

# The Visualization and Representation of Electroacoustic Music

Ph.D. Thesis

David Gray

This thesis is submitted in partial fulfilment of the  
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# Declaration

I declare that the work described in this thesis is original work undertaken by me between September 2005 and March 2013 for the degree of Doctor of Philosophy, at the De Montfort University, United Kingdom. Apart from the stated degree, no other academic degree or award was applied for based on this work.

# Acknowledgements

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I am especially thankful to my family for their support and encouragement. They always believed in me, sustained me, and helped me arrive at where I am today. This thesis is in large part dedicated to them.

It is finally dedicated to the world wide electroacoustic community, who continually seek to produce new, innovative and surprising musical experiences.

# The Visualization and Representation of Electroacoustic Music

## Abstract

This research is an attempt to review, and then restore the place of visualization within the process of electroacoustic music composition. This has involved outlining the nature of visualization generally as a form of representation, as well as of electroacoustic music itself. This research has also involved a review of some of the relevant historical contexts surrounding electroacoustic music, and identified the potential use of visualization in promoting compositional understanding and reflection. A key part of the methodology has been to examine the practice of living composers, and make comparisons with this practice and certain historical figures that are important to the genre. From this, it has been possible to identify a taxonomy of the various ways that visualization can and does contribute to electroacoustic composition. In this thesis this taxonomy is used as a tool for further investigation.

In *Chapters 1* and *2* there are definitions and a review of electroacoustic music, and then visualization generally and as applied to music. *Chapter 3* is a review of specific and relevant literature as regards to the visualization of electroacoustic music. *Chapter 4* introduces the concepts of imagining as opposed to discovering new sound,



and what is important to this research about these terms; in addition what is meant and indicated by them. *Chapter 5* deals with the responses that composers currently working have made to the enquiry concerning visualization. In this chapter these responses are dealt with as case studies. In a similar way, *Chapter 6* looks at some examples of historical work in electroacoustic music, again as case studies. In *Chapter 7* a taxonomical structure for the use of visualization in electroacoustic composition is established and derived from the case study results. *Chapter 8* looks at relevant examples of software and how they offer visualization case studies. *Chapter 9* looks at the place of the archive in various stages of the compositional process. *Chapter 10* investigates the problems of visualizing musical timbre as possible evidence for future strategies. *Chapter 11* offers some conclusions and implications as to the main research questions, as well as more specific outlines of potential strategies for the visualization of electroacoustic music.

It is fundamental to this research that whilst composition should remain creative, innovative, aesthetic and often intuitive, it should also have a cognitive element based on composers knowing and understanding what they are doing. In many circumstances visualization can be important to this process, providing that Schaeffer's priority of *audition* remains paramount.

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# Knowing the Unknown – the role of visualization in electroacoustic music

## 1.Introduction and Statement of Aims

### **1.1 Introduction**

#### 1.1.1 Research Questions

The aim of this research is to examine and, in the light of Pierre Schaeffer's statements, restore a role for visualization in the composition of electroacoustic music<sup>1</sup>. As a kind of representation, it has become evident during this investigation, that there is a need for the visualization of electroacoustic music that is based on a well founded conceptual framework. This research will seek to discover if this has been a significant omission of the genre, at least as regards its first intentions and inception. It will be seen in *Chapters 7* and *9* how visualization can enhance compositional understanding, both as regards to formulation of intentions during the compositional process, and the

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<sup>1</sup> Pierre Schaeffer's statements are dealt with in more detail in *Chapter 6*

analysis and archiving of more finalized results. The reasons why this might be so and, if it is the case, how this might be addressed, are the main questions examined by this thesis.

### 1.1.2 Areas of Investigation

In order to do this, I intend to look at what visualization actually is and how it is defined, and the kinds of roles visualization has played in music in the past, and might also play in the field of electroacoustic music itself. I also intend to look at some of the reasons why there has often been a relationship between auditory and visual experience, and perhaps other modes of experience as well. Some of these reasons are philosophical, some physiological or psychological, and some are more pragmatic or even based on informal anecdotal experience. Finally, I intend to look at the ways in which visualization can enhance musical understanding and meaning, especially in the field of electroacoustic music, and in particular to do this by examining the current practice of composers and others in the field.

The aims and methodology can be summarized as follows:-

## **1.2 Aims**

To research the nature and use of visualization in electroacoustic music, and examine the current practice of composers with regard to visualization.

To examine the visualization practice of a range of significant historical figures in electroacoustic music.

### **1.3 Methodology**

Examine the historical role of visualization in electroacoustic music in general, and make comparisons with the role of visualization in music generally.

Discuss the relationship of visualization in the composition of electroacoustic music with that of audio-visual work.

Examine the role of visualization in software used for electroacoustic music.

Establish and justify a taxonomy of observed types of visualization in electroacoustic music.

Apply the taxonomy to the responses of historical figures and living composers.

In conclusion, discuss the future implications of these findings.

### **1.4 Electroacoustic Music**

#### **1.4.1 Origin of Terms**

Firstly, there needs to be brief consideration given to the nature of



electroacoustic music. The term 'electroacoustic' primarily refers to the relationship between electricity and sound. Definitions of the term electroacoustic music have been somewhat elusive and often debated vigorously, and have changed over time. This has given rise to differing sub-genres. Debate around the subject arose from the two traditions *musique concrète* (Paris) and *elektronische Musik* (Cologne). Nevertheless the term has only been in use since the late 1960s and early 1970s. The French term '*électroacoustique*' has tended to replace the term '*musique concrète*' since at least the early 1970s. Furthermore *acousmatic* is a term used to describe some of the composers and musical examples that are reviewed later on in this research. Acousmatic literally means sound whose source or origin cannot be seen. The complex discussions that surround more recent applications of the term acousmatic do not effect the answers to the main questions that this research seeks to address. This thesis therefore concerns music that has been referred to as electroacoustic, *musique concrète* or acousmatic.

#### 1.4.2 Definitions and Characteristics

In the production of electroacoustic music, electronic datum of some kind is transformed into sound. In some instances, actual sound may have generated the electronic data in the first place, although this is not always the case. This is the case with recordings subsequently used as sound material, which are sometimes referred to as 'samples'. The musical discourse however evolves from electronic manipulation of some kind. Electronic or electroacoustic music were essentially groups of genres that

arose as a development of the techniques of recording (and broadcasting), and especially the loudspeaker and the microphone. Their development and their possibilities thus have a relatively long history, that ultimately can be traced back to Alexander Graham Bell's patent for the first electrical loudspeaker, incorporated in the telephone in 1876. The earliest recording can be traced back to Édouard-Léon Scott de Martinville's invention of the Phonautograph in 1859, and Charles Cros (1877) who made the visible trace of the Phonautograph playable from a photoengraved groove.

Unlike much other music, electroacoustic music does not of necessity require live instrumental performance. To that extent the composer often produces the finished product. Where live performance interaction with electronics is missing therefore, electroacoustic music has characteristics that derive from this quite fundamental difference. For example, because instruments needing performance (and perhaps the reading of performance instructions) are not a requirement, timbre need not be an assumed given in quite the way that it is in non-electronic (acoustic) music, with specific instrumental sounds and performance techniques often known and established beforehand. Sometimes this has occurred over a long period of time, especially as regards to the development of acoustic instruments, often in response to compositional demands<sup>2</sup>. The art of orchestration for example has developed to a high level as a result of this knowledge and assumptions. In contrast however, providing that sufficient *analysis* can take place, any waveform can be produced or *synthesized* in electroacoustic

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<sup>2</sup> The development of piano technology is cited later as an example of this in relation to the piano compositions of Beethoven

music. This has often resulted in far greater creative emphasis being placed on timbre as a musical parameter, as opposed to pitch<sup>3</sup>. Nevertheless, analysis is not always necessary *before* the creation of electroacoustic music, because as with all music, sounds can be discovered, edited, manipulated and finalized, as part of the compositional process.

#### 1.4.3 The Concrete and the Abstract - Reduced Listening

The philosophical and aesthetical basis of *musique concrète* is particularly important in this study, because the Schaefferian tradition demanded that the compositional process should be based firmly on audition. Visualization of any kind was regarded as indicating a tendency to work in the abstract, in such a way that the final musical product would emerge from this abstraction. This is dealt with more fully later in this thesis with particular reference to Pierre Schaeffer in *Chapters 4* and *6*. Initially therefore, notation was to be avoided<sup>4</sup>. It is this position, and the fact that timbre, with its multi-dimensional characteristics, presents particular difficulties as regards to visualization, that has made the relationship between visualization and electroacoustic music so problematic. It was said therefore by Schaeffer, that traditional music of the Western classical tradition moves as it were from the *abstract* to the *concrete*. *Musique concrète* however moves from the *concrete* to the *abstract*. This is a

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<sup>3</sup> There are numerous examples of electroacoustic music where pitch events are non-existent.

