within this domain (recall how this oscillation between the film's surface and the pro-filmic image occurs within *Railings*), it must surely be pertinent to allow them a conceptual grounding on this particular substrate. So it proves upon further listening – the roar of the film's materiality, or 'objecthood' often penetrates and suffuses Sherwin's sound events, eliding the boundaries between carrier and signal. This is particularly the case with *At the Academy*, where the introductory leader for a film, along with the test tones, is printed upon itself time and time again using different exposure methods – with the soundtrack subject to the same processes as the image.

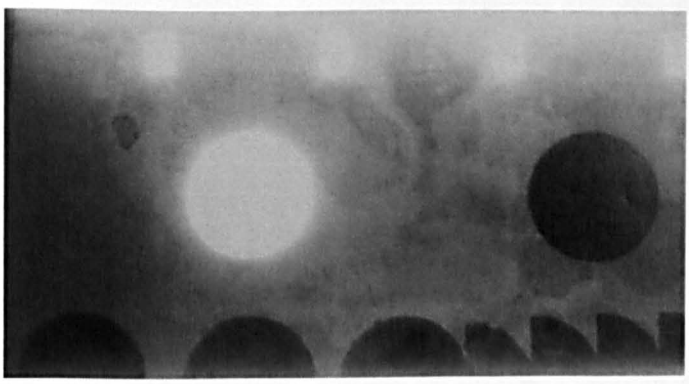


Figure 14
Photogram of a section of film strip from: Guy Sherwin (1972) *Cycles*.
The optical soundtrack runs along the bottom.
Courtesy The British Artists' Film and Video Study Collection

[135] Birtwistle (2010:89)
[136] Birtwistle (2010:91)

Comparing, then, the site of sound's operations in Sherwin's works to those of *The Flicker*, where Conrad's sense of 'aural vastness' pertains, we may further see how, despite the similarities between the two (especially *Cycles*), the soundtrack serves to place the works in rather different territories. In the attempted jettisoning of cinematic, or any other baggage from *The Flicker* – in its possible iterations in other modes of consumption, or subjection upon the spectator – the remaining materials of light (its purpose to be direct-injected) and sound (which comes pre-spatialised), bring about a diminution of the spectator's notional contact with the varieties of perceptual space available when artificial sound and image collide and interact. If indeed this work was intended to be fired into the central nervous system, then perhaps in contrast to Sherwin's work, any possible emergent haptic properties that Marks outlines are defused as well – since perception is strobed and echoed into something transparent to the film, the spectator is rendered perceptually 'skinless'.

We are within ourselves watching Sherwin; *The Flicker* cuts us adrift. Sherwin brings the spectator's perception to a meeting with the film, while Conrad fires his through it. In destabilising or even negating the distances and spaces that the film might occupy, as well as the cultural sites that it could operate within, *The Flicker* seeks to shrink the spectator back to within themselves, to leave nothing but their own pre-conscious ability (or otherwise) to deal with the materials they are being subjected to. To avail oneself of ideas concerning the nature of cinema's apparatus (as Conrad might wish us to do) under such conditions is perfectly possible – some might find the conditions soothing in the way that white noise can be, for example – but my own impression while watching The Flicker was one of a moment-to-moment zeroing of thought, or a becoming of forgetting, temporally locked to the film's will. Perhaps for some folks in New York, 1966, this was indeed worth running from.

Chapter 4:

Strategies for the Production of Sound from Light

In the three chapters that follow, I have attempted to corral my thoughts on photophonic sound production thematically, by articulating them alongside the physical processes that they relate to most closely. These processes are differentiated according to different spatial or mechanical themes – that is to say, they describe how modulations in light are produced in different ways, in order that those modulations may be turned into sound. These processes are not mutually exclusive to each other, can be combined in any number of ways, and indeed might be said to amount to the same thing in the end – flickering light shining into a sensor. To be clear, the photocell which engenders the photophonic transformation is indifferent to these things. It will just produce a voltage according to the amount of light that falls upon it. However, this output, and from there the sound that can be listened to, or recorded, is intimately acquainted with its luminous progenitor. If performed sensitively, these photophonic acts seemingly enable a peculiar form of eavesdropping to occur; the often invisible vibrations, occlusions, and flickering that take place may have an acoustic 'life' when amplified in air, but the signal present within the light itself is often, as I discuss below, of a particular character – neither quite natural nor electronic. Furthermore, with an example such as the Photophone, the processes occurring within the device are just a small part of a much larger story concerning the changes in thinking about how light and sound may act upon one another. As I will discuss, the normative regimes of seeing and hearing were (and perhaps still are) being contested, and in some cases reformulated in some small ways by the peculiar alchemy of photophonic sound production.

Each of these sections will also include details of the processes I describe, but from the context of my own practice. This integration of practicality and theorising has been essential in getting to grips with the issues I raise – whether it be through the use of systems designed and built by others, such as the ANS synthesizer, or through the building and use of them by myself, such as a version of A.A Michelson's interferometry experiments, but adapted to produce sound. Where such works have been unsuccessful, I have tried to examine what can be learned from such shortfalls – either as glimpses into historical events which relate to what I have attempted, or perhaps different theoretical perspectives.

Chapter 4.1:

Interference and Sonorous Surfaces

Long Strings, The Michelson Morley Experiment, Heterodyning and Emergent Audio-Visuality

> Vibrations in long strings are clearly visible. One can easily see the nodes and curves of the standing waves. Sound is translated directly into an image.[137]

A proposition: some wire, perhaps 10 metres long and made of high tensile steel, stretched across a space, made to vibrate. It can only be mechanically supported or attached by its ends or its nodes – the points at which it vibrates the least – resulting in loss of energy, especially if more than one or two harmonics are present, and the wire is supported between each. If a thin beam of light is shone across the wire, and then onto a photodiode, a corresponding, sonifiable signal will be generated. Using light to read these vibrations by means of reflection or occlusion enables us to tap into any length of any section of a wire – node or anti-node[138] – without subjecting it to mechanical inertia. Multiple points of scanning (or audition), can be selected and each in total isolation with respect to each other, so that complete control over these multiple signals can be sustained. Each signal might be thought of as listening to an isolated section of wire vibrating freely in space but in close proximity – the length of the section determined by the cross section dimensions of the emitted beam. Beams may be re-routed back across the wire using mirrors to superimpose one section upon another, collapsing it into the signal chain; each re-crossing of the light beam a fold in space. This may produce a form of amplitude modulation, taking each section of wire as a signal to be modulated by the next, with each stage being a synthesis of the proceeding ones.

The sonification of the encoded light can be performed at a displaced location depending on, for example, the sensitivity of the sensor, affording us numerous listening opportunities. We may exploit the acoustic characteristics of the space by placing our speakers at a distance, we may hide them elsewhere in the building, or surround the viewer/listener with multiple listening points along the wire they are watching as it sings; effectively folding it sonically around in a circle.

Complex and unknowable combinations of signal and feedback may be generated if the sounds produced by scanning the wire are fed mechanically back into it using a speaker driver, or solenoid. The proximity or otherwise of a driving sound source and the point of the wire from which its sound originates may have further consequences in terms of complexity and stability. Each part of the wire will only be able to listen to itself over the chatter of the other parts, with differing distances between sound and source making a clear chain of feedback either more or less

[137] Van Peer (1998:9)

[138] The points at which the wire vibrates the least and the most.

likely, and either reinforcing or undermining the stability of the wire's harmonics. Further opportunities for complexity may be introduced by modulating the light at source by altering its power supply with signals culled from the humming wire. Further reading of reflected instead of occluded light for turning into sound may produce phase differences in multiple angles from the same illuminated point of wire. The number of combinations, while not infinite, are staggeringly large.

What is heard? The wire may hum and buzz sonorously in the way that wires do, but the shimmering patches of light that carry its shadows produce abrasive distortion, even while possessing the variations associated with a vibrating mass under constantly changing demands. As with other photophonic systems (for example, optical soundtrack experiments in film), acoustic space within the signal is almost entirely absent, and a stroboscopic severity characterises the transformation, the string scraping over the edges of the photodiode's field of view, or the edges of the light beam as though it were a physical barrier – its exit and entry points in and out of the illuminated field physically protesting their breaching.

Paul Panhuysen is perhaps the long string instrument's most prolific exponent, having produced upwards of 200 site specific installations, each of which deal intimately with the acoustic architectures that they both generate and inhabit. The actuating force is Panhuysen himself, caressing the long wires with rosined fingers which generate longitudinal waves with complex overtones. He acts as a reading and writing device; a drifting point of contact or motile node, coaxing constant transformations in the harmonic relationships of the strings as he wanders down them in carefully graduated paces. Sound is somatically troublesome – both 'Out There' and 'In Here',[139] and it might be said of Panhuysen's fingertips that a canceling of these comings and goings occurs at their point of touch, since the skin's envelope by its very nature participates in both realms, albeit less complicatedly than the ear (the ear's tympanum is, lest we forget, a part of that envelope).

> *The 'Short String Instrument' I have built consists of a 2 metre length of softwood, approximately 50 by 30 millimetres in section, leaning against a wall. Down the length of this runs a copper wire, stretched between a wooden bridge at the top, with a speaker acting as a bridge at the bottom. I've hot-glued a rawl plug to the centre of the speaker to hold the wire. A laser points directly at the wire, and a photodiode reads the reflected light, which feeds to a small amplifier, which drives the speaker, which drives the wire...This instrument, or versions of it, has probably been built a*

[139] Despite the churnings of the great philosophical paper machine, one must ultimately defer to one's own experience. As I listen (I'm sitting in a café), the man sitting to my right's presentation of some business to his client is certainly over there, but I can situate it inside my head if I wish. There's no single position, it seems, that can't be surmounted with a little consideration, or imagination.

Figure 15
Interference fringes caused by the interection of a laser beam and wire. 2009.
Photo - the author

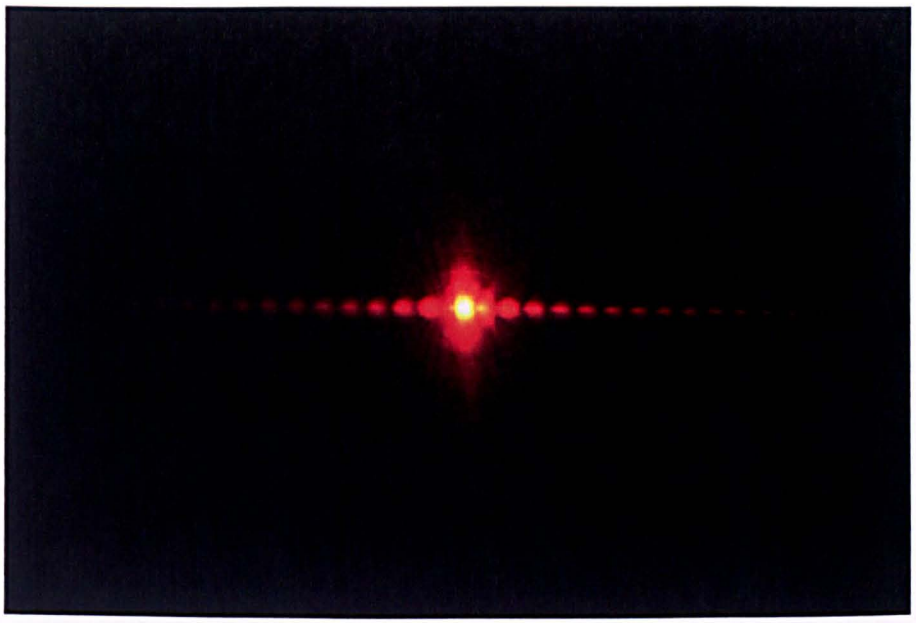


Figure 16
The Short String Instrument in situ, with amplifier in the foreground. 2009.
Photo - Will Scrimshaw

Figure 17
The *Short String Instrument's* laser and photodiode, with vibrating wire. 2009.
Photo - Danja Vassiliev

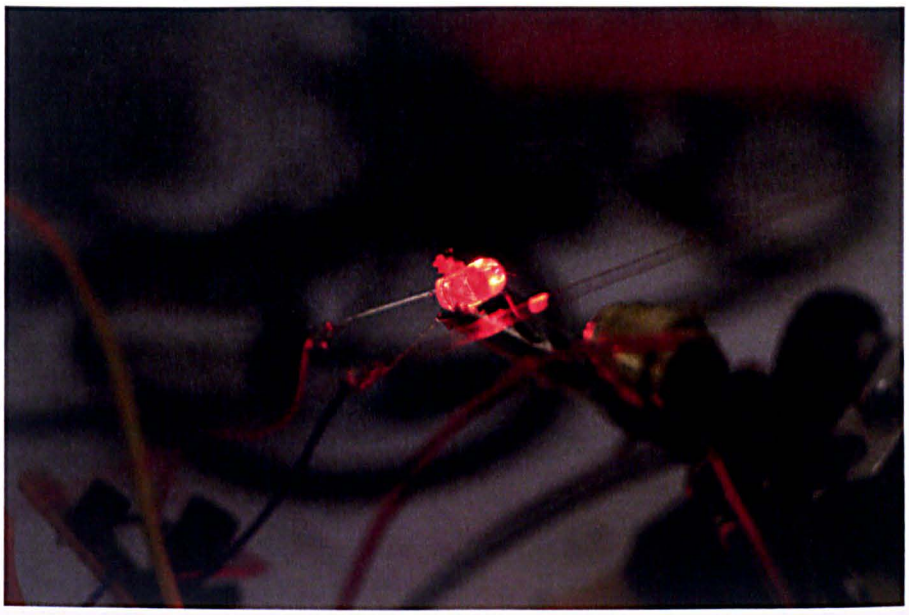
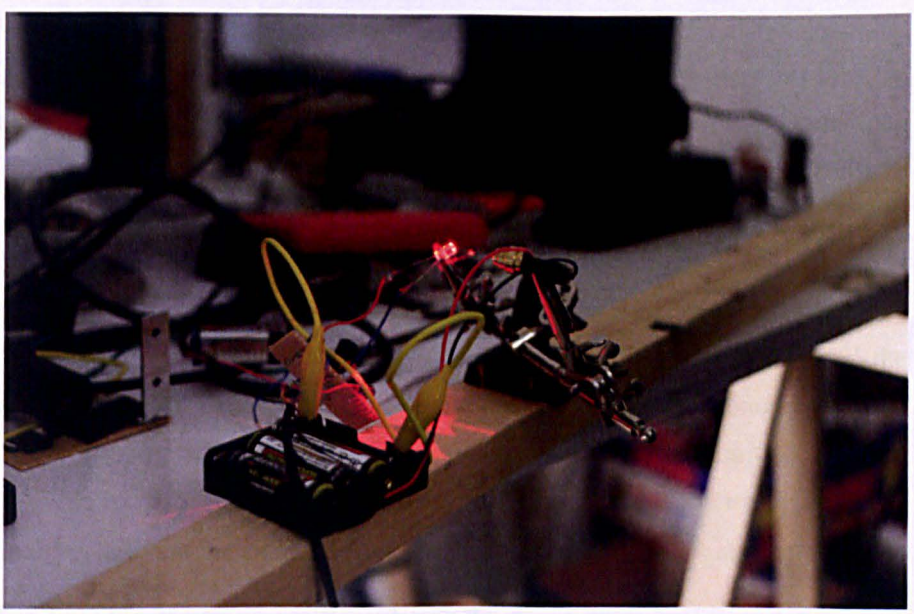


Figure 18
The *Short String Instrument's* power supply, amplifier circuit and connectors. 2009.
Photo - Danja Vassiliev



> *thousand times before by musicians and sound artists over the years (Alvin Lucier's 'Music on a Long Thin Wire' for example) – essentially a materially mediated electronic feedback loop. My modest version is the result of a hardware hacking workshop at Club Transmediale in Berlin, 2009. The old hospital where the workshop is being held is a variation on the classic European design of long corridors flanked by long rows of rooms on either side, and an idea was mooted to make use of these. So Alexei Blinov is standing at the other end of the corridor examining the pattern of the laser on the wall as I gently push the wire in and out of the laser's path. "There are circle patterns and dots!" I wander down and have a look myself, to find a beautiful set of diffraction fringes extending out either side of the laser's central bright beam, now much diverged. A quick online search reveals that I have produced a variation on single slit diffraction – it seems that the process can be reversed out, so that instead of an aperture (slit), an obstacle will do the same job (wire). I have stumbled across an easy way to generate a regular pattern for scanning.*[140] (Figures 15 - 18)

The piece I have described here was rebuilt on a subsequent occasion under somewhat different circumstances; at a residency at PVA Medialab in Bridport, in March 2010. The wire was increased in length to around 8 metres, and mounted horizontally across wooden trestles which I constructed especially for the purpose. The sound source driving the wire took the form of a cheap home hi-fi speaker with a 16mm film tin lid placed over the top to act as a bridge and resonator, which added complexity to the system, as well as a harsh, metallic timbre to the sound. A piezoelectric transducer acted as a pickup at the opposite end of the wire, feeding the signal back to the speaker via an old hi-fi amplifier. The multiple, cheap, Chinese laser pointers I had ordered for the work, contained batteries which lasted less than two or three minutes before running down, so I resorted to two older lasers I had brought along, which worked fine, but meant that I had only two scanning points instead of six; the wire would only be folded into two on this occasion. (Figures 19 & 20)

In order that this instrument (called *Long String Instrument*), and its particular outputs might be properly, but also creatively documented, I shot and edited a short video, *Wire Lights*,[141] for a presentation at the end of the residency. The sound on this video is a mixture of the modulated light produced by the lasers and wire, and the feedback signal between the piezo pickup and the speaker at the other end. The intention here was to concentrate on the point of interference between the laser and the wire, highlighting this point of deferred contact, and the concomitant sound it produced, but careful viewing of the film reveals a deeper interaction between the materials being captured, and the device they are captured on. The action of laser light directed straight into the

[140] Author's personal sketchbook entry. See accompanying DVD: *Short String Instrument*
[141] See accompanying DVD: *Wire Lights*

Figure 19
View of *Long String Instrument* at PVA medialabs. 2010.
Photo - the author.

Figure 20
The *Long String Instrument's* improvised speaker/film can bridge. 2010.
Photo - the author.

camera generates unpredictable textured flashes of crimson, occasionally shot through with regular dark bands in close formation, which having not come from the laser on its own, would seemingly be interference patterns – either within the lens configuration, or the sensor itself (figure 21). More unexpected than this, however, is the presence of blue lens-flare (distinctly unlikely from a light source that supposedly contains a very narrow bandwidth of red light), which when formed by the laser unmediated, presents itself as continuous vertical blue bands, but when formed by light reflected from the vibrating wire, becomes a discontinuous flickering – discrete packets of colour traveling rapidly from a central source (figure 22). This difference in form between the two – continuous/static from direct light, and discontinuous/mobile from the reflected light is significant on several levels, and combined with the interference pattern seemingly attributable to laser light within the lenses, has three implications. Firstly, and most simply, it is an articulation of the mechanics of the camera that the video was shot on, since the discontinuity in the reflected lens-flare seems likely to be an interference, or heterodyne pattern caused by the wire's vibration (and hence the light's) interacting with the scan function of the camera's sensor. Secondly, these interactions complicate the status of the video itself, since rather than performing the function of a (somewhat artfully shot) documentation of a temporary installation/instrument, it becomes hybridised as also a component of the installation; structurally implicated in the work, through the camera's readable self-inscription in the image. The third implication is to open the video (and hence to some extent the installation) out to more structural/material interpretations. Specifically it suggests a look at how beat frequencies, or heterodyning might be made use of.

In the previous chapter, I examined how the possibility of 'haptic vision' operated within certain works of Guy Sherwin, and how it could be thought of as emergent from the image/soundtrack interactions particular to optical sound experiments within the 16mm film medium. The trope of emergence – that a property not specifically present within a moving image may arise from a combination of events over time – is well established in writings on experimental moving image, and the model of the interference pattern, or heterodyne has proved a useful one when articulating a mechanism as to how emergence may operate within these contexts. Paul Sharits – who made a (colour) flicker film entitled *Ray Gun Virus* independently, simultaneously, and without knowledge of Conrad's *The Flicker* – eventually came to a conceptual use of the heterodyne as a way of considering how the complex effects sometimes induced by his films seemed to arise out of the most basic of materials (frames of solid colour, the rapid rumbling thuds of sprocket holes passing the optical sound head). Sharits produced a succession of 'flicker' films from 1965, which as a body of work could be said to have grappled extensively with many of the preoccupations of the structural film canon.[142] Specifically for us here, he outlines two models of

[142] A full examination of Sharits's work lies outside of the scope of this writing. He theorised extensively on his own films – for an account of his concept of overtones see Sharits (1978). For a more detailed chronological overview of much of his career, see Windhausen (2008)

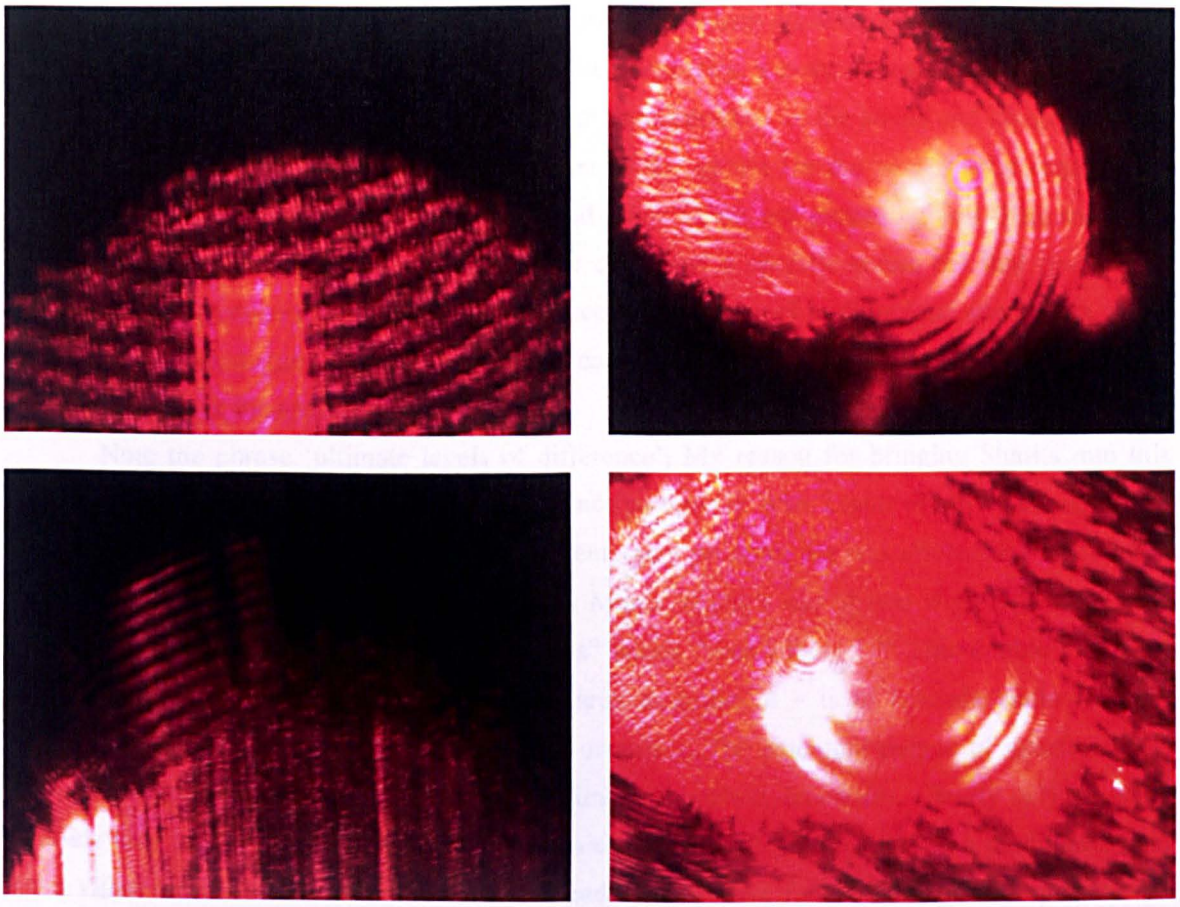


Figure 21
Rob Mullender - *Wire Lights*. 2010.
Interference patterns in laser light.

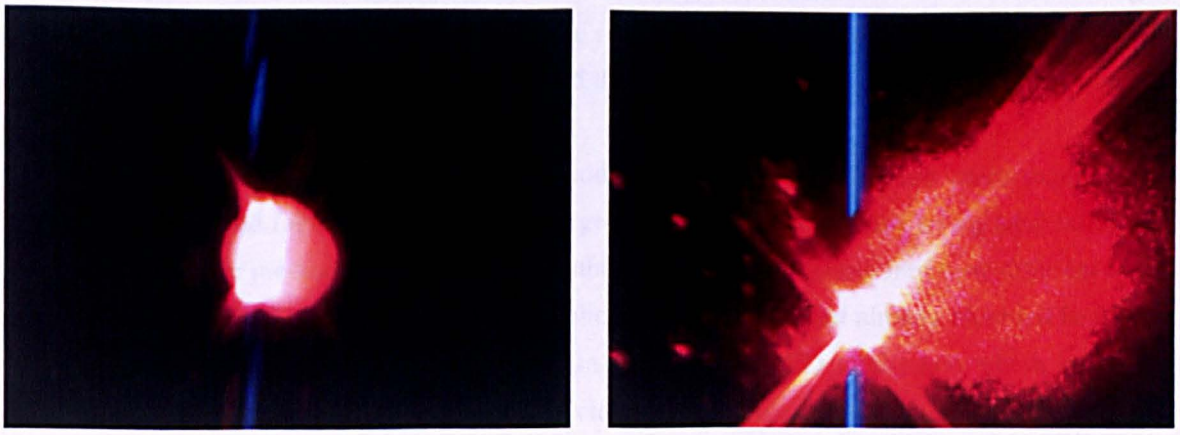


Figure 22
Rob Mullender - *Wire Lights*. 2010.
Vibrating and continuous lens flare.

heterodyning he considers apparent within his work – one which accounts for purely optical effects within the eye and brain of the spectator, but more pertinently, a more abstract notion of emergent audiovisuality is also asserted, which derives from the interaction of the sound and image tracks. It was clear to Sharits that the putative unification of the senses (in the synaesthetic regard) that experimental film ostensibly offered was a blind alley: 'I am not proposing that there exist any direct correspondences between, say, a specific color and a specific sound but that operational analogues can be constructed between ways of seeing and ways of hearing (and sometimes, when such structural analogues are composed, one can thereby experience those levels of ultimate difference between the two systems).'[143]

Note the phrase 'ultimate levels of difference'. My reason for bringing Sharits into this discussion, is in part to suggest that the interference patterns in Wire Lights might be thought of as analogous to his notion of audio-visuality as an emergent property. He was effectively '...trying to generate the sort of thing which happens in La Monte Young's use of two slightly out of phase "continuous" sine tones where you hear "pulses" which "aren't there"'[144] This double switch of meaning – of inducing the non-existent as Sharits describes it – is to concede audio-visuality (within this context) to a condition of collapse, or nullity. The emergent pattern of interference is ultimately only known to the spectator, and is time and context dependent. Clearly only so many parallels may be drawn between phenomena which exist as interactions between modulated light and a video camera's sensor on the one hand, and the cognitive functions of gallery spectator on the other. But in both cases, the respective combinations and devices and their strategies for dealing with sound and image can again be considered as material demonstrations of the gulf between seeing and hearing – a gulf articulated by the beat frequency caused my their immiscibility. In the video camera's inadvertent revealing of modulations in reflected laser light, there hovers an artefact which is necessarily time related, and in its un-sonified, un-video-recorded reality, unperceivable. In this way, the signal and the devices or system used for its generation and capture are inseparable.

This interaction between sensor and modulated light source is even more explicit in a video which I entitled *Light Trap,*[145] which emerged again by accident while trying (and failing) to document a specific method of photophonic synthesis. When researching into how different kinds of thermal convection in air might be recorded photophonically – I had already recorded heat haze modulating sunlight – I set up a light source (in this case an LED torch) into which would be pumped an audio signal, and having mounted a video camera on a tripod some three metres away, built a fire in between the two. The intention was that the heat haze from the fire would cause additional modulations in the light source from the torch by virtue of a dynamic refraction process

[143] Sharits (1978:256)

[144] Sharits in Windhausen (2008:128)

[145] See accompanying DVD: *Light Trap*

– effectively a variety of synthesis – which I would record on a photo-voltaic cell plugged into the video camera's microphone socket (my standard method for recording most of the sound on the video works which appear in this research). Frustratingly this proved elusive, simply because the lightest breeze sent the heat from the fire away from the direct path between light source and camera/photocell, and despite my choosing a cold, still night to try this experiment, the air wasn't still enough. While repositioning the camera to try and get the angle I needed, I noticed that when the camera was at a certain angle, the lens flare produced contained oscillating dark bands which fluctuated according to the changing audio frequencies being pumped into the torch, altering their number, speed and distribution in accordance with the 'sound' being captured on the photocell.

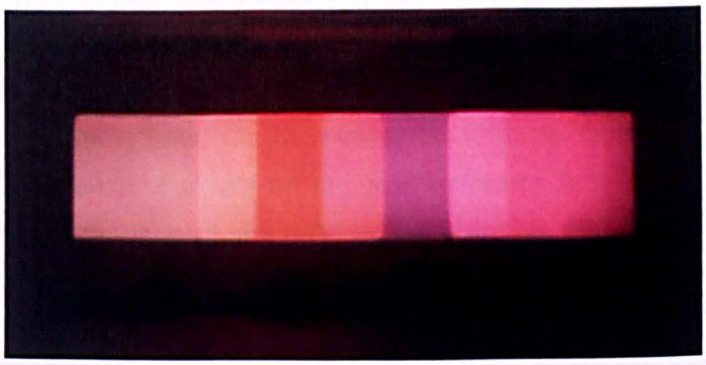


Figure 23
Paul Sharits (1975) *Shutter Interface*
Artforumint (2009)

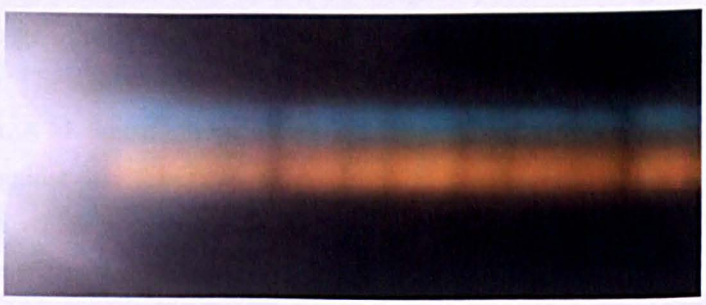


Figure 24
Rob Mullender (2009) *Light Trap*
Lens flare detail

Perhaps it is fitting then that viewing online footage of Paul Sharits's *Shutter Interface* – an expanded film installation of four 'flicker' projections overlapping (Figure 22) – and comparing it with *Light Trap's* heterodyning lens flare (Figure 23), there seem to be resonances between the two images (although not the sound, which in Sharits's installation consists of a torrent of short bleeps - one for every frame projected on each of the films). The two types of heterodyning here are of course of different orders - one metaphorical and psychological, and one technical and structural (this concept, it's fair to say, also being the shared territories of the two). Sharits's films interact

and interfere in unpredictable and satisfying combinations, reminding the spectator of their position in the work, and the role of their senses in its making; the camera's sensor reminds us of its role in the existance of the peculiar lens-flare artifacts in the video it produces. We may infer a mirroring occurring between the two forms – the camera's sensor is re-figured as a screen for the light source to project onto; a membrane for the image to be viewed on the reverse, and a notional delegation of the act of seeing. The heterodyne, or beat frequency can perhaps, then, be understood as a sensitization, or explication of mediation through difference (the phenomena is also known as 'difference tones') – enabling the apprehension of two modulated or vibrating states (the light, the camera) through a third, which paradoxically exists in neither, but which cannot exist without both. The shifting bands of dark and light are a reminder both of our sensory limits, and the fecundity of imagination.

It is unwise to stare into a laser, no matter how weak. Even if we were to do so, putting ourselves in the position of the sensor would be futile. To observe, we must rely on projection – upon the virtual image articulated into a real one by a surface. The surface that diffracted laser light illuminates is both an explication and a cessation of events for the observer/hearer. Interference patterns projected onto a surface so that they can be seen, are reflected and therefore thrown into relative diffusion, or indeed confusion. At all points between the beam's point of departure from the diffracting object, and the surface which it is called upon to display itself, interference – nullity and increase in equal measure – happens. This striation of space, an energetic pattern fanning out from a point source, can surely be put to good use, set relatively in motion with respect to a sensor, to become a component of an oscillator. The use of light's wave properties to produce interference patterns was famously made use of by A. A Michelson in his series of 'Aether Drift' experiments in the late 19th century, pitting light against itself to detect the Earth's movement through a theoretical and undetectable medium in which it propagated; thereby proving or disproving that medium's existence. The details of these experiments, and their impact are well covered in writing on the history of science, since the results from them indirectly but crucially contributed to the work of Lorentz, Poincaré and Einstein. However, the Michelson Interferometer, as it has become known, is of interest here, simply because of a different near miss. The Aether Drift experiments were also fascinating, since their side effects, faults, or de-tunings might have been seen as positive phenomena if understood in the realm of the auditory, rather than the visual.

This shift in thinking emerges as a plausible alternative history, simply because of the presence of Alexander Graham Bell, who at the same time had been applying himself to the problem of how light could be used to transmit speech, and who was to arrange the funds for Michelson's Potsdam and Berlin interferometry work. Historians such as Sterne, and Hankins and

Silverman have demonstrated that the definitions and functions of apparatuses which manipulated energies from various mediums for the purposes of communication, recording and measurement, were contested and fluid.[146] The boundaries between, for example, a scientific experiment and a communications medium were only negotiated through the interactions and effects of numerous economic and social forces, and Bell, as an entrepreneur and inventor, worked at the nexus of all of these. The short text that follows is informed partly from my own work producing audio from interferometry, and the descriptions of the sounds produced are an amplified statement – an expression of the potential contained within the conjoining of these apparatuses...

A corridor in an educational institute, early summer, Cleveland Ohio. High vaulted ceilings, the walls a gloss powder blue, the utilitarian woodwork an old white. Off to one side at the south end, a stone staircase with wrought iron balustrade (candy twist) disappears up to a distant first floor. Further up still, the stairs default to pitch pine. Tucked around the side of the stonework is a paneled door – domestic in its aspect – ajar by perhaps enough to spill cool air, tinged with a whiff of mould in lime mortar onto the tiled floor. Unsurprising sounds reverberate quietly; footsteps, doors closing, a distant conversation. It is warm.

Alexander Graham Bell arrives at the basement door, carrying a large brown case, out of which dangles a silk bow-tie with a lurid polka-dot pattern in maroon and yellow. To the casual glance, the case appears to be made of leather, with patinated brass corner protectors and rivets, but upon closer inspection reveals itself to be of a loosely woven cloth set in a translucent brown resinous material, now bathed in sunlight flooding in from two arched windows set high in the wall of the corridor behind. There is no structural stitching or seam work on the case – it appears to have been cast, or milled from a solid block of composite. In certain places, the cloth breaches the boundaries of its plastic medium, breaking out in tiny regular tufts of dirty white.

A slight creak is heard as the handle of the case protests gently, followed by footsteps as, after a pause, Bell disappears into the gloom; the sound of Bell descending the stone steps goes on slightly too long.

Presently, in a brick basement with a compacted earth floor, Michelson and Morley watch as Bell circles the experiment with a look of studied interest. A large square block of carefully cut stone sits atop the black collar of a circular iron trough; this in turn supported by an octagonal brick pier squatting directly on the earth. On the circumference of the trough are

[146] See Hankins and Silverman (1999) and Sterne (2006)

numbered marks, just visible in the half-light... and then we see: the whole monolith is revolving almost imperceptibly. An array of small mirrors on brass mounts reflect a zigzag network of pencil-thin light beams across the revolving stone's top, terminating in a bright spot upon the wall, augmenting the sunlight struggling through the thick glass cellar lights over to one side, scanning the dank brick in slow scintillation. Tiny screws are adjusted, breath is held. Distantly, unknowably, the Cuyahoga rumbles and resonates against its banks.

Bell stalks deliberately around the room as silently as he can, watched expectantly by the two scientists. They are dressed in formal attire, standing in opposite corners of the room, hands stiffly at their sides. In time, the case is laid on the floor next to a chair, knurled thumb-wheels are turned, latches sprung. Footsteps pass overhead, knocking dully across the low vaulted ceiling – the processional bright spot shimmers in response, and the camera follows the sound invisibly, tracking someone who may not know what goes on beneath their feet. With a glance at Michelson, and then Morley, Bell opens the case to reveal a number of instruments, ensconced in a lurid maroon and yellow plaid cushioned setting. Two lenses, a heavy brass rod, and a length of gutta-percha tubing, in the disposition of a smiling face gaze out at the ceiling. The bow-tie drops on the floor, an aroma of phenolic resin is detectable. Bell perches on the chair, and with a flourish, lifts the brass rod and places it upright on his knee. At its base is a curved plate for this purpose. Next is one of the lenses, which upon extraction reveals itself to be a cylindrical capsule with a thick lens in one end, which Bell screws on top of the brass rod so that it looks out into the room. Finally, the tubing is attached to the back of the capsule. Bell articulates the capsule with his left hand, roving it to and fro like an eye, and points the other end of the tube out into the room with his other, in sock-puppet fashion. The proffered end is vaguely trumpet shaped and in the dim light, it is just possible to see red paint, cracked and flaking around the mouth...

The scientists exchange looks, and in time the bright spot, perhaps a quarter inch in diameter, makes its way round to an expectant Bell, scanning slowly across his shoulder...collar. It drifts upon the capsule and immediately the sound of what seems like a swollen stream, or even waves upon a seashore issues from the mouth of the apparatus perched on Bell's knee – quiet, but clear. The scientists start as if from a trance and gingerly make their way over to Bell, each delicate footfall's vibration crunching from the tube as if a foley artist had them stalking on snow. Bell tracks the orbiting light in squatting position as the monolith revolves; the antenna tunes. Rumbling, swooshing, inexplicable clattering. Footsteps ringing like dull bells from across the building, and much further. Distant shouts, buzzing, horses

> hooves as if filtered through torrential rain, subterranean hums, the Earth, and the chthonic sighing of the dead. All break like waves upon the luminous network, as if heard from the dome of the sky itself, and all speak from the rubber eosophagus...The three men, enraptured, listen long into the evening.

In this short tale, events and possibilities are deliberately conjoined and convolved, apparatus altered, energies amplified. Bell's Photophone is of the photoacoustic, rather than selenium/electrical variety – not sensitive enough under these conditions.[147] The basement laboratory becomes a navigation space; an act of orientation through listening. Albert A Michelson's daughter and sole biographer wrote of his Naval service: 'During the quiet evenings while he had the watch, he had ample opportunity to reflect and wonder about the motion of the ship as she glided noiselessly through the waters of the Caribbean...he began to consider whether, when he was relieved and returned to his quarters below decks, there was any way to determine the ship's motion...Michelson found it disturbing not to be able to tell where the ship was going, and it was always a satisfaction to emerge from the cabin to see the night's progress written into the ship's log.'[148] This illusion of stasis, or isolation from a greater dynamic of flow and relative motion would be addressed by Michelson on a planetary scale.

The Aether Drift experiment represented the ultimate in Earth-bound isolation, in an attempt to provide proof of a much greater communication; between light and the corporeal universe with which it interacts. Perhaps never before had a system of such sensitivity been constructed, to be then laboriously made so insensible to everything, except a supposed relative motion; so sensitive that the apparatus took a full two years to build and tune. Michelson had previously developed a version of his 'Interferential Refractometer' in the basement of the University of Berlin, but this attempt was beset with problems. The apparatus worked very simply, by splitting a beam of light in half to form two paths, and then recombining them to interfere with each other. An interference pattern of concentric circular dark and light bands, or 'fringes' (the same in principle to the laser pattern derived from the wire instrument I mentioned above) would be observable under ideal conditions. The difficulties arose because any change in length of the beam paths equivalent to a wavelength of visible light or more – a few hundred nanometers – would produce disturbances in the interference pattern.

He wrote: 'In the first experiment one of the principle difficulties was that of revolving the

[147] The significance of this distinction will be explained in the following section- 'Signals from Nature'; suffice to say that for the photoacoustic effect to be audible under these conditions would require strong sunlight.

[148] Livingston Michelson (1973:39-40)

apparatus without producing distortion; and the other was its extreme sensitiveness to vibration. This was so great that it was impossible to see the interference fringes except at brief intervals when working in the city, even at two o'clock in the morning.'[149] Michelson retreated to the observatory at Potsdam, some thirty miles away, which proved sufficiently silent for the most part: 'Here, the fringes under ordinary circumstances were sufficiently quiet to measure, but so extraordinarily sensitive was the instrument, that the stamping on the pavement about 100 meters from the observatory made the fringes disappear entirely!'[150]

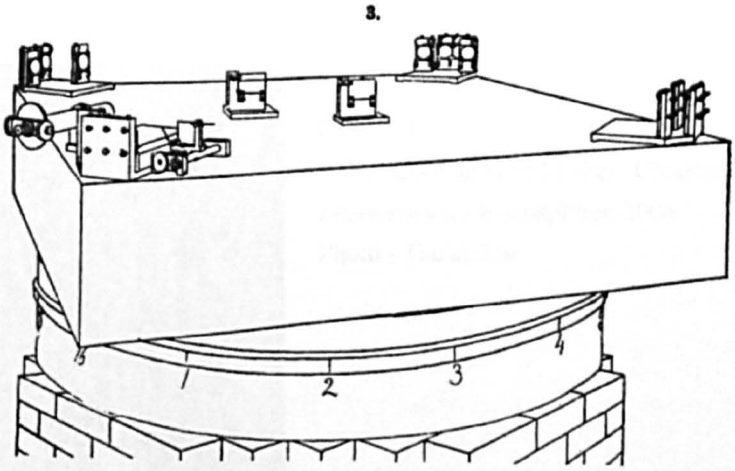


Figure 25
The Michelson-Morley experiment.
Michelson (1887)

Some time later, Michelson and Morley repeated the experiment again in Cleveland using much longer beam-paths for greatly increased sensitivity, which called for much greater isolation from vibration; the arrangement of the massive stone (which floated on mercury contained within the iron trough) was the engineering solution to these difficulties of overhearing encountered with the previous apparatus (Figure 25). It was as though the Berlin experiment – made possible due to funds secured from the Volta Foundation by Alexander Graham Bell – was being drowned out by a society that it was meant to enlighten. Had Michelson, like Bell before him, employed a Selenium 'ear' instead of his measuring eye, he would have discovered that the 'disappeared' interference fringes were not lost – just hidden by velocity and the eye's flicker threshold; that they had been rendered into an optical soundtrack carrying the subterranean rumble of mechanically transmitted sound. He may have found himself ensconced in a surveillance hide-out; albeit one that co-opted the building he made his measurements in as a listening device. When eventually rendered deaf by mechanical isolation in Cleveland a few years later, this device would eventually contribute to the

[149] Michelson & Morley (1887:336).
[150] Michelson and Morely, quoted In: Livingston Michelson (1973:78-79).

onset of a revolution in Physics and Astronomy. David Park notes that Michelson died still believing in his 'beloved ether', despite a lifetime of negative results from his careful interferometry experiments:

> 'They were dismayed and astonished. The great experiment had failed. It is a rare thing when the Lord bends down and speaks to his children, but on this occasion he did. Clothing his word in the language of nature, he told those two men that they had blown the ether away; but they didn't hear him.'[151]

Figure 26
Rob Mullender with Mathew Chadwick
Interferometer beamsplitter. 2006
Photo - The author

In 2003, I made my first recordings on an interferometer (cruciform in shape, and based loosely on Michelson's first Berlin experiment) that I had built in collaboration with Mathew Chadwick, a computer physicist, now based in Sydney (Figure 26, and accompanying DVD: *Interferometer)* After several conversations about how light might produce sound, it was agreed that we might be able to hear the shifts in the interference fringes that were happening in one that he had built before, but at too rapid a rate to be visible; so after crudely cobbling together a meccano version, I made another. That these movements in the striped pattern that the apparatus made were present at all was as a result of bad construction; I had neither the time, patience, equipment, nor funds to build an interferometer which worked in the way it was supposed to, and this malfunction is chiefly what links this effort to Michelson's first apparatus.

The ideal interferometer (like, we are told, the ideal audio/visual apparatus) is an effacement of itself; the luminous patterns that constitute its output are the data to be studied, and the materials of the apparatus are significant only insofar as in their attributes of stability and

[151] Park (1997:295)

reliability, they enable themselves to be *invisible to the signal*. The use of listening in interferometry, at least within this context, represents an admission of previously unwanted or extraneous energy into the optical domain, and further to that, an inclusion of materiality through the effects of contact and vibration; the apparatus becomes itself, or is materialised through the pollution of noise and the act of listening. Thermal noise within air and on the surface of mirrors, the bodily sounds of the listener, and the creaking of components heating and cooling can be heard under the right conditions. Both distant and proximal sounds are all herded through the same narrow aperture of coherent red laser light, compressed within the matching intensities of interference fringes; and hence, equal prominence is afforded to each. This drawing in of the world, through the averaging intensity of light and vibration, is simultaneously an auditory flattening of space, and a projection through listening out into space of the perception of the listener, in an act of quasi-haptic exchange.

The extreme sensitivity of this apparatus when adapted for audio renders it un-amplifiable in anything like close proximity, since to do otherwise produces instantaneous and overwhelming feedback. All acts of listening must be performed on closed-back headphones; the sensitivity and mode of listening engendering a sense of eavesdropping on normally sub-audible events. Furthermore, the dimensions and constituent parts of such a system can be understood as essentially open and flexible. For example a distant domestic window might stand in for a laboratory mirror, thereby incorporating something ordinarily considered to be a demarcation of

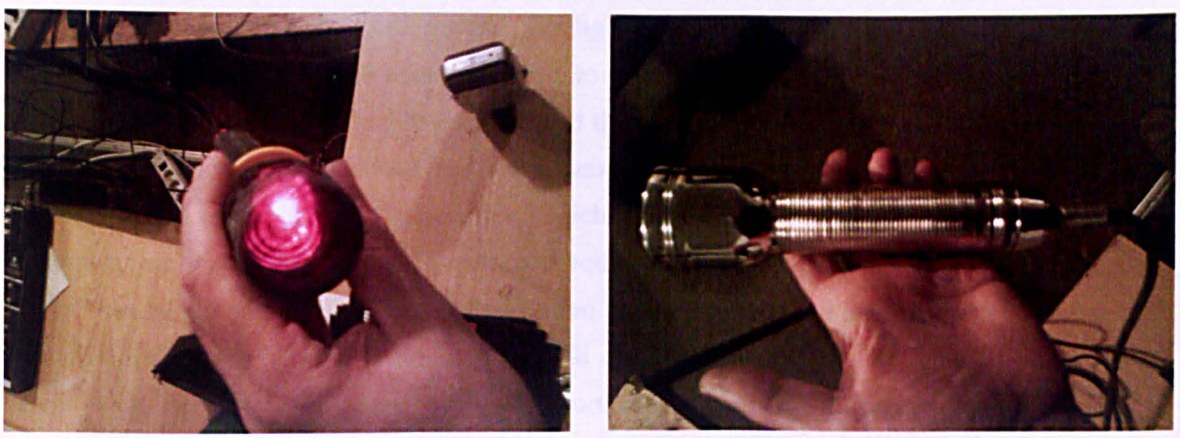


Figure 27
Transmitter and receiver units (made from torches) for Andrei Smirnov's laser bugging system. 2009.
Photo - The author.

private acoustic space, into a component designed for compromising that privacy through listening in. If correctly aligned, one beam path – a single reflection – is in fact all that is necessary for this reversal of power; the acoustic on the other side of the glass is brought directly into the listening 'eye' of the eavesdropper's equipment. This technique was developed by Leon Theremin in the 1940's, and wielded against the American embassy in Moscow to great effect – one problem, however, being that microwaves were used in order that the process remain visually undetectable, causing illness amongst the embassy staff. This was only alleviated when the NKVD[152] moved to an infra-red system – still invisible, but without the cooking.

At the Thermin Centre in Moscow, Andrei Smirnov has developed a sonified interferometry system along these lines as sound art – generating complex and subtle drones using lasers and photodiode sensors built into torches (in an interesting semiotic mix - Figure 27), and amplifying them through especially built heterodyne circuits to try and prevent unwanted feedback problems. In public performances of his system, Smirnov sometimes even uses a window (another inversion) to reflect the listening beams, presumably in a nod to the origins of this peculiar hybrid of technologies; a hybrid which arrived a little later than it would have, if Bell and Michelson had collaborated.

We begin, then, to see here ways in which light can seemingly collapse distance in the auditory, even while it is maintained in the visual. The dynamic, fluid striation of a volume of space with an instantaneously transmitted luminous pattern in effect sensitises that volume instrumentally, or makes it available to the photocell in the audible signal chain, which may be placed anywhere within it. Furthermore, the light used to transport vibrations in this way is unaffected, in perceived spatio-acoustic terms, to the air through which it passes;[153] the sound is about contact – between listened-to surfaces and the listener. As we saw in the chapter concerning certain experimental film practices, this haptic sensibility consists of a blend of mediation through devices, and creation through perception. Michelson and Bell might have understood these principles, but it was Bell who both occupied both the position outside strict scientific discourse, and possessed the imagination that seemed often to pertain to media entrepreneurs of his era, to convolve seeing and hearing in this way. I will discuss Bell and his Photophone in more detail below, including what I consider to be its importance with respect to certain modern day sound practices, not least my own.

[152] The People's Ministry Of Internal Affairs, later to become the KGB.

[153] The volume of air does not articulate itself spatially. However it makes itself known in other ways, as I go on to discuss.

Chapter 4.2:

Signals From Nature

The Photophone, the Eidophone, and Tuning Out the Human.

That light can carry sound across considerable distances is still an esoteric fact. Not only are electromagnetic communications generally invisible, but where light is used to communicate at a distance, it is kept to what it supposedly does best – images. In this way, photophonic signals can be dual-register phenomena; an electrical shop-sign carries its visual message, and if sonified, an auditory one as well – the crackle of neon, or the shriek and buzz of LEDs. It is when a perceived image becomes perceived as causal to a sound, that the interplay between the two becomes bound up with materiality – and so touch becomes emergent through sound's unexpected alignment with visual fixity and solidity; a suggested material bond holding together the chain of sonification. In early 20th century experiments involving the optical film soundtrack, photophonic recording's folding together of recorded sound with image sublimated this solidity by removing the need for surface contact with sensing devices as it was read. Instead of indentations in wax, photo-chemical encoding of amplitudes as two dimensional forms made their presence felt as sculpting mechanisms working upon light (the earliest known recordings of sound were committed to daguerreotype by Arthur Morin in 1841, by way of reflecting light from a small mirror attached to a vibrating rubber diaphragm.)[154] Upon playback, the contact with surface was in a sense deferred – sublimated into the signal and sent to the sensor, to be reified within the consciousness of the listener as a quasi-haptic suggestion of materiality through sound...

> The exterior of a large Georgian terrace house in Islington, London – an orphanage and the home of Margaret Watts-Hughes. It is a warm, bright afternoon. Alexander Graham Bell walks up the short path from the street to the door, the patterned terra-cotta tiles rocking loose under his feet. The house is in poor repair, but tended to. Cracked putty around clean windows, cobwebs swept from graying lime-washed stucco, peeling paint. Airborne soot and smoke have taken their toll upon the brickwork and bestowed upon the façade a grey patina. Bell's gaze is fixed upon these windows as he approaches the front door, with measured, deliberate steps, before operating the recessed iron bell-pull. The brass fittings on the door are shined, except for verdigris and polish impacted into the slotted heads of screws.
>
> The sound of the bell from within the house is soon followed by quick staccato footsteps, and the door (which sticks in its frame) is rattled open by a neat, intense looking

[154] Hecht, H (date unknown:1)

woman of small stature, in her late middle-age. After an exchange of greetings, Bell is invited in – he is expected. Inside, despite the bright autumn sun, it is dim. Along the hallway of the house and up the stairs are stood perhaps twenty children with their backs to the walls, all boys, and of various ages – their clothes plain and in some disrepair but clean. All are barefoot. Hat in hand, he acknowledges the faces turned toward him before being led into the reception room with windows facing out onto the street. Irregularly, carts clatter past.

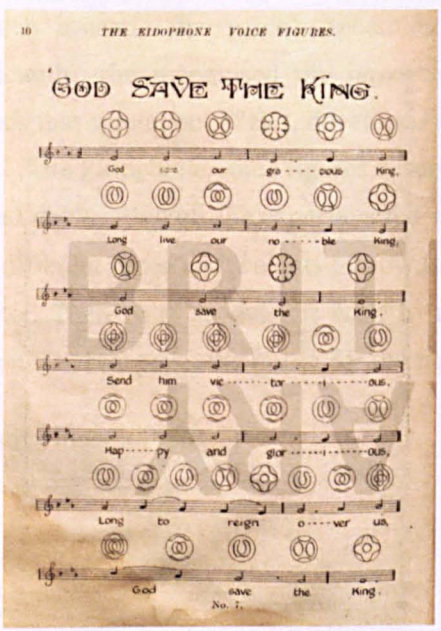
The room is sparsely furnished, with dining chairs arranged evenly against the furniture rail, and two portraits hanging above the fireplace. A harmonium occupies one corner, sheets of music arranged neatly across its lid, and on small shelves to one side. A large rectangular oak table with ornately carved legs and stays occupies the bulk of the frayed red carpet in the centre of a dark wooden floor, indentations marking the mis-registering of its legs from previous positions. Upon it are arranged what appear to be various inverted, brightly polished brass goblets, only appended with oddly angled nose-like spouts, rubber tubes attached to the ends. The tubes each terminate in a simulacrum of a mouth, widening out to an oval shaped funnel, lips painted a blood red – now cracked through the paint's inflexibility. Next to these lie a neat stack of rectangular glass plates, separated by paper, and accompanied by various clear glass jars of pastes, coloured with inks – concentrated and dark – along with artist's brushes, cloths and papers.

The powder blue walls and ceiling of the room are ablaze with coloured light, since rather than any curtains at the windows, there hang instead more rectangular glass plates similar to those on the table, all seemingly supporting or depicting various natural forms in luminous hues. Coral formations, arborescent feelers, complex floral arrangements, what might be cross-sections of finely stratified mineral deposits, others seemingly depicting trees within a landscape – all cast garish chiaroscuro around the walls. Bell, Watts-Hughes, and the gathering group of boys filing into the room stand around the table and eye the apparatus there. At some unnoticed signal, one of the boys sits at the harmonium and waits, as Watts-Hughes picks up a brass container, turning it over to reveal that instead of an open end, a brown gutta-percha membrane is stretched across, stained with the residue of various colours, and secured with a brass ring and thumb-screw in a similar fashion to an embroidery hoop. A jar is relieved of its ground-glass stopper and some thick red paste applied to the centre of the rubber, before being spread around into a more even covering, and a glass plate removed from its position atop the pile is placed gently upon the top. The rubber is slightly recessed, and so the ink does not spread out on the glass; it sits just below it in readiness...

Watts-Hughes nods to the expectant harmonium player, and presently a note drifts into the brightly lit chamber, hesitant at first, and unaccompanied except for the swish and

gentle creak of leather bellows. She lifts the tube to the brass apparatus, placing its spout over her mouth as she emits a strong and purposeful 'aaaaaaaaaah', inflected with gentle vibrato. The ink-paste dances about, animated by its new purpose – patterns feeling outwards from the centre of the glass according to some unknown but pre-ordained map – a soft geometric formation takes hold. As she intones into the mouthpiece, her other hand moves the glass plate around in gentle circles, coaxing striated serpentine forms on its surface; a procession of shell like forms superimposed atop one another, each erasing the last. Another note from the boy at the harmonium – this time a third interval below, and an almost imperceptible concurrence issues from the others in the room, before Watts-Hughes begins again, lifting the tube to her mouth. 'Eeeeeeeeeeeeeeeeerrrrrrrrrrr' shifts the pattern around from the edge still more – a mandala spreads from its bubbling churning centre but with different iterations and ratios, modifying the 'Ah' that previously had prevailed. As the glass moves, the shapes edges leave behind their particular signature in regular formation.

Bell watches transfixed, and as the light plays across his face – the already coloured sun is reflected off of the device and modified once again as it sings into his vision – and he utters a quiet rejoinder of his own, perhaps privately surprised at the semi-involuntary movements of his throat, and tongue; a cosseting of this new notional shape being made by Watts-Hughes. She is reaching the limit of her expiration and finishes with a guttural sound that spatters tiny droplets of crimson onto her apron, the glass buzzes slightly; this final declamation adding a constellation of filigree and noise to the patterns upon the glass. As if by way of a command, this noise halts the voices and reeds in the room. The resonating apparatus's tube is placed upon a bright purple and yellow plaid cloth. The boys and Bell, breaking ranks, jostle for position; all eyes look on as Watts-Hughes lifts the now inscribed, luminous voice from its recording mechanism, holding it up to the sun's eye…


10 THE KIDOPHONE VOICE FIGURES.

GOD SAVE THE KING.

God save our gra - cious King.
Long live our no - ble King.
God save the King.
Send him vic - tor - i - ous.
Hap - py and glor - i - ous,
Long to reign o - ver us.
God save the King.

No. 1.

Figure 28
Voice figures corresponding to the various sung syllables in the national anthem
Watts-Hughes (1904:10)

This story of the voice's ability to fix itself through its own energetic animation of quiescent matter, is only truly fictional in one regard; Bell's fugitive presence. My reasons for placing him there are two-fold. Firstly, the peculiar device I describe, and the way that it produces its hybrids of sonority and time in graphical form, could almost be a modification of one of Bell's devices – specifically, the Photophone's transmitter/mouthpiece. Secondly, the way that the device is used, and the way that its input and output are understood by its operators, coaxes further resonances in this line of association between the two. That the voice (and sound) could be directly inscribed was not new, but for it's inscription to be considered an aesthetic object, so much so that it was hung in the windows of a house, prefigures much of the burgeoning enthusiasm for 'synaesthetic' art in Europe. Margaret Watts-Hughes began her work on what was soon to be known as the Eidophone in 1885. Hers was a wish to gauge vitality through the voice; measuring its power as articulated by how high fine dust would leap from the eidophone's membrane – the Chladni-style figures that resulted were unexpected:

> 'I had been working on this path until May, 1885, when on one occasion as I sang I noticed that the seeds which I had placed on the India rubber membrane, on becoming quiescent, instead of scattering promiscuously in all directions and falling over the edge of the receiver onto the table, as was customary when a rather loud note was sung, resolved themselves into a perfect geometrical figure.'[155]

I love the symbolism in Watts-Hughes's account, the clear association between spilling seeds and promiscuity – or perhaps conversely, the saving of seed for the parturition of what she considered to be a new art-form. Her voice figures are studies in the interactions between the ephemeral forces of the voice, and its possible articulation through the vitalisation of materials and surfaces. In her short book, she gives a thorough account of how she researched into different materials, their weights and viscosities, in order to generate different visual forms, and how a careful and skilled approach towards the voice's tonalities and inflections could effect those forms. Just as significantly, she recognised the importance of somehow recording these effects, and in the methods that sprang out of this, developed a unique hybrid of vocality, gesture, and inscription.

The Eidophone voice figures described by Watts-Hughes broadly fall into two categories – wet and dry – although she experimented with a broad range of different combinations of the two, using different types and weights of powders, either on their own or mixed with different amounts of water. There was an evident wish to understand the different forms produced as a kind of notation. On one page, the music for the national anthem (Figure 28) is reproduced, and above the

[155] Watts-Hughes (1904:2)

stave, a small drawing of a voice figure for each pitch/word composite contained within the tune is placed above the relevant note and word. A careful typology of dry figures is developed, mostly represented by drawings, since photography seems likely to have been impractical, and perhaps, expensive to conduct in her home.

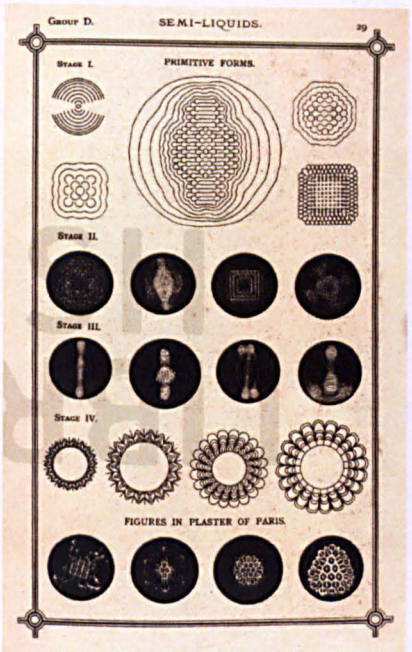
Where photography is utilized to great effect, however, is in the reproductions (presumably contact prints from the original glass) of her 'impression' figures, that is to say, the type that involved pastes mixed with pigments. She writes: 'Soon after the production by singing of the semi-liquid forms, a great desire took hold of me to find a method of rendering them permanent, for it seemed obvious that if the whole motion of the disc under the influence of vocal notes could be preserved, this might prove not only interesting and pleasing to the sight, but also of advantage to science.'[156] Watts-Hughes eventually, after '...many attempts and many failures...',[157] developed a method of dragging the Eidophone's membrane across a sheet of glass with both surfaces covered in coloured paste, generating remarkable striated curvilinear, or 'serpentine' patterns. 'After some considerable practice I found it was possible not only to retain the lines, but also that with every change of pitch the number of the lines varied'[158] (Figure 29b). Importantly, this variety of voice figure was time-based; a form of scanning, or moving inscription of an object activated by resonant concordance with the voice, which was then intended for visual display. Henry Holbrook Curtis, whose otherwise very dry book concerning the repair of the vocal organs by exercise, contains a chapter on Watts-Hughes's work, which in turn quotes from a wonderful account of a visit to her house in 1899:

> Instead of blinds or curtains drawn across the lower panes of the windows, there are wonderful designs in colour, strange, beautiful things suggesting objects in nature, but which are certainly neither exact repetitions or imitations of anything in it. Perfectly drawn designs of shell-like forms, of trumpet and snake-like designs, twisted and involved in complicated curves... strange and suggestive indeed are these window panes that the little boys at Islington have to look through. They see weird caverns at the bottom of the sea, full of beautiful beautiful coloured sea anemones and mussel shells, headless snakes, entanglements of leaf-like forms, all seemingly vital with the same laws of growth as those which inspired the creation of the designs in Nature which they suggested.[159]

This breathless account gives some clue as to the variety of effects that Watts-Hughes had managed to develop, and that she clearly valued them as aesthetic, visual entities. The reason that I highlight

[156] Watts-Hughes (1904:30)
[157] Ibid.
[158] Watts-Hughes (1904:31)
[159] Quote from Isabel Barrington in The London Spectator, October 26, 1899, In Curtis, H.H (1919:225-227).

their display, is because the way that she (and perhaps others) read them as images may hold a clue as to how the Eidophone was considered to articulate ideas concerning nature, sound, and the voice. These figures, when at their most skilled, are considered by their maker to be works of nature, rather than synthetic, or even to some degree man-made entities. One chart in the first edition of Watts-Hughes's book, depicting dry sand figures, is partly a record of development of complexity and form. The simpler, more geometric forms are labelled 'primitive', before being shown progressing onto ever more complex 'natural' shapes – usually resembling, and being named after flowers such as the daisy, the sunflower and the pansy. Clearly these objects aspired to the condition of nature even if they did not always get there, and this quality was considered a mirror to the well trained voice's natural prowess: 'Indeed it would seem that the infinite delicacy, intricacies, and differences of the human voice may find their counterpart in the variations of these flowery forms, and dramatic expression and emotion have also their effect in varying the exquisite tracery.[160] As an elaborator of a kind of phylogenesis of forms from the 'primitive' to the 'natural', the voice here is figured as an indicator not only of skill, but also of that skill's inherent aspirations towards what would most probably have been considered God's designs. It is worth noting that these more 'natural' forms were no more morphologically complex than those which were deemed 'primitive' – they simply resembled 'flowery forms' more than any other (Figure 29a).



a

b

Figure 29
a: Progression of voice figure forms, from primitive to natural.
Watts-Hughes (1904:29)

b: Wet voice figure on glass
Watts-Hughes (1904:36)

[160] Curtis (1919:230-231)

Might it be suggested then, that Watts-Hughes (a devout Congregationalist), perhaps by virtue of some divine agency, seemed to aspire to 'tune out' the human acting behind the voice, in order to channel nature, and by extension, its creator?[161] The rendering of these voice figures as translucent to human agency as well as light – a mixing of signals, so to speak – seems to sit obliquely as an idea with a machine whose primary mechanism was a recapitulation of biological function; the ear's tympanum, or diaphragm.