<sup>4</sup> Even Schaeffer however would resort to visualization to clarify explanations or analysis. (Schaeffer 1952)

somewhat theoretical position, given that there is usually a symbiotic relationship between the concrete and the abstract in any compositional process. Later in this thesis reference is made to *inner* and *outer* hearing. This refers to sound that is *imagined before* it is made, as opposed to sound whose characteristics are *discovered after* it is made. Again, although there is a distinction to be made between the two, there is always a symbiotic relationship between them. Inner and outer hearing can in part in this thesis be understood as having a relationship to what Schaeffer described as the abstract symbol and the concrete. This is referred to in more detail in *Chapter 3.3*.

In an introduction to a transcription of an interview with Pierre Schaeffer, Tim Hodgkinson summarized these issues in the following way: -

Almost immediately, Musique Concrete found itself locked in mortal combat not only with its opponents within traditionally notated music, but also with Electronic Music, which emerged in Cologne in 1950 at the NWDR (Nord West Deutscher Rundfunk). Electronic Music involved the use of precisely controllable electronic equipment to generate the sound material - for example, the oscillator, which can produce any desired wave-form, which can then be shaped, modulated, etc...

At the time, the antagonism between Musique Concrete and Electronic music seemed to revolve largely around the difference in sound material. Over the decades, this difference has become less important, so that what we now call 'Electroacoustic Music' is less concerned with the origin of the sound material than with what is done with it afterwards.

The real difference, the most lasting difference, between Musique Concrete and Electronic revolves around a basic disagreement as to the nature of the whole project. For Musique Concrete, the essential character of music as a human activity is such that the listening experience and the 'ear' are crucial things. For Electronic Music, the priority is the idea, the system, the perfection of control, of precise rationalization... to become scientific... (Hodgkinson 1986-1987)

Pierre Schaeffer himself has written about what he describes as the *abstract* and the *concrete* in music: -

MUSIQUE HABITUELLE  
 (dite abstraite)  
 PHASE I.  
 Conception (mentale);  
 PHASE II.  
 Expression (chiffreé);  
 PHASE III.  
 Exécution (instrumentale).  
 (de l'abstrait au concret)

MUSIQUE NOUVELLE  
 (dite concrète)  
 PHASE III.  
 Composition (matérielle);  
 PHASE II.  
 Esquisses (expérimentation);  
 PHASE I.  
 Matériaux (fabrication).  
 (du concret à l'abstrait)

(Schaeffer 1971–1972)

Schaeffer's position appeared to be that notation is not needed, because *musique concrète* is composed with sounds that already exist.

One can in effect exactly compare the two musical steps, the abstract and the concrete. We apply, we have said, the term abstract to conventional music, since it is first conceived by the mind, then theoretically notated, and finally realized in instrumental performance. We called our music <concrete> because it is formed from preexisting elements, borrowed from any sound material, that can be noise or music, then made experimentally by a direct construction, leading to a desire to achieve a composition without the aid, before impossible, of an ordinary music notation<sup>5</sup>.

(Schaeffer 1971–1972)

However, all music is composed or derived from at least an outline of possible sounds that exist in a person's perception and cognition already, at the very least in the imagination or memory, except where these sounds are intentionally sought out by a process of discovery. Given the situation that the instruments that make these sounds are

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<sup>5</sup> On peut en effet comparer exactement les deux démarches musicales, l'abstraite et la concrète. Nous appliquons, nous l'avons dit, le qualificatif d'abstraite à la musique habituelle, du fait qu'elle est d'abord conçue par l'esprit, puis notée théoriquement, enfin réalisée dans une exécution instrumentale. Nous avons appelé notre musique < concrète > parce qu'elle est constituée à partir d'éléments préexistants, empruntés à n'importe quel matériau sonore, qu'il soit bruit ou musique habituelle, puis composée expérimentalement par une construction directe, aboutissant à réaliser une volonté de composition sans le secours, devenu impossible, d'une notation musical ordinaire.

usually already familiar to the composer, it is surely the function of the composer to take these as it were *pre-existing* sounds and manipulate them into new musical and aesthetic expression; furthermore, to do this using imagination, perhaps with the addition of visual representation. The reason that representation and visualization is problematic in *musique concrète* and subsequent genres, is that it is essentially *timbral*, rather than based on sounds derived from notes or pitch.

This thesis will show that it is possible to represent timbre in electroacoustic music in ways that are meaningful and relevant to the various purposes that may arise, and to contribute something meaningful to the compositional process itself, particularly by way of compositional understanding and reflection. Some of the implications of these points are discussed more fully later in later chapters.

## **1.5 Visual Music**

There is a long history of work done in the visual music field which is characterized more fully below, and whilst this thesis is not specifically concerned with investigating or reviewing visual music, there are issues, techniques and approaches that are relevant to the visualization and representation of electroacoustic music for the enhancement of compositional understanding. The approach to this work however often has different aims and therefore outcomes. In a paper by Jack Ox and Cindy Keefer *On Curating Recent Digital Abstract Music* four definitions of visual music are given, of which the first is most relevant to this research.

A visualization of music which is the translation of a specific musical composition (or sound) into a visual language, with the original syntax being emulated in the new visual rendition. This can be done with or without a computer. This can also be defined as intermedia.

and also the other three:-

A time based narrative visual structure that is similar to the structure of a kind or style of music. It is a new composition created visually but as if it were an aural piece. This can have sound, or exist silent. Theorist/inventor Adrian Klein wrote in 1930: "...somehow or other, we have got to treat light, form and movement, as sound has already been treated. A satisfactory unity will never be found between these expressive media until they are reduced to the same terms.

A direct translation of image to sound or music, as images photographed, drawn or scratched onto a film's soundtrack are directly converted to sound when the film is projected. Often these images are simultaneously shown visually. Literally, what you see is also what you hear. (An early example is filmmaker Oskar Fischinger's Ornament Sound experiments c. 1932). There are many examples in Visual Music film of this process, e.g. McLaren, Spinello, Damonte and other contemporary filmmakers, including sections of Pengilly's work in this show. This method has been called a "pure" type of Visual Music."

A visual composition that is not done in a linear, time-based manner, but rather something more static like a 7' x 8' canvas. However, as in Klee, the movement of the painted elements can and have achieved a kind of Visual Music, serving as an artist's visual interpretation of specific music.

(Ox and Keefer 2006)

Visual music often results in new work of a multimedia or 'intermedia' nature. In this instance the other three definitions quoted above become more relevant. Visualization for the purpose of creating new artistic work, produces an audio-visual experience that moves somewhat away from the purely aural and musical experience. Nevertheless there may be some effective visualization practice, in terms of the first definition quoted above. Some early examples of this kind of work are the films of Oskar Fischinger. ( [www.centerforvisualmusic.org](http://www.centerforvisualmusic.org) ). (Fischinger also experimented with

sound scrolls on paper on which he would draw sound waves.) Later contemporary examples of this kind are some of the works by Bret Battey, who is one of the composers whose response is referred to in *Chapter 5*.



*Fig.1.1Mercurius*

( [www.mti.dmu.ac.uk/~bbattey/Gallery/index.html](http://www.mti.dmu.ac.uk/~bbattey/Gallery/index.html) )

Mercurius expands algorithmic animation techniques I developed for cMatrix10 (2004) and Autarkeia Aggregatum (2005), while also being my first work in which the audio is constructed entirely using modulated-feedback techniques I have been developing since the late 1990's. Both the audio and visual components of the work have no cuts or edits. What we hear is a continual transformation of one synthesis process, just as what we see is the continuous animation of nearly 12,000 individual points. (Battey 2007)

It is interesting that, as evidenced by his response outlined in *Chapter 5*, there is a distinction made by Bret Battey between visualization undertaken to compose sound, and visualization as part of a multimedia art work.



On the face of it, the kind of procedures outlined by Adriano Abbado quoted below, seem to focus more precisely on the visualization of music for descriptive or analytical purposes in the creation of the music itself. Ultimately however the product outcomes refer to an audio-visual work of art.

Composing with timbres involves an approach that is very different from the usual way of conceiving traditional Western music. In fact, it is problematic to attempt to organize timbres according to traditional principles. The author believes that if it is possible to establish links between audio and video events, then it is both possible to use the visual language to organize a music composition and possible to create abstract visual objects that correspond to synthetic sounds, consequently having a biunivocal link between audio and video events. The relationships between abstract animation and synthetic sounds are investigated in light of the correspondences between sound timbres and visual shapes, between perceived audio and video spatial locations and between perceived audio and video intensities. An audiovisual work called "Dynamics" was based on these correspondences. (Abbado 1988)

This quote, perhaps more than any other, has relevance to the visualization of electroacoustic music, because of its emphasis on timbre.

Artists in the visual music field self-evidently believe in and exploit the relationship between the auditory and the visual. This may sometimes be codified by them, particularly for specific compositions and intended aesthetic outcomes. In some cases there has been the desire to integrate the auditory and the visual, such that as quoted above '*a unity [can] be found between these expressive media until they are reduced to the same terms.*' It is the hypothesis of this research that such unity and codification may well assist visualization techniques in achieving enhanced understanding within the compositional process. It is also the case that the technology employed in multimedia work may well benefit visualization for compositional

purposes.