The Eidophone and the Photophone's transmitter are almost identical devices. One uses a rubber membrane, the other a thin concave mirror, but otherwise they are essentially tympanic mechanisms for channeling the energies of the voice and rendering these energies into different media – either coloured paste on glass, or light. It is the receivers that are very different; the Eidophone's recording mechanism was conceived to provide both a visual aesthetic and hermeneutic of the voice, part diagnostic, part transcendental – a concatenation of voices (nature and man), ear and eye. The Photophone's receiver (in Bell's hands) also received a 'voice' of nature, and as we shall see below, the biological mirroring within devices such as these, in the form of the tympanum-as-eardrum, becomes problematised where the Photophone is concerned. Its utilising of light enabled processes unique to photophonic sonification to take place, excising the mimetic ear from the signal chain, and lifting the device somewhat out of the genealogy of sound reproduction technology.

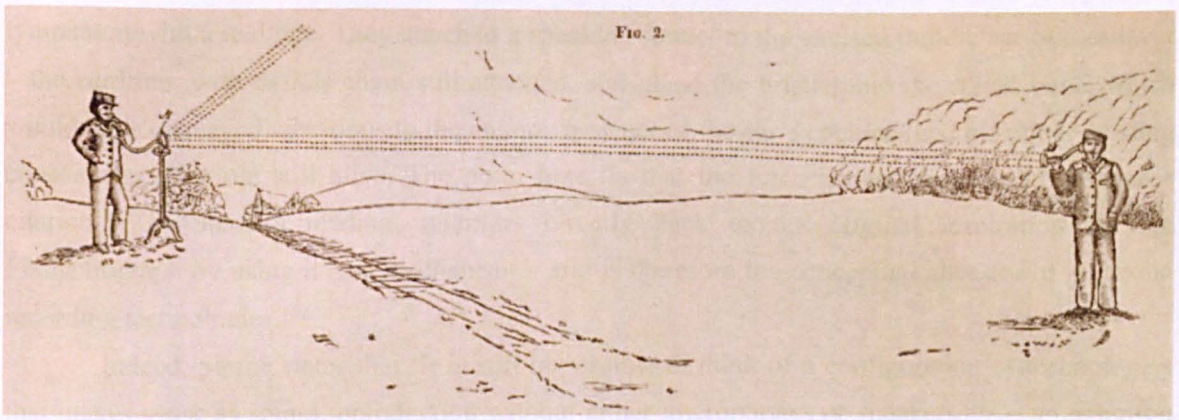


Figure 30
A Photophone transmitter and photoacoustic receiver
Bell (1881:190)

[161] Unmediated access to the divinity being a tenet of Lutherian strains of protestantism, of which the congregational denomination was one.

In his monumental history of sound's recording and reproducing media, Jonathan Sterne fixes the tympanum – or rather the trope of a vibrating membrane – as the key mechanistic agent in the collapse of sound's diffuse pressures down into the indentations, scratches, magnetic bands and glyphs which have constituted its capture for the majority of its history. Likewise its reproduction, in that it is almost always the case that a diaphragm be set in motion by these inscriptions, augmented by amplification or otherwise. Alexander Graham Bell is positioned as a central figure in this account, which is told by Sterne as the move toward the establishment of sound's nature as a quantitative energy – amplitudes at frequencies, as distinct from differing volumes of ratios and musical pitches – and the epistemological consequences of such a shift. Through the outer ear's transmission of vibration through the ossicular chain to the cochlea's oval window, sound's return to the body's mechanistic receiving apparatus meant that it could be understood as an effect which might be measured and represented as data, rather than a product of sound producing systems, with their attendant, often musical baggage. Sound had become a measurable influence upon a mechanism.

Emblematic here is the Ear Phonautograph – Bell and Clarence Blake's reworking of Charles Cros's Phonautograph, which itself took the form of a funnel directing sound onto a thin diaphragm (tympanum). Attached to this was a hogs bristle at a perpendicular angle, so that its tip moved laterally across the surface of a rotating cardboard cylinder coated in soot. As the sound (nearly always it seems, the human voice is the primary input at the genesis of a new recording medium) actuated the membrane, the hog's bristle scratched an amplitude-indexed line into the soot as it moved under it. Bell and Blake's advancement on this was to replace a synthetic tympanum with a real one. They attached a speaking funnel to the excised middle ear of a cadaver – the eardrum, with ossicle chain still attached, and glued the bristle onto the stapes bone, which would have conveyed vibrations to the unknown owner of the ear's cochlea (and his or her existing consciousness) while still alive. The point here, is that the Ear Phonautograph is in essence a citation – in Sterne's reading, it refers directly back to the original inspiration for the Phonautograph by using it as a mechanism – and is therefore the conceptual ancestor of all sound recording technologies.[162]

Indeed, Sterne states that 'It is still impossible to think of a configuration of technologies that makes sense as sound reproduction without either microphones or speakers.'[163] – an assertion refuted in part by William Duddel's 'Singing Arc' of 1899; an electric 'organ' derived from carbon arc-lamp technology (a precursor to Edison's filament bulb).[164] An electrical engineer, Duddel was asked to solve the problem of London's arc lamps' audible buzzing, and discovered that he could alter a lamp's 'musical' pitch through a resonant circuit (essentially creating a tunable spark-gap

[162] Sterne (2006:32)

[163] Sterne (2006:34-35)

[164] See in Simon Crab's historical timeline: Crab (2005)

radio transmitter but at audio frequencies); it was a short, logical step to add a keyboard and the relevant circuitry, thereby producing one of the world's first electronic musical instruments. The tympanum, as Sterne uses it, was not in attendance – except in the heads of those listening.

It may at first seem pedantic to raise what seems to be a small exception to undoubtedly an otherwise solid rule, but I do so because the non-tympanic ingestion or production of sound and, in Duddel's case its by-products (his 'singing arc' produced modulated light concomitant to its sound; something which had already been used by the German navy to communicate between ships photophonically) go on to point to an alternative thread in audio production, which in one sense bypasses the closed circuit of hearing and speaking diaphragms which Sterne evokes – or perhaps nuances the model somewhat.

I develop the following line of argument from part of Thomas Levin's genealogy of synthetic sound on film (which I deal with more fully in the next chapter), but my angle here is different. What I tentatively propose, is that the very idea of what sound constituted – only pressure waves from vibrations in materials – was complicated by the formulation of devices which used light as the medium by which that sound was recorded and reproduced, and further to that, that these devices severed the assured chain of causality between the two. That the probably inevitable entanglement of the image, and its constitutive media in such technologies brought about questions concerning sound's nature, was already latent in the indentations of the phonographic cylinder, and therefore so was the idea that a field of endeavour other than the acoustic could find its way into the audio signal.[165]

However, I have broadened things a little, and brought Bell into the fray, simply because his Photophone, was just as open to the sonification of modulated light 'which had never been sound', as the cinema's optical soundtrack was to become...[166]

> I have heard articulate speech produced by sunlight! I have heard a ray of the sun laugh and cough and sing!... I have been able to hear a shadow, and I have even perceived by ear the passage of the cloud across the sun's disk!...Can imagination picture what the future of this invention is to be!... We may talk by light to any visible distance without any conducting wire... In warfare the electric communications of an army could neither be cut nor tapped. On the ocean communication may be carried on... between... vessels... and lighthouses may be identified by the sound of their lights. In general science, discoveries will be made with the Photophone that are undreamed of just now... The twinkling of stars may yet be recognized by characteristic sounds, and storms and sun-spots be detected in the sun.[167]

[165] Rainer Maria Rilke's 'Primal Sound' essay is one of the most often quoted examples of this tendency. See in Kittler (1999:41)

[166] The optical soundtrack for film would not appear until some 30 or more years later.

[167] From a letter from Alexander Graham Bell to Alexander Melville Bell. In: Bruce (1973:337)

I quote from this letter in full (or at least as it appears in Bruce's extensive biography of Bell), simply because in just a few sentences, Bell covers many of the most fascinating aspects of photophonic sound production in its most expansive definition. In one sense, his letter discusses one of the material beginnings of what has become known within the discourse in experimental sound as 'esoteric phonography' – whereby the sonification of (usually) environmental energies is borrowed from the scientific, engineering or meteorological domains.[168] In such works, these transformations are reconsidered as aesthetic entities, an example being Steven McGreevy's recordings of Very Low Frequency radio emissions from lightning strikes – broad bandwidth electromagnetic explosions caught in the Earth's magnetic field to be resonated around the globe, or perhaps more famously, the electromagnetic sound-walks of Christina Kubisch. Since the 1970's Kubisch has used bespoke headphones which contain several magnetic induction coils and amplifiers, thereby converting the electromagnetic smog of the user's surroundings into voltages to be treated as audio.[169] This ascription of meaning to sounds which are in one sense authorless – insofar as the phenomena that are causal to their making is not of the human/sonic domain – has been critiqued by writers such as Steven Connor and Seth Kim-Cohen as indicative of a paucity of critical thinking on sound, and more specifically, symptomatic of a particularly muddle-headed romanticism. I will tackle this in the conclusion of this thesis, where I hope, my relation to my own practice and this critique will be spelled out.

That a non-sonic energy was now able to become sound causally through the employment of an instrument, seems to produce in Bell a small but detectable epistemological shift. The very idea that it was now possible to hear the supposed sound of a cloud scanning over the sun, and clearly – from Bell's excited tone – that it could be understood as signal, not noise, re-renders it as an audio-visual object; the cloud was not obscuring the light, but articulating itself for the ear using the sun's radiation, under the photophone's direction. Something of its nature, for him, had been implied.

That he still referred to the carrier of the voice as a 'ray of the sun' also suggests that, like Michelson with his aether drift experiments, Bell may have been partly in thrall to the peculiar poetry of light's properties, and in this case the transformations that he had engineered using them – the energy he employed was more than just white light and heat, but also it was in some way, of an experiential, cultural or personal, perceptual import. Indeed, he attributes the emerging voice to the sun's energy itself, not Charles Sumner Tainter (Bell's younger collaborator on the Photophone, and perhaps as much its creator than Bell himself), who was most likely the person speaking into the mouthpiece's reflector. This sports the suggestion of a kind of ventriloqy, but one where the medium of transmission is the site where the voice operates; in his account, the light itself, not the

[168] Also, see Thomas Watson's account of 'atmospherics' in Kahn (2008:83)
[169] Kubisch (no date).

Photophone's receiver does the talking.

In this both literal and ideational convolution of sunlight with audio, a volumetric field of influence is constructed between the transmitter's mirror, and the receiver, within which the signal – Tainter's voice – exists at all points simultaneously, and outside of which is either silence or 'other'. When used in this way, the spatio-temporal characteristics of light – that its speed in air effects a condition of instantaneity, and its delimiting and defining ability, when focused, is seemingly irreducible – gives rise to the effective collapse in auditory distance particular to communications such as the telephone and radio, but with the paradoxical fixing of that distance through vision. Bell's beam of sunlight is simply a part of the air where Tainter's words exist at the time that they are uttered, at all points from transmitter to receiver, without diffusion or echo – thereby placing them within touching proximity, despite the distance at which they are being spoken. As long as lines of sight are maintained, lines of instantaneous audition are too.

As Bell exclaims in his letter to his father ('...communications of an army could neither be cut nor tapped...') this specific collection of attributes could be a cryptological asset – the photophone's beam is a narrowcast rather than a broadcast, delivering its cargo to within tightly defined locations; hermetically resistant to pollution from other signals (although not, as we shall see, from pollution itself) and without the burden of actual transmission wires, nor any of the leakage that both telephone and radio would suffer from a few years later. As Steven Connor points out, the first electrical communications networks were porous in both directions to inductive forces:

> 'For toward the end of the 19th Century, the air acquired a new accent. Users of the telephone had for many years been inured to the fizzing, crackling and other strange noises of electrical interference... But the development of radio, which would be identified with the air through which it was for the most part transmitted, rather than through the sea or earth, made for a new vulnerability of transmitted sound (and later on, television images) to the vicissitudes of the air.'[170]

The physical rubber barrier that telegraph and telephone lines were sheathed in was of little use in holding back the invasive fields of electrical storms and other 'atmospherics' that would form a background noise to the increasing chatter of the late 19th Century (soon, cross-chattering in its radiophonic proliferation, to pollute itself), and since materially, the emissions from lightning and radio broadcasts were of the same stuff, the problem of co-mingling, was to some extent inevitable.

The proximal paradox of the Photophone – of distance negated through audition, even as it

[170] Connor (2006:3)

is maintained through vision is, as we have seen, of a kind that is often experienced within the artificial moving image; an unstable fixing of vision to a planar, haptic, sensibility, subject to any number of moment-to-moment audio-visual interactions and effects. And while it would be historically illiterate to place it in the same strata of media as the expanded cinema practices of the 20th century, both the Photophone and Michelson's interferometer contained within them the same possibilities for, or dispositions toward perceptual reflexivity, fluidity of context and adaptability of space that experimental, or more specifically, structural film saw within itself. The possibility that light and sound were themselves materials, whose causal interactions could be regarded as aesthetic acts, seems latent within these instruments.

The Photophone's alternative context here represents two essential shifts – firstly it de-emphasises the recording of sound, since it contained no provision for that (though one imagines that Bell must at some point have been thinking of something along those lines), and hence is freed from the act of sound reproduction through inscription per se. But secondly, there is a concomitant move away from the human agency contained within the signal to be heard – simply in opening the Photophone's input to signals which are products of the environment – be they natural or man made.

Figure 31
Front silvered parabolic collector
or London taxi headlamp.
Photo - The author

I have requisitioned a whole box load of London taxi headlamps from the mechanics garage at the end of the yard (Figure 31). *They are the 'sealed unit' variety – essentially a very large lightbulb with spade-connector terminals on the back. Normally they last for many years, but are now surplus since they have been superseded. I borrow a water-cooled tile cutter, and cut the lens off of the front, to reveal that the main body of the bulb is a front-silvered parabolic reflector, with the bulb's element at its focal point. After drilling a hole or two, and attaching a small*

glass jar containing metal mesh coated in soot (or lamp-black), I mount the whole thing upright on a trestle, and arrange my tone generator – a slotted wheel made from MDF mounted on a motor. Arranging a mirror outside to reflect the hot afternoon sun through the spinning tonewheel, I make my way back into the workshop and listen intently through a small piece of rubber tube connected to the air space in the jar. I can hear nothing apart from the jar's resonance.

After a few different arrangements of different sized reflectors and collectors, I get a small degree of success with a small aluminium light-bulb housing/reflector coated in soot, with thin perspex taped to the front, and a hand-held battery fan casting a shadow upon it. The sound is very faint, and I can't be absolutely sure that I'm not hearing the sound of my own wishful thinking... [171]

In Bell's quest to construct a working selenium cell, an unexpected property emerged which sidetracked the research that he was conducting with Tainter, but which has largely been overlooked within media history – perhaps because of the overarching importance that electrification within these early media has been afforded. It was discovered, that by concentrating an intermittent beam of sunlight onto a dark material (such as wool, or most effectively, a steel gauze coated in soot), sound was produced without the aid of electricity: 'To test the power of the light beam, Bell had resorted to a device analogous to one of his early harmonic telegraph transmitters: a whirling, perforated disc that made the light beam intermittent, like a make-and-break current, and so produced a simple telephone tone for testing. Bell discovered that such an intermittent beam, falling on a diaphragm, produced an audible tone directly, without the intervention of any electrical apparatus. He went on to produce tones from all kinds of substances, including a test-tube of cigar smoke (although he got no response one day in July from a fried egg and a stick of sugar candy)'[172]

In my own attempts to produce sound photoacoustically, the effects that Bell and his biographer describe began to take on a mythical, or magical quality. How could something so ostensibly simple be so difficult to produce? It seemed (as the notebook entry above suggests) that only the faintest of sounds was achievable, and not, as Tainter and Bell had claimed in one publication, sounds so loud as to be clearly audible across the other side of the room.[173] After several attempts with varying sizes of reflector and glass container, I obtained some small degree of success, but the clear, poetically transformational tones – essentially non-electrical synthetic sound synthesis – remain elusive at the time of writing...

[171] Author's personal sketchbook entry, June 2009
[172] Bruce (1973:338)
[173] Bell (1881:189)

We are inclined to attach more credibility to accounts of these intermedial experiments – of voices or music being eaten by, or emanating from mechanisms – if they involve tangible forces, material traces, means of action. Electricity had been shown to generate a force; it turned motors by shunting magnets – it had become both social and utilitarian with its maturing status as an enabler of force and communication, instead of an ineffable field of influence emanating from the likes of the Mesmerists at the turn of the 19th century. Perhaps we understand as bodies that sound is kin with these forces, and that our tympana are simply extraordinarily sensitive organs of touch, which themselves touch more sensitive organs still; it seems suddenly odd that despite being a mass of nerves intimately connected to these interfaces, the brain is insensitive to touch in itself. Proof of an object's sonorous state can be supplied directly by the skin, which may serve notice of events below our normal auditory frequency threshold, and in so doing provide the sensorial continuity through to events which our ears are ill equipped to deal with. The rise and fall of a boat upon the swell, as well as the vibration of its engine through a hull, may be sensed with my hand, and produces concomitant disturbances in the air, but somewhere between the two, something stopped being audible sound. As ever, time is the key.

It is certainly the case that we think of light as an energy (it hurts, if bright enough), but sunburn not withstanding, its effects are broadly intangible as a force outside of the optical paradigm; it won't throw us onto our backs like electricity can. If the forces are removed from the generation of sound, we are no longer presented with any kind of technological contrivance, or perceptible chain of events which we may reconstruct, but something more akin to sublimation; the static solid articulates some invisible part of the energy it is subject to under specific conditions. Bell's photoacoustic experiments with the Photophone – where flickering light was fired at soft dark materials to discover whether they made a noise or not, have the flavour of a speculative historical fiction or spiritualist hoax about them when considered today. Perhaps even hallucinogenic: 'I have heard articulate speech produced by sunlight! I have heard a ray of the sun laugh and cough and sing!'. It also does not belong in the pantheon of Sterne's 'tympanic' technology, where the mechanism of the middle ear is unleashed into the world in the guise of the receiving mouthpiece and the emitting earpiece (note the mirrored language – through these opposites, the circuit between user and media is formed). The middle ear has again been excised, the device deafened (Figure 32).

So there is seemingly no motive force to be reckoned with, and the Photophone receiver is cut adrift from this history, its genealogy blurred, both in antecedents and descendents.
Furthermore, we are warned against viewing the development of audio and visual media through the lens of technological determinism.[174] For example, as a carefully crafted set of material and mechanical relationships, the phonograph has been possible as an object since antiquity. But as a

[174] Friedrich Kittler's analysis of media's structural interrelationships is one attempt at skirting technological determinism. See Kittler (1999)

composite of philosophical positions, as understandings of the body and its energies, it is a child of the enlightenment or later; perhaps, as Sterne points out, as much to do with capitalism and anatomy as music and speech.[175]

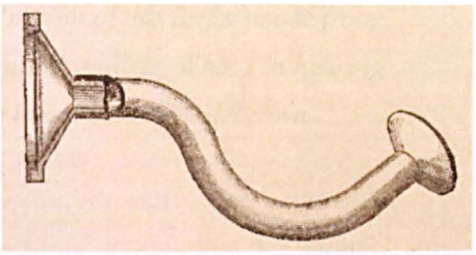


Figure 32
Photophone photoacoustic reciever and earpiece
Bell (1881:188)

In contrast, the Photophone's photoacoustic receiver (eye-mouth) is less constrained by such preconditions, given its unlikely simplicity. It is not electrical, kinetically mechanical, or even morphologically rare – it could almost arise accidentally out of a carelessly placed set of containers on a hot day.[176] Rather, its specificity lies in the transformations it enables with respect to instrumentation and its mirroring of the senses. In the absence of an electro-mechanical means of translation to produce audio (the tympanum's force upon the coil of wire via a magnet) on the one hand, and the lack of selenium to 'see' the light signal and modulate the telephone circuit's current on the other, we are simply left with a mechanically irreducible threshold between the two media; it becomes a point, or singularity into which all these ideas concerning the genealogy of media machines fall in on themselves, or become redundant. Put simply – it tells of an accident from elsewhere, or, a class of processes other than those that have been 'engineered'. At that threshold of transformation, the mirror of human agency that derives its existence from ideas about the senses, and which articulates itself in their mimesis, becomes ghostly, insubstantial… human agency is tuned out of the signal…

> *I have begun today in what must be the most primitive way possible – cutting out shapes from paper to make tone-wheels. I then attach these to a battery fan to see what king of sound I get. So far so dull – a sort of half sine/half square wave but with a fundamental from the speed of the fan spindle. This more than likely has to do with a-symmetry in the wheel or maybe even the grain of the paper showing up. As I*

[175] Sterne's considerable treatment of this subject lies outside of the scope of this research. See Sterne (2006).

[176] One imagines that in the explosion of experimentation in optics within science and the arts during the renaissance, that somehow this instrument might have well have accidentally arisen, but would have been missed, simply because of the implausible nature of its effects.

ponder what to do next, the little battery amp on my workbench produces an odd muffled roaring sound. I plug in the headphones and listen closely. Underneath the buzz of the strip-light above the bench is what sounds like wind on a microphone, but filtered and with sudden and unpredictable dynamics.

The sun is streaming through the pear tree in the in the garden opposite, and in the open doors, onto the bench and the photocell. In front of this drifts smoke from a small fire that Steve next door is using to get rid of all his pallets. What I'm hearing is the smoke drifting in front of the sun, modulating it into a kind of pink/brown noise... [177]

The ephemeral nature of the gaseous or diffuse body is an opportunity to employ noise, unpredictability or chance as an attribute in filtering, routing or reflecting a given luminous signal, either auditory or photophonic. In his book Lost Sounds – the story of coast fog signals, Alan Renton describes John Tyndall's experiments with the transmission of acoustic signals through differing atmospheric conditions in the 1870's. Tyndall predicted that fog would impede the transmission of sound as it did light: '...a portion of the vibration is reflected and lost...at each of the innumerable surfaces where the air and globules of water...touch...'[178] The inverse proved to be the case, however, with clear days performing poorly, but: 'During several days of heavy rain in October, all of the signals had improved ranges...If air pockets of variable density caused obstacles for sound transmission, then an homogenous atmosphere should be a better medium, and indeed one of the conclusions of the report was that foggy conditions presented the ideal medium for sound transmission.'[179]

This presents an alluring, complementary acoustic accompaniment to the shadow-play of smoke or heat modulated sunlight; a diffuse body performing several concurrent functions, to the impediment of light's transmission, but the aiding of an acoustic photophonic signal that this impediment had produced. In fact, my own attempts at recording modulated light signals through smoke or heat-haze proved to produce little more than one effect superimposed upon another – the original signal (a battery fan producing a steady tone) subject to sudden changes in dynamics, and with a strong component of soft noise from the thermal currents and smoke – both caused by differing magnitudes of refraction and occlusion by smoke particles. Indeed, this may provide one of the clues as to why the Photophone was impractical in terms of its utility as a communications device over long range. Strong sunlight, it seems, is needed for a good signal, but the thermal disturbances in air that a hot day produces would make that signal prone to noisy interference – not from light, but from the medium that light was intended to pass through unaltered – from the air.

[177] Author's personal sketchbook entry, January 2008. Audio Available on accompanying DVD: *Smoke*

[178] Tyndall in Renton (2001:39)

[179] Renton (2001:40)

It seemed that the theoretical distances of transmission that Bell had hoped for never truly came to fruition. In Bruce's words: 'In an American Telephone and Telegraph Company exhibit at the Columbian exposition in Chicago three years later [1893], the photophone – now renamed the "Radiophone" by Bell – transmitted speech a hundred feet to a lampblack receiver, from which hearing tubes passed into the listeners' booth. The limit of transmission was no more than six or seven hundred feet.'[180] Bell's renaming of the device – to the 'radiophone' – now reads as an attempt to break it out of these confines, and into what was soon to be thought of as the almost limitless terrain that Marconi's first radio broadcasts of 1897 were laying claim to. It seems paradoxical that the Photophone had been confined to ranges within which its operators could easily see each other. Given its immediate commercial competitors' advantages, it feels like a rather an ignominious conclusion: that energy from the sun, that had after all traveled so far, would be reduced within the parentheses of the photophone's components, to only being effective over shouting distance.

> *The sound of sun on the sea ought, I imagine, to be a crackling or popping sound. Perhaps this expectation is a mixture of what I think I can see, and the cloud of associative sounds that seem to coalesce around random dynamic texture... crackling, buzzing, popping, crinkling... all seem to be sounds that might arise out of a dynamic body of multiple energetic, small, transient events. And so I head down to the beach with a DV camera and photovoltaic cell. They day is hot and breezy, producing a rough-ish swell and a bright band of glittering light down from the horizon in the south-by-southwest. The PV cell I'm using has a relatively wide angle of capture, and I feel sure that I'll get the whole 'glitter path' with it – and so it seems to be the case. When monitoring on headphones, the only sound I can hear is a roar clicking in and out seemingly at random. It seems the power that the PV cell is too much for the mic pre-amp (it is a battery charger after all). So I mask off most of the cell with a t-shirt in order to bring the signal back down to a reasonable level, leaving perhaps one third exposed... settling down to record, I listen to what eventually turns out to sound rather like the sea...*[181]

Despite its expanse, its continuous presence from where I stand to the horizon, and its seemingly limitless variety, subtleties of movement, light and texture; the sea in this instance has gone nowhere. Perhaps this should not have been a surprise, given that light contains no acoustic spatial

[180] Bruce (1973:342)

[181] Author's personal notebook entry, August 2008

properties when recorded and treated as sound; it is airless, as if coming from inside one's own body. When shooting what would become *Glitter Path*, the intention was to gain some of kind auditory access to the specific quality of light that plays across the sea's surface on a clear day.[182] The expectation was not that anything about the sea or its image would be meaningfully revealed as such, but that sound that was in some way unique might be generated. This was achieved to a subtle degree, but was frustratingly close to the normal acoustic presence of the sea from the perspective of the shore, only dynamically and spectrally impoverished.

I had decided that in order to move away from the purely representational, the video image should be deliberately defocused (Figure 33) – the idea being to draw attention away from the illusionistic surface of the water and toward the textures and rhythms that are continually present. The resulting combination of the sound and image amounts to an unambiguous and unstable flattening of perspective; the notional horizon is drawn inward, the scene becomes vertical and functions in parallel consonance with the surface of the screen.

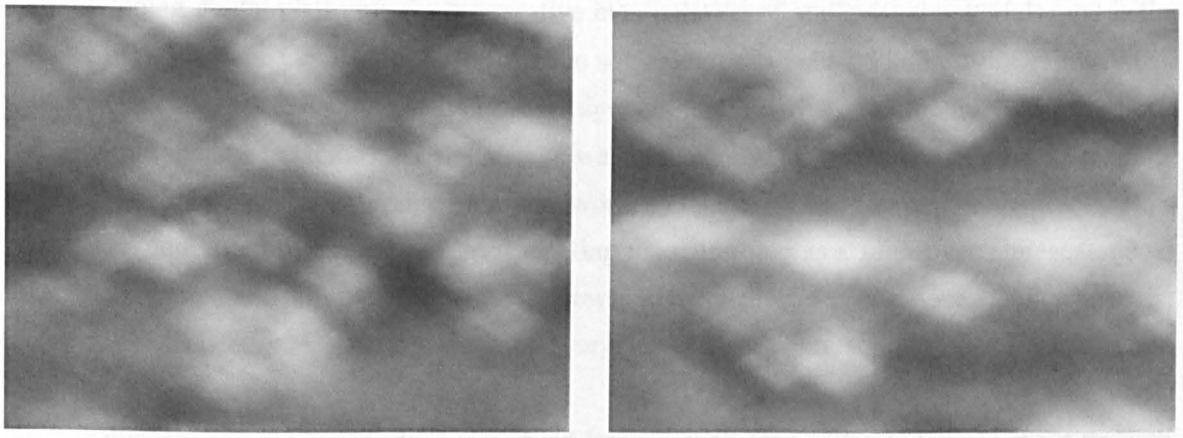


Figure 33
Rob Mullender (2009)
Glitter Path

However, the normal sonic dynamics of waves crashing on the shore are also flattened back into a band of mid/high noise, over a basso continuo (to borrow from Birtwistle) of low frequency rumbling – there being a marked absence of mid range activity. An unstable, perceptual re-ordering of the image is a specific attribute of photophonic sound recording in film and video – as we have seen with Guy Sherwin's work (and as I explore in a later chapter, 'A Somatic Optic'). But here, the implied question in environmental photophonics – that since it is derived from the world, we

[182] See accompanying DVD: *Glitter Path*

might ask if it inherently has something to say about it – is returned and strengthened by the sound's apparent proximity to reality, becomes mirrored. Its almost-ness serves to blind, or flare out alternative readings and possibilities within the soundtrack, blanketing the video in a noise that provides no space for musicality, texture, or synthetic audiovisual counterpoint, and what remains is a poor simulacrum of the sea's true sonic nature. Simply, it is both too similar, but not similar enough. And since there are no forms to work with or against one another, there can be no overtone – no third structure may arise from the tumult as a protection from the storm. Almost nothing can emerge...

In September 2008, soon after the completion of *Glitter Path*, I began an open-ended collaboration with Dr. Mick Grierson (Director of Computational Art at Goldsmiths) centering on analogue audio-visual experimentation or intervention into digital video. From the outset it was thought that this would involve a sculptural or mechanical element somewhat akin to optical tonewheels, which might succeed in altering the video image and soundtrack simultaneously, and in ways which would be readably linked. Grierson has worked extensively on programming and commissioning digital platforms for the creative manipulation of audiovisual materials, and is the director of the Daphne Oram archive.[183] It was to some degree our shared interest in Oram's drawn sound techniques that led us to discuss how it might be possible to produce audio-visual synthesis using simple analogue methods. Grierson's aim was to make use of the unpredictability of tangible and imperfect mechanisms to produce complex works: 'Generating abstract patterning processes as part of an audiovisual synthesis, and then applying the patterning as a filter over representational material is computationally an intense task. However, with the *Spectra* device (as it was to be called), this all occurs as a consequence of everyday existence interacting with electronics and mechanical devices.'[184]

Recognizing the need to find something large enough for a video camera to shoot through (and in an homage to Chris Welsby's *Windmill* films),[185] two small desk fans with transparent blades were purchased, disassembled, and mounted on a bespoke shooting rig so that their area of overlap coincided centrally with the video camera's lens axis (Fig.34). A photodiode was attached to the end of a flexible 'swan-neck' mount, so that it might be accurately and stably positioned at he fans' overlap, and the output from this forms the soundtrack heard on the video. It was partly as a response to the particular properties of *Glitter Path* that the sea should be the subject of the first video shot with this peculiar collision of cheap domestic appliance and video technology – a desire to face down the flat thunder of the photophonic sea's voice with some mechanical tonality.

The main focus of this video is the horizon, which horizontally bisects both the screen and

[183] See Grierson (2011)

[184] Email to the author, 5/9/2011.

[185] Welsby produced a series of films which made use of wind to change different aspects of the image. In particular, the Windmill series were shot through the mirrored plastic blades of a windmill, ensuring that the wind speed changed what was visible: if the blades turned slowly, the camera shot periodic images of itself alternating with the scene behind. At high speed, the blades blurred and all that could be seen was landscape.