The approach and aims of visual music are relevant to this research, only in as much as such artists see and sense a close relationship between the auditory and the visual, so that they may be closely integrated together. The visual in this case is produced for aesthetic and creative reasons. The techniques are of interest however, although such visualization is not likely to directly inform the compositional process.

### **1.6 Some Earlier Devices for the Visualization of Music and Sound**

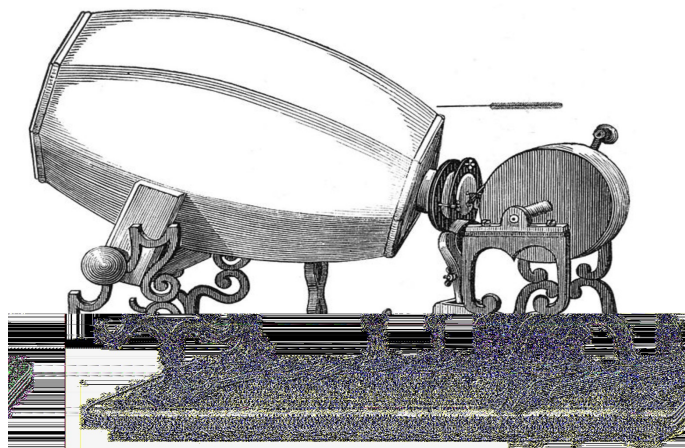
In the history and development of the use of electronics and machines in music, there were several attempts to create devices capable of visualizing sound waves or music. This section is not intended to be a complete and detailed overview of this history. A representative selection has been chosen which indicates a wish to visualize sound. It is important to note that the need for such visualization seemed to exist early on. In some cases experiments with such devices led to the invention of recording, which is fundamental to electroacoustic music.

Some of these quite early examples of sound visualization, occurred before the common use or discovery of electricity. Some of these devices may have had a more analytical purpose, albeit of a limited kind. In all cases they can be viewed in relation to the taxonomical structure outlined in *Chapter 7*. The main point with reference to this

particular thesis, is what may have been the reason for such developments, and what did the use of such devices seek to illuminate about the sounds in question? In some cases these are experimental projects, that intentionally or unintentionally led to the process of recording.

As referred to earlier, Leon Scott de Martinville developed the *Phonautograph* in 1857, the development of which in part led to the development of the first phonograph by Thomas Edison. Unlike the phonograph:-

-the phonautograph created a visual analogue of sound waves, [but] could not reproduce those sounds.



*Fig. 1.2 The Phonautograph*

The device consisted of a diaphragm and a boar's hair bristle that traced a sinuous line laterally on a manually rotated cylinder coated with lampblack. (*Early Sound Recording and the Invention of the Gramophone* – Library and Archives Canada)

One would well question the purpose of such a visualization, if reproduction of the sound was not *yet* possible. However it is important to note that this was the first attempt in history to *see* sound and to freeze time.

The Melograph was an early device for recording a visualization of sound, that was eventually developed by Charles Seeger in the 1950s. However there is a reference to the early version of the device in *Grove's Dictionary of Music and Musicians* that was invented by Johann Freidrich Unger (1716-1781). This device, also called a Melograph, was attached to a harpsichord for the purpose of recording the notes played. A later version of a Melograph was also mentioned in the *New York Times* of the 26th September 1887. It was referred to as:-

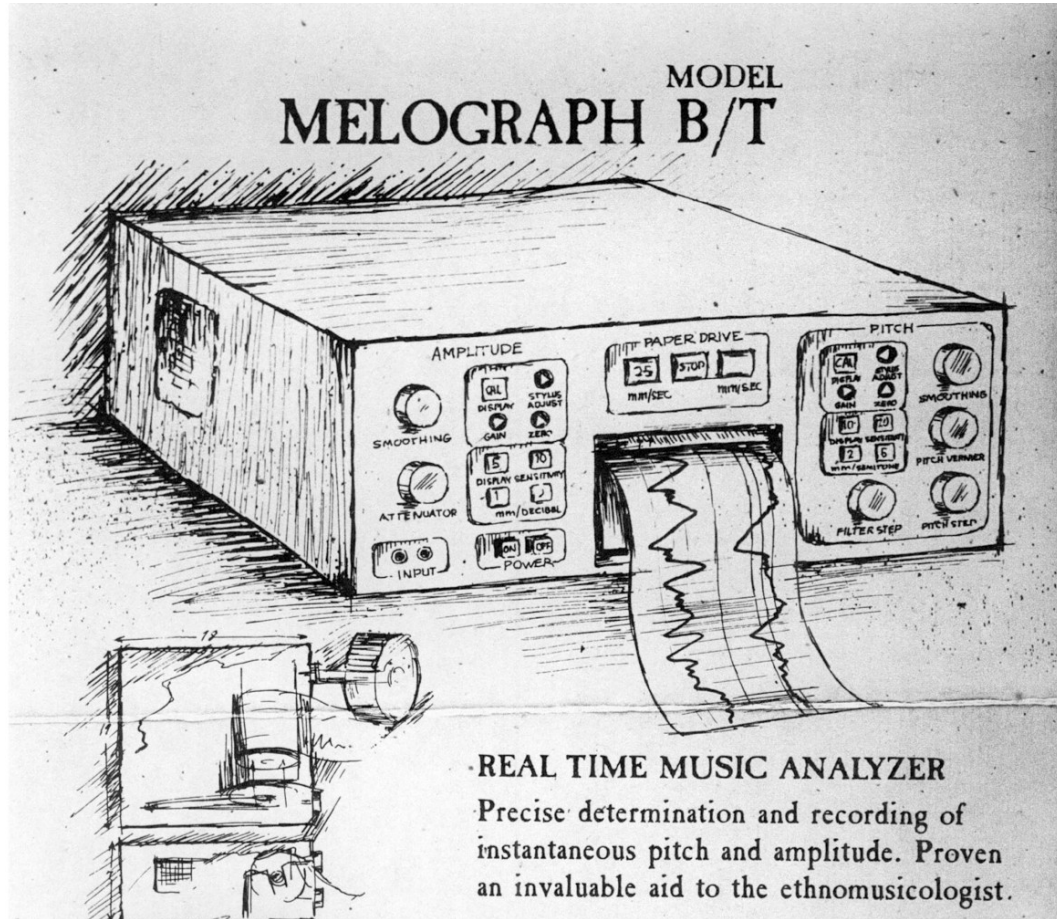
a dumb automatic recorder of musical sounds [which it] preserves in printed form, jotting them down, note by note, [ ] on a continuous scroll of paper (*The New York Times* - 26<sup>th</sup> September 1887)

Presumably such a '*recording*' was to serve as an *archive* of what had been heard.

The Charles Seeger Melograph of the 1950s and 60s developed to the Model C version for the purpose of aiding the transcription of folk song, and analysis in the field of ethnomusicology. References to it indicate its limitations.

As sophisticated as for instance the different stages in the development of Seeger's melographs have been - he somehow stopped short of making available the full potential of his machine by focusing mainly on 'the development of the graph' i. e. graphic registration (Seeger 1958). Musical analyses performed with the aid of the melograph or similar instruments are all confined to a more or less qualitative description of the output (fundamental frequencies are estimated by comparison

with a grid of reference lines, frequencies of harmonics are determined via the frequency of fundamentals, etc.) and if quantitative data are supplied they are estimations with no indication of the degree of accuracy or the method by which they were obtained - . (Will 1998)



*Fig. 1.3 The Melograph*

(Meer and Rao 2006)

Another device, that was one of a series over the centuries concerned with the visualization of sound, was first developed by Louis Bertrand Castel in 1730, and which was known as the Ocular Harpsichord. Castel was a theorist and writer on music who also studied mathematics. He was one of several to explore the relationship between

colour and pitch or key centres. Castel became particularly interested in the ratio similarity between the seven colours in the spectrum and the seven string lengths that produce the seven notes of the scale. He was thus one of the earliest to explore the relationship between colour and sound. The theory of this relationship was based on Newton's optics. In the 1890s Bainbridge Bishop designed and developed so-called colour organs again relating colours to pitches; C red, C# orange-red, D orange, D# yellow-orange, E green gold/yellow, F yellow-green, F# green, G green-blue, G # blue, A violet-blue, Bflat violet, B violet-red. Whilst machines like these are of interest in the history of visual music, they remain restricted in scope and purpose as a type of musical visualization, because they involve only a limited number of, or limited approach to, musical parameters. Associated with the thinking behind devices like these, is the attempt to see a correlation between both pitch and colour on the one hand, and between timbre and colour on the other<sup>6</sup>.

Whilst explorations into the possible relationships between the visual and the musical may produce results of some interest and relevance as representations of sound, these are somewhat removed from the concept of the visualization of music, for the purpose of enhancing the understanding of music as data or as an experience. This is an important distinction to make, because visualization has a utilitarian function concerned with data comprehension even if, as Edward Tufte suggests in the next chapter, the visualization has aesthetic qualities. Visual music on the other hand, as discussed in the

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<sup>6</sup> An excellent website developed by Fred Callopy has extensive information on the history of visual music, including a comprehensive time line going back to 1743 and continuing to the present day. (<http://RhythmicLight.com> )

previous section, often has other aesthetic or expressive aims inherent in the final product, other than enhancement of understanding of the sound being represented. This thesis does not primarily concern itself with the many initiatives to produce machines or software that generate visual images triggered by sounds.