Figure 34
Spectra shooting rig, showing the camera lens, and the two fans.
Photo - The author

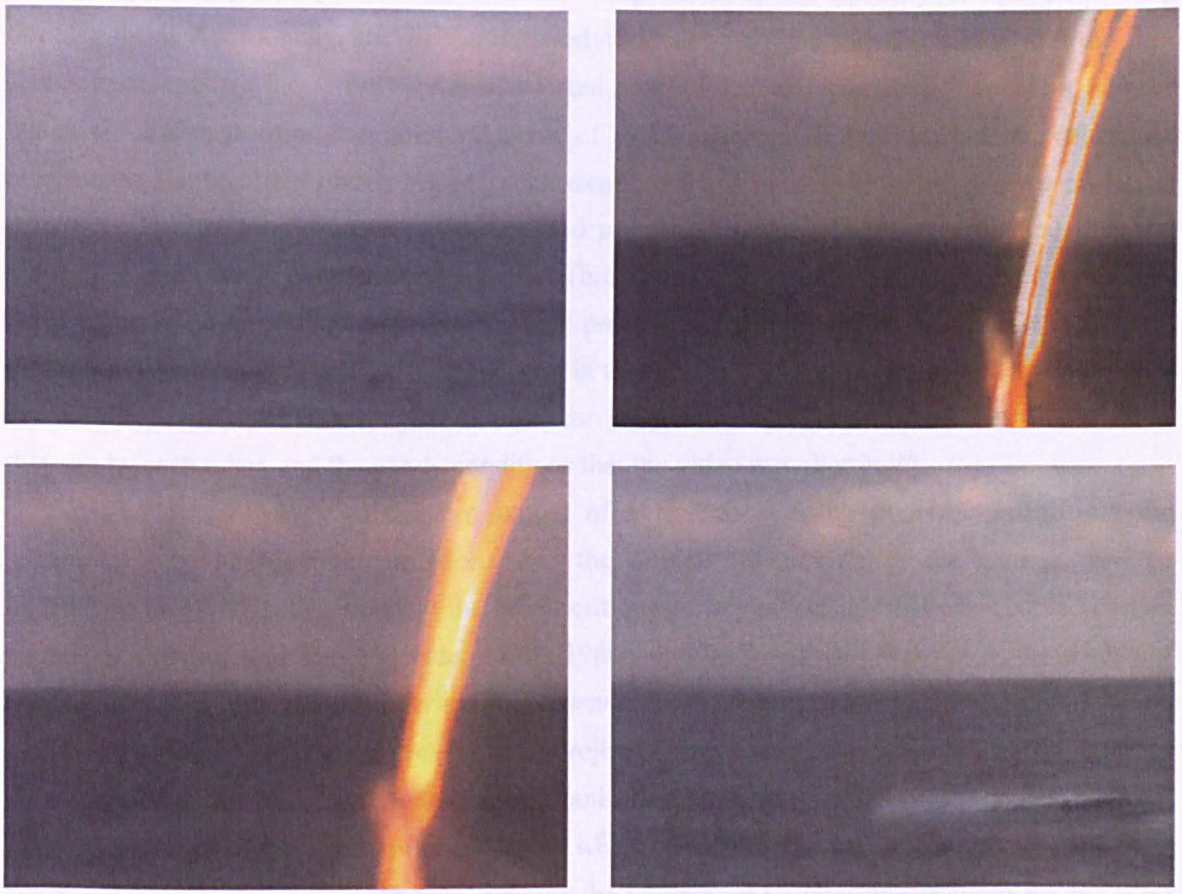


Figure 35
Rob Mullender & Mick Grierson (2009)
Spectra (video component)

hence the area of the fans' overlap; the eyes of both the camera and photodiode. When processed through this simple mechanism, it seems configured to articulate the shifting phase patterns generated between the spinning blades, and that image's indexical relationship to the soundtrack. A subtle, shifting and blurred waveform prints itself onto this almost colourless meeting point between sky and sea, reframing it as a seascape convolved with an oscilloscope readout, or perhaps even an optical soundtrack rushing horizontally, vibrating in consonance with the audio it engenders, while simultaneously being scrubbed by the fans' blades and bringing it to within touching distance of the screen (Figure 35). Most simply though, it feels violent – akin to viewing the world from within an inhuman and mediated environment, and this tendency reaches its peak when the unexpected arrival of the late afternoon sun arcs streaks across the screen, cranking the soundtrack into a harsh square-wave growl as different areas of the fans' blades become highlighted.

In one sense, this might be thought of as both an environmental and structural video, since the varying pitches and timbres of the soundtrack, and the visual phasing in the image are all directly affected by the speed of the wind buffeting the fans, and intensity of light penetrating through them. Additionally, the further heterodyning between the video's sensor and the fans serves to complicate the already extensive visual ambiguities, and inscribes the camera into the image. If analysed from the point of view of mechanisms and their effects, or rather, the mechanistic heritage that underpins and coalesces into those mechanisms, the *Spectra* project is permeated by 20th century avant-garde musical practice, as well as with experimental film and video. The fans effectively constitute primitive (brutal to the point of atavistic) optical tonewheels, but even so we might faintly detect the spectral presence of Murzin's ANS synthesizer in the way the sound is generated. This is distantly echoed in the presence of the constantly shifting overtones and beat-frequencies which emerge out of the slurring glissandi generated by the fans – buffeted as they are by each other, and the windy conditions that the video was shot in.[186]

The drawing in toward the proximal of a horizon – using both the image and the soundtrack –by introducing disruptions into the normal functioning of the camera, can be understood as aligning *Spectra* with the broad critique of 'foveal' vision that preoccupied certain strands of experimental film and video in the 1960's and 70's. William Wees plots the course of standardised western regimes of visual representation from Descartes's *La Dipotrique*, which depicted the retina as a screen for reality to be projected onto, via the camera obscura (analogous to the eye) and the renaissance development of vanishing-point perspective in the projected image, directly into the refinement of modern optics which permeate moving image culture in almost every conceivable way. One need only examine the terms used to describe variations on this ideal

[186] See accompanying DVD: *Spectra*. As we shall see in the next section, microtonality and predisposition toward glissandi are a primary characteristic of the ANS, although it should also be noted that the synthesizer's sound pallet consists, unlike Spectra, entirely of sine tones.

of the veridical to begin to understand the ideological forces at work – imperfect lenses cause 'aberrations' and 'distortions', images are 'defocused'; all synonyms for deviations from established truths, nature and attentive thinking. The model of vanishing point perspective applied to a flat image offered a seemingly self evident and unassailably rational composite of natural order and geometry (themselves almost interchangeable terms) which situated the viewer's eye, and by extension consciousness, at the locus of all things: 'No matter how complex or ambiguous those [observed] objects might be – in form, spatial relationships, or emotional impact – they were caught in the same geometrical net and seen and depicted in the same rigid framework.'[187] No wonder then, given the metonymic familiarity with which camera and eye regard each other (Wees's description of this set of ideas is a 'visualization of sight'), that 'normative' or 'foveal' vision's almost unquestioned, and therefore institutionalised domination within the moving image would be critiqued by those who understood that the field of seeing in its totality is ill represented under such a schema:

> Therein lies the source of the "trouble" in the lens: a mechanization and standardisation of seeing that sacrifice much of what motion, imagination, and the total visual experience offer to visual artists. Filmmakers dedicated to "vision and visualization" would therefore find it easy to agree with the artist and art historian José Argüelles when he calls perspective "a graph applied to the eye for the purpose of mechanizing vision and thus mind"...[188]

At stake was the very notion of individual, unique perception, which need not necessarily conform to the paradoxically prescribed norm of the individual's viewpoint; since the image had been filtered and standardised through the fine mesh of western *logos*, the personal sediment of individual visuality did not exist. Only a disruption of the camera and its attendant apparatus and materials could restore the possibility of the totality of vision. Spectra's audio-visual disruption – or rather the heterodyne screen that generates its effects – engages these notions through the abrogation of stability and focus, generating fluctuations in illusionistic depth; the horizon is no longer able to support a vanishing point, being in a constant state of agitation. The soundtrack's energising of the image further decouples proceedings from nature – a throbbing drone unpredictably wends its way through from beginning to end, opening out into a full throated growl before receding back onto the horizon line – but as with Guy Sherwin's optical soundtrack experiments, this denatured existence would not be effective without the residue of the normative

[187] Wees (1992:40)
[188] Wees (1992:45)

image for it to vibrate against as a reference. It seems that instability – inseparable from temporality, is essential.

Importantly, since the fans are simply 'disruptors' of the 'normal', as distinct from generators or recipients of it, the camera can be discarded, and interference between the fans and the camera's sensor notwithstanding, their effects remain. The second component of the *Spectra* project was an installation which made use of this self sufficiency in ways which worked in dialogue with the video in a gallery environment. Eventually named *Signaling Hut*, it consisted of a basic elevated wooden shelter, accessed by steps, which when entered allowed a view of the gallery through four viewing portals, each of which housed a separate heterodyne screen identical to that used to shoot the video component, only larger (Figure 36 & 37). Taking the form of boxes made of a bespoke polyester resin and cloth composite,[189] each portal is paired with a corresponding speaker box below it, emitting the amplified output from a photodiode arranged to capture the mechanism's transmitted, modulated light.[190] From the co-presentation of the *Signaling Hut* and *Spectra* video, a system of interrelations can be inferred, which draw together several strands of thought concerning experimental cinema and the senses, sound's propensity toward territorial demarcation, and the spectator's role in constructing narrative in the work. The two works were exhibited at the Meantime experimental arts space in Cheltenham, in January 2009, and occupied separate rooms. *Signaling Hut* enjoyed the benefit of a brightly lit white space to operate within, leaning against the back wall of the gallery space, and facing towards visitors as they came up the stairs.

On first viewing of this piece, the immediate impression is of some obsolete artifact of public address or flood warning, occupying the room both visually as a quasi-anthropomorphic presence, and sonically, as monolithic throbbing drone. Since the heterodyne screens in the viewing portals alter their volume according to the prevailing ambient light in the gallery, the intensity and timbre of sound generated by the installation rises and falls according to weather conditions and time of day. Looking though the viewing portals, one is presented with the same unstable shimmering that affects the video work, only here it is a specific, physical and more subtle presence (Figure 39). Likewise the sound, which articulates the gallery space in a much richer and more complex set of interlocking and interfering pitches and overtones than the video soundtrack manages to do – due in no small part to the differing speeds that the motors driving the heterodyne screens are set to run at. This is more pronounced in the hut's interior, which as a structure vibrates perceptibly in concordance with the machinations of the viewing portals (Figure 38). The sound in this instance reveals itself to be the unifying element in the piece as a whole. A spectator, unseen within the hut, may survey other people in the gallery as mediated presences, shimmering and

[189] The significance of this material – which I developed myself – will become apparent in the penultimate chapter.

[190] See the accompanying DVD: *Spectra Exhibit video*, and *Inside the Spectra Signalling Hut* audio.

Figure 36
Rob Mullender (2009)
Spectra Signaling Hut

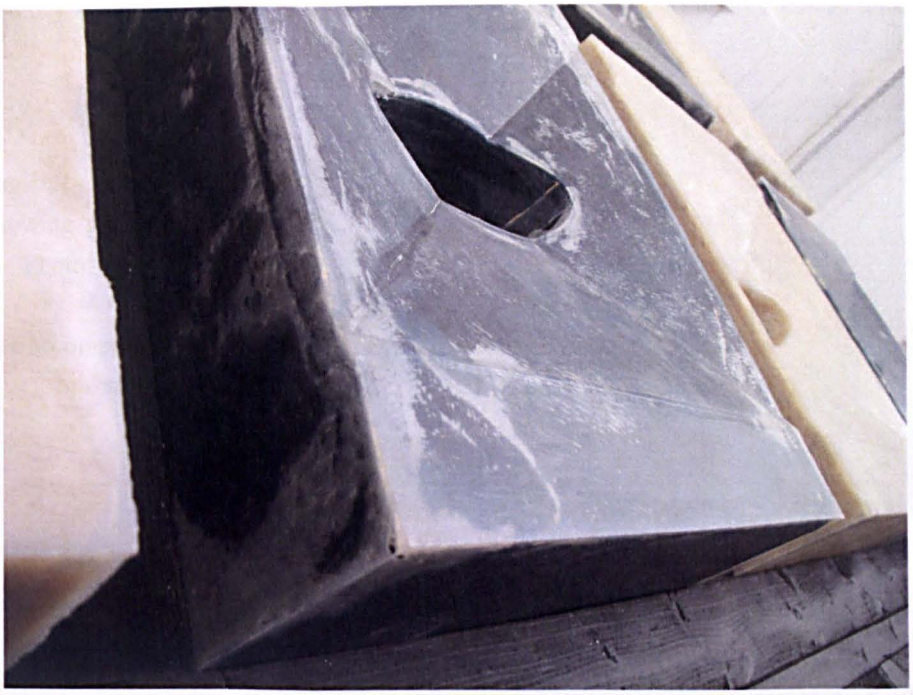


Figure 37
Signaling Hut viewing and speaker port construction
Photo: the author.

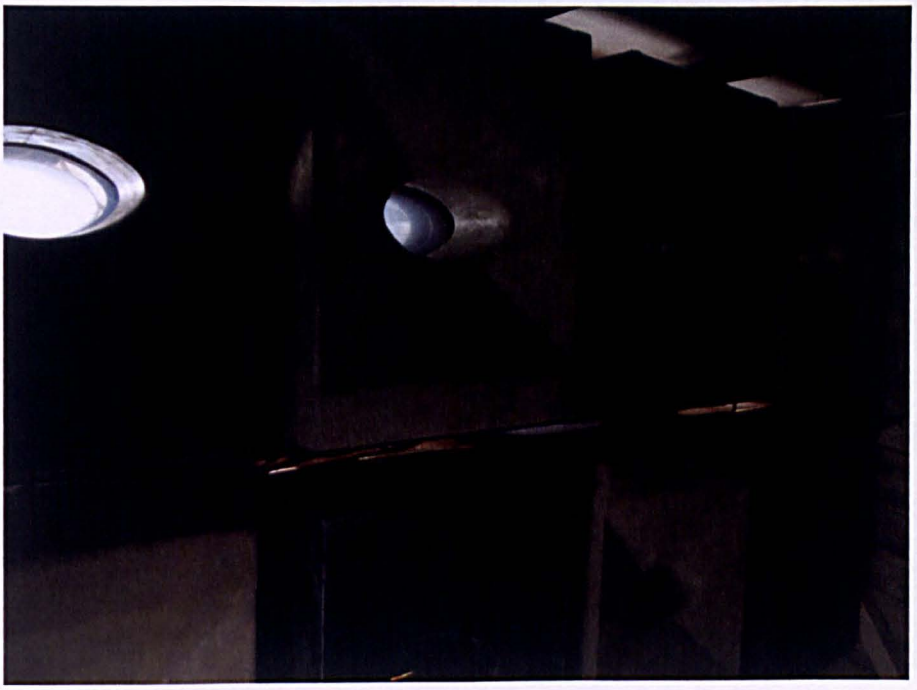


Figure 38
Signalling Hut interior
Photo: the author

Figure 39
Signaling Hut - Viewing portal, showing 'ghosting' effect.
Photo: Mick Grierson

See accompanying DVD:
Spectra Exhibition

vibrating in concert with the complex drone being directed at them, but equally, the occupant is subject to that same sound, complicating the implied power relations between the viewer and the viewed.

The insubstantiality that the heterodyne screen bestows upon the world outside the hut is partly responsible for these relations – and the piece's name is a testament to this. The exterior world as seen through the viewing ports is rendered more as a spectral entity; people become marginally ghosted, losing hard-edged solidity while simultaneously gaining a mediated auditory presence by virtue of the shared root of both effects – the heterodyne screen's function being audio-visual in essence. But more than this, a sense of the implicit rejection of the normative visual regime – although decoupled from the 'cinematic', and so less defined in its opposition – still makes itself felt, especially when considered in tandem with the video. Taken to some kind of conclusion, we might surmise that the *Signaling Hut* takes this ideological 'look at seeing' and the camera, removes it from the artificial moving mage and places it in the realm of the real moving image, and real reverberant space.

The possibility that the complex and varied cluster of attributes that constitute the 'cinematic' may be separated from the apparatus and materials with which it is made, has been latent in experimental moving image since at least the 1960's. In a move to address a theoretical dissonance within practices in avant-garde film that follow this path, Jonathan Walley revisits (and re-appropriates) the idea of the 'paracinematic', as a way of naming such a diverse body of work. This problem turns on how essentialist, 'pure' filmic practices which questioned the limits of what materially constituted cinema, sometimes moved on to shed the material basis for their inclusion in the canon at all. How could a philosophy of film making like that of the avant-garde in the mid 20th century, which unrelentingly foregrounded and engaged with its own materiality reconcile itself with works which jettisoned all physical traces of film's production?

An example Walley gives is Anthony McCall's *Long Film for Ambient Light* which: '...employed no camera, film strip, projector or screen, taking instead space, light, and duration as its parameters. The work consisted of an empty Manhattan loft, its windows covered with diffusion paper, lit in the evening by a single bare lightbulb hanging from the ceiling. It lasted for twenty four hours, during which time the spectators could come and go as they pleased, moving about the space at will.'[191] The clear desire here was to reduce the properties of film to their absolute basic ingredients: note the lamentable absence of sound from the list, despite its inseparability from spatial considerations. What arises from Walley's inclusion of this work – a piece with which McCall was responding to '...the trend of medium-specific essentialism in film theory and avant-garde practice'[192] – is the recognition of a variegation in this essentialist tendency. If film, projector

[191] Walley (2003:20)
[192] Ibid

and light could be essentially cinematic qualities, then so could space, duration (here in dialectical relation to minimalist strictures of the day, which according to McCall held experimental film below painting and sculpture in hierarchical distinction) and in a broader sense, montage, editing and perhaps even the urge toward memesis as a human condition. The essential characteristics of cinema need not be confined to the technological or material – but rather that events in time between people, objects, narratives, the conjunctions and collisions of images and the aesthetic implications for those events might be understood as cinematic entities under the right conditions. A detailed discussion of Walley's use of both Eisenstein and Bazin lies outside of the scope of this writing, but it suffices to say that both thinkers saw broader structures and dynamics in cultures which predated cinema's inception, but which, as far as they were concerned, cinema was effectively invented to articulate: the condition of cinema was there all along waiting for its own apparatus to bring itself into material being.

I have no wish to apply this teleological mirroring to *Spectra* (indeed, any individual work by an artist would fall short of such a test) but I do want to suggest that the *Signaling Hut* engages with the paracinematic in a mechanistic sense, and a sonic one. The images that reach the eye through the heterodyne screen's mediation are simply no longer continuous, but shimmer and vibrate at speeds above its capability to resolve, but which are made explicit through the mechanism's sounding. Importantly, it is a machine that is driven, or structurally informed and energised by optical sound, and by implication the various devices that have historically brought it about. It is a concatenation of tonewheel, optical soundtrack experiment, camera and projector, photographing and viewing space, which exists in dialogue with the *Spectra* video component.

Since the video's effects are the same as the hut's, the seascape becomes read by inference as a view from inside it. Reflexively, the structure becomes understood as either removed from, or destined for some shoreline. It is in this switching between the two, and the readings that might arise from between them, that the work comes fully into being. Perhaps, given that the heterodyne screen owes its existence to a colliding set of ideas on the part of myself and Grierson – the *Signaling Hut* might be thought of as a shelter against un-coded noise (the photophonic sea's denatured voice in *Glitter Path*) on the one hand, and coded noise (Grierson's digital audio-visual strategies) on the other – but signaling to what, or to whom? A more poetic, or socially engaged reading (and from someone new to the work, maybe a more likely one) might be that the hut's seaward emissions are meant for some exogenous force or group – and that within the mediated ghosting of the world outside (and over the sea) lies an implication of otherness, and of territories breached; warning signals too late for the drowned.

The concept of paracinematic as Walley proposes it is undoubtedly useful, but also seems

too porous to operate without some attendant guiding principle. With this in mind, I have used it here only with respect to physical mechanisms with operations common or similar to those found in the apparatus connected to the moving image, and their effects on sound and light. This, I hope, serves to underpin and strengthen some of the suggested connections between seemingly disparate devices so far – Michelson's Interferometer (and mine), the Photophone, Eidophone, and the *Signaling Hut* to name but some. But still, the clear connecting thread running through all of these devices is photophonic sound.

In my examination of Bell above, I have considered how photophonic sound production can be thought of in a more expansive, or perhaps environmental way, and how Bell's Photophone, and the immediacy of the transformations that it produced enabled a reconsideration of what sound might be, and what might be sound. One might easily imagine a scenario where Bell could have listened not only to a cloud occluding the sun, but in a precursor to *Glitter Path*, also the sun's bright dance upon the sea. As I have discussed, the way that devices for sound's transformations can be viewed is a composite of mechanical strategies, morphology, practices surrounding their use, and the consumption of the 'signal' that they produce; all need to be considered. That the Photophone, and Eidophone could be understood as open systems, mechanically and conceptually, was both a feature of their simple mechanics, but also of the reflexivity they enabled, through the instantaneity of the transformations they produced. In both cases, light or image was altered under the auspices of a voice; in the Eidophone's case, the voice's nature was read retrospectively through its traces (which in turn revealed its fealty to Nature), and with the Photophone, it was a force vitalizing and articulating the medium that carried it, and which unexpectedly seemed to Bell to contain voices from nature also.

Margaret Watts-Hughes's Eidophone conforms in part to the rubrics as proposed by Sterne – occupies this field of operations of the body (partly through the late Victorian cult of self improvement), sonic hermeneutic, direct inscription and functional morphology. But her understanding of the tympanum developed through a mixture of heuristic inquisitiveness and bodily intuition, or a haptic understanding of her own voice's role as articulator and resonator of the self. Unlike Bell, she was not an engineer, inventor or entrepreneur. Rather, she came to the depiction of sound via the throat not the ear, and so brought with her a sensibility of touch allied to form through resonant concordances – of the sounding column of air within, to the sympathetic vibrations in rubber without – albeit complicated by the unpredictable dynamics of viscous fluids upon glass. In terms of mechanical reproducibility, these works are malformed as sound recordings – but are nonetheless paracinematic in their essence, and hence presage developments in abstract film which would be several decades away.

Chapter 4.3:

Scanning

The ANS, Oramics, Visible Speech and Optical Soundtracks.

> *After three builds using various methods, I've hit on a fibre optic loom as a way of getting the light signal in from the torroidal lens on the outside, to a static point in the centre of the motor's axis. the coupling point will be where the light leaves the optical fibres, and enters the photodiode, which needs to be static. The fibres' rotation here is irrelevant, since the end of the fibre is completely even in its luminescence – fibre optics cannot transmit an image in two dimensions like a message in a stick of rock, since the light bounces around inside. With the motor up and running, and the diode amplified, I hear gentle hiss, and not much else. The diode and pre-amp is just not sensitive enough to pick up the fine gradations of tone in the scanned scene. Pointing my bike lights at the assembly, a growling, buzzing noise issues from the amp, with a phasing quality apparent if I move the lights around at different radial angles relative to each other. There is something simplistic, unrefined and dissatisfying about it; I was hoping for an immediate and readable experience, whereby moving objects and peoples' gestures would transform into audible changes in timbre. Instead I end up having to shine lights at the thing, which changes the work completely...* [193]

A torroidal acrylic lens, mounted horizontally, with an optical fibre directed perpendicularly outwards upon a motor's spindle, its end spinning inside. This lower end of the fibre spins in contact with the lens's focal point (or ring in this case) the other points upward, terminating axially just above the motor spindle's end, rotating below a photocell's eye. When viewing the world through this lens (effectively a cylinder bent round into a hoop), a scene denuded of nearly all form is presented to the eye. Stereoscopic vision and other clues to proximity such as size are removed, and all features within the field of view are stretched into bands of colour of various tones. If understood only as tones (in other words, monochrome), then the apex of light constituting the lens's focal ring can now be seen as a variable density optical soundtrack to be played; visual surroundings are re-figured as levels of brightness to be transferred up within the optical fibre and projected into the sensor. Each revolution of the motor's spindle performs one pass of a complex wave cycle, and so the apparatus can be understood as more like an oscillator or synthesizer, as distinct from a recording device; no storage or playback takes place, only direct transcription. In

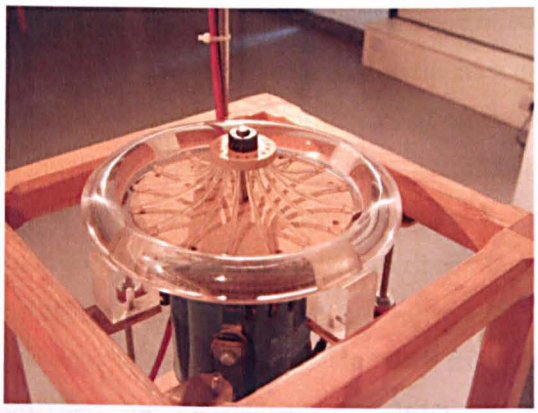
[193] Author's personal sketchbook entry. For an audio example, see accompanying DVD: *Fibre Loom Oscillator*

this sense it is analogous to the optical film soundtrack experiment without the mediation of the camera – one might suggest a step toward materialist film without the film material itself, since the film is the device's surroundings, and hence, an engagement with the motion of the paracinematic mentioned above (Figure 40)

The photocell is a mono-cellular eye without a brain to see with, and simple in essence. It does not receive or transcribe image, since its input needs are simply quantitative – light within a certain frequency bandwidth is either there for it in certain amounts, or it is absent. As such, it might be seen as the last stage in collapsing and encoding the three dimensional world into a one dimensional, potentially acoustic signal (a diaphragm, or tympanum for receiving light, perhaps). For audible variation to occur within this signal, these changes in luminescence must themselves exist within the audible frequency domain. Given the generally static nature of the visual world with respect to these requirements, the act of sonification is almost always ineluctably bound up with movement: movement of the sensor with respect to features within the 'image' to generate change, and if the signal is being recorded, the movement of storage media on which it occurs.

The aesthetic agency inherent within a transcription from the visual to the auditory is a composite of technical/material solutions, which manifest themselves as physical artifacts (film, photocell, amplifier, speaker for example), and the intentions, mistakes, and discoveries of the artist using them. In the case of the cinematic optical soundtrack, more than a century of engineering refinement and acoustic-epistemological shifts are bound up within the machinations of the waveform or bands within which sound is encoded, and the way in which they are read.[194] The journey from graphical mark on a transparent substrate to flicker upon the photocell's surface is enabled via illumination and sensing through thin slits, the width of which are crucial to the tone and loudness of the resulting sound. If too thick a section of the waveform is scanned, the result would be a loss of detail, similar to a low-pass filter; the higher frequencies disappear into the scanning-slot's void – averaged out of existence. Too thin and not enough light is available and the signal begins to sink into the notoriously high noise characteristics traditionally endemic to opto-electronic components.[195] Furthermore, the fidelity of the sound is dependent upon the quality of emulsion on the film stock; lower quality emulsions result in larger grain, producing, (as mentioned above) 'optical rumble'; an agglomeration of countless individual granular 'objects' passing under the projector's sensor.[196] Interventions into these parameters notwithstanding, optical soundtrack experiments in film, such as Guy Sherwin's optical sound experiments, must pass through this set of conditions.

[194] See Lastra (2000), Sterne (2006).
[195] Douglas (1961)
[196] Birtwistle (2010:85)



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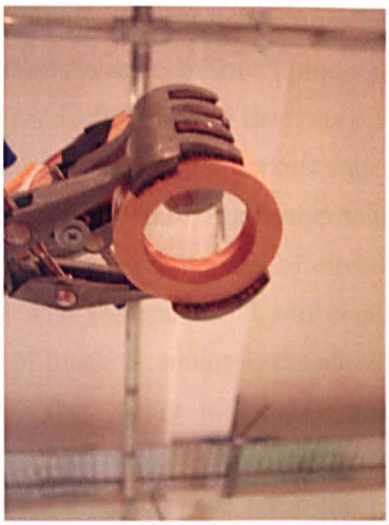

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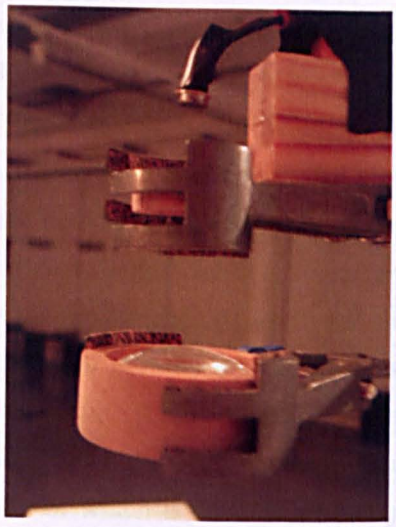

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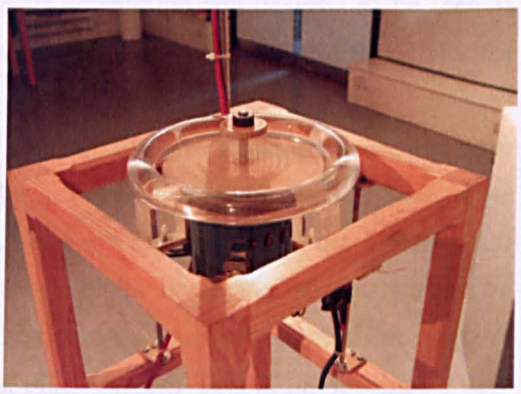


d

Figure 40
Rob Mullender (2007) *Continuous Profile of Eugeny Murzin* at the 'Soundwaves group' exhibition, Kinetica gallery, London 2007. This is the exhibited version of the device described in the above text. a: the optical fibre loom, b: lens arrangement, c: lenses and photodiode and d: in operation.

Photos: the author.

In what follows, I will pursue the trope of scanned information in its transformation from image to sound, and use this to recapitulate the idea that many photophonic systems of sound production are inherently open to the influences of other forms of cultural production, due to the nature of their input. Sound-as-image may be understood as carrying the theoretical weight of various endeavours – writing, painting, photography, and even mechanically speaking, sculpture. But further to this, all of these bring with them the inscribed aftermath of manual activity; of doing and of direct haptic exchange, bringing solidity to a discourse often permeated with the ephemeral and diaphanous presence of synaesthesia – cut adrift from the 'lower' sense of touch. Scanning is the activity that provides the mechanistic key from one modality to the other, being ineluctably linked to movement, and hence time; the line of visual information becomes moving pressure waves in air. Sound on film aside, the most commonly employed media for scanning have taken the form of glass discs or drums, with an opaque waveform photographically printed onto them. Perhaps the most singularly unique machine to employ these methods is the ANS synthesizer, first conceived in 1938 by engineer Yevgeny Murzin, with the first incarnation finally completed some twenty years later. This machine is significant for several reasons, as its conception and design can be seen as the manifestations of a number of threads which run through intermedial art, and especially the interface between light and music, painting and film.

The sounds that the ANS produces are the product of two scanning processes, one performed by the machine itself, and the other enabled by it, but performed by the user. First is the modulation of light by a bank of glass discs with sinusoidal waveforms printed on, yielding 720 microtones, or 10 octaves of 1/12th semitones; effectively pitch increments so small as to be inaudible. The light from these oscillators is then projected onto the back of a large sheet of glass, the front of which is covered in an opaque, non-drying black mastic. This is the machine's user interface, and it is here that the second scanning process takes place. The mastic covered glass is a drawing field, which when scratched allows the modulated light to shine through – the pitches being arranged from high at the top, to low at the bottom. This sheet then scans horizontally in front of a bank of photocells, which generate pitches concomitant with the luminous marks it carries.[197] Murzin's inspiration for developing the ANS came after hearing the synthesized optical soundtrack music produced on film in the 1930's by Yevgeny Sholpo, produced on the various iterations of his 'Variophon' system.[198]

The acronym 'ANS' stands for Anatoly Nikolyavitch Scriabin, the late 19th Century composer, mystic, and supposed synaesthete. Scriabin was a major figure in the swirling mix of eschatology, theosophy, neo-Pythagorism and visionary zeal that constituted the synaesthetic, light-music, or colour sound tendency in late romantic and symbolist art. The dedication of a drawn-

[198] Sholpo's 'Variophon' utilised spinning cardboard discs with shapes cut from them to record synthetic shapes onto the optical soundtrack of the film. Either multiple exposures or the subdivision of the soundtrack provided polyphony. See: Smirnov (2008)

sound synthesizer to such a figure was perhaps unsurprising, since Scriabin was perhaps more well known for his 'synaesthetic' works, than for his exclusively musical ones – particularly *Prometheus*, with its additional notations within the score for luminous events ('Luce') to be projected as the piece was played.[199] Murzin's tastes and aspirations also chimed with broader musical sensibilities orbiting the nascent space race at the time the ANS was being developed. A more recent biography review mentions that 'Scriabin is regarded as a kind of musical mascot of the space-age Soviets'[200] – something no doubt driven by the grandiose cosmic sensibilities of some of his work – and it seemed that in some sense the ANS represented a futuristic exploratory urge, as the then director of the Scriabin Museum (where it was housed) had noted: 'The appearance of the ANS in our time, a time of conquering the cosmos, is not a chance occurrence. I think that Murzin's ANS is meant to create new musical rules, to create the music of the COSMOS'[201]

In the flesh, the ANS presents itself as something like a cross between a jukebox and printing machine, perhaps unsurprising considering the technologies and media involved. Scattered about its console are to be found various mark-making implements smeared with black mastic, each for producing a different quality of line, with a corresponding quality of auditory tone; the thicker a horizontal mark on the drawing field, the noisier the note becomes, having been aggregated out of clusters of adjacent microtones (Figure 41). Removing the glass drawing plate from between the oscillators and bank of sensors generates a roaring wash of noise, with all 720 tones being available to the ear at once.

When not being scanned, the drawing plate is lit from behind by an incandescent bulb in a separately partitioned enclosure, so that it can be worked on in silence – or perhaps the imaginary soundtrack to its own image. The plate can be scanned at different rates under the sensors using a wheel turned by hand, or alternatively, this process can be automated by engaging a clutch, to which is in turn connected to a variable speed motor. This is a fundamental and defining attribute which separates the ANS from the sound-on-film experiments and systems that inspired it; the pitches constituting the sound it produces are entirely independent of the speed of the score's playing, something which is a function of separating the two scanning processes as mentioned above. By maneuvering the score into a position under the sensors' gaze and leaving it there, a particular thin vertical slice of luminous marks can be articulated indefinitely: animated sound in stasis. This pitch/duration flexibility made the ANS, unique among electronic/synthetic sound production systems at the time, most of which were modelled around the piano keyboard/electronic organ or variations thereof – it was now possible to score and perform a theoretically open ended work duration-wise, even if the means to record that work were not available, nor perhaps the

[199] For an overview of this work, and its relationship to Kandinsky, see Vanechkina, et (1998:183-184)

[200] Dickinson (1974)

[201] Tat'yana Grigor'yevna quoted in: Schmelz (2009:260).