It is to be noted that the examples quoted above are predominantly concerned with pitch as a musical parameter, and largely avoid attempts to notate timbre. As has been discussed previously in this chapter, this would have presented formidable difficulties beyond the scope of the technology available at the time. To some extent this situation remains unresolved, hence this early discussion in this thesis. It is probably true to say that these devices seemed to be answering the need of representing sound visually, even if this need was not well stated. Certainly one of the outcomes was to arrive at the possibility of recording sound. Using these early visualizations to enhance understanding and analysis was a clear aim, if not a consistently clear endeavour.

## 2. Visualization

### 2.1 Definitions and Characteristics

#### 2.1.1 Seeing the Meaning of Data

Visualization is a common technique of representation, employed to enhance the understanding of many different types of information or data. In its various guises it has been employed throughout very many centuries of human culture. The term visualization is used to indicate ways of representing data so as to make the understanding of that data more meaningful and comprehensible. Currently VizNet, for example, is a research network that aims to bring together new techniques of visualization in a multi-disciplinary sense and share good practice. ([www.vizNet.ac.uk](http://www.vizNet.ac.uk))

Researchers in arts and humanities, social sciences, scientific and engineering communities are generating, and accessing via grid and other networked technologies, ever increasing amounts of complex data. In turn, the analysis and presentation, or the enabling of real-time collaboration on such data and its constructed models, relies increasingly on visualization techniques and environments. (Kalawsky 2007)

Visualization therefore means *seeing* and understanding the meaning of the data more easily. Visualization is often 'visual' and in this thesis is we are referring to the



visual mode. However this does not preclude the use of text and numbers. Many visualizations using modern technology are multi-media representations of particular and quite specialized data. As a contrast to this, in Australian aboriginal culture as an early example, the 'data' required for survival, cultural development and contact between tribal groups, was *represented* in songs and chants that were never written down.

### 2.1.2 Purpose and Public Agreement

A key question concerning visualization is often what does or should a visualization include, and what it might exclude? Alongside this is the question of who decides on this, as well as the relevance and type of data, and how it is to be effectively represented or visualized? Since there is usually a connection between the data, the visualization, and the acquisition of some kind of knowledge or understanding, this may turn out to be a matter of public agreement about that knowledge, and therefore the visualization that represents it. As will be shown in *Chapter 5*, what can be identified as the electroacoustic community has as yet shown quite profound inconsistencies as regards this knowledge and common background. It is rare to find agreement as to how to visualize and for what purpose, and certainly agreement on the meaning of symbols or modes of expression. This public or inter-subjective agreement has even been a matter of philosophical discussion in, for example, *The Theory of Knowledge* by D. W. Hamlyn.

Intersubjectivity in turn implies the existence of a common framework against the background of which people can communicate; that is to say that it implies a common world. (Hamlyn 1970)

The acceptance of this common background, whilst being the subject of philosophical theory and debate, is also a matter of practical application, sometimes on a day to day basis. A common background is something that effective visualization can help to clarify. For example in music, traditional notation is itself a visualization protocol that is commonly agreed, has evolved over time, and that has to be learned in order to be understood and applied.

## **2.2 Edward Tufte – Truth and Economy**

### **2.2.1 Data in General**

Edward Tufte, who has written extensively on visualization, referred to visualization as *Envisioning Information* (Tufte 1990), which was what was meant earlier by 'seeing the meaning of the data'. According to Tufte, the two key characteristics of good visualization practice can be described as truthfulness, or making the representation of the data true to its meaning, and economy of representation, thus making the visualization as clear as is needed for the required purpose and understanding of the data. In the visual mode, Tufte has referred to this as the “ink to data ratio”. For example he has stated: -

Sometimes decorations can help editorialize about the substance of the graphic. But it's wrong to distort the data measures—the ink locating values of numbers—in order to make an editorial comment or fit a decorative scheme. (Tufte 2001)

It is possible therefore for visualization to actually distort the data, and sometimes this can be deliberate. A common example of this might occur when a data sequence such as the rise and fall on a stock market is recorded over time, yet the time intervals are not shown as equal intervals, thus distorting the appearance of the resulting graph so as to have a more emphatic and persuasive impact. In the following graph downloaded from a website concerning global warming, the time intervals have been adapted very slightly so as to produce a steeper slope to the graph. More importantly, the bandwidth of parts per million is vastly out of proportion in the vertical. If the parts per million were more in proportion to the million in question, then the rise in the graph would scarcely be discernible. In fact, the outcome of the visualization in terms of understanding the concept of global warming, is entirely dependent on the way in which the data outlined in the vertical axis is represented. Thus it could be regarded as highly persuasive. Nevertheless that is not to say that a slight rise in the graph may not yet have serious environmental implications.

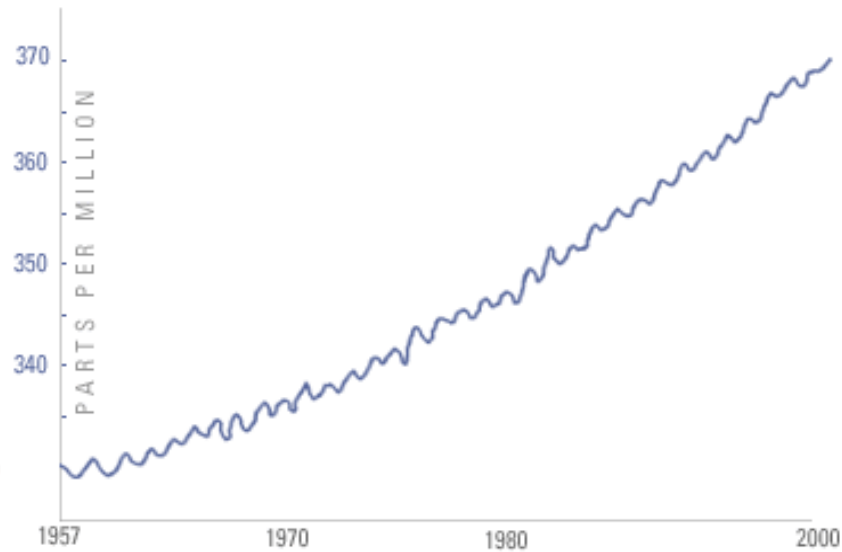


Fig. 2.1 Graph 'Parts to Millions'

### 2.2.2 Musical Data<sup>7</sup>

To attempt a musical example, these kinds of distortion might occur when a particular analytical point is over emphasized in order to strengthen a particular musicological argument, which is perhaps that not born out by the experience of listening. Hindemith, in Book 1 of his *Craft of Musical Composition* gives one of the many analyses that exist of the opening of the Prelude from Wagner's *Tristan und Isolde*. In it, he uses traditional notation as a visualization to clarify his analysis. Apart from a skeleton outline of the score, the basic material of the music is laid out in his

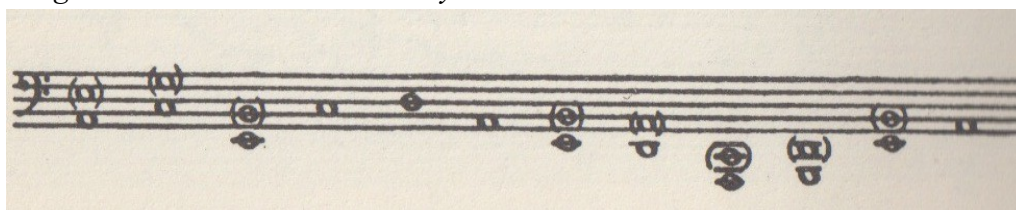
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<sup>7</sup> Musical data can be taken as an example of data that gives rise to aesthetic experience, which is later discussed (*Chapter 2.2.4*) and referred to in *Appendix B*.

book so as to emphasize his underlying compositional theory. Much of this material is highly persuasive in character, and could be considered to be a distortion of the actual aural experience of the piece. Material in the form of notes are actually added to emphasize the analysis. For example, tonal centers are established and *written in* that are not overtly composed into the music, and may not be readily perceived. The visualization and analysis results in the following conclusions: -

In the analysis of the *tonality* it should be noticed that those roots upon which tritone chords are built must be regarded as dominants of [non-existent] tonics lying a fifth below. Thus the tonal center of the first three measures is a, and of measures 5-7, c. If we set out the centers of the various tonalities in succession, we obtain the following series: -

*Fig 2.2 Hindemith 'Tristan' Analysis 1*



4. Richard Wagner  
Tristan und Isolde, Prelude

Harmonic and Melodic Analysis

1 Fluctuation

2 Two-Voice Framework

3 Degree-Progression

4 Tonality

[ 210 ]

Fig.2.3 Hindemith 'Tristan' Analysis 2

(Hindemith trans. Mendel 1942 – revised edition 1945)

Of course this is merely Hindemith's point of view. One might want to question if a tonic A is indeed heard or felt in the opening three bars of Wagner's Prelude, which thus rises a minor 3<sup>rd</sup> to C in the subsequent near sequential pattern. Certainly the visualization tries to confirm this analysis and experience as a reality. To conclude this particular point, it might be reasonable to regard Hindemith's visualization as effective and economical using traditional musical notation, and effective as regards *his* analysis. Therefore perhaps, it might be said that the visualization leads to good comprehension of somewhat misleading data. This is an example of how persuasive a visualization can be in achieving a particular conceptualization. Here the original notation has been edited and adapted to achieve the desired visualization and conceptualization. This is common to visualization in general.

Nattiez in his book *Musicologie générale et sémiologie* (later translated into English by Carolyn Abbate as *Music and Discourse – Toward a Semiology of Music*) compares several other analyses of the 'Tristan' chord. As one would expect, much use of traditional notational visualization is made to make these analyses clear. Nattiez goes much further however in that he uses visualization, and thereby indicates, that it can be an integral part of analytical processes, ultimately leading to musical understanding, significance and meaning. Visualization for particular musical purposes including analysis is discussed later in this thesis.

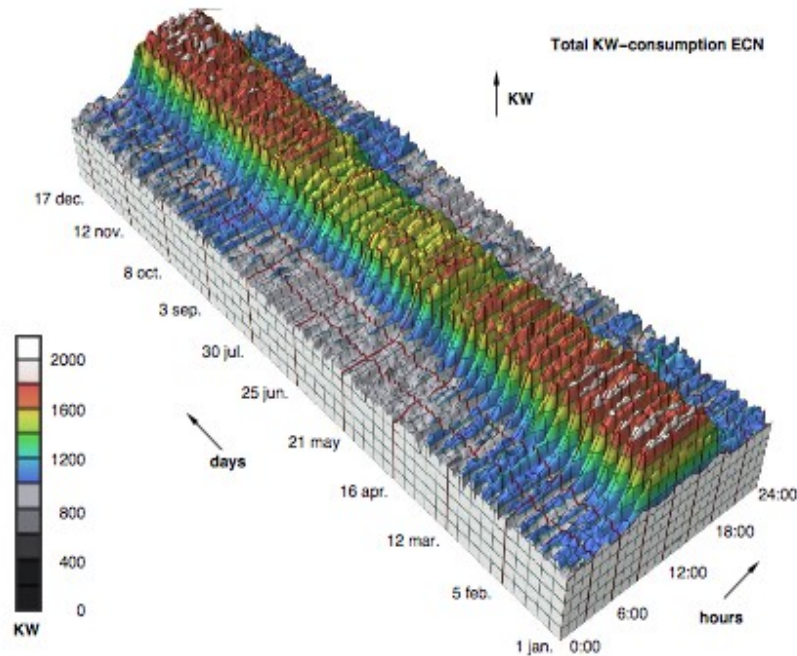
Visualization therefore can both assist and mask good comprehension of data. The essential point of the examples referred to above, is that a very fine judgment must be made in preparing an effective visualization, often about what to include and what to leave out, but that none the less remains *truthful* to the meaning of the data; and musical data should be no exception to this. It can be seen therefore, that this applies as much to existing systems of visualizing music as to any other data. It can also be seen that the *purpose* of the visualization is of great importance namely, who it is for and for what reason. Again we shall see later that this is important in music, including electroacoustic music.

### 2.2.3 Visualization of Events Over Time

Visualization of data that continually evolves over time such as sound or sonic events can present more complex problems. Unless 3D visualization techniques are employed then 'snapshots' or 'samples' of the data at fixed points in time must be plotted in 2D in some way. Historically, one of the most common visualization methods is the plotting of some kind of graph with fixed points occurring at a predetermined sampling rate. These are often joined by predictive lines to produce an analogue curve. Again distortion, or masking of the true and exact meaning of the data may thereby occur. (Coincidentally, this is somewhat analogous to digital sampling of an analogue audio signal.) Modern software visualization solutions can overcome this problem. A good example of a 3D visualization is given below that gives a representation of days, hours



and kilowatts to offer a visual analysis of the consumption of electricity: -



*Fig. 2.4 3D Visualization*

( [www.win.tue.nl/~vanwijk/clv.pdf](http://www.win.tue.nl/~vanwijk/clv.pdf) )

Issues concerning the representation of sound over time in 3D was referred to by Pierre Couprie in the EMS conference of 2007. (Couprie 2007)

3D and immersive environments are two technologies that invade the computer since only a few years through the field of gaming. Particularly suited to them, since their aim is to recreate

reality situations to immerse the player in a virtual world, they could bring to electroacoustic music performances interfaces better suited to educational work but also, for example, to allow the composer to intervene directly in his work during creation. Thus, such interfaces would put graphics techniques, not as a simple illustration of an analysis or dissemination, but directly in the process of creation and dissemination of the work<sup>8</sup>.

Here Couprie indicates that the programming environments created by the games industry offer potential opportunities for greatly enhanced visualization techniques in electroacoustic music, particularly as regards analytical and pedagogical work.

#### 2.2.4 Aesthetic Experiences as Data

Likewise, aesthetic experiences themselves usually take place over time. Aesthetic experiences including music may therefore involve more specialized approaches to visualization. In the first instance, this is because there must be some understanding of the nature of aesthetic experiences. There might be some doubt as to whether aesthetic experiences can be considered as data or at least expressed as data. However an aesthetic experience has a cognitive framework that both informs and is informed by our knowledge. This author, in previous research concerning the nature of aesthetic experience, produced a *Model of Musical Experience* that seeks to clarify the *cognitive* nature of aesthetic experience. This model is shown as *Appendix B*. In this

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<sup>8</sup> La 3D et les environnements immersifs sont deux technologies qui envahissent l'informatique depuis seulement quelques années à travers le domaine des jeux. Particulièrement adaptés à ceux-ci, puisque leur objectif est de recréer des situations de réalité pour immerger le joueur dans un monde virtuel, ils pourraient apporter à la musique électroacoustique des interfaces de représentations plus adaptées aux travaux pédagogiques mais aussi, par exemple, de permettre au compositeur d'intervenir directement sur son œuvre pendant la création. Ainsi, de telles interfaces placeraient les techniques de représentations graphiques, non plus comme de simple illustration d'une analyse ou d'une diffusion mais, directement au sein des processus de création et de diffusion de l'œuvre. (published abstract to the conference presentation–2007)

model the *musical coherence* presented by data that the various musical parameters generate are perceived as *musical metaphors*. These perceptions are accommodated in the Piagetian sense and then assimilated as part of our body of knowledge, and thus become cognitive. (Piaget 1966) In any case, it is not at all clear if data must be limited merely to cognitive information, as opposed to being more experiential or sensory. Are we to say that the senses of touch, taste and smell, for example, are devoid of information? Surely our sensory apparatus informs us about the world in which we live, and allows us to make sense of that world. Sometimes '*making sense of*' involves *feeling*, and yet is part of our cognition. In other words this is part of the process of perception that eventually leads to cognition and the formation of concepts. Aesthetic experiences play a full part here, and are not to be separated off into some isolated and different part of our lives. Their value to us would not be credible if this were so. David Fenner explains the relationship between data and aesthetic experience as unequivocally as follows:-

The “raw data” that aesthetics is meant to explain IS [my emphasis] the aesthetic experience. (Fenner 2003) although he admits that this is a '*relatively recent*' philosophical point of view. Much of his paper differentiates between the focus on aesthetic analysis leading to judgment as exemplified by Shaftesbury, Hutcheson, Hume and Kant, as opposed to aesthetic experience as exemplified by Santayana, Dewey and Stolnitz.

The movement from the Taste Theories to those focused on aesthetic experience is not a movement that is over and done with – far from it. There is still (and I think there will always be)

a tension between these two very basic aspects of philosophical aesthetics. (Fenner 2003)

Be that as it may, both approaches can derive from, or be the source of '*raw data*', moreover data that in many circumstances can benefit from effective and appropriate visualization.

Aesthetic experiences, if we are to treat them as “raw data”, must be explored without preconception, prejudice, or limitation. And, truly enough, the vast majority of aesthetic experiences are not focused exclusively, in terms of their contents, on formal or simple-sensory matters. Aesthetic experiences are, first, experiences. (Fenner 2003)

Later we read that analysis is only one part of experience, and that it is indeed the more experiential aspects in aesthetics that give rise to the '*raw data*'.

To return to the point, since we are more specifically concerned here with aesthetic experiences that are musical ones, some attention must be given to the nature of sound itself. We are of course concerned with the visualization of sound as music. Nevertheless, the numerous debates about how and when sound becomes music can be avoided at this stage, unless and until it happens that the sounds in question *are characteristically* different *because* they are musical ones. It follows that if the visualization of sounds can be meaningful in any way, then so can the visualization of musical sounds. (It must be kept in mind however, that musical visualization might and often does entail the visualization of form and structure in the music.) Ultimately, it could be that the *visualization itself* might indicate what it is about particular sounds that make them musical ones, because the visualization allows for a different quality of

reflection on or contemplation of the sounds in question. One would expect this as part of the process of visualization achieving an improvement in understanding. This could, amongst other factors, be very useful and important on a pragmatic level to a composer, musicologist or teacher. Some of the respondents mentioned in *Chapter 5*, have offered evidence that tends to affirm these assertions.