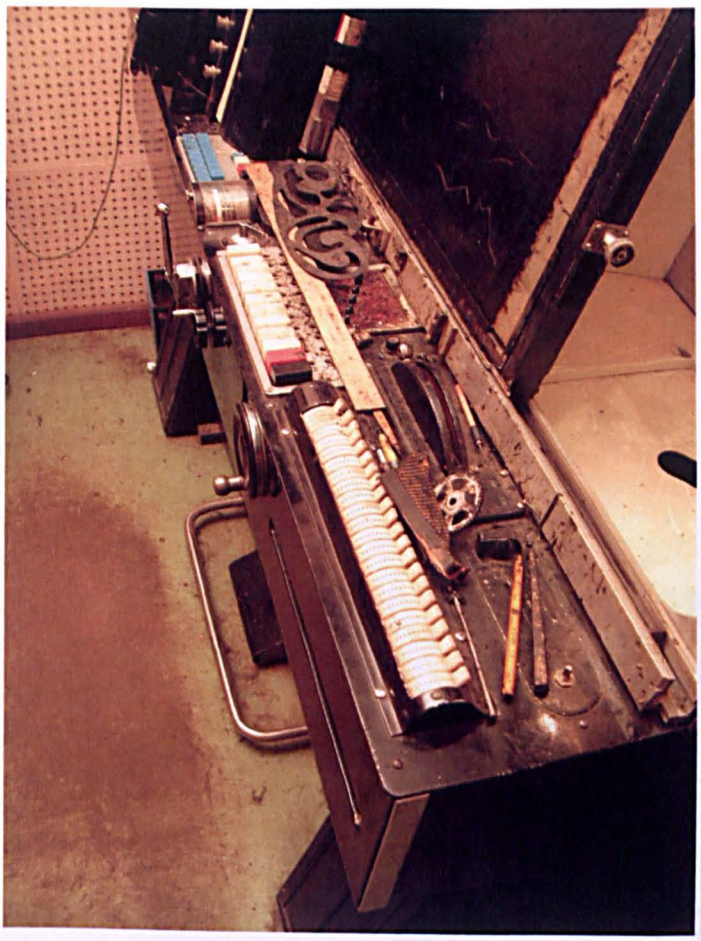


Figure 41
ANS synthesizer console, with drawing implements.
Photo: the author

ideological or aesthetic weather in place to conceive of it. The overall impression of the ANS's sound, however, can indeed best be described as 'cosmic' – the machine seems to want to produce long duration pitches, and the microtonal freedom available makes glissandi seem similarly appropriate – reinforced by the very fact that any line drawn which is not horizontal will produce a glissando at a given rate over time; a predisposition that is direct product of the design of the interface. It certainly seems appropriate that Edward Artemiev would go on to incorporate sounds from the ANS into his soundtracks for the Tarkovsky films Solaris and Stalker.

The mode of input on the ANS (its drawing field) is simultaneously a mode of input and of visual display, and one which works upon fairly traditional notions of how an image might be sonified – those of time on the x-axis, and pitch on the y-axis. Its size and orientation facilitate a range of gestures on the part of the user, from glyphic details to broad sweeps of the arm, all of which may or may not translate meaningfully at the stage of sonification. The marks made in the mastic are necessarily of high tonal contrast because of the material's opacity, and this, combined

Figure 42.
Depiction of the original ANS synthesizer for a magazine article. Artist and publication unknown. Photo: courtesy of Andrei Smirnov

with (I would suggest) a presumption towards the schematic in such contexts, gives rise to an unambiguously flattened field of information, regardless of its notional content. Pictorial or 'illusionistic' marks seem simply to be inappropriate, or maybe rendered representationally impotent – something borne out by studying the scores produced by artists on other plates, all of which are unambiguously schematic, regardless of their semblance or otherwise to traditional pitch/time scores.[202] Although the score/display is visually still within itself, its articulation with sound through scanning is redolent of the visual component of experimental sound-on-film experiments of the period, and (at the considerable risk of a tautology, since the screen is touched) one might concede that this type of image sits within the haptic visual paradigm as outlined by Marks, which I have already discussed.

Whether an even remotely cinematic model of viewing and consumption was considered seriously by Murzin is another matter – after all, the ANS's display is intended fundamentally as an instrumental contrivance to exercise power over the acoustic, and the marks used to enable these

[202] The glass plate is removable, and perhaps a dozen or so others are stored alongside the ANS.

new sounds would seem to have had an uncertain status beyond their private relationship with the composer. These little films were to be overheard, not overlooked (except perhaps over a shoulder). Performing live on the ANS would have required the event to happen in the electronic music studio where it was housed, since the machine is so unwieldy as to make moving it impractical, and accounts of public performances of recorded works produced with the machine usually describe accompanying projections by other artists in the classic 'light-music' fashion, rather than static projections of the score used to generate the sound. Is the listener intended to intuit a graphical score from the recording? Or to put it another way, is understanding the machine's functionality, or strategy for sound production a necessary key to the understanding of its sonic output? A different dynamic is possible here – that the extreme microtonal polyphony that the ANS was (and is) capable of was simply one display further; that Scriabin's supposed privileged insight into higher, more spiritual consciousness of luminous correspondences was what Murzin wished to bestow upon the audience via a utopian quasi-synaesthetic induction... that the exquisite control over sound's parameters afforded by the ANS may, in skilled enough hands, yield a return to light in sound's after-image (Figure 42)

The idea of synaesthesia, its cultural corpus in the arts of the first half of the 20th century, drifts in front of the vision like a softening filter, obscuring and simplifying what must ultimately be a detailed and heterogeneous constellation of individual sensory realities. The prevailing association of synaesthesia with purity, higher knowledge, or spiritual prowess can be seen as a prelapsarian call; a paradoxical concordance between the trope of child-like, utopian or primitive consciousness, unsullied by western modern thought, or a flight away from the body into a unified field of higher consciousness. Kevin Dann traces this complex of misidentification and idealism from its primary source in the Romantic and Symbolist movements in fin de siécle European arts, and their opposition to the positivist, rationalist approach to perception as evinced in the work of such individuals as Galton, Fechner, Müller and Perkinje. Dann points out that the descriptions of 'photisms'[203] from artists such as Scriabin and Schonberg, singularly fail to live up to the nuanced and rich personal systems of associations possessed of Synaesthetes in the medical and psychological literature. More specifically, the common notion of amorphous primary colours manifesting in the vision without any accompanying linguistic, material/haptic or spatial correlations is rarely the case. True synaesthetes (or for this particular case, 'chromaesthetes') 'invariably include black or white in their photism descriptions, along with dozens of highly idiosyncratic colour terms – 'beeswax yellow', 'mouse colour', 'mixture of yellow and grey like new rope". Note the intrinsic material nature of what is being recounted. More startlingly, he

[203] The coloured abstract manifestations which synaesthetes perceive as visual components of other sensory stimulation, typically sound.

recounts the extraordinary, singular reality of Solomon Shereshevsky, a prodigious Russian synaesthete, as recorded by A.R Luria. For example, when considering the associations conjured by letters, Sherechevsky remarks that:

> 'A is something white and long; И moves off somewhere ahead so that you just can't sketch it, whereas Й is pointed in form. Ю is also pointed and sharper than e whereas Я is so big that you can actually roll right over it. O is a sound that comes from your chest... It's broad, though the sound itself tends to fall. Эй moves off somewhere to the side.'[204]

He then goes on to describe some further manifestations contained within these composites with respect to their interaction with simple drawn figures, and the different arenas each of them inhabit when influenced by changes in these marks: 'But one thing still isn't clear to me: if the line goes up, I experience a sound, but if it moves in the reverse direction, it no longer comes through as a sound but as some sort of wooden hook for a yoke'[205] It is perhaps mischievous to cite this case as an exemplar of true synaesthesia , particularly with a view to highlighting the paucity of colour-sound correspondences in the arts – after all, Dann goes on to explain that Shereshevsky was an extreme case; a five-point synaesthete and true eidetic,[206] who, because of the intensity of his condition, was unable to engage with language in anything other than literal concrete terms. Indeed, such was the irrefutable, vivid permanence of his multi-sensory composites of experience, that abstract engagement with language, say, on the level of metaphor, was simply too much. 'All words were concrete objects to him, usually with a host of synaesthetic associations to give them even further "weight". For example the concepts of "nothing" and "infinity" were both impossible for Shereshevsky, since both these words evoked real, material entities for him.'[207]

In discussing the outer limits of this dichotomy between what I think of broadly as biological and cultural synaesthesia, I am not setting out a binary polemical position to critique synaesthetic art in general – I rather like some of it, in fact. Nor do I infer here that all intermedial art that plays with sound and light is aspiring to, but falling short of synaesthesia. There is, though, a nagging impression that somehow, in just maintaining that one experiences a vivid, primary set of diaphanous formless colours in direct, indexical relation to a set of standard diatonic tones or semitones, one is selling the whole thing short. After all, to reduce musical sounds to pitches is also to strip away timbre; a denuding of materiality, or object-hood from listening. I would suggest that the ANS synthesizer could be understood as engaging with this shortfall; as a reconciliation between the notions concerning the intangible and transcendental which characterise the

[204] Dann (1998:2-3)
[205] ibid.
[206] 'Five point' meaning that he experienced synaesthesia in all his five senses. An eidetic has the ability to recall at will, past experiences with a clarity that is often more than life-like.
[207] Dann (1998:163)

'synaesthetic' works of artists such as Scriabin – and by virtue of this singular machine's physicality and modes of input and operation – the body-bound complex of associations that attend sonic experience to differing degrees, for both true synaesthetes and non-synaesthetes.

In briefly outlining the poly-sensory richness possible within synaesthesia, Dann explicitly refutes Scriabin's (and others) claim to the condition. The powerful identification with, and invocation of materials evident in the accounts above – a gestalt of 'objecthood' – as an essential attribute in addition to colour, runs contrary to the non-corporeal aspirations of the synaesthetic arts.[208] One might detect that an urge toward purification is at work within this sub-genre of artistic production, a flight from mere 'things', from dirt and from the touch of earthly bodies. That the ANS synthesizer may be somehow a channeling device for this predilection might perhaps be interpreting Murzin's dedication of his brainchild to Scriabin too avidly, or simply being a little inflexible. Other considerations are worth mentioning here as well, specifically Douglas Kahn's situating of the synaesthetic tendency squarely within the dialectic between noise and music that played out within western art during this period, and which still continues. For Kahn, the artistic synaesthetic urge finds some of its roots in the denial of noise, and of direct representation within western art music – a protection, or inoculation against the supposed contagion of non-tonality. The atomization of vision within painting presaged by the arrival of photography's assumption of the pictoral mantle, is not understood (in Kahn's particular history) to have been recapitulated by a similar crisis in music and its relationship to new phonographic practices, nor indeed to telephony or radio. The synonymising of noise (as an agent of disorder) with sounds outside of music, or of the world, he suggests, also found sustenance from the denigration of, and general distaste towards mimesis within it; simply put, the mimicry of extra-musical sounds threatened the purity of the composition.

In allowing the outside in and letting it speak for itself, rather than applying the familiar, oblique codes of allusion through tonality, a de-focussing of the work is perpetrated. He quotes Roger Scruton: 'When music attempts the direct 'representation' of sounds it has a tendency to become transparent, as it were, to its subject.'[209] – in the dynamic proposed here, the suspension of disbelief (to borrow a term from cinema) collapses. The action of extra-musical manifestations seem, in this report from the conservative tendency, to be afforded a visceral ability to denude music of its power to carry – reducing it to an insubstantial field within which reality, with all its dirty, uneven harmonic content, unpredictable dynamics, and straightforwardness to itself can be foregrounded and played out. A hermetic, rational and rarified system of correspondences between pitch and colour, which valorised both aural and visual non-representation for the sake of access to a unification of both, could not find space within itself for such brutish behaviour.

[208] Something which continues uninterrupted into current works in the microsound/visual music arena.

[209] Scruton in Kahn (1999:110)

Additionally, the drive towards mathematical analysis within acoustics, as developed by Helmholtz and Fourier, offered up the tools (if not the computing power – not yet) for the re-evaluation and consequent ownership of noise; domination of the irrational – proof of which could be supplied in its synthesis on paper – was now simply a matter of doing the work. All noise could be understood as a confluence of smaller, simpler components, to be aggregated under the curves of a single graphical figure: 'Consequently, the marvellous analytical power of mathematics , the simplicity of graphical representation, and acoustical discourse within the framework of science at that time enforced cultural practice; noise was eliminated, and music bolstered within the given confines of musical sound.'[210]

The carefully arranged mass of projected sinusoidal tones that Murzin's ANS so efficiently provides, and the way that these are filtered, might be seen as a pulling together all of these contradictory strands of endeavour and desire concerning sound's perceived nature. The graph-like interface is both literally and figuratively a mask against noise, since it makes possible the selection of single fields of sinusoidally modulated light, plucking them from the cacophony behind. It also enables – and to those of a particular disposition, invites – operations particular to additive synthesis by providing a working surface that facilitates manual, graphical, mathematical schema. Simultaneously, the aspirations of moving painting toward the condition of music are clearly manifest in the machine's design;[211] using the ANS leaves one in no doubt of how the gestures made upon its surface operate in terms their subsequent manifestation in the acoustic realm, based as they are on well established norms. We begin to see, then, that the ANS can be thought of as the reconciliation of a set of competing urges – to employ the instrumentality of drawing as a means to acoustic freedom (and indeed to get one's hands dirty – no other synthesizer leaves you with black goo under your nails); to contrive a two dimensional, gestural graphical system to control a diffuse three dimensional medium, and to draw from the scientific discourses within acoustics to aim for privileged, more spiritual modes of perception through the possibility of disavowal of noise and duration.

[210] Kahn (1999:79)

[211] Particularly the second model, which is oriented in the fashion of an artist's easle. Murzin's original prototype had a horizontal drawing surface – this is now lost (Figure 42)

Oramics, Graphical Sound, and Visible Speech

At around the time of Murzin's completing of his ANS prototype, similar attempts at applying drawing and gesture directly and instrumentally to sound were going on in the U.K, where Daphne Oram was approaching the end of a considerable period of development of her own drawn sound system, which she called 'Oramics'. Murzin and Oram's projects bear some similarities to each other, in addition to the use of drawing as a means of input. The Oramics system like the ANS, and unlike sound-on-film systems, decouples the instrumental or control function of the drawing interface from the sound production aspects.[212] It also draws upon tone generation systems which, rather than hand drawn, are predetermined or automated in character – specifically, the oscillators producing the tones are of the more common transistorized variety (although, the sound from these is modified again by graphical figures, as I explain below). More broadly, Oram, like Murzin, developed her synthesizer on her own, outside of any institute, with the support that such an affiliation might have provided, and up until two grants from the Gulbenkian Foundation were awarded, also self-financed the project.[213]

The machine consists of an input, or control component, and a separate sound generation system. Sounds are triggered and controlled by a total of ten individual lengths of film, which are overlaid on a flat surface with a time-line grid or stave on it, acting as the main interface. These strips then pass under an acrylic strip at one end of the interface, which serves to channel light down through the film from a festoon of small tungsten bulbs. Underneath this sit an array of photocells which detect modulations in the light caused by the marks on the film as it passes above. Each film strip is spooled at both ends, and all of the spools are linked to a single drive system, enabling accurate synchronization. The first four strips carry either small squares of electrical tape, or blobs of opaque paint, which are pitch information, and go on to trigger reed switches, which in turn activate oscillators. The fifth strip is a continuous wave-form which controls vibrato. The next four strips carry envelope information, for the pitch tracks and the last is effectively a master volume control (Figure 43a)

The oscillators themselves are housed in a separate cabinet, and are individually tuned (each is annotated, with a musical pitch written next to it), and underneath these sit two round cathode ray tubes (CRTs), with further provision for two more on either side. Above them are situated photomultipliers, and between the two, glass slides with opaque wave-forms painted onto

[212] I'm using the present tense when discussing the Oramics system, despite its completely non-functioning and generally very poor condition. This can be taken as a small token of optimism, since it now belongs to the Science Museum in London, and the hope is that it will one day be restored.

[213] Hutton (2003)

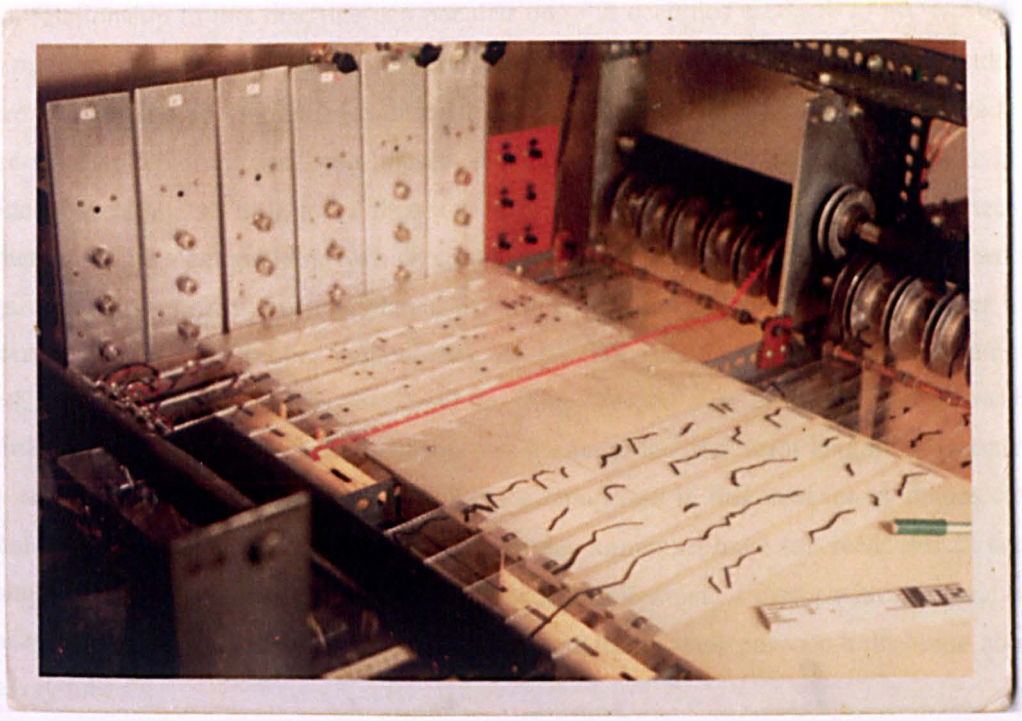
them. This arrangement of cathode ray tubes, photomultipliers and masks amount to a wave-shaping, or timbral control system. The rate of scan on the cathode ray tube is dictated by the pitch of the oscillator, and the amount of light reaching the photomultiplier (and therefore the voltage of its output) is modulated by the opaque mask as the line from the tube scans across, effectively sculpting the waveform. This form of wave-shaping, known as 'masking', is a common technique for producing timbres in early 20th century photophonic instruments.[214]

So Oram had, over several years, created a form of electronic sound synthesis which used a combination of graphical marks and electro-mechanical strategies, which she was confident could control every aspect of the sound in the amplitude/time domain. The Oramics system is sometimes mistakenly categorized as a sound-on-film synthesizer, which is not strictly the case (in fact given the presence of the CRT wave-shapers, it might be more appropriately thought of as televisual). Oram did indeed use blank 35mm film stock to draw her scores onto, but this is where the similarity ends. Her use of materials, I would suggest, would have been largely borne out of expediency,[215] since in 35mm film, she had at her disposal an accurately made, mass produced (ie, cheap), tried and tested material, which came with a complete system of useful mechanical parts for its accurate transportation and storage. A large number of technical problems would have been solved simply in making this fundamental decision, and a similar attitude is in evidence with her use of Dexion as a main construction material – a system designed for light industrial shelving, but repurposed to her needs. I would suggest that this machine wasn't designed in the normal sense of the word – it is an agglomeration of small inspirations and problem solving, tweaks and bodges. As such it has an aura of endeavour and complexity which is impossible to fake or design - a patina of many meaningful decisions and actions effected over years.

This patina is not about surface and age (as the dictionary would have it), but rather it is a composite of visual noise, manifest functionality and heuristics; a manifestation of personality transmitted as though a radio signal, or more pertinently, modulated light. Unlike the ANS, all of the workings of this machine are on display, except for the wave-shaping stage, which stays housed inside what seems to be a cabinet purpose built for the occasion, but which is obviously designed to look like an item of furniture; to blend rather demurely into a middle class interior (Figure 43b).

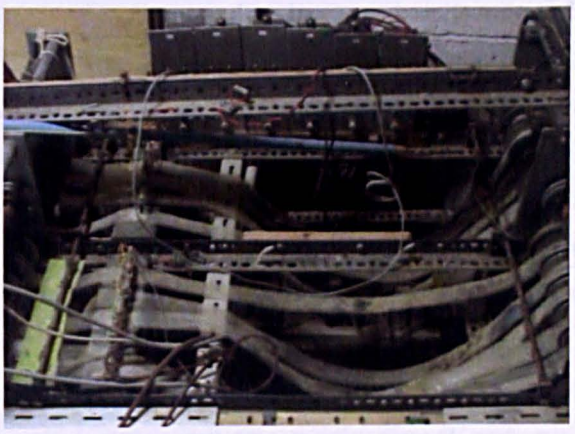
[214] Douglas (1957)

[215] But perhaps leavened with symbolism. The complex and personal spiritual aspects of Oram's creativity were carefully and fully integrated into the physical, practical aspects. I feel that so fundamental a part of her brainchild would as some point been integrated in similar fashion.



a

b



c

Figure 43
Oramics, a: in its heyday, and
b & c: before restoration
Photos courtesy of the Daphne Oram
Archive, and the author.

My own relationship to this machine is a peculiar one – it occupied a corner of my workshop for several months while negotiations for its purchase by London's Science Museum were underway. I therefore had ample opportunity to examine it, but was unable to do much else, since its fragility and dire state of repair (it had been housed in a barn in France for some ten years) reduced it, functionally speaking, to little more than a bizarre conglomeration of electrical and mechanical components.[216] The Dexion chassis which comprises much of the machine's structure was bent at the legs, and being mostly un-triangulated, the whole thing wobbled precariously under its own considerable weight. Any rubber components on the film spooling mechanisms had long since perished, and disconnected cables festooned the thing, draped over broken valves, cobwebs and even birdshit. Most poignant of all, however, was the presence of several lengths of Oramics film strips – the graphical marks on their filthy surface comprised in this instance of shapes cut from electrical tape. At present, they are the only examples known to have survived, and as such, are important artifacts in the history of 20th century electronic music – along with the hand painted wave-shaping slides which were to be found still mounted in their purpose built home above the cathode ray tubes.

In terms of gesture, the Oramics machine's input is more akin to writing than drawing, organizing the composer's work into distinct (albeit co-presented) streams of information, which coalesce to form a larger construct at the mixing or auditory stage; something reinforced by the flat orientation of the interface, and the general scale of each field. However, the nature of this 'script' differs from the sort that historians and theorists of early sound technology have examined – the phonograph's trace and the sound film's visible inscription. In writing upon the Oramics' film strips, one is sculpting the broader durational and dynamic parameters of the tones that the oscillators produce, rather than operating on the timbral or waveform level. The marks that are required by the Oramics system sit across several fields of artistic activity; as relatives of writing, drawing, and musical scores, but also the products of the network of technologies and artistic attitudes which enabled Oram to conceive of such a system. Her technological savvy (she started her career as a 'music balancer' at the BBC, before going on to design and co-found the BBC Radiophonic Workshop) meant that she would have been entirely conversant with the techniques and technologies of audio production and reproduction, and this would almost certainly have included the optical film soundtrack.[217]

Oram's writing on sound aims to draw direct correlations between the central nervous system and the circuitry of sound production. More specifically, she makes links to different processes within electro-acoustic sound production, and different spiritual and mental states, such as auditory distortion and mental illness – for example, unnatural 'clipping' of waveforms

[216] Also, since the Oramics machine was a historically significant artifact awaiting conservation, interfering with it in any way would have been outside of my remit.

[217] It is worth noting that synthesizers which utilized cathode ray tubes to sculpt timbre had already been patented previously in America and elsewhere. Some of these patents can be viewed at: UBUWEB (2011) under the section entitled 'Instruments Using Optical Generators'

constituting the brain's electrical signals might be the cause of both character, but in its extreme form, distortion within a person's character: 'Do we, both humanly and musically, walk a tightrope? If we lean one way we plunge into the futile void of the ineffectual sine wave; if we lean the other way we fall into the abyss of annihilating noise.'[218] For Oram, mental stability and personality are defined by a clarity of form as carried by the wave functions of the brain, whereby she suggests we 'sense a relationship between the control of the formants and the growth of individuality; furthermore we [see] the abuse of formant control leading to madness.'[219] This philosophy carries into her conception of the Oramics system, which she understands as containing the possibility of 'humanising' electronic music through the effective employment of manual gesture, and through the learning of the Oramics system's marks as a kind of linguistic text: 'We have an immediate *visual* feedback of what we are writing in our graphic notation, and as we gradually come to know the "language", our "inner ears" will let us "hear" what we are doing...'[220] Oram makes clear the circuit between the machine and its user through the mirroring of their functions, thereby creating a more effective concordance between the two – enabling better communication, and hence a refining of the artistic process. The exchange aspect here is notable, since the 'reading' of the sounds that are 'scripted' is both explicit on the part of the machine, and implicit in return through the operator's reflexive understanding of what that script generates sonically. We might surmise that it was Oram's wish, that through the machine, or through the user's acquisition of virtuosity through reflexive listening, the self is programmed as well; only the human party in this exchange, however, may hear the results.

Oram's technique of scripting sound – of 'programming' a using haptic / gestural, manual and reflexive system of marks to elicit the entire gamut of sounds possible has clear antecedents in programmable musical instruments such as the player piano, music box, or indeed the RCA synthesizer. But if we are to be sympathetic to her professed aims of mirroring the musical/human though the intricacies of gesture and manual articulation, then it is possible to consider a forerunner to Oramics which excluded the technology almost entirely.

> 'Imagine, for instance, that you have been stone deaf since you were seven years old. How difficult it will be for you to now sing a song. You will have some muscular memory which will guide you in controlling the lungs, vocal chords and mouth; but without feedback through the ears, you will not know exactly what notes you are producing...'[221]

[218] Oram (1972:49)
[219] Oram (1972:52)
[220] Oram (1972:38) Emphasis in original.
[221] Oram (1972:94)

The 'Visible Speech' system Formulated by Melville Bell, Alexander's father, and then proselytized extensively by Bell himself, occupies an unusual position in the histories of sound's representation and production. It was designed as a set of symbols which codified, on a sub-linguistic, or exclusively phonetic plane, the total possible constituent elements of speech, so that any language (in theory) could be constructed and articulated by a speaker from their formulation. Consisting of a series of modular, interlocking curves, dashes and dots, these glyphs were on one level, a set of symbols which represented the entirety of sounds that were necessary for verbal communication.[222] When seen as such, they can be understood to require no recourse on the part of the speaker to any linguistic understanding or structures at all; I myself could quite happily read at length in some dialect of Urdu or Yupik, assuming a strong enough conversance with Visible Speech. I would have no idea what I was saying, however. This removal of the speaker from the loop of language and therefore agency, represents an unusual shift in the balance of power between the written 'word' (if it can be called such a thing here), and its reader, or more specifically, speaker.

Sterne (quoting John Peters) names '...the Bell family's work in visible speech "the primal scene in the supercession of presence by programming" because it was an attempt to enact communication without interiority, "a code that can pass as an adequate substitute for the original."'[223] However, the nature of these symbols is different than in Sterne's reading; he states that although 'visible speech' required '...only a person following instructions to make sounds with his or her voice... It did, however require a subject who could hear and make sense of the available sounds.'[224] Not only does an examination of Bell's explication of the system and the methods outlined for teaching it suggest that this is not necessarily the case, it also reveals an alternative means of operation on the part of its script, by virtue of how its constituent symbols were designed, revealing a re-figuring of meaning through the sense of touch.

Bell's series of lectures which comprise *The Mechanism of Speech* carefully delineate the way that the various apparatuses within the body generate the resonances, sibilances, and transients that constitute vocal communication. But more importantly, a reflexive pedagogic methodology involving how these organs look and feel when in use is systematically developed. These methods crucially involve physical intervention on the part of the teacher with respect to the deaf child, physically coercing the tongue into the required positions. In response to an elocution teacher's request to explain how the digraph 'ng' can be taught: 'Take a manipulator (for example; a paper cutter) and hold it in the pupil's mouth so as to cover the top or front part of the tongue. Now tell the pupil to say n. The point and front of the tongue being fettered, the back of the tongue alone is free to rise; and the attempt to say n results in ng. Now give the pupil a hand-mirror and tell him to

[222] I would suggest that this may not be the case with certain Asian languages. The pitch inflections so essential to Mandarin, for example, seem to be uncodifiable in visible speech.

[223] Peters in Sterne (2006:37)

[224] Sterne (2006:37)

keep his tongue still while you withdraw the manipulator.'[225]

Several different modes of communication are at play here. Bell advises that the questioner tell her pupil which sound to make – suggesting that he or she may be able to hear, but more likely these would be mimetic visual instructions. This positioning of the tongue is then corrected by touch via way of the invasion of the mouth by an instrument, followed by the visual reinforcement of that kinesthetic input: to bestow upon that posture a visible sign seems the necessary condition for the bypass of the reflexivity that the ear provides the voice in those possessed of hearing. The mirror's anchoring of the tongue's posture in the speaker's mind enables the making sense, (to echo Sterne's term) so that the ear need not – and to be clear, this understanding may contain no trace of aurality, but be a composite of the visual and the internal gestural/haptic. With this amalgam of sensory feedback now established, it is a relatively small step toward a substitution of that mirror for something codified, or 'universal'.

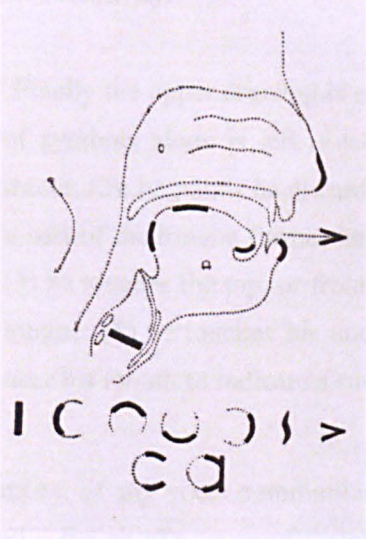


Figure 44
Visible Speech head schematic, showing coding of the organs of speech.
Bell (1914:53)

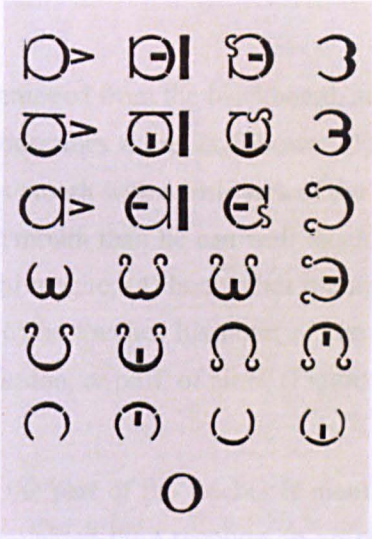


Figure 45
Coded parts arranged into glyphs
Bell (1914:71)

[225] Bell (1914:12)

Hence, the constituent parts of the symbols in the Visible Speech system are coded instructions for the movement of the body's formant apparatuses in the production of speech. Each curved mark within its glyphs pertains to a part of the body: the larynx, parts of the tongue, lips and even the tip of the nose. Finally, an arrow indicates the escape of breath from the mouth. In teaching deaf children how these elements relate to their internal structures, a schematic cutaway of a head is drawn, with these parts highlighted in heavier lines against dotted lines for the rest of the head, so that the pupils may link the two.: '...the teacher erases from the blackboard all those parts of the diagram which are shown by dotted lines in Chart I, leaving the Visible Speech symbols in position as shown by the heavy lines... The next step is to have the pupils recognize the symbols independently of their position on the blackboard.'[226] (Figure 44) The symbols' elements are internalized – first by the erasure of the schematic, or notional head (enabling its re-figuring into symbolic constitutive elements), and then by the return of these sites to the child's self through his or her own touch. In effect, a naming of the child's interior occurs, which is carried and reinforced by haptic reflexivity:

> 'Finally the upper drawing is entirely removed from the blackboard, and the lower line of symbols alone is left. Each pupil describes these as follows: (1) he touches his throat; (2); he points backwards into his mouth with a little jerk of the hand, indicating a part of the tongue further back in the mouth than he can well touch with his finger; (3) he touches the top, or front part of hi tongue; (4) he touches the tip, or point of his tongue; (5) he touches his under lip; (6) he touches his nose; (7) he places his hand near his mouth to indicate a sudden emission, or puff, of air.[227] (Figure 44)

No mention of any vocal communication on the part of the teacher is mentioned because none is required – the child's sense of vocality is surplanted by a recourse to proprioception (the body's feeling of itself) – but without the register of hearing to compare against; only the mirror of vision to reassure an inexperienced and underdeveloped kinesthetic interior. As Bell states, in answer to the question 'Can a person realize by any feeling the muscular condition represented by your symbols?'