## 2.3 Summary

To summarize the main points of this chapter: -

- 1) Visualization is a way of representing data that enables better comprehension and understanding of the data.
- 2) Visualization is envisioning or *seeing* the data more meaningfully.
- 3) It needs to be truthful and economical and adapted for its intended purpose.
- 4) It can distort the meaning of data either intentionally or unintentionally.
- 5) It can be used for musical and other aesthetic data or experiences.

### 3. Some Important Examples of Relevant Literature

Many references to the relevant literature occur elsewhere in this thesis, for particular or more specialized reasons. However, there are examples of other work in this field that may shed light on the main research question and its associated problems, and may benefit from closer attention.

#### 3.1 Notation in New Music

*Notation in New Music* by Erhard Karkoschka (trans. Ruth Koenig 1972) is a review of twentieth century music visualization practice. Whilst this includes some examples of notation of electronic music, there are also examples of contemporary instrumental music that address problems relevant to this research. The principles are well stated: -

The main purpose of musical notation is to make possible the construction, preservation and communication of more complex kinds of music.

(Karkoschka 1972 Page 1 Chapter One)

But there is an immediate caution: -

The technical possibilities of a notation system also influence the act of composing – the entire musical way of thinking of all musicians – so that the aural image of a musical work in every epoch is characteristically related to its visual configuration. (Page 1 Chapter One)

The last sentence quoted is a fundamental issue that directly relates to the research questions associated with, and answered by this thesis. This is also a point taken up and criticized by amongst others Trevor Wishart in *On Sonic Art* (ed. Simon Emmerson – 1996) which is referred to later in this chapter. In the Karkoschka, there then follows a discussion of the pitfalls and weaknesses of any system of notation, but in the sense of 'doing justice to a composer's intentions.'

Karkoschka divides his approach to the whole area into four levels: -

- 1) exact notation
- 2) frame notation
- 3) indicative notation
- 4) musical graphics

(Page 19 Part Two)

What is important here is that he suggests: -

-by and large, precision of notation decreases from level to level, whilst the importance of the graphic effect increases. (Page 19 Part Two)

In other words, he is suggesting that as notation begins to employ more freely graphical images, then the absence of agreed and understood symbols renders the notation less

predictive as to auditory outcome. This is something that hinders and limits visualization practice in electroacoustic music as well. It is also interesting that within the subsequent discussion of these levels, register and timbre are very much sub-sets of pitch. Later he states with reference to electronic music: -

- frequency, duration and intensity can be fixed exactly; timbre can be decided upon and continuously changed. (Page 81 Chapter Five)

Acoustically however pitch is a sub-set of timbre and this has importance in understanding much of the characteristics of electroacoustic music<sup>9</sup>.

In the section on exact notation, specific symbols are made reference to from particular works, sometimes applied to particular instruments or performance situations and conducting scores. Even in this section, symbols are shown that would commonly not be known, and would require explanation as to intent in particular scores or performances. An example of this by Berio is given in *Chapter 7 (Fig. 7.1)*

'*Frame notation*' is a term that originated with Boguslaw Schäffer in *Topofonica* and means that according to Karkoschka '*possibilities of choice exist within fixed limits.*' The '*frame*' is fixed exactly but not the contents within it. Here the symbols referred to would certainly require explanation in any score. Similarly some examples of approaches to visualization in electroacoustic music avoid a precise indication of outcome. This would be even more the case with what Karkoschka refers to as

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<sup>9</sup>This is discussed more fully in *Chapter 4*



'indicative' notation, which however appears to rely on *performance*.

This is the name for a style of notation which does not limit the *interpreter*[my italics] strictly, but which frees him from the rigid pattern of the bar metre and permits him to feel, rather than count, the “qualitative” proportions of the durations. (Page 63)

Karkoschka regards graphic notation as: -

diametrically opposed to precise instructions” and that it is intended to “stimulate without constricting the imagination.” The <sup>10</sup>*initiated* [the author's italics] can enjoy them simply as reading material, their interpretative possibilities having an enriching effect. (Page 77)

This will be an important issue when considering visualizations employing more graphic images.

In *Chapter 5* entitled *The Notation of Electronic Music*, he outlines some important procedures that have also become quite commonplace in electroacoustic music visualizations. The problems he sets out may be summarized as: -

- ways of editing and manipulating material cannot be shown clearly.
- durations cannot always take account of large differences in the length of different sound objects.
- “noise” not only defeats meaningful representation “on the basis of pitch notation” but any kind of systematic visual representation.

He does however make some significant recommendations. These may be summarized as: -

- 1) signal processing could be indicated precisely and diagrammatically in time often with symbols rather than textual explanation

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<sup>10</sup> *Those in a position to know* which refers to Hamlyn *Theory of Knowledge* (1970)

- 2) using transparent paper to indicate how sounds or processes are superimposed over each other
- 3) sound objects could be indicated temporally and then given more precise detail on separate scores [currently this could be done using hyperlinks or something similar]
- 4) use of perspective [or 3D] drawings

Karkoshcka highlights many of the issues that can also be associated specifically with the visualization of electroacoustic music, particularly if more predictive work is intended or required.

### 3.2 On Sonic Art

*On Sonic Art* by Trevor Wishart (ed. Emmerson 1996) is a review of electroacoustic or acousmatic music that also raises specific issues relevant to this thesis. The nature of electroacoustic music and its relationship with other types of music is closely examined, but contrasted with what we may regard as more conventional music.

- conventional music theories, dealing with the organization of pitch in finite sets, rhythms using summative notation and most usually in fixed tempi, and sets of instruments grouped into clearly differentiated timbre-classes, I shall call *lattice sonics*. (Wishart 1996 Page 8 – Preface)

'Lattice' indicates a process of classifying and filtering the organization of data, in this case musical parameters and material, into groups, sets and sub-sets, for example the defined notes of a scale, or the relationships established by diatonic tonality. Wishart then announces the intention in the book to deal with matters that fall outside these well

documented theories. The book assumes there is no such thing as 'an *unmusical* sound-object.' (Page 8) As far as visualization is concerned, conventional notation is regarded as '*lattice oriented*'. (Page 11 Chapter 2) Wishart regards this as unnecessary to musical creation or composition, and that importantly: -

-the priorities of notation do not merely reflect musical priorities – they actually create them. It is fundamentally important to grasp this point if we are to understand an approach to music based on our listening experience. (Page 11)

The problems arising from these issues and prioritization are dealt with in considerable detail and set in historical context. We have said elsewhere in this thesis that pitch is a sub-set of timbre: -

Conceptually, at least, an instrument is a source of stable timbre, but variable pitch. The essential function of an instrument is to hold the timbre steady and to articulate the pitch parameter. This conception contributes to the myth of the primacy of pitch (and duration) in musical architecture. (Page 23)

This is important, since one of the main findings of this thesis is that apart from other issues, visualization of predominantly timbral music is in itself problematic for acoustic reasons, pitch being a sub-set of timbre. Furthermore this controversy:-

-eventually leads to Boulez's theoretical distinction between primary and secondary qualities in music. The primary qualities are those which have been accurately notated – in a certain limited sense – the secondary qualities those which have not. (Page 31)

It follows from Wishart's expressed analysis of the relationship between visualization and electroacoustic music, that his view of the situation would need to be addressed in

any attempt to establish a conceptual framework for such a relationship. Certainly his response to questions about his own visualization practice, discussed later in this thesis, would bear this out. Wishart's explanation of this is extremely succinct: -

In the West, the rationalization of music on a lattice is taken to its extreme. First from the infinitude of possible pitch levels which could give rise to numerous subtly different musical scales – a small set of twelve clearly specified pitch-levels is gradually selected. Then partly through the tendency – intrinsic in the notation system and its realisation in the technology of the instrument [ ] design – towards a rational simplicity, a notational economy, the well-tempered scale arrives - (Page 30)

It must be said however that most of the book develops a *speculative* approach (to quote Wishart (Page 3 Chapter 1)) to a conceptual framework of electroacoustic itself, and that the issue of visualization is placed in context. It is also true to say that timbre, as traditionally represented by the technology of instruments, is placed alongside, embedded in and as it were *driven* by the conceptual framework behind traditional notation. (Chapter 16 *Beyond The Instrument: Sound-Models*)

### 3.3 Guide des objets sonores

Michel Chion's book *Guide des objets sonores – Pierre Schaeffer et la recherche musicale* (Chion 1982) presents a number of issues concerning electroacoustic music which need to be addressed within the concerns of this thesis. It is now available in English on the EARS website ( [www.ears.dmu.ac.uk](http://www.ears.dmu.ac.uk)). Page numbers quoted will be from the original French but using the English translation. The book is structured as a dictionary or glossary of terms or as it were concepts, but presents an in-depth analysis

and some definitions concerning the nature of electroacoustic music, its origins and the philosophy of Pierre Schaeffer. This review will concentrate on those matters that are relevant here.

The first term in the book, acousmatic, raises and introduces the conceptual basis to listening (and reduced listening) and the way it is regarded in acousmatic music. Essentially it is listening without reference to a sound source or source/cause; or in fact without reference to a visual stimulus of any kind.

The acousmatic situation changes the way we hear. By isolating the sound from the “audiovisual complex” to which it initially belonged, it creates favourable conditions for *reduced listening* which concentrates on the sound for its own sake, as *sound object*, independently of its causes or its meaning (although reduced listening can also take place, but with greater difficulty, in a direct listening situation [where the evident source is visible]). (Page 18 French ed.)

and: -

This is why he [Schaeffer] came to extend the meaning of the term “acousmatic” and speak of the “acousmatic experience” to describe a new way of hearing: “*giving oneself over entirely and exclusively to listening*”, in order to discover the path from the “sonorous” to the “musical”. (Page 19 French ed.)

This is fundamental to the philosophy underlying *musique concrète*, and may explain the reservations of many composers in this genre, about any kind of visual representation. This would also seem to conflict with the stated position in this thesis, that visual representation can be a useful part of the compositional process in this genre. However, visual representation in the context of this thesis is intended as a

compositional *aid*, not a compositional stimulus and in particular should be a representation of what has already been *imagined*, or made or discovered in the studio. Imagination and discovery is a point taken up in the next chapter.

Elsewhere in this thesis the concept of the *sound object* is referred to. Schaeffer's use of the term 'sound object' needs to be addressed by any hypothesis concerning the visualization of electroacoustic music. Schaeffer makes a distinction between *identification* and *description* of particular sound objects. Both of these concepts are what any visualization will consist of.

Musical objects, phonetic objects, industrial sounds, bird-song etc. are sound objects. The common stock of these has as many branches as categories defined by these terms. How can we separate what belongs to the common stock and what is a matter for description?

So we are obliged, when listening to sound objects, to make a distinction between the two aspects, one to do with the identification, the other with the description of the objects.

(Page 59 French ed.)

Schaeffer's position is that the roles of identification and description are reversed in electroacoustic or the '*new experimental music*' as compared to *traditional* music.

In the new programme of musical research - [the] sonorous becomes a matter for *identification* (by isolating and locating types of objects through *typology* in the chaos of a sound context), and the musical, a matter for *description* (description, through morphology and analysis, of structures of criteria in the perceptual field). These similarities and contrasts can be summed up thus:

IDENTIFICATION	DESCRIPTION
of an object as	
an OBJECT in a STRUCTURE	a STRUCTURE composed of

where it is IDENTIFIED	OBJECTS enabling it to be DESCRIBED
	is applied in the traditional musical system
to the explicitly MUSICAL	to the vaguely SONOROUS
	and conversely in the Programme of Musical Research
to the SONOROUS which is clarified by means of a TYPOLOGY (rather like TRANSLATION [VERSION])	to the MUSICAL which is established by means of a MORPHOLOGY (rather like PROSE COMPOSITION [THÈME])
(PAGE 60 FRENCH ed.)	

This is surely the basis on which visualization must be carried out in this genre namely, identification by *typology* of particular sound objects. This will enable relationships to be *seen* and established. Identification by *morphology* of particular sound objects again to see relationships, to see some aspects of how they were made and whether *other* sound objects are embedded within them, as well as their possible relationships within the whole composition; and in addition show how all these matters might relate to the structure of the whole piece. Broadly, Section 4 in Chion's book deals with typology and Section 5 morphology, although there is considerable interplay between the two. In the first instance however: -

Typo-morphology is the initial phase of the programme of musical research, which groups together as complementary the two procedures of typology and morphology: (Page 113 French ed.)

Typology is described as '*taking care of*' identification and classification, morphology takes care of description. To summarize this position:-

The three tasks of typo-morphology are therefore: *identification*, *classification*, *description*.

- 1) identifying sound objects, i.e. isolating them, cutting them up into sound units.
- 2) then, classifying them into rough characteristic types.
- 3) finally, describing their characteristics in detail.

Typology takes care of the first two; morphology, the third. (Page 113 French ed.)

Of course however, this is seen in the context of earlier comments regarding *reduced* listening: -

Naturally, our approach is through *reduced listening*, so that in theory, to identify, classify and describe objects we make no reference to their cause, their origin, what they evoke ... etc. (Page 113 French ed.)

Clearly visualization could, and perhaps should deal with these issues, or at least take place in the context of these issues. The hypothesis behind this research into visualization however, remains compatible with what Schaeffer conceived of as '*reduced listening*'. It could be argued that in the right part of the *compositional process*, visualization can enhance the quality of reduced listening.

Much detailed work is done and reported on in the book (Chion 1982) on *identification, classification and description* of sound objects. Of course, if this were met with a large measure of agreement by composers within the electroacoustic genre, symbols could also be agreed on that would enable visualization to be far more simple and meaningful to the compositional process; this in fact has become the position with traditional notation and its relationship to more conventional instrumental and vocal



music.

### 3.4 Spectro-Morphology and Structuring Processes

Denis Smalley referred to the problem above in *Spectro-Morphology and Structuring Processes* (Emmerson 1986) Here, the term spectro-morphology or even spectro-typology replaces typology. He also takes up several of the last points relevant to this thesis in particular: -

The lack of a shared terminology is a serious problem confronting electroacoustic music because a description of sound materials and their relationships is a prerequisite for evaluative discussion. In searching for appropriate words we are obliged to borrow non-musical terms because the circumscribed vocabulary invented for purely musical explication is too limited for spectro-morphological purposes. (Page 63)

The contention of this thesis is that lack of agreement about terminology leads to an inevitable lack of agreement about symbols. He is also in agreement on *reduced listening* : -

-In trying to describe the sound of an approaching car we should have to forget that it is a car [ ] confining our observations to discovering how the spectrum of the sound changes in time. This investigative process is known as *reduced listening* – (Page 63)

Smalley then begins to introduce some classification into spectral types based on perception in the first instance working from a '*note to noise continuum*'. (Page 65) Importantly there is no conflict here concerning the way in which some sounds acquire pitch identity through our perception, as compared to other written references quoted

elsewhere in this text. Interestingly however, we are presented with classifications and typological distinctions that are different to the kind outlined by Schaeffer and described by Chion. This again points up the lack of consistent agreement on definitions, acoustical models, typology and any subsequent or possible representational symbols. In the section on morphology, symbols are introduced to indicate differing attack profiles. Later on these symbols are combined into 'morphological strings' (Page 71). There is no reason why symbols such as these could not add considerably more meaning to any visual representation, but they would need a key to achieve real understanding. Of course far more information is also required for a complete understanding of traditional notation. In fact there are even examinations held in such traditional Western notational understanding. Whilst visual representation is not the main thrust of Smalley's paper, it does offer some relevant clues as to the nature of electroacoustic music, and what problems we may encounter in trying to establish some kind of conceptual framework for such representation.

### 3.5 The Mirror of Ambiguity

Many of these points are summarized in the volume quoted immediately above in a chapter by Jonathan Harvey entitled *The Mirror of Ambiguity*. (Chapter 9)

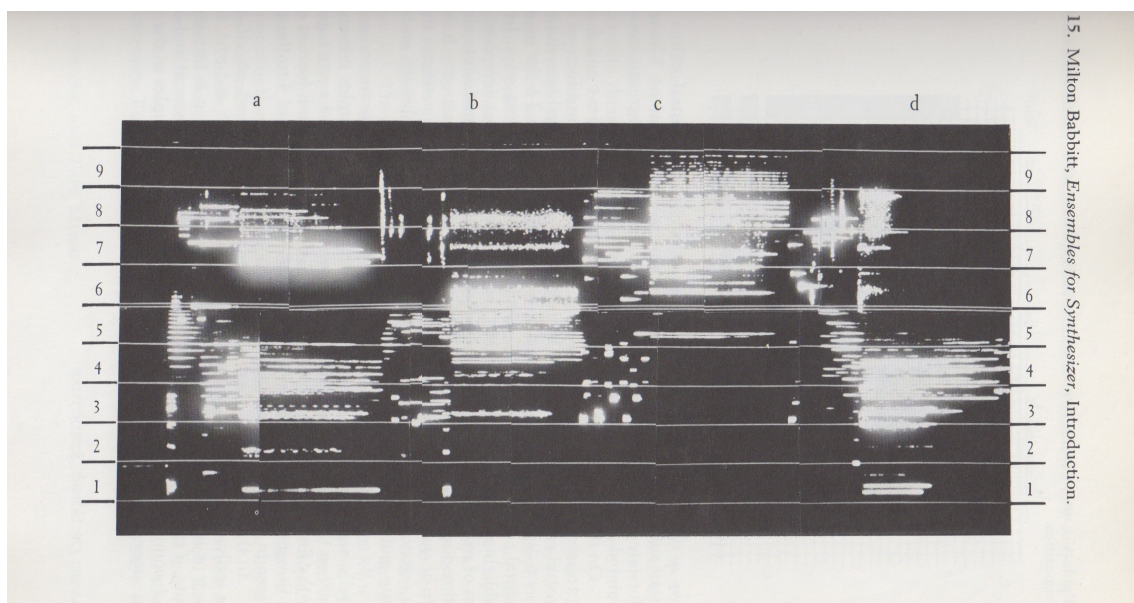
When composing, the normal course of action is to imagine a sound, sometimes check or adjust it at the piano, then write it down: notate it. Is there any essential difference between such traditional ways of working and the composing of computer synthesized music? At the terminal a sound is also imagined, tried out, adjusted and then saved in program language notation: a very similar procedure. [ ] One is searching for the final form of the sound, as it will be played at

concerts, whereas in traditional composing one is searching for the final *notation* that will *lead* to the desired, still imaginary sound. (Page 175)

This reference to *imagined* sound as opposed to *discovered* or completed sound is a point taken up in the next chapter.