> Certainly. Familiarity with the organs through the use of a mirror leads to a perception of muscular feelings of the positions assumed by the vocal organs...The deaf child...through training...becomes conscious of the movements of his vocal organs and can tell by muscular feeling exactly what he does.[228]

[226] Bell (1914:52)
[227] ibid.
[228] Bell (1914:75)

But this mirror must be replaced, ultimately by Bell's symbolic graphical surrogate; a representation of posture and touch that is structurally predisposed to a fluid power dynamic, since its authorship is open to anyone with a will to learn the script, the meaning of which would be opaque to the child in its opaque linguistic operations (Figure 45). As the child progresses from the basics, these newly named parts of his or her vocal apparatus are recombined further in more complex symbols. Further marks of articulation, restriction and movement are added; effectively the child, as a sonorous body, is coded by the instructions of visible speech.

Sterne asserts that sound's technologies of reproduction are a form of delegation of hearing, or a mimesis of the auditory faculty, and we may find that this does indeed find an analogy within the visible speech system. However, as we have seen earlier, it might also be seen as related not to causally inscribed (that is to say, recorded) sound, but leans more toward the realm of the drawn-sound experiments that followed the arrival of the optical film soundtrack of the cinema – crucially, because of the severing of the link between the heard and the spoken. The silent lacuna – both sensory and linguistic – exploited by the Bells' script, is in part recapitulated in these synthetic shapes. Both theoretically produced sounds (speech from the profoundly deaf, and musical tones from the non-acoustic) whose antecedents were not auditory, but composites of ideas concerning the possibility of sound brought about by technology's transformative prowess. These experiments were sounds generated entirely synthetically, which (as we shall see below) broke the link between recording and reproduction, hearing and the world being heard, since they had never existed sonically but were code to be sonified.

However, it may be the case that Oram's system is a closer relative, since within Oramics there exists a further level of instrumentation; the graphical shapes on a horizontal drawing interface are control data for the sounds generated elsewhere in the apparatus – and this brings them into consonance with visible speech, which operated on the human in analogous ways. In Oram's desire to 'humanise' her machine, and her 'formants' of the nervous system, and Bell's project to encode sound production in the deaf, we may infer a notional meeting point though the agency of the script upon the machine and body respectively. In still retaining the need for a vestige of hearing within 'visible speech', Sterne misses the possibility of the purely instrumental systems at work; a script instructing the body under the auspices of the voice's absence. If a profoundly deaf child could be taught, however synthetically, to speak by an encoded system of vision and haptic feedback, then Sterne's mimetic machines ('machines to hear for them')[229] were twice mirrored - back into the body, in a mechanization reaching instrumentally inward through the void of deafness. Visible speech reached into the body of the speaker and spoke on his behalf, using his biology – it was, in effect, a form of ventriloquy.

[229] A quote from Bell, and the title of the chapter in Sterne's book being discussed.

The short-circuiting of the agency in a sounding body from the chain of audio production, be it vocal or musical, was to reassert itself at the advent of the optical film soundtrack. The media historian Thomas Levin sees unease in the recounting of performances of early sound-on-film synthesis works, indicative of a perceived threat posed by recorded audio phenomena whose ontology was new and uncertain. The removal of the amplitude component of the sound from the third dimension (the phonograph's indentations) to the second, rendered recorded sound into a graphical script. Crucially, the plain visibility of this sound was an analytical asset to engineers, musicians and composers, being a condition of, and short step from readability. And what could easily be read and analysed could be reproduced and synthesized, thereby giving birth to sounds which had never before existed, and destroying the assumed causality between acoustic event and its represented remains. To quote from a short information film made about Yevgeny Sholpo's 'Variophone' system: 'Thus the Variophone is a purely optical device that doesn't receive or produce any sounds. The sounds produced by the loudspeaker near the screen are artificially produced without the use of any acoustic or noise instruments. It is drawn (graphical) sound.'[230] As Andrei Smirnov has noted, Sholpo was working on what he termed 'performer-less' music, and this term exemplifies in part the anxieties produced by these new instruments – and given a further ideological, anti-bourgeois vigour in pre-Stalinist Russia.[231] Arsenii Avraamov also understood the new graphical sound systems being developed by him and others as a way of breaking free of the 'material culture' of music.[232]

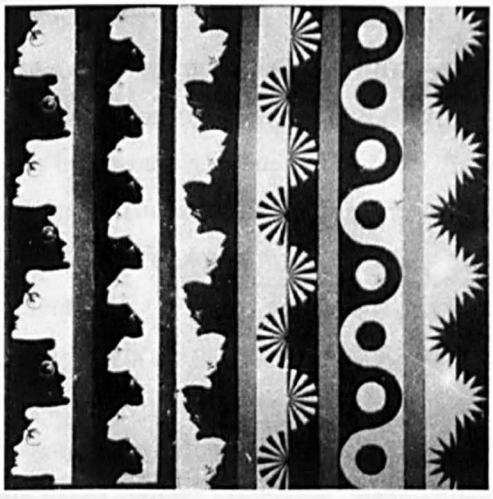


Figure 46
Ornamental optical soundtracks by Arsenii Avraamov
Photo: courtesy Andrei Smirnov

[230] 'Scientific Research Laboratory at the Cinema-Factory 'Lenfilm'. Department of Graphical Sound 1934'. Film maker unknown. Courtesy of Andrei Smirnov/the Theremin Centre.
[231] Smirnov (2008)
[232] ibid

A more basic question concerning what graphical sound's image actually constituted – its ontological nature – emerged almost as soon as the first examples materialised in the developing tank. A report from the inception of sound on film in Russia mentions, 'When in October 1929 the first film roll was developed, the crewmembers were amazed with the view of the first soundtrack they ever saw. It was Mikhail Tsekhanovsky who had voiced the idea: "What if we take some Egyptian or ancient Greek ornaments as a soundtrack, perhaps we will hear some unknown archaic music?"'[233] While this must have been one of the more credulously wide-eyed responses to this newly born medium, it is nonetheless indicative of part of a subtle variegation of attitudes that would emerge concerning the nature of image based sound recording, one which did not trouble its mechanical relatives such as the phonograph (Figure 46).

The analysis and re-synthesis of the phonograph's grooves was being proposed as early as 1916 by Arsenei Avraamov, and more famously by Lazslo Moholy-Nagy in 1922 – but the advent of optical sound and its inherent relations between morphology (or from the photocell's perspective, luminosity as a result of fluctuations in the image's surface area) and amplitude also invited experiments which probed possible meaningful relations between shape and tone, resulting in what at the time was called 'ornamental sound'. Levin uses the examples of Oskar Fischinger and his contemporary, Rudolph Pfenninger, as a way of highlighting this split – between generation of tones through the scanning of visual patterning on the one hand, and analysis of the visual/acoustic, followed by re-synthesis by a construction of 'credible' sonic waveforms on the other. Fischinger is best known for his work with Disney, specifically preliminary work on what would become 'Fantasia' in 1940, and laboured extensively on a taxonomic system of interrelationships between sound and image, which he called an opto-acoustic ornamentation system; indeed, Oscar Fischinger's experimental short which demonstrates this approach (it begins with the explanation: 'What you see you hear. What you hear you see') carries the title *Tönende Ornamente.*[234] Pfenninger, however, applied a more structural and analytical approach to sound production, reasoning that if the fundamentals, or building blocks of sound were established, then synthesis of more complex forms could follow on from there.

In eschewing any significance in the visual form of his graphical sounds, Pfenninger's work is characterised by Levin as driven by more rigorous, scientific, and worthwhile concerns – nothing less than the genesis of an acoustic form of ur-language; a quasi-linguistic tonal system, yielding the condition of writing through a rigorous rule-based syntax. Fischinger, meanwhile '... as he himself is the first to admit, is basically interested in exploring the relationship between given graphic forms and their acoustic correlates, and how that isomorphism might allow one to make cultural-physiognomic comparisons.'[235] Levin feels that since the very act of articulating a non-

[233] Ibid.

[234] Photograms uncovered by Smirnov show us that Avraamov did work with ornamental sound at the beginning of his research, but very quickly moved on to acoustically driven experiments utilising analysis techniques pioneered by Boris Yankowski to produce spectral morphing. All but 30 seconds worth of his work is now lost. See Smirnov (2008).

[235] Levin (2003:57)

acoustically derived graphical shape using the cinematic optical sound apparatus, was for Fischinger, a teleological admission of that shape possessing a meaningful sound in and of itself, his (professed) lofty artistic aims were a misunderstanding of sound's essential nature. What Levin ultimately fails to address, however, is the question of audio-visual meaning in the reception of the work. He does not describe whether or not Pfenninger's films (the *Tönende Handschrift* series) contained any visual component at all – although the suggestion is that they did not, since later on:

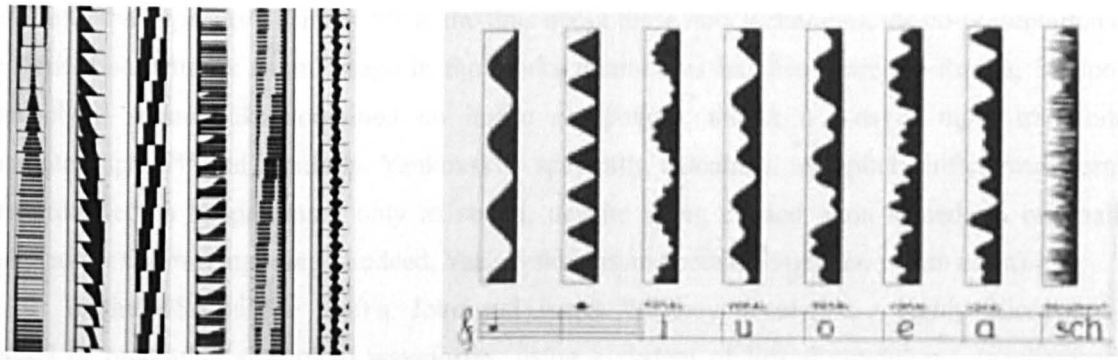
> '...Moholy-Nagy himself explored some of the challenges raised by Pfenninger's technique in the form of a short experimental film entitled *Tönendes ABC* (Sounding ABC) whose optical soundtrack was re-photographed so that it could be projected onto the image track simultaneously with the sound (allowing one to see the same forms that one was also hearing)....'[236]

Furthermore, the press reports that Levin quotes make no mention of any visual aspect to the sound. The disavowal of any iconographic significance in the soundtrack, or isomorphic significance between its physical and acoustic form would support this position – after all, why visually display something that was meaningless, except in its utility to the photocell and the audio it generated? The very act of display in itself is symbolic, and invites correspondences to be made, meaningful or otherwise. If Pfenninger's sound works (if there is no image component, then Levin's use of the term 'films' here is perhaps misleading) had been intended for audio-visual presentation like Fischinger's, then the non-ascription of meaning to visual form would be undermined by a clear indexicality between sound and image, regardless of whether the spectator considered these meaningful or satisfactory. To somehow derive a deeper meaning between graphical shape and auditory tone is, after all, not the imperative of the artist alone, but is equally a matter of the viewer's reception of the work...it becomes itself in the viewing.

It is arguable as to whether that, if viewed during audition, Pfenninger's soundtracks would be clearly derived from a system of rigorous acoustic analysis, whereas Fischinger's would not.[237] The images of Pfenninger's hand-drawn sound figures are as visibly synthetic as Fischinger's, and within the audiovisual paradigm would be seen as such, which alters, or frays the boundaries between the two artists' work proposed by Levin. Fischinger had not engaged in any rough or aleatory processes to produce the individual 'waveforms' on the soundtrack, nor even indulged in, for example, recognisably figurative forms, as Avraamov was producing in Russia. That the typology of forms was texturally limited shows us that Fischinger was aware of the attributes needed to generate relatively noise free timbres and stable pitches; he had also not engaged in

[236] Levin (2003:63)

[237] Some caution is needed here. Fischinger's 'Sounding Ornaments' soundtracks are clearly more iconographic than other works reproduced in his paper – something which Levin does not address properly, other than to suggest that it was only through getting to hear of Pfenninger's research that he changed methods. This is refuted by Moritz (2004).



a b

Figure 47
Optical soundtracks
a: fischinger, and b: pfenninger
Levin (2003:48-49)

anything so recklessly noisy as Guy Sherwin's trickster transformations some forty years on. To complicate matters further, there is the probability that, according to William Moritz, the famous shots of Fischinger holding his large scrolls of hand painted graphical sound, along with pictures of his assistants painting them, were produced for publicity purposes: '...Hans, Oskar and the hired young women had quickly painted them just for the purpose of having a flashy object for press photos – and possibly to deceive anyone who would try to mimic Oskar's work for his own profit.'[238] ...that person presumably being Pfenninger.

In designating optical sound as audio-visual, in its basic nature, Fischinger was exploiting or exploring a latent possibility of his chosen medium to its fullest – that being the co-presentation of artifacts as simultaneous aural and visual aesthetic entities. Pfenninger's project was indeed different, as Levin points out, but perhaps for different reasons. To compare them as works both striving toward the same ends, but with one falling short, is to conflate the problems concerning optical sound's ontology within a purely aural framework with those within an audio-visual one; concluding that Fischinger's work was conceptually flawed as a result is unfortunate. He essentially approached his project from the part of the film designated for the image, after seeing that '...the kind of "ornaments", abstract designs that he used in his films, were not substantially different from the sort of patterns that were generated by sounds on the optical soundtrack.'[239] One wonders what may have been produced by both artists, had the combined forces of economic hardship and the rise to power of the Nazis, with their denunciation of abstract art as degenerate, not brought such experiments to a halt.

[238] Moritz (2004:44)
[239] Moritz (2004:42)

Outside of the expository films made at the time about these new techniques, the co-presentation of the optical soundtrack as an image in the works themselves has been rare. In Russia, Sholpo's 'Variophon' soundtracks contained no image component, unless it was of more traditional cinematography,[240] and similarly, Yankovski's spectrally calculated and pitch-shifted waveforms were intended to be presented only as sound, despite being carried upon a medium originally designed for the moving image (indeed, Yankovski was an acoustic engineer, not an artist).

In the USA in the 1940's, John and James Whitney developed a highly idiosyncratic method of producing sinusoidal waveforms, using a system of linked pendulums, mechanically actuating a gate which opened and closed accordingly as the film's soundtrack was scanned past and exposed. The film was spooled past the recording slot at a relatively slow speed compared to that which it was to be played, and hence the soundtrack is effectively recorded in time-lapse. The resulting Five Film Exercises, dating from 1942 to 1945, are complex, sophisticated pieces of polyphonic electronica with a luminous, abstract visual component; sounding somewhat like a set of short proto ANS works – perhaps due to the sinusoidal waveforms. However, they still possess a warm, peculiar sound entirely of their own, being also characterised by the reduced frequency range available with optical sound, and the rapid transitions and dynamic properties only possible in editing with film at that time.[241] Continually present is the soft roar of the film's grain, and the crackle of dirt, scratches and other inconsistencies in the emulsion and its celluloid support as they pass under the optical sound-head's eye; the sound struggling at times to find its way above the fog.

John Whitney had previously studied 12-tone musical composition in France, and this carries through strongly into both the sound and its interplay with the image. Working at times in unison, and at others in counterpoint to the image, Five Film Exercises soundtrack is both microtonal and formally disciplined in its progression, exploring and overlaying motifs in various iterations. The image consists of basic shapes in differing hues, drifting, intersecting, flickering, moving in and out of focus from a black background; the overall impression is of an etude on the recombination of basic elements in the audio-visual domain.

However, in deriving their compositional strategies from serialism, the Whitneys were not seeking to reference the Vienna school, but to lift the work out of all forms of musical signification whatsoever. In striving for an audio-visual hermeticism which operated strictly on its own terms, the Whitneys initially chose the '...simplest, least common, primitive music we could find. But another source of disunity became apparent. In this case, the dominant source of distraction was the contradiction between the origins (the players, instruments, time, place, etc.) of this kind of music and our animated image.'[242] Hence, as Birtwistle goes on to note, the pendulum soundtrack

[240] Something which contributed to their languishing undiscovered in the state film archives near Moscow up until 2006.

[241] Spegel (2009)

[242] John and James Whitney in Birtwistle (2010:144)

[243] Birtwistle (2010:145)

[244] This is nicely demonstrated in a short film about McClaren's methods, entitled Pen Point Percussion. See: Carlosbela (2008)

generator was invented as a way of rinsing all broader cultural signification from the work, refiguring the cinematic apparatus into a system of production, as distinct from reproduction, and placing the Five Film Exercises squarely within the tendency already discussed – of Kahn's 'noise reduced' synaesthetic forms, and of the disavowal of the supposed noise and dirt of corporeal concerns.[243]

A further feature common to most systems of graphical sound production is a drive toward stability. Automating the repetition of waveforms effected the standardisation and consistent reproduction of (eventually) sonic events, by the eradication of audible mistakes, or inconsistencies that would ordinarily characterise soundtracks were hand drawn. The Whitneys' pendulum soundtrack generator is an ingenious solution to the problem of how to derive a stable waveform which betrays no trace of manual craft. A listening comparison of the Five Film Exercises with Norman McClaren's Dots suffices to illustrate this. McClaren developed three techniques to produce the graphical sound tracks to his animations – photographing waveforms using a rostrum camera, scratching onto black film leader to allow light to pass through, or painting marks onto the soundtrack. Dots uses this last technique, and there is a tremulous, erratic quality to the tones produced – the product of tiny differences in the shape and regularity of spacing of McClaren's brush strokes.[244] Additionally, the film is timbrally distinct; the individual brush strokes produce a squelchy, playful and inimitable sound. In contrast, works produced on the Whitneys' machine, Sholpo's Variophon, or indeed McClaren's films which involved the photographing of pre-produced 'comb' square-wave forms onto the soundtrack, possess a synthetic, electronic timbral stability which belies their mechanical, or quasi-mechanical methods of creation. This additionally sets such mechanically produced works apart from what is occasionally called 'animated sound' – of which Dots might be considered an exemplar – with all that the term entails; a painstaking and time consuming frame by frame, or more accurately, waveform by waveform crafting of sound. The ear's ability to resolve events within the time domain means we can detect the smallest discrepancies in otherwise stable sonic events; something that Moholy-Nagy would surely have appreciated more fully once he had shifted his attention from the gramophone's 'groove script' to film's 'ABC'.

Likewise, other acoustic attributes. From the perspective of the photocell (and from there, our ears), the rapidly flitting object boundaries that construct the recorded image on film need not attune themselves to any sonic norms, such as attack, decay, or any of the reverberant spatial cues that we would expect in an acoustic articulation of a given environment; I would suggest it might prove to be virtually impossible do draw a credibly reverberant sound by hand.[245] Timbre and pitch are generated by shape and spacing, angle, contrast and pattern, and these attributes are rendered into audio by the agency of movement; time must be present in sound, and this process of scanning is present in all analogue systems that have used image as their sound source.

[245] Although, it is possible to digitally add reverb to sounds by altering their spectrograms in photoshop, and then re-sonify the results

Perceptual Violence

Morphological themes – for example the line and the scroll – have on occasion been explored by writers when attempting to address how the senses become mirrored in technologies, highlighting the way that information is collapsed, spooled, and denuded in order to encode and decode itself in the intermediations necessary for modern sound. Within this well explored trope of memesis, an obverse is implied, which is characterised by perceptual violence and perhaps even insanity. The notion that adverse, or anomalous states of consciousness are connoted by abstraction within experimental audio-visual works has been discussed above, for example with Guy Sherwin's abrasively haptic optical sound experiments, or Tony Conrad's drive towards the dissolution of the spectator's orientational wits through the application of flicker and sonic 'vastness'; the internal 'nature' of the apparatus is consumed as part of the work. But there is a return journey on offer – a notion of our three dimensional, coherent sensorium contorted and funneled into signal, spooled and stored as two, or even one dimensional information.

Douglas Kahn sees this process at work in the writing and drawings of Henri Michaux, who in 'Miserable Miracle' described in detail his mescaline drenched divesting of one or two dimensions as he plunged into the hell of the non-conscious. Michaux's searingly frank and bleak accounts, are reports from an interior processed into an unrecognisably fractured and brutally disassociated thing by the drug: '"...at this incessant, inhuman speed, I was beset pierced by the electric mole boring its way through the essence of the most personal part of myself...Caught, not by anything human, but in a frenzied mechanical agitator, a kneader-crusher-crumbler, treated like metal in a steel mill, like water in a turbine, like wind in a blower, like a root in an automatic fibre shredder."' 'Mentally sound people', writes Kahn, 'live their lives as spheres, but he experienced

Figure 48
Mescaline drawing
Henri Michaux
Michaux (2002:71)

the ultimate helplessness of being "nothing but a line...I, the accelerated line."'[246] Regardless of one's view on whether or not a sphere is the correct shape of a 'normal' consciousness,[247] the experience of one's mind being processed violently by a machine, to be reformed and coerced by a mechanism (malevolent or otherwise), to be denatured, is perhaps one of The Flicker's antecedents, or at least a foreshadowing of its professed aims. Michaux's mescaline experiments produced text and drawings of a strangely impersonal, or inhuman complexion – suggestive, for example, of the aleatory systems drawings of Tim Knowles, who has designed, among other things, plotter-like momentum operated machines to fit into the boot of a car, or simply attached a pen to the branch of a tree and let the breeze do the work.[248] The impression one gets is of Michaux's drawings being governed by other forces (if mescaline can be categorized as such); perhaps revealing that he was being buffeted by a chaotic Nature invading his consciousness, and shaping it to suit its purposes, and he had been forced into an antenna role. Indeed, many of the more abstract works are strongly reminiscent of sonograms. In recalling the physically engraved sonograms of the phonograph and gramophone, Steven Connor reminds us that the spiral and the helix are returned to with 'odd insistence' by the technologies of recorded sound.[249] He may well have thought it to be labouring the point to have included film in his examples, but it is nonetheless pertinent here as the differing management of time for the particular requirements of the eye and the ear are bound onto the same physical substrate. Perhaps only a millimetre or two of clear plastic may separate the soundtrack from the frame, and perhaps nowhere else is the gulf between seeing and hearing so inadequately articulated.

The sound projector's method for dealing with these co-presented streams of information is revealing as an operational and epistemological locus; a story reiterated moment to moment, of time, seeing and hearing. As each frame of film is advanced, projected onto the screen in stasis, shrouded again and sent on its way for the next to take its place, the sound pertaining to those images must be spooled smoothly and continuously, and must therefore physically exist elsewhere on the film. Hence, a time-lag of some 22 frames exists between the image and its associated sound, to enable the two differences in reading – one discontinuous, the other smooth and unbroken – to be performed. This creates a 22 frame loop of film which perches between the two modalities; stuttering at its beginning and uninterrupted at its end, its point of exit/entry from the projection gate and sound-reader brought into temporal alignment. For the image printed across onto the soundtrack to be synchronised, the soundtrack section of the film must be separated, offset by nearly a second, reattached, and then either projected in this fragile state, or re-printed to form a coherent whole.

[246] Michaux in Kahn (1999:99-100)

[247] One might speculate that this imposition of a geometric figure upon such a nebulous idea (the shape of consciousness) may have its roots in phrases such as 'auditory sphere'.

[248] See Knowles (date unknown)

[249] Connor (2004a:160)

In *Spirals* (1974), Guy Sherwin takes a length of 'raw' film, and loading it onto a developing spool, half submerges the film into the developer. The chemical's meniscus becomes the threshold between the developed and undeveloped worlds of film as it is projected; the soundtrack hisses brightly, then thuds through the liquid's surface as it submerges, then re-emerges from the silent gloom. Although mostly in stark black and white, 'Spirals' does not operate in the same way as a flicker movie; but is sonically strongly reminiscent of the run-out groove of a vinyl record, played on a clockwork gramophone gently winding down... The spiral, or scroll, takes Michaux's obliterated consciousness and wraps it around upon itself. Here, time is being expediently stored, and one can detect artifacts (echoes) of its presence in analogue tape recordings, when for example, imprints of events to come advance themselves from the future into the silence preceding a piece of sound by printing across from the adjacent section of tape in a magnetic migration. Likewise in *Railings*, Sherwin's unspooling frame-by-frame violence advances and retards itself in the printing process, so that cinematic time is scrubbed backwards and forwards, even as the railings themselves are clattered at inhuman speed – an action that Michaux would surely have understood in his buffeted, atomised state, and one which Oram might have understood as 'clipped' or distorted beyond normal recognition (indeed, sonically, this is its primary property).

So we begin to see how the simple differing requirements of the reproduction of vision and hearing articulate themselves in the different strategies (be they newly invented, or the subversion of existing technologies) that have been contrived to find meaningful, structural or causal correlations between the two modalities. These strategies betray a heterogeneous, and often contradictory field of ideas which can be said to address either directly, or obliquely, the conundrum of how a notionally static medium can be rendered into a sequential, temporally dependent one – the solution to which almost always involves the rapid scanning of some kind of image or difference in luminosity. In a few cases, these systems (such as the ANS and the Oramics system) have been built from scratch to a high level of refinement, requiring their own unique form of input. Either this stream of information has been causally derived from sound itself (in other words a standard sound recording, albeit in the form of an image), or has been synthetically contrived to produce sound according to whichever mechanism it is being sonified with. But in many cases, the desire that meaningful correspondences between light and sound, seeing and hearing, may be discovered is either explicitly manifest, or in more thoughtful works, critiqued and questioned. This critique can in itself be unintentional, or perhaps bound into a work that was not meant as such; I think that Guy Sherwin's work here is exemplary in its clear-eyed and exploratory methodology, focussing a cool light on the visual image's irrelevance to the optical sound head. In examining different methods of photophonic sound production over the last few chapters, I have

attempted to show how the apparatus performing the translation from light to sound should be considered as an integral component of the overall signal chain, and how such an analysis – of techniques of the apparatus's use, its morphology, and relationship to other technologies and fields of production – can establish a more complex and multi-sensory understanding of the work in question. In showing how an apparatus, or instrument readably embeds itself in its output (be it audio, visual, or both), my intention has also been to introduce the materiality of that apparatus into the work it produces; an object designed, made, and operated by a mind and body, or bodies. Hence, gesture, touch, proprioception, and even orientation can, depending on the apparatus in question, become part of its output, either explicitly or implicitly; an extension into the haptic of the well established idea of such media being 'mirrors' of the senses.

Further to this, in discussing certain tropes within 'synaesthetic art', and their articulation as expressed in the aspirations and functions manifest in the instruments being discussed (particularly the ANS synthesizer and the Oramics machine), I have attempted to show how these instruments can be seen as a reconciliation between the transcendental and mystical on the one hand, and the polysensory and corporeal on the other, by virtue of this materiality and instrumentation. The theme of a haptic component emerging from the effects particular to photophonic audio-visual systems has also been examined, and this theme will be further explored below, where I describe three pieces of my practice – two dimensional, three dimensional and video – in which touch and gesture are an essential component of these works' operation.

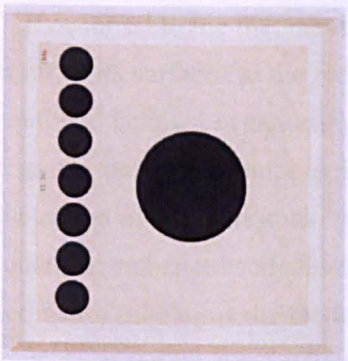
Addendum

2nd April 2012

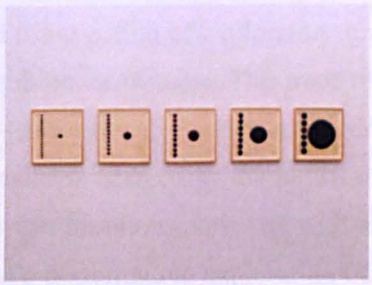
Shortly after submitting this thesis for examination in September 2011, I attended the 'Seeing Sound' conference at Bath Spa university in England, which included a kenynote paper presented by Cindy Keefer entitled 'Ornaments are Music – Oskar Fischinger's experiments with ornament and synthetic sounds'* Keefer is an archivist, curator and the director of Center for Visual Music, where the Oskar Fischinger archive is now kept. During her presentation, Keefer made two points concerning Fischinger's work which affect the arguments made in the preceding chapter.

Firstly, the version of the film Tönende Ornamente which has been available since the 1970's is a compilation of short optical sound experiments by Fischinger, but compiled by William Moritz, the foremost historian on Fischinger, also referenced in this text. Moritz arranged to have the soundtrack printed onto the image frame when having the original print made, and added the title and the text 'what you see you hear, what you hear you see' at the same time. The musical note annotations on the frame are believed to be Fischinger's originals. No original film survives by Fischinger himself, where the graphical sound ornaments have been co-presented on the image.

Secondly, Keefer showed images of several drawings, that were part of a series that Fischinger intended to animate. Each drawing consists of two parts – a larger shape for the image, which was echoed in repetition to be photographed onto the optical soundtrack (Figures a & b). It seems clear that despite the absence of any extant original film by Fischinger where the soundtrack was co-presented as image, these drawings show that he considered his 'sounding ornaments' to be audio-visual objects.



a



b

Oskar Fischinger,
Ornament Sound, 1932
Image: (2006),
Gladstone Gallery

* On 29.10.2011. See: http://www.seeingsound.co.uk/programme-2/papers/

Chapter 5:

A Somatic Optic*

> 'Where is the part of us that understands outline drawing? Is it in the eye? In the visual nerves? Or is it in vision at all?'[250]

What is the best way to record an object? This seemingly simple question probably represents a whole landscape of enquiry, rather than a path, so to rephrase: how can we come to know an object – its weight, surfaces, balance, temperatures, and so on – and is the capture of this information in the best interests of the object itself? (Or to put it another way, do we see it in its best light?) We know what the normal responses to these questions are: the camera holds dominion, then text description or drawing, and perhaps for some things, sound recording bringing up the rear; it depends on what our attention is turned to. So to focus further, I have been confronting the question: what is the best way to record a recording object, say, a 16mm camera?

I'll readily admit that I find the paraphernalia of 'old style' film making seductive, perhaps because they're tangible mechanisms – as opposed to digital ones – of a sort that are often beautifully engineered, usually from durable materials. Not only is this apparent in many hand-held film cameras, but even more so in the equipment needed for the printing, copying and developing of film. The imperatives of clarity within the recorded moving image – consistent speed, registration, stability, the absence of aberrations – serve to filter down through engineering strategies, to coalesce in mechanisms designed to direct exactly the correct amount of light at exactly the right time, in just the right place, on a moving piece of plastic substrate carrying photographic emulsion. Keyways and transport mechanisms, sprocket wheels, focus-pulls and locking levers all (hopefully) work just so... And then there's the interfaces and the surfaces: knurled knobs, striated lens-rings, butterfly catches, covers, switches, pitted or reticulated thermoplastic coatings, rubber grips.

It occurred to me that maybe it was possible to allow something to write itself using itself; to offer all of its surfaces to the record using a kind of exploratory imprint. To this end, and a few others outlined below, I began using rubbing, or frottage. This trace of an activity is clearly neither a photograph, despite its autographic (self-writing) flavour, nor a drawing in the strictest sense, since the action of the mark-making device is coerced by the physicality of the object in a directly causal manner; rather it oscillates between these categories as well as others. It might equally be proposed that a rubbing is the record of a performative exploration of an object, in an operation of touch outside of the intended parameters which are negotiated between the designers and users of these things.

* Of, or relating to the outer wall of the body, as opposed to the viscera.

[250] Kennedy & Fox (1977:118)

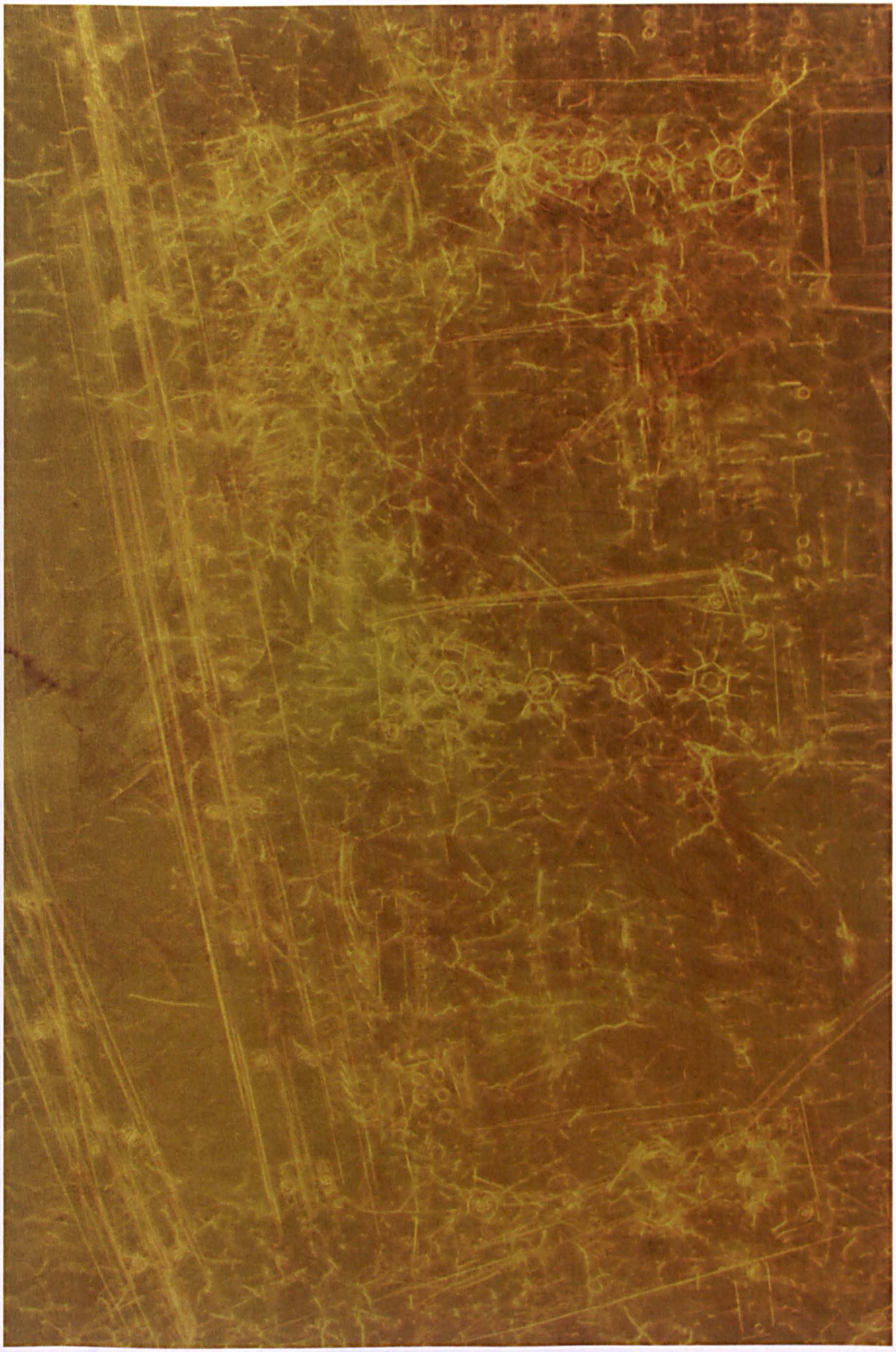


Figure 49
Rob Mullender (2008)
Eidola Series: Oramics. (Detail)
Photo: Nicholas Phillips

In taking a rubbing of a complex object, the object to be recorded is covered up, for it to re-reveal itself as work progresses. In this sense the object makes itself anew but as a multi-sensory percept; it expands as a site of knowledge. This sensory land-grab is never complete since the barrier-medium (the membrane which is also a gulf) is inelastic, and must be endlessly manipulated and re-sited to perform its purpose in a saccadic exploration of cracks and crevasses.[251] Since the membrane is forced into this time-based relationship with a surface, each rubbing represents a set of micro-superimpositions, or even what might be described as a gestural palimpsest; the recursive quest for an impossibly complete knowledge of an object. In this way, multiple readings of time can be derived from its surface – either as a journey around the original object (or a set of decisions made by myself; a constant re-alignment of the recording surface to the imprinting one), or as a battered looking and unreliable net.[252]

As for the object itself – we might think of it as being refigured as a recording head, or imprinting mechanism, which works in two intercommunicating ways. Firstly, it is made active at one particular point on its surface; this point is the locus of desire for all elements present in the tripartite exchange; the hand of the artist, the recording medium, or membrane upon which he or she acts, and the original imprinting object. Secondly, if considered as a set of problems, to be negotiated using the imprinting medium as negotiating tool, the original object's surface complexity requires a continuously shifting train of actions on the part of the recordist in manipulating this 'skin'. These encode themselves as creases and cracks, particular and peculiar to the material; a skin to be scarred by its own folding...

Thin paper tears on sharp things, and in the list of features mentioned earlier, sharp things inevitably stand out. In searching for a membrane that would not tear in the way that paper did, I tried a few different materials, before hitting upon a particularly fine ivory coloured nylon. This presented its own problems, in so far as it would simply slide around, or off the thing I was going to work on (in this case, a Bell & Howell contact printer). To counteract this, I tried coating a sample in shellac to stiffen it, and give the surface more friction. I began to see that this new translucent composite would take marks without the need for a second medium such as graphite, thereby embedding this act of frottage structurally within the material, instead of simply adding a pigment to a substrate. It feels to me now that the condition of making a cast has somehow been bestowed upon an unsuspectingly two-dimensional process, however tenuous or fugitive this condition may be. This latent dimensionality, encoded as process, permeates further through each crease and fold produced by the manipulation, folding and re-siting of the material. Also, I like the smell of shellac.

The idea of producing rubbings in part arose from a wish to articulate, however inexactly,

[251] As you may recall from the beginning of this text, 'Saccadic' refers to the way that the eye jumps from one point to another in twitching motions, or saccades.

[252] In the geometric sense – for example the simplest net of a cube is a cruciform shape made of six squares.

the concept of the simulacra or eidolon, that peculiar but evocative vision of vision proposed by the Atomists (and latterly the Epicureans) as the means by which images transported themselves via the eye into the mind. The idea put simply, is that objects throw off atom-thin skins in all directions, which flit lightning fast to the eye, all the while retaining their original form. Lucretius, in his epic poem *De Rerum Natura* describes this world of diffuse kinetic bodies:

> In the first place, since amongst visible things many throw off bodies, sometimes loosely diffused abroad, as wood throws off smoke fire and heat, sometimes more close-knit and condensed, as often when cicadas drop their neat coats in summer, and when calves at birth throw off their caul from their outermost surface, and also when the slippery serpent throws off his vesture amongst the thorns (for we often see the brambles enriched with their flying spoils): since these things happen, a thin image must also be thrown off from things, from the outermost surface of things.[253]

The etymological descendents of both eidolon (the Greek) and simulacrum (the Latin) include image, idea, icon, spectrum, and particularly spectre, even though Lucretius's project was essentially humanistic in its flavour. In identifying ghosts as errant simulacra, cut adrift while on the proper path from their engendering object, he was able to re-figure man's place in a universe in which a capricious pantheon of Gods and Demigods normally held sway. The sheer richness of the mechanism (for Lucretius understood it as exactly that) described in the passage above and others like it, its connotative pluralities, enable many different interpretations. The Atomist/Epicurean model is a flexible and fertile terrain upon which ideas concerning time, the senses, mortality, navigation, identity, memory, and mimesis, can be played out; suffice it to say, this implication of a striated, quantized world, with objects incessantly in flight from themselves, never in stasis, was something not lost on some early 20th century thinkers.

Eric Downing delineates the implications of the Atomist model for Walter Benjamin's notions of time, memory, and their operation within the photographic process – in short, the historicisation of space into discrete super-perceptual moments. Benjamin refers to Balzac's 'theory of the daguerreotype'. According to Downing, this is an allusion to a quote from Nadar, the French photographer, and Balzac's portraitist: 'each body is *composed of a series of spectres*, in infinitely superimposed strata foliated in infinitesimal films, extending in every direction that the optic perceives the body'.[254] Here, not only do eidola persist at all times throughout space in every direction, they are the constituent material of all physical bodies, generated from some central

[253] Lucretius (1992:281)

[254] Downing (2006:23) My emphasis.

singularity and migrating outward to the surface, before being shed. Light itself is not a distinct energy, which articulates surfaces and spaces, it is understood as one and the same. By extension, the photographic process is reconceived as a corporeal concern: 'Photographic images are in fact based on projected images that emanate from physical objects themselves; that traverse (or simply inhabit) the empty space or atmosphere that intervenes between (or rather encompasses both) the object and the camera... It is a model in which material objects themselves are constituted of spectral images, and in which these spectral images are themselves material objects'[255]

In considering this continuity of constitution, it might be asked as to how a body and its image are differentiated, since they are one and the same. It seems that the answer to this question must be nothing – since it is an interstice that separates each eidolon from the next, and that the very instituting of a void into the outward flow of spectres from a body designates that body's surface. Vision is here extended into the arena of touch, since it is of surface, both at the point of the image's departure, and by virtue of its constitution, at the point of arrival at the viewer. The essential nature, of a sound generated from a modulated luminous source – often by way of the scanning of graphical information – seems to be at once counterintuitive (light is for seeing with), revelatory (that's what the flickering of my TV sounds like) and even quasi-mystical (there are voices coming out of that light-bulb). How might the spectres of Lucretius's fecund imagination make light of this mixing of registers?

This is a particularly filmic, or paracinematic question – not least because, as we have seen, the optical soundtrack of 20th century cinema was the premier site for exploration and experimentation into this process. But equally, the clear implication of the Atomist model of vision – that visual reality is discontinuous, interstitial, indeed cinematic – resonates strongly with the peculiar condition of turning light into sound – particularly environmental light sources, both natural and man-made. The perceptual parameters that enable the artificial moving image to work (that is to say, our visual flicker threshold) are also what prevent us from noticing, for example, the 100Hz flashing of mains lighting, or the even higher tones of modern digital lighting systems, which use pulse width modulation to produce dimming effects.[256] This flashing may not be visible, but by virtue of the ear's ability to resolve detail in the time domain – to hear faster than we see – it can be made audible.

[255] ibid.

[256] This is used in modern electronics to control power, thereby producing dimming effects in lighting. For example, when the rear brake-light of some modern cars turns from full on to dim, as the brake is released, a buzzing would be heard in the sonified light signal. For an example of how different versions of this sound, see accomanying DVD: *Amber*

Having made one or two semi-successful attempts at recording swarms of midges in sunlight, I've begun to discover the problem with recording insects – they're so small and mobile. Thankfully I have access to a pretty surefire way of getting them to come and go through a certain point; not so long ago I built a beehive, which now lives on the roof of the Royal Festival Hall on the south bank of the Thames in London. During a visit there it is sunny, and I take along my PV cell and field recorder to see what I can get from the bees. Initially they do just sound like bees (but with some peculiar distortion in places), but after a little while, something else becomes apparent. Rather than hear them fly over the PV cell and away, the 'sound' of their shadows is abruptly bracketed, as if they were flying past a window, and suddenly inaudible when out of view...[257] (Figure 50)

Figure 50
Author recording bees on the roof of London's Royal Festival Hall
Photo: Andrew Hinton

Travelling with my photocells, field recorder and headphones, I have recorded ambulance lights crackle, LED display boards shriek and hiss; Piccadilly Circus bathed in an electromagnetic storm. The glittering of the sun upon the sea, perhaps predictably, sounds pretty much like the sea, and the invisible flickering produced by a mosquito's wings as it passes through a beam of sunlight, even though it may be several metres distant, makes a sound very similar to that which you might hear as it hovered next to your ear as you lay in bed.

This telescoping of space is significant. Because sound is somatically troublesome – oscillating between over there and inside our heads, depending on how we interrogate the experience of hearing – the sounds derived from light take on a proximal, or internal quality. Since they are denuded of the spatial characteristics of diffusion, filtering and reverberation that would place them outside of ourselves, these sounds/non-sounds (their status is, in my view, unstable) are brought within us – internalised, or stripped of their over-there-ness. A similar quality of listening

[257] Author's personal sketchbook entry, August 2008. See accompanying DVD: Photophonic Study. A longer video is also included, focussing entirely on shop windows, entitled Amber
For a recording of bees made in this way (Figure 50), see the track on the DVD entitled: *Bees*, and also a recording of *Fireworks*.

can be attained through biting on vibrating surfaces or objects, thereby transmitting the sound to our middle ear via the skull's resonant properties, and completely removing any spatial characteristics that might have been derived through normal audition.[258] Listening to light introduces a plasticity of space brought about by this spilling over of events between registers – by this condition of internality – in ways that are entirely familiar within the audio-visual construct of cinema. Sounds are 'framed' by the photovoltaic sensor's optical properties; they go 'off camera'. Luminous transient events, such as fireworks, or the flashing of emergency lights, are instantaneously accompanied by their auditory correlates, in ways that are entirely consistent with the conventions of timing and synchresis present in mainstream cinema sound effects.[259] And most importantly – for all of this, a camera is neither necessary, nor perhaps even desirable – just a photovoltaic cell, a field recorder, and headphones. Using a technique developed before the advent of cinema, some of its conditions can be imported directly into unmediated visual experience by the migration of visual into the auditory. The screen of the artificial moving image is invoked by artificial sound; the sound provides the screen.

In recruiting the ear to interrogate vision in this way, a knowledge of previously unperceived events is offered up, and somehow, Lucretius's universe, populated by innumerable successive lightning-fast spectres seems to float into focus, re-texturing as it does, the previously undifferentiated volumes of space between seer and seen with discrete temporal events. And sound is nothing if not textured space. We understand as bodies, the connection between touch and sound, vibration and hearing – one need only visit a dance-floor to be reminded of this – and given the eidolon's material links with its bodily progenitor, the Atomist version of events also brings vision into the tactile arena. In an examination of the extension of the skin through and into vision, Steven Connor explores, in a typically evocative fashion, some subtle re-workings and translations of Lucretius's ideas from various historical sources. In a key passage, he cites an anonymous translation of Quillet, which:

> 'enlarges over six lines the suggestion that the skin apprehends the atoms in ways that pass under the threshold of visibility... something is seen – imperceptibly affects the sight – even though it escapes the eye. It is as though vision had a tactile dimension which acted directly upon the organism (and on senses other than vision), rather than through the eye, which can only respond to the form of what is seen, rather than the substance.'[260]

[258] Christof Migone's essay on the ontology of internal acoustics from the perspective of sound art addresses this notional space-lessness: for example in quoting José Gill's referral to self-hearing as 'an act of absolute reduction of space'. See: Migone (2003)

[259] Synchresis is a term coined by Michel Chion to describe the 'added value' that sound effects editing can bring to cinema, giving an example of a sound designer using the sound of an axe chopping wood giving a gestalt of weight, or violence to the act of a baseball player hitting a ball, which would have been absent had the natural sound been used. See: Chion M (1994:xviii)

[260] Connor (2004a:112)

The substance of what is seen is not metaphoric in essence here, but literal, tactile, tangible. Likewise, F. Gonzalez-Crusi devotes an entire chapter of his meditation on vision to what he terms 'the material power of the gaze' – although his consideration of the Atomists is brief compared to his account of the Platonic idea of 'effluvial' vision, or the 'extramission' theory.[261] Significantly, though, he considers the issue of porosity to be of importance – that each sense possesses its own particular variety of pore, through which only those atoms for which the pores are designed will fit: 'Empedocles thought that as in vision the particles harmonized with the pores of the eye, so a perfect adaptation of pore and particle had to be the basis for all sense perceptions.'[262] One wonders what Empedocles would have made of synaesthetes – presumably a porous mismatch or migration was to blame.

Listening to light is inherently synthetic as an experience - a category error, so to speak – and so it seems entirely fitting that a fantastical, or synthetic model of the world be brought to bear upon it. Moreover, it seems to me that an object's surface – the point of departure of its sensory output – is an interesting notional point of synthesis, through which different sense modalities may act upon one another. The world of flitting eidola sits neatly, if a little awkwardly, between our understanding of how sound and light actually do work; a theory of light as a longitudinal compression wave, perhaps. These successive images are certainly reminiscent of the compression and rarefaction at work during the transport of sonic energy. Perhaps I am overburdening these relatively demure objects, but I sense that these rubbings might be considered as analogues of the 'photophonic' exchange. They are in some way 'ghosts of ghosts' – eidolic shadows, or their fragments, which have been coerced into conforming to the materiality of nylon and shellac.

The corollary of these images entering the consciousness, is that we project our own selves into the world, and back inwards in an identical fashion. Since our constituitive eidola regress inward to a central point (and here, according to this model as we look inward we see forward in time), the self is refigured as locked to a central point, which may be expressed as a singularity, or point in space for the purposes of navigation. The body's nested selves, constructed of images, made of the stuff that we see, finds its analogue in the artificial media that we use, but drawn out into the world. And how strange that something as ostensibly mundane as sitting down and making a rubbing, can contain all these possibilities.

[261] Gonzalez-Crusi (2006:101)
[262] ibid

Chapter 6:

A Said Object

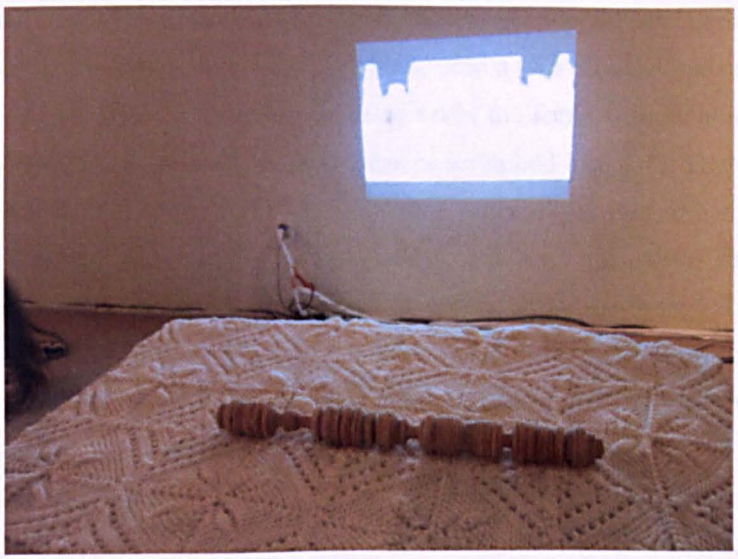
'Embodied Sound', Creative Misattribution, and Loss

This research has often led me back to the voice. The comings and goings of sound and its relationship to the other senses; the associations of touch, projection, and the knowledge of existing within one's self, all seem to be attributable in some way to the voice's actions, or comparable to them. The intimacy inherent in the loop of speaking and hearing one's own voice, and its folding and blending into kinesthetic knowledge and bodily techniques – and from there the simultaneity of the voice's projections outside of the body – seems recapitulated in the synthetic spaces uncovered by listening to light. Perhaps this is why the sense of solidity, and materiality can, in certain circumstances, rush in to fill the unbridgeable gap between seeing a luminous event or image, and hearing its transformation into sound; we sense that a body must exist between the two media for them to connect, and we supply the emergent surfaces for ourselves.

As I made the piece of work that I discuss below, these slippery and insubstantial notions (about how a slippery and insubstantial action could become substantial) began to circulate around it. I should state that its inconclusive nature – that a micro-climate of interpretation, misattribution and epistemological uncertainty still prevails within it – seems structurally embedded into the work; that as a whole, it is a mode of questioning rather than a declaration. So here I use this piece – which was made toward the very end of this research project – as a questioning device for the perusal of sound's representation as an image, or an object, and how that relates to memory and the body. Those questions may, of course, be ultimately unanswerable...

> *I first staple the mutton cloth onto the wooden dowel so that it won't just slip off, then begin painting it on with gel-coat, making as sure possible not to get any air bubbles inside. The arrangement is book-ended with round blanks made of solid utile (a close relative of mahogany – pronounced 'yootilly'), so that the whole mess doesn't spill off of the ends. When it comes to turning up the profile, these end blanks prove worse than useless – just twisting off of the end in the chuck a soon as I apply any force with the cutting tool. The result being that I have to grip the thing in the chuck by the resin, and jam a live centre in the other end of the dowel, all the while hoping that the end in the chuck won't be hopelessly concentric when I turn it around and machine it into a*

a



b

Figure 51
Rob Mullender (2009) *Said Object*
a: video still,
b: *Phony* with video, exhibited at 'Non-Cochlear Sound',
Diapason Gallery, New York. October 2010

cylinder. I probably should just have bitten the bullet and bought some phenolic composite. What emerges is a strange, fleshy looking transversely striated stick – not a 'technological' object in any sense. Not what I was necessarily expecting...[263]

The Object

The object is a wooden dowel, about 12mm in diameter and 400mm long, with a collection of forms strung or stacked along its length. These forms might be best described as to be made up of discs and cylinders of different widths and thicknesses, which when viewed from the side are suggestive of a waveform. The 'waveform' itself is made from a flesh-coloured composite material, consisting of polyester resin impregnated with 'mutton cloth'; a stretchy, loose weave fabric commonly used in medical dressings. However, rather than adding these 'waveform' elements on to the central dowel, I first produced a solid bar of cloth/resin composite, before cutting away, or carving the material on an engineering lathe to produce the desired profile. In making a piece in this way, a link is made to the Phonograph and its antecedent, the Phonautograph, simply by the allusion to information turned onto a cylinder, but after this, the similarities begin to fall away.

Early mechanical sound recording made use of a cylinder, to encode and wind the information extracted from three dimensional, time-based medium, onto a two dimensional surface in helical formation. In the case of the phonograph, the encoding takes the form of indentations in wax or foil, and with the phonautograph, transverse graphical traces scratched into soot. The object we are considering here, in contrast, is a corrupted obverse of this process – a two dimensional graph of energy over time, expanded out into three dimensions, but with the result that no additional information about any further properties is added. The surface might be thought of as a waveform, which has simply been spun upon an axis below its lowest point, in order for it to exist in the three dimensional world. This is a seemingly meaningless undertaking in many ways – so why is this a worthwhile thing to do?

An answer may lie in the allusive relation of vision to hearing via touch that I have been attempting to develop. We have already seen in chapter three's discussion of Guy Sherwin, how an emergent haptic sense of engagement may come about within the moving image's audio-visual construct, and how a resulting condition of materiality, or solidity arises. Would a literal translation of a representation of sound into three dimensions confer any understanding of sonority or

[263] Author's personal sketchbook entry

perhaps, of hearing back upon it, through touch?

My original motives for making this piece are difficult to pin down, but underlying everything was an intuition that the representation of sound could be more than a just strategy derived from either the materially denuded audio-visual acrobatics of the visual-music, or colour-sound tradition, or the more straightforward necessities of sound analysis and editing. I also felt that given its basic limitations, the finished item would be no more qualified a depiction of sound than a simple two dimensional graphical trace, and so therefore it should be an orphan; its form should carry precisely nothing, bestowing a paradoxical condition of silence upon suggested sonority. So I invented its 'content'. The intention here was not to attempt to reproduce a three dimensional version of an existing recording, but to generate an impression of one; a *Phony.* When I began to machine the piece, the lathe complained rhythmically, as the unevenness of the material made itself felt in metronomic changes of force upon the tool block and chuck, and I began to think that this disappearing act would be an impossibility, simply because such a racket would be bound to imprint itself upon the object's surface as an acoustic memory. In one sense, I wasn't wrong – the process used to produce the piece is undeniably a factor in one's understanding of its nature (a different kind of resonance), and was to influence the way that people would respond to it; it spoke regardless.

We think we know what sound looks like. There is a wealth of examples of representation, or visual depiction, and they most often flow from a common trope, or cultural standard of display; that of a time-line stretching from left to right, with the information itself encoded as vertical variations in amplitude. But a moment's consideration – coupled, perhaps, with an act of imagining – must of course show this to be a product of engineering and informatics rather than an effort to deal with the experience of listening. Furthermore, this method of depiction would be inconceivable without sound recording; the object has a beginning and an end, and it can be viewed as a single discrete event in time. In contrast, (as has been noted by John Cage,) the parentheses that govern listening consist of the void before and after consciousness. And what would, experientially, this visual representation of sound mean without its progenitor, and its mirror – that is, the sound itself? After all, without a referent, we are only left with squiggles or shapes to convey absence, redolent perhaps of how a perfume lingers after someone has left a room. An image is ascribed the condition of a name by the sound's absence. This is not to suggest that sound has an original state that we can claim to know. All recordings, and acts of listening depend upon a spatial co-ordinate, or point of audition – of the microphone and of the body respectively. The very idea that an ideal sound exists (something Platonic in its flavour) exerts a force of expectation upon the recording, and the recording reciprocally upon the 'original' sound. What is an original indeed, if a copy does not exist for it to refer itself to?

These opposing forces, of the critique of the form versus a desire to make a solid 'body' of sound, coexist with distinct and separate issues concerning materials and presentation (which I will deal with below), but all serve to impact upon the work's second incarnation: as a hermeneutic device. These paradoxes bequeath a space ready to take on board new possibilities for interpretation and projection – in other words, we might use this popular trope of sonic depiction, to further allow a participant to interpret themselves through the object.

What the Object Could Become

To bring this work to life, and perhaps try to confer a stability upon the slippery and fluctuating nature of what I had made, I recruited a number of volunteers to interpret the *Phony* in as open a fashion as they wished, while recording their responses on video. I have picked out some of these responses (italicised in what follows) to discuss various ideas concerning vision, touch, and the voice. The respondents were not told what it was they were going to be asked to talk about, only that they would be able to hold the object in their hands, and that only their hands would be in shot. I began by asking them the question: 'What does it say?' Initially I expected a straightforward interpretation of the question, and that the contributors would try to read the 'waveform', vocalizing the object in a direct sense. Not only was this notion naïve, but happily (it turns out), it lacked imagination and ambition, in that it did not even begin to address the variety and richness of the responses that this so-called simple act of reading would engender.

Firstly, and importantly, I was quickly disabused of the notion that this was very obviously an object derived from sound in some way; all but perhaps three of the contributors needed to be led into this area by further questioning – in fact one contributor refused to even accept the idea that this had anything to with sound at all. Perhaps less surprisingly, most contributors were also reticent to directly vocalize what they eventually thought might be the content of the 'waveform', although a few attempted to do so.

'It's some sort of code, but I don't have the key'

'It says a rolling pin, but very tough pastry'

Figure 52
Rob Mullender (2009)
Said Object

This lack of attribution of form to sound was tempered by a general understanding that the *Phony* was probably encoded information of some form, although its exact nature was unclear. I would tentatively suggest two explanations for this; one is that the 'waveform' is not that skillfully made, and that the crudeness of the cut, roughness of the material, and slightly awkward nature of the overall form combine to suggest it may be something else. It seems to have been poorly recorded. The other is a problem concerning materials. The direct transcription of sound to another medium – what James Lastra has insightfully termed 'object causality'[264] – is considered by historians of sound and technology to have first materialised with Hooke, and subsequently with Chladni's famous 'sound figures' at the end of the 18th century.[265] While explaining the impact in the 19th Century of the Phonautograph, Lastra explains that 'This rhetoric [of autography] continued a tradition begun decades earlier in response to phenomena like Chladni's sound figures (klangfiguren) and Marey's attempts to render biological movements, as he put it "in the language of the phenomena themselves"'[266] Central to this model of sound's representation is a condition of direct transcription, which influences our understanding of the motives for its display; an expectation of causality upon the image or object denudes it of immediate authorship and ascribes agency to the original source of the sound – it is understood as a transparent, natural entity. If we consider another model, where sound's conditions are inferred, complemented, or synthesized through artistic representations (such as with 'colour-sound' instruments, or 'visual music' films), then we are invited to invest in a personal aesthetic interpretation or agency, and we may or may not find those particular correspondences resonate within ourselves.

'It reminds me of offal'

Within sound's representation, a problem of ascribed materiality becomes apparent; the interposition of a particular material, between the trope of ideal visualised sound and the spectator (and in this case, the contributor), forming an occlusion, or blind spot. One is reminded, perhaps of Kevin Dann's critique of faux-synaesthesia in early modernist art, as containing no material associations – just sound and light. When sound is depicted, its material nature is only alluded to, or even avoided rather than described, as if seen with our peripheral vision instead of directly. It must perform a disappearing act – be both there and not there simultaneously, be itself but not – simply because to materialize, it must manifest either as stuff, or as articulated by something else (other stuff). And since recognisable materials have meanings and associations, they cannot be

[265] Lastra, (2000:73)

[266] Chladni produced a systematic study of how sand or dust arranged itself upon vibrating plates of various shapes. The plates would be bowed across their edge, causing them to sing, and compelling the powder to collect at the points of least vibration, known as nodes.

made to disappear, producing a tendency within acoustic visualization toward the demure, the translucent, or the gaseous; an ineffability perhaps pointing to a solidified, structured light. Our ascription of sounds to a source, or more expansively, a source within a mediating environment of reflectors and filters, rushes in to fill this vacuum – a bell is heard up above in the tower and becomes itself, instead of a series of harmonically complex direct and reflected waves propelled by a resonating bronze object… the sound, among many other things, is metallic. What, then, should a voice be made of?

The voice has been represented in this way before, in 2008, by Carsten Nicolai, with his piece *yes/no*[267] (Figure 53). This piece consists of two cylindrical waveforms, in the manner I have described above, but nestled next to each other on mounts. On his website, Nicolai states in a text accompanying a photograph of the piece (which is worth quoting in full), that:

> both elaborately produced sculptures are conceived of acoustic wave forms of the spoken words 'yes' and 'no'. they represent the attempt to materialize the sculptural characteristics of sound when flowing through space into a respective visual effigy. the semantic content of the sculptures give answers to unasked questions and hence open up a wide range of interpretation and association. yes/no could additionally be considered a very special portrait of laurie anderson, who originally spoke the two words that have been solidified here.[268]

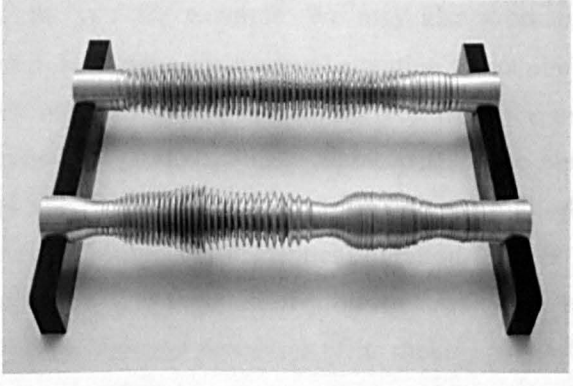


Figure 53
Carsten Nicolai (2008)
yes/no

I infer from this statement that Nicolai's motives for making the piece are in a similar territory to my own, and that there is the desire is to produce a representation of sound's three-dimensionality, and its temporality – but any similarities between this piece and mine become tenuous beyond this first impression. My intention here is not to critique Nicolai's piece in a straightforward sense, but rather to provide a negative space upon which the positive of my own work can become clearer –

[267] Nicolai (2008)

[268] Ibid. I have corrected minor spelling errors.

to use one to bring the other into relief.

Firstly, the use of aluminium as a material is born of visual aesthetics, but confers upon the piece a notional sibilance, or perhaps a high pitch ring which one might expect if one were to 'ping' the more generously spaced waves on the piece; if it were polished bronze or brass, it would look like number of miniature cymbals stacked upon two central armatures. Indeed, I recently found myself absent-mindedly running my fingernail across the heat-sink on the back of an 'active' monitor speaker (*pingpingpingping*), and Laurie Anderson's voice was suddenly there in my mind's eye – not, I should say, its ear, though.[269]

As has been explained above, the material I decided to use for my *Phony* was a composite of polyester resin embedded with a loose weave cloth. The development of this material originally addressed a desire to work with regularly textured, or differentiated volumes and surfaces, so that traveling across or through them (either with vision or touch) would be temporally delineated, or would contain momentary events. Cutting through and viewing a sedimented, or layered composite is suggestive to me of an act of listening, in that a volume of material is sectioned and offered up to conscious examination. The plane of a section through this is analogous to a listening position – a unique point of audition which contains the illusion of a knowledge of the remaining volume, whereas each part is in fact unique. The phenolic cloth board on which many circuits are printed on is a more even, denser illustration of this.

When pondering *yes/no*, it is reasonable, I think, to pin down the depicted words in question to a rough value in durational terms – perhaps to around half a second. Flowing from this, a sense of scale can be derived from the piece, in that the detailing of the waveforms might ascribed to certain acoustic forms – the 'e' in 'yes' for example. We may also work out the approximate speed with which we might read it. However, this notional attention to detail may be illusory, in that there appears to be no attack or decay characteristics derived from the original words; they both begin and end in solid cylindrical forms, whose characteristics are abrupt – instantaneous, framed even. Furthermore, the two forms appear to be of identical length, despite the very small likelihood that the spoken originals would be of identical duration. This is not to suggest any subterfuge on Nicolai's part, but simply that the aura of 'object causality' emanating from the piece – certainly engendered by the computational processes of its making – is a fragile thing, that may not withstand scrutiny. If one aspect of it doesn't comply, then this construct of a faithfulness to 'nature' seems suddenly to teeter on its foundations; we expect all or nothing, forgetting that human aesthetic decisions are at play throughout every part of the process. Responsibility cannot, after all, be abrogated. The act of presenting a piece of shiny, technologically rendered material as sound, seems to demand that we consider this as an exemplar

[269] A heat-sink is a piece of aluminium extrusion, comb-like in section, which draws heat away from an electrical circuit (in this case, the speaker's built in amplifier).

of some sort, and in this case it is, again, of the voice. This is reinforced in no small way by the decision to use none other than Laurie Anderson's voice as its subject; indeed such is the strength of Anderson's vocal persona, that this is given the status of a 'very special portrait'. When considering this attribution, I am again drawn to those abrupt ends: why so violent? Must it be the case that Anderson is subject to such harsh editing, or is something else at play here? I suspect an answer can partly be found in the phrase 'flowing through space' – these sounds have left the body far behind, and find themselves articulating a space very different to that found within the intimate proximity of interpersonal exchange. Their ends are edited by either a cold architectural surface, the selection tool within a ProTools session, or the imperatives negotiated between the data set and CNC lathe that brought *yes/no* into aluminium-hood. Perhaps all three spaces are in play, and that Laurie Anderson's technological expertise and fascination with the apparatus's of sound's transformations (rather than her voice itself) might, after all, be the real subject of this portrait.

Of course, my own *Phony* has ends (as all things must), but they have the good manners to arrive in a slightly less brutal fashion, and when examined, at least some silence (a putative silence that runs through the piece, in the form of the wooden dowel) can be inferred from its construction; seen and felt, but not heard. The paradox here is that for silence to exist in the piece, it would collapse in that structural absence, snapping at its quietest points into a series of discreet packets to be ordered any which way. The dowel becomes a wooden noise floor, and in doing so guarantees its continuity, providing a wild-track for the voice to exist upon.[270]

'It says it's not meant to be here.'

Perhaps the most interesting point of departure to be found within the text accompanying yes/no is the designation of the sculpture as an 'effigy'. Through this simple change of register, the work suddenly expands to occupy different ground; the implication is that somehow, these embodiments of Anderson's voice are mimetic devices that hold power over the sounds that they represent, thorough an act of naming. But importantly, effigies do something. Either they are destined to be destroyed, and in this destruction, a form of cleansing takes place in a display of disrespect which exerts power through banishment, or they act as simulacra for the deceased; the already lost. Perhaps in this idea we can sense a tacit admission that recorded sound is only ever a representation of an unknowably complex original – that a condition of loss is inevitable.

There is an idea that arises occasionally in discourse on sound; that sound will never

[270] A term used in film sound to describe the ambient bed within which dialogue may be couched in the mixing stage. Recordists will often call for silence on location to record three minutes of 'wild track' as an essential ingredient for later on in the editing suite.

disappear, but decays asymptotically – that is to say that, like radiation, sound's energy dissipates but never reaches zero. This may or may not be true, but the possibility for its recovery in theoretically endlessly regressive states from the fabric of the world, as an idea, is a poignant echo of denial set against sound's quotidian ephemerality. Quoting from Aden Evans, Christoph Cox convolves this idea of all sounds' continuing dissipation with a kind of cosmic auditory noise-floor:

> 'Vibrations do not disappear, but dissipate, echoing all the while, for energy is conserved. Every vibration, every sound, hangs in the air, in the room, in bodies. Sounds spread out, they become less and less contracted, they fuse but they still remain, the energy of vibration moving the air and the walls in the room, making a noise that still tickles the strings of a violin playing weeks later. Every sound masks an entire history of sound, a cacophony of silence...'[271]

Cox goes on, by way of Leibniz, to characterise consciousness as a bulwark against noise; that the subconscious experiences all sound, but that we are its spectral filters. This seeming fight against entropy and death through the non-submersion into noise has its converse. In our perception's function as filter, we generate the possibility of sound's loss through its perception and apperception – in keeping sound as itself. The auditory world that hovers above the noise-floor briefly before sinking below, inheres in us as the minds that listen, since we are the organising principle; we decide what the signal is. When contemplating yes/no, and perhaps also my phony, one might perhaps be inclined to understand them not as a portrait, but as an urge toward immortality; if it is an effigy, it is one that will be destroyed in order to banish oblivion.

The trope of audio (or indeed visual) media apparatuses as chiefly recorders or reproducers of otherwise lost events has become so ubiquitous, that its subversion is now almost a calling card of experimental sound practices. We have seen, with the optical soundtrack as an example, how the inception of new technologies of representation have immediately presaged experiments dealing with their use and misuse. A historiographical praxis can be detected in many aspects of sound arts, where obsolete media become a subject for disinterment, study and integration with modern technologies. A foremost exponent of this is Paul DeMarinis, whose preoccupation with media archaeology is strongly informed by the interplay between inscription, memory and loss. In his series of pieces, collectively entitled The Edison Effect, he sonifies the traces of recordings on various wax cylinders, 78rpm records, and holograms of records by reading them remotely with

[271] Evens, quoted in Cox (2009:21)

laser light and photodiodes, thereby analogising, dust, noise and history by subjecting them to the unfaltering gaze of that bright exemplar of accuracy and science. In reading the recordings at a distance, they are preserved; both physically by the lack of contact within the process, and temporally by their haptic isolation: 'A dream of early phonographers was to read with their eyes the wiggly line inscribed by the needle as a lasting trace upon the wax... the laser touches but fleetingly upon the groove, the impact of its photons abrading no material whatsoever. The rupture is complete. The emancipation of touch from memory has been fulfilled.'[272]

'That's quite a noise floor there...'

'Close up, it's a CTTTHHRRDDR. CSSHSHHHHRDDTTHHHRTTTHH. COISHHHHHHRRRRTTHHHHRD. But further away, obviously, it becomes a sort of KTHRRRRRK KTHRRRRRK. Obviously.'

Noise, it seems, is a defining characteristic of this piece. When the *Phony* was vocalized, there was usually a (literally) pronounced noise component to the reading, and I would contend that this is only properly understood through the process of providing the mind's ear with the necessary haptic information; by picking up the piece and 'feeling' how it sounds. After all, I made it to be held, to be understood in part through the skin. Through this, it has subsequently acted to both mediate and become a surface for the interchange of other sensorial ideas. It is held in the first instance by its blanket – 'cosseted' as one respondent put it – and when the beholder becomes holder, only then can the act of reading be fully undertaken. This proximity is the method by which the piece orientates itself, both literally in the actions of the contributors in the video, and conceptually in its pulling together the 'higher' senses via the skin. When one looks at Carsten Nicolai's *yes/no*, it is displayed – mounted on rubber stands to perform its work; to pick it up would be to leave fingerprints, polluting the signal.[273] In setting the piece in this way, Nicolai renders the objects partially inarticulate, since they can only communicate what they need to via the eye.

[272] DeMarinis quoted In: Wilson (2002:402)

[273] It should also be noted that the decision to mount the words on rubber was also an aesthetic one and not, as I had first suspected, as a kind of conceptual 'damping' The information about 'yes/no' was kindly supplied by Daniel Klemm, who is Carsten Nicolai's studio assistant. I've tried not to make too much of my reading of the piece hinge upon his information, even though I don't doubt its veracity.

'I don't think I could make it sound like a voice. Maybe it's instructions for breathing'

The *Phony's* incarnation as a set of instructions for breathing joyously liberates it from both language, and sound's inevitable fugitive journeys away from the body. Indeed, the liberation may be considered inward, both through the susurrus of breath (which, is never truly silent, but a soft noise often only heard and felt by the breather), and through ideation – potential utterances which the breath stands ready to assist. It is a return to ideation that is expressed here, and in this state of almost-becoming, the conditions of loss inherent in this manifest urge to embody, or solidify sound, are counterbalanced by potentiality. In the lacuna left by the voice's absence, the *Phony* may stay as a device for the projection of ideas. It finds itself used as a soundtrack for its own moment; for the vision and for the holding of itself. The possibility that image, touch, and sound's potential can be combined together in meaningful ways can surely find its expression in a myriad of combinations of the senses, of which this is but one...

Chapter 7:

Conclusion

...and perhaps within the openness of this particular work, in the multiple ways it may be read, we may find the *Phony* has much in common with the many other technical apparatuses discussed in this thesis. Indeed, a theme that I have tried to develop during this research, is that any device for the re-coding of mediums into others, can also be reflexively understood as subject to the effects of those mediums as they are understood by the spectator; a factor which may, in return, nuance our reception and understanding of the works produced with it. The *Phony* seems to echo these sentiments, since it has emerged as a device for interpretation through more than one of its 'outputs' or 'signals' – be they haptic (including weight and temperature), visual, or invariably a composite of all of these things.

This may yet help us to get to grips with an as yet semi-articulated fault line which has emerged from within this thesis – different aspects of which seem to exert an undertow in parts of each chapter. In many of the subjects discussed above, the proposal has been that certain photophonic devices, due to their predisposition toward, or even, requirement of information in the form of an image as their input, leave themselves open to collision, or dialogue with fields of activity which are normally thought of as unrelated to sound. The convolution of sound recording and painted animation, for example, or in the particular case of the Photophone, the possibility that modulated light from the environment can be 'read' as sound under the right conditions. For some this has profound implications.

In a recent lecture entitled 'Photophonics', Steven Connor lays out a critique of sonification, beginning with Bell's Photophone (which he rightly implies is the founding device for this activity), situating it within a milieu of a 'conversion hysteria', where (according to Friedrich Kittler) 'inventors and engineers sought more and more ways in which different kinds of energy and sensory form could be translated into each other.'[274] In one sense, production of this kind of sound is considered authorless or transcribed, to quote Marey again 'In the language of the phenomena themselves'[275], and the crux of the problem lies within the way that meaning is inferred, or retrospectively applied to such types of sound. Connor refers to Altman's description of the 'sonic hermeneutic', as instrumental in this misconstruction of meaning – we are, as he points out, hardwired to ascribe sounds to a source: *Homo Significans*. But, he argues, this natural order becomes synthetically overcharged, in that with photophonic sonification, previously mute objects

[274] Connor (2011)
[275] Marey in Lastra (2000:73)

may be understood to given a 'voice', supposedly revealing to us a previously unheard dimension that was latent, just waiting for the right moment to be revealed: 'The point of sonification lies in a mysticism of the primal, a set of beliefs that sees translation into sound as a kind of making manifest of the latent truths, of a set of absolute but hidden primal conditions.'[276]

The tendencies made manifest by Bell's invention, in this reading, have in recent years reached a peak, giving rise to such mundanities as the sonification of proteins by the assigning of values corresponding to different molecules to MIDI data, or to isomorphically mapping weather data sets across into MIDI in much the same way.[277] That such undertakings are often described as musical, or sometimes entitled 'The music of...' belies their creators' investment of certain types of meaning in what eventually emerges. The point that Connor is getting to here is that our requirement for meaning generates meaning, which is, however instantaneously, retrospectively applied to these sounds' own genesis:

> But the stubbornly genitive case of sound, its inseparability from the idea of an originating circumstance, helps us deceive ourselves into seeing this new thing as the actualisation of some primal sound-potential that was latent all along in the non-auditory source-material. But this primality is an after-effect of what has come later or last in time. The origin of the projected sonification therefore has its origin in it. Sonification gives rise to what seems to have given rise to it. Sound can do this, or cannot help but do it, because of sound's failure of self-sufficiency, as the manifestation of a presence that it is not.[278]

Put simply, adherents to this variety of magical thinking aren't putting the cart before the horse, but rather, imagining that it is mysteriously pushing the beast forward. This is a useful critique, in part because it indeed nails a particular mystical tendency within those aspects of the arts concerned with correspondences between sensory modalities – as discussed previously with respect to the ANS, for example. But it is also useful because of what it doesn't address – and hence helps me here to frame my own practice, while reiterating points made earlier on in this writing. My concern with Connor's analysis, is that it echoes around in a space almost entirely unpopulated by devices, or the people inventing and using them; and it is precisely these activities of creation, usage and their bearing on the work's reception that I have explored. Within the context of arts practice and

[276] Connor (2011)
[277] For an example of such an experiment, See Dukich (2004)
[278] Connor (2011)

discourse, this is an omission of details which some might consider otherwise essential to the understanding of those works being held up to scrutiny...

Interestingly, Connor finds it worthwhile explaining that Bell experimented extensively with producing sound non-electrically (photoacoustically) in the ways that we saw in a previous chapter (along with myself, he is almost alone in teasing this out from under the shadow cast by the grand narrative of electronic sound production), taking the lead from one of Bell's pronouncements that all substances can be sonorous under the influence of modulated light. The conclusion we are to draw from this is that Bell (like Fischinger many years later) was intent on drawing out of materials some mysterious latent or innate property, spoken back to him through sound's uniquely revelatory properties – although as we have seen, in less guarded, private communications, he enthused about the poetics of singing, coughing sunlight, not soot or water.[279] We saw in an earlier chapter that the photoacoustic (non electrical) photophone is a peculiar case, simply because of the absence of any electro-mechanical or magnetic driving force in its workings. When considered as a physical process (it is just one, after all), it could be viewed as almost irreducible, less an apparatus than a singular effect; from flickering sunlight upon a dark surface comes sound directly, and this is useful for Connor's critique. In his account, the Photophone in any of its incarnations, as a physical object, is somewhat demure, or translucent; insubstantial in what is otherwise a substantial treatment. Apart from a reference to telephony, it is not described, either morphologically or mechanically as an apparatus, an enabler of any particular mode of listening or techniques of use (in stark contrast to Sterne, for example), and hence it becomes an empty volume within which the critique plays out, carrying within itself these wrong-headed ascriptions of meaning with it into the present day; Connor is asking us to hear its influence reverberate across a century of sound production, but only as this single process.

I would be overstating my objections here considerably, were it not that this non-engagement with any other devices instrumental to photophonic sonification, the techniques in their use, and the presentation of them in relation to the work they are embedded within, continues unaddressed. Given that photophonic audio is firstly, ineluctably synthetic, and secondly, operates as but a component within a range of artistic works, the apparatus that enables it – it's form, how it is used, who it is used by – is essential to our understanding of what it produces. To view, for example, Steven Vitiello's photophonic *World Trade Centre recordings* with Paul DeMarinis's *The Edison Effect* and Oskar Fischinger's *Tönende Ornamente* in the same light, is to compare a man near the top of an iconic (and now uniquely historically resonant) building recording distant neon and police car emergency lights through a telescope, to lasers reading defunct recording media to be amplified in a gallery, to a film maker photographing different graphical shapes to be scanned

[279] Two of the many materials that Bell experimented with in this fashion.

into auditory existence by a newly invented aspect of cinematic apparatus. All cohere around the central fundamental process of photophonic sound, but this process is simultaneously common and specific to each, since each work is presented differently, reflexively nuancing the perceived desires behind its creation. All the same, but all very different. In Connor's schema, these devices, or practices (and others, were any actually mentioned) seem reduced to a homogeneous, anonymous collection of false prostheses, rather than objects or systems which have been either purpose built, or deliberately mis-appropriated by individual artists with a variety of ideas to explore. I will explore exploration shortly.

The one exception here is the gramophone's needle, which is dealt with specifically since it stars in an often quoted text which is an exemplar of the tendency being critiqued – that being Rilke's 'Primal Sound' essay of 1922 (where he speculates poetically on what sounds might spring forth from a skull's coronal suture, if a gramophone's needle were allowed to play within its the undulating line). In citing Rilke, and Seth Kim-Cohen (who deals with this idea extensively, although with particular reference to Christina Kubisch's electro-magnetic sound walks), Connor expands the frame of reference here, from photophonics to sonification in general, enabling him to include digital sonification works,[280] but likewise, the processes behind these works remain fuzzy. The reason is that for Connor, the processes really don't matter, only the underlying desire that he supposes they articulate. To find meaning where none exists; using sound to falsely resonate meaning back out of whichever input – coronal suture, brainwaves, a passing cloud, magnetic fields, ornamental graphical symbols, meteorological data-as-MIDI – happens to be used. [281]

Clearly here I am deliberately foregrounding technology, in whichever guise it takes, over the mediums that it is designed to shunt signals from and to. My analysis is intended to prepare the ground to outline what I would suggest is one way through this particular critique of an entire specific mode of audio production, with particular reference to my own work – which is to reiterate the way that the sonifying apparatus and its context are read may change the understanding of the sound it produces. Simply put, the device used to produce the sound cannot be excised from what is heard, and this extends into the way that it is used – how it is performed, so to speak.

Something which fascinates me about these processes, is the simple performative switch that they enable between two different domains of signal; between what Connor would characterise as meaningful and empty modes of operation. To entirely alter a sound's ontology from states of meaning to non-meaning requires just a change in direction of an electromagnetic sensor with a gesture, the tuning of a radio's dial just half a turn, or the opening of the casing on the side of a film projector.

[280] In this case, the sonification of brain wave data.

[281] An acronym standing for Musical Instrument Digital Interface – which is the standard protocol by which software synthesizers are controlled.

A recent performance by Australian film maker Sally Golding at London's No.w.here lab saw her manipulating multiple 16mm sound projectors while they played film loops.[282] Leaving the casing open to enable access to the projectors' sound heads, Golding periodically pointed a strobe light into the exposed mechanism, generating a harsh popping sound over the top of the film's soundtrack (already itself, a grating, noise-based series of loops), sonifying, according to Connor, a phenomenon never meant to be heard, creating 'authorless' sound. How are we to read this activity? Perhaps there are a few interpretations – a tacit reference to the flicker genre, and hence mid 20th century neuro-psychological experiments with alpha brainwaves, or a structural/material cinema-style highlighting of the light derived nature of the projector's sound production. Perhaps (and Golding's generally non-committal attitude under questioning after the performance seems to support this), the idea was to play 'live' sound, in a visually arresting performance, by interfering with the playback equipment at her disposal: and this is my point here. The piece was made in the doing, to be consumed in the event of its own making, and while I didn't care for what was produced in the end, to me this event is emblematic of Connor's problem.

Clearly Golding was not attempting to reveal a hitherto un-grasped truth concerning the nature of strobe lights, but rather that she was playing the projectors more as instruments, and (within a limited range of possibilities) improvising – thereby exposing the work to a different set of possible interpretations; and that's before we begin to consider the image being projected.[283] The sound and image components, as well as Golding's presence and her activities as a performer/improviser (often, she projects onto herself), the status of the projectors in their slightly hacked nature; all these point to an exploration of different possibilities within film, its presentation as live event, and the importance of the position of the spectator. At the auditory heart of this, sonification is being explicitly and readably deployed (in addition to the strobe light, the optical soundtracks also consisted of 'image derived', rather than 'sound derived' information), but from the point of view of the spectator, any suggestion of the tendency discussed above is tenuous at best. Perhaps because of the flavour of live performed or improvised events such as these –necessarily ephemeral and transient – they seem ill disposed to sharing the same ground as concepts such as the revelation of latent truths as outlined by Connor. Such concepts infer timelessness and fixity, alluding as they do to substrate of natural order, only accessible to the ear via the sonifying apparatus. To marry the two would bestow upon a performance such as Golding's the status of ritual or sermon rather than anything more playful or exploratory.

That film can be 'live' or improvised is something which – still – runs contrary to what we generally imagine it is for, and at the heart of this lies the complex of problems and assumptions

[282] This took place on the 10th of November 2010. Golding's statement on the no.w.here lab web page reads like a synopsis of expanded cinema practices: 'Golding deconstructs cinematic materials and apparatus, slipping between materialist investigation, sculptural forms, and bodily intervention. Cracked cinema for darkroom compositions, light bleed, contorted projection sports, dismembered narrative, whimsical instructional and wanton optics' See: <http://www.no-w-here.org.uk/index.php?cat=1&subCat=docdetail&&id=251>. Accessed 17/07/11.

[283] An in depth discussion of the work here is unnecessary.

often bound up with linear recorded media, some of which are discussed in previous chapters.[284] We have seen how addressing these assumptions has been a key weapon in the structural film arsenal in its ongoing battle against the 'mainstream' of perception in the moving image. Fundamentally artisanal and personal, it often lays claims to anti-illusionistic modes of operation in order to enter into a dialectic with perception and the body, and the spectator's relationship to the ongoing event. Within this we may discern the oscillating state of attention between materials and meaning which seems to persist at the heart of the discussion outlined so far in this chapter; something to which hearing seems more prone to than vision. Sound and light are often referred to (including by myself) as materials, in other words, raw ingredients for doing things with; for making artistic works (film and video, music) *from* or out *of*. But their specific nature, additionally as carriers of information to the eye and ear complicates their status, and this is particularly true of sound, perhaps because of its contiguity with touch, where the *of* and the *from* can oscillate between foreground and background in the ongoing work; the 'over there' as well as the 'in my head'. The consideration of sound as a material – or more accurately, a disturbance within a material medium – is all that is required to effect this shift in attention between carrier and signal, and contrary to Pasnau's declarations, momentarily supervening one upon the other. The spatiality of sound becomes a correlate of the continuity of space, and of air – linking listener to sound source.

The structural/material film's mission to remind the spectator that they were watching images generated from materials and devices, ought therefore to be seen as framing photophonic sound somewhat differently; that is to say, photophonic sound revealing truths about its own artifice, as distinct from truths about the images scrolling through the projector's sound head, as revealed by the sound they produce. The emphasis on the event, on the 'liveness' possible within works which involved the projection of film has often been seen by artists and scholars alike as shifting the medium towards the territory occupied by performed music, and not just in the sense of audio-visual compositional strategies. As Steven Ball writes when discussing the current state of the genre: 'These formulations of the conditions of music usually rely on formal metaphor, drawing an analogous relationship between sonic and visual tone, rhythm and other factors, at a solely perceptual and symbolic pictorial level. The condition of musical practice, however, is not just expressed as affective reaction alone; it is also relational, spatial, contextual, generally constitutional as much as about form: which is to say where, through what means, and by whom produced and received.'[285] Again, we see a complex assemblage of possibilities and associations surrounding sonification, simply by dint of its almost metonymic relationship with film, and more specifically its materials and apparatus.

[284] Such as the veridical nature of sound and image recording (or otherwise), the re-presentation of sound in the audition space and the spectator's point of audition, the status of the sound carrier's presence in what is heard (optical rumble), the sound's paradoxical existence as an image, to name but a few.

[285] Ball (2011:286).

During the course of this research, a lacuna has become apparent in the literature available on experimental film and sound practices – that the cross talk between the two, despite being extensive in terms of technological innovation (many techniques used in avant-garde and experimental western music were initially used in film), performative practices and cultural impact, has barely been mapped. Theoretical and historical writing on film sound in general (as distinct from film music composition) is sparse, and in experimental film, especially so.

The rigour and attention afforded to the analysis of the image in film is bafflingly threadbare when it comes to the soundtrack – baffling since sound, as Chion reminds us, is an equal partner in the audio-visual construct. Likewise, writing on sound practice rarely attempts to tackle how film has affected the production, consumption, and performance of experimental sound works, unless, again, film music is the subject. Any future research into this subject must address these concerns; it is my hope that I will be given an opportunity to do so, especially given the new focus on audio-visuality that the internet, now coming of age as an audio-visual as well as tect medium, is foregrounding. Such a scholarly study is, in my opinion, timely and necessary, and the role of optical sound would surely play a central part.

I have sought to use the different ways that photophonic sonification has been, and can be utilised and performed, as loose thematic devices to organise the central section of this writing. This has been both a practical way of corralling a relatively disparate array of materials and practices (esoteric musical instruments, cinematic experiments, failed communications devices, abused scientific experiments), and a tacit, structural reference to these mechanical strategies' importance in the analysis of the subject at hand. To this end I have attempted to (necessarily succinctly) analyse how each device which enables photophonic sound production, such as the ANS or the Oramics system, can be considered as a locus of intent, or fulcrum, about which a number of physical mediums, ideas, influences, cultural assumptions and flights of imagination act upon one another. This mechanical metaphor (although somewhat reductive) seems appropriate, since it suggests a dynamic system of movements and interactions, whose forces or importance – weight, I suppose – may change according to the differing circumstances of receptive audition/spectatorship, and historical or cultural context. But also, this point of leverage is suggestive of work, or of doing, and in this regard the device and the work it produces are in my view inseparable; perhaps in some cases indistinguishable.

Here, I hope, we may discern a clarification in terms of register, or of intentions. I would propose that within my own work which has formed the practice aspect to this research, a form of exploration through sonification persists, rather than one of territorial definition; the work, its making, and its presentation possessing the condition of enquiry, as distinct from a series of

statements (the curatorial exercise known as the 'artist's statement' has always made my heart sink a little). That the physical systems I use might be considered as posed questions in themselves, is a logical progression in this line of thinking – for example the act of plugging a solar photovoltaic cell into the microphone socket of a field recorder or video camera can usefully be re-framed as an act of enquiry-through-action.

This simple functional subversion has produced a range of unexpected outcomes – I found myself wandering around London's centre on a winter's night, attempting to figure out whether or not my eyes or ears were leading me towards a particular light. Discovering that something interesting 'sounding' might be coming from a particular location, I found myself asking whether I was listening to a direct light source or reflections from an adjacent wall. Shop windows became sound mixers, part transmitting what was going on within the building, part reflecting what was going on behind me; I ended up going to firework displays just to hear how their light signals might sound. But perhaps most significantly, we have seen how the possibility of spatial collapse, or of fluctuation through ascription of sound to source, and of a notional photophonic 'frame' arises from this combination of optical and audio components; complementing the symbolic marrying of ostensibly incompatible physical technologies with the commingling of similarly incompatible attributes from each medium's opposite. Again a simple performative shift between the authored and the authorless, or the tuning out of human agency from the signal, crystalises the illogical, or perhaps counter-biological character of photophonic sound.

In the chapter entitled The Somatic Optic, we saw how the inherently irrational, synthetic nature of listening to light was unexpectedly allied to touch through the atomist model of vision – whereby atom-thin skins fly from objects to the eye and mind, imbuing sight with materiality by virtue of those images being constituted of the same stuff as the objects they left behind. That skin – or rather its possibilities, its field of associations – might find itself again between the eye ear, should by now no longer be anything less than a familiar idea in this writing. In each chapter I have touched on touch as both a bridge and a membranous barrier between sight and hearing, and expanded the notion of the body's surface out into notional contacts with photophonic works on film or video – and accordingly, I have attempted to show how I consider much of my practice to sit in some state of relation or other to this particular genre. Indeed, I would expect that any reading of time-based works in which light and sound are materially causal to each others' states, needs to address how film has been the prime wellspring of such practices. Hence, when discussing Guy Sherwin, I suggested (with the help of Laura Marks and Tony Conrad) that an emergent haptic sensibility was strongly evident in his optical sound experiments – that the image/soundtrack composite effectively energised the films as a surface, thereby engaging the spectator's 'perceptual

skin' (as Marks characterises it) in a relationship more latent with, or redolent of physical forces.

That touch is ineluctably wrapped up with notions of agency, of doing – more so than with the more receptive 'higher order' senses – is of no small importance to this central field of ideas. Its enabling of an exchange of potentials, the done-to and the done, the distant and the proximal, the body's envelope and its interior, gesture and stillness, seems to enable an analysis of the different works and devices discussed, that avails itself of the mechanical and all its attendant tropes of leverage, forces, contiguity, and dynamic change. All of these might be available through different routes of course, for these purposes, the doing is in the device, the device the doing, and this cluster of meanings seems to clarify the way that we understand machine's to inscribe themselves into what they produce.

To return again to *Said Object*, the act of doing is returned back in to the self, the *Phony's* muteness opens up to a re-routing of the sonorous, back through the cultural conventions of sound's depiction, at the service of the imagination of the spectator (or as I say above, the beholder), informed and mediated by touch. The *Phony* is brought, in no small degree, into existence by its vocalisation, acting as both score and recording, projection and projected – but just as importantly, its status as a sign that may be unrelated to sound (as some saw it) is of equal or even greater value to the intentions I invested in the work, since it recapitulates the trope of a system open to inputs from unassociated fields of activity, and hence, balances the condition of muteness, or rather completes it with deafness. We have seen how this tension between authorship and reception, its interaction with deafness can be supervened with, or supplanted by touch and gesture elsewhere – most notably with Bell's 'Visible Speech' system, where I examined how the re-routing of meaning (albeit entirely prescriptively) through touch, might be thought of as standing for a denuded aurality, yielding a concomitant denuding of the self through a non-engagement with the processes of language. This deafness finds echoes within 'scripted' photophonic sound – either 'direct' sound as with Fischinger and Pfenninger's optical sound works, or more instrumentally and more accurately, with the 'Oramics' system. The graphical marks which constitute these works sit at the confluence of conflicting notions concerning intentionality and meaning in the sounds produced; authorless as sound but authored as images and activity – intentionally of language, but falling on deaf ears.

In one sense, the act of making work like *Said Object* – insofar as it is framed as a hermeneutic activity, or a form of consultation, both social and sensory – is to acknowledge the ultimate impossibility of access to the consciousness of another person. I find it reassuring when considering the essentialist proclamations of other artists and thinkers concerning what may constitute a 'valid' representation of one modality in the form of another, that one need only ask

other people what these things mean for these givens to suddenly melt away; very quickly the only way to make sense of these correspondences is by recourse to the seemingly unending complexities of memory and knowledge that provide the background and bedrock to our experiences, and inform our engagement with the present. It suggests that likewise, the act of creating work, as an act of enquiry, must similarly be unending in order to stare back into this complexity and understand it for what it is. To be clear, this is a statement of hopeful optimism – a faith that in recourse to the personal, the interpersonal, and the honest, any importance of a piece of work to others may simply be a matter of some recognition; a compatibility enabling the work's resonances and plurality of meanings to flow outward and onward into the social. So it was, that when I was considering what to call the *Phony*, my thoughts returned eventually to the conditions of the voice that the object I held in my hands must ultimately stand for; that in the absence of some ubiquitous omniscient recording deity, almost all voices must ultimately be lost after utterance, except to memory. The holding of the ungraspable that this object embodied was an admission of the anxiety of that loss, and of the unreliability of memory. Since the awkward, crude waveforms cut into the object's 'flesh' were authorless themselves, or rather, mute through being lost to any acoustically engendered inscriptive chain that might have given birth to them, a recourse to memory's unreliable and mutable soft storage was the only course to take. So I settled on the title *Daughter's Voice from Memory* – a specific voice that has now been all but lost, but joyously so, to the miraculous speed with which children grow, both physically and, through intelligence, linguistically. To inscribe the idea of that voice, as distinct from the voice itself, opens the work and turns it around from looking to the past, to facing the future, ensuring I hope, its life through enquiry, not its loss through the fixity of declaration.

It might therefore be concluded that Said Object, and Daughter's Voice From Memory can be thought of as emblematic of the spirit of this research, since in their interplay they connect with many of the themes that have been examined: the visual and the auditory both being informed by the haptic, or giving rise to it, the condition of silence or 'deafness' implicit in inceptive optical sound, the aura of loss conjured through capture of the ephemeral (allied to the impossibility of truly veridical sound recording), and where works are at their most successful, their capacity to support multiple readings. These themes, and others besides, have not been derived or conjured from the references cited in this thesis alone, but have come about through the recognition of a resonance, or concordance between them and my practice. In this way, the dynamics of reflexivity concerning experimental sound works that I have discussed – of the understanding of the apparatus central to the work as being a point through which a network of forces and ideas act – applies

equally to the ideas within the thesis that the work operates in concordance with. They may be understood as part of that network.

It is my hope then, that the reader will not be left with the impression that I have delineated a rigid and immutable set of relationships between ideas, or writing and practice, since this would be antithetical to the spirit of inquiry that I hope I have foregrounded in this research. Afterall, it is only a degree of openness in thinking that enables such seemingly unrelated practices and histories to be linked together as I have done, to bring unique perspectives to the research.

'It looks like it could take on magic...'

Perhaps, in the words of one respondent in Said Object, a piece of work can indeed 'take on magic'. But it is only the person experiencing the work – and indeed this is the case all of the works that I have examined – that can bestow that condition. If, as with *Daughter's Voice*, a work is the concept of a sound source that is present, then it is the case that these works are as much receivers of meaning as givers: since the 'truth' of the interrelationships between sound and light ultimately only inheres in the person experiencing them, the works' significance perhaps lies in what they allow, not what they are. And it is within such openness – such a refusal of finality – that the possibility of further works is brought about.

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