### 3.6 New Images of Musical Sound

This book by Robert Cogan (1984) is an early approach to looking at the possible compositional or analytical significance of spectrum photographs. An example of one such is given below.



*Fig. 3.1 A Spectrum Photograph*

To a large extent the conclusions of this book reveal the difficulty of making a close and meaningful connection between sound events as they are perceived and how they appear in a spectrum photograph. These difficulties are also reviewed in *Chapter 12.4.2.* which discusses FFTs as possible devices for visualization. In *Part II Tone Colour: A Phonological Theory* (beginning on page 121) there begins to be outlined an analysis strategy intended to put such images to use. Within this strategy some consistent sonic attributes are outlined based on what is termed in the book a *Table of Opposites*.

Such a table is constructed so as to include all spectral distributions and the full panorama of available tone color characteristics. A composer makes choices among the opposing features – choices that chisel away certain of the total (and contradictory) possibilities of the sonic medium. The significance of these choices can be seen by comparing sonorities and contexts. In the end, the specific morphology of each sonority and the sound shape of each context stand revealed.

(Cogan 1984 Page 125)

One example of a table is shown below. The work in question is that of the spectrum photo shown above of work by Milton Babbitt. Of particular interest to this research is an early attempt to identify timbral (sonic) attributes each one of which being *opposites* becomes two dimensional. The terms on the left hand side are also a significant use of language used to describe sounds.

We see in this instance how analysis of the sonic features in terms of negative and positive oppositions reveals how an entire context is shaped. The Babbitt introduction displays a two-step progression from positive (+2) to negative (-6) over intermediate sonorities (-2 and 0). This transformation is especially vivid in the graph [in Figure 34].

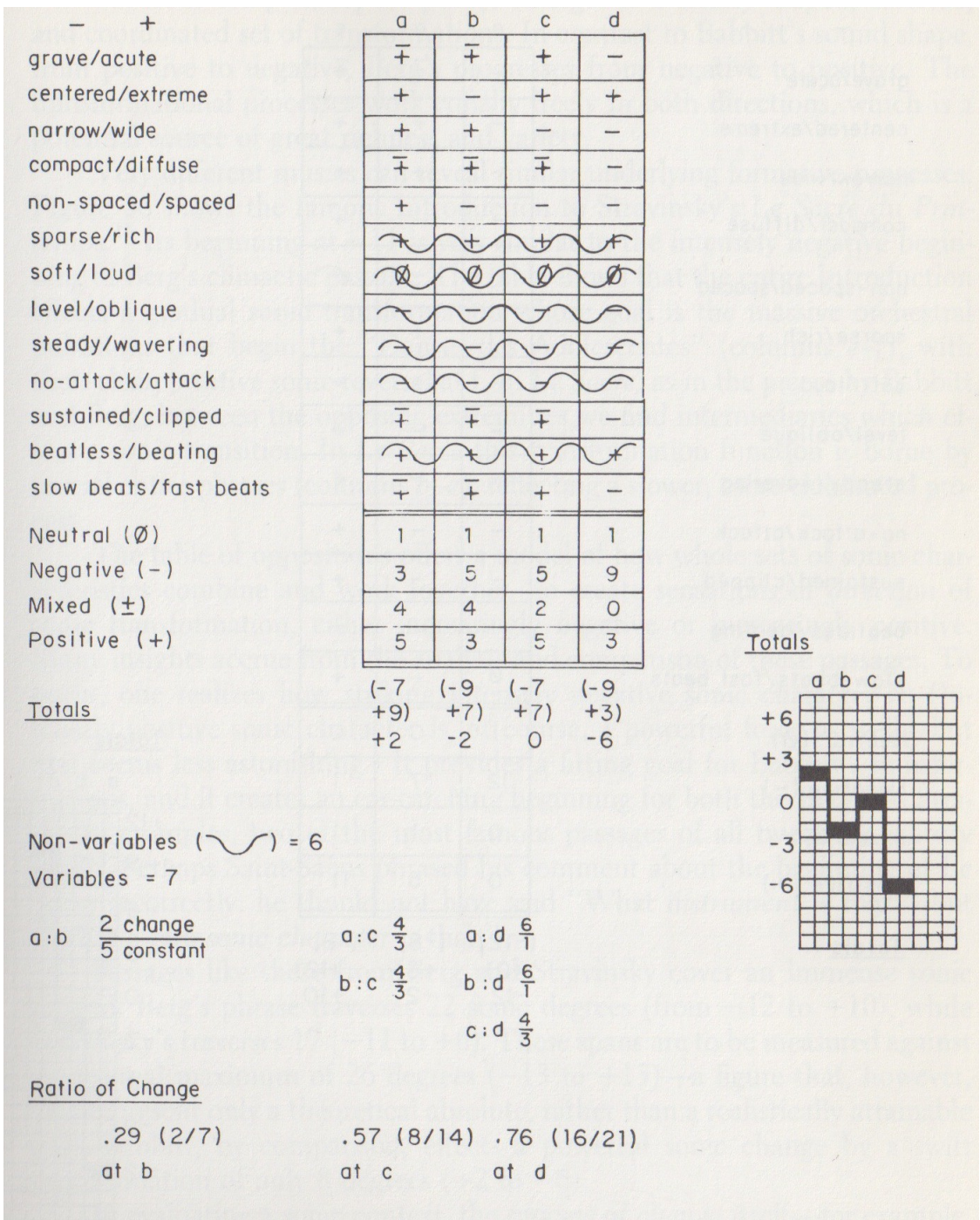


Fig. 3.2 Table of Opposites

(Fig. 34 and quote from Cogan Page 127)

### 3.7 In Search of a Concrete Music

This recently published (2012) translation of Schaeffer's book *A la recherche d'une musique concrète* allows us to read the original book in English. (North and Dack 2012). The final two parts of the book focus more specifically on what was intended by Schaeffer, in identifying a possible experimental solution to music in the 20<sup>th</sup> century. Schaeffer also places '*concrete music*' in a contemporary context with other musics of the time, and in particular serialism.

If the first clash between concrete music and dodecaphonic music has been severe, it is because of this way of going about things. There are already two opposing schools in concrete music. One is for empiricism in construction, which essentially relies on the instinctive ear. The other school, which takes its method from the serial musicians, applies arbitrarily preconceived schemas to concrete matter and relies on the automatic process that then leads from the diagram to the result.

He adds importantly for this research: -

Dare I say that the second way of doing things, even if I find it shocking, seems to me to be more justified in concrete music than in piano or orchestral music? In effect, as there is still nothing to guide us, or to attach us to the past, and thousands of concrete sounds have no reference to usual sounds, objects made "in series" at least do not run the risk of being caricatures of some previous music, or musics that go against nature. We simply have to submit the results of these structures to analysis and above all to the judgement of the ear. (North and Dack 2012 Pages 127 - 128)

The assertions made here help to make explicable many of the issues raised by the research questions of this thesis. The practice of visualization is merely to inform and aid these judgements. The following chapter discusses the *musical object*, its importance and its neglect in more conventional music.

The concept of the object is not mentioned at all in the theory of music, whether in musicianship, harmony, composition, or criticism. The facture of the work, with the symbolism of notation, the structure of forms, and the effect produced, forms a perfectly enclosed whole, sufficient to itself, a closed universe. (Page 132)

It is an assertion of this thesis that if we are to visualize or notate electroacoustic music, many of the other assumptions that notation gives rise to need to be reviewed or re-assessed.

*Chapter 4* of this thesis discusses '*imagining and discovering new musical sound*'. In Schaeffer's book, he refers to '*intended*' and to '*found*' objects. Intended can be interpreted as '*imagined*', found can be interpreted as discovered. Intended implies sounds that are yet to be created but exist in the imagination. Discovered implies sounds that exist already and whose qualities are available to be used musically.

This is the "way" [ ] which leads [ ] from the world of found objects to the world of intended objects. (Page 147)

There follows discussion, based on the analogy of a sea-shell, as to the nature of objects that are found, and the extent to which a '*specialist*' can carry out informed analysis so that it can be '*understood*', for reasons not at first evidenced by the object itself; this being regarded as different to merely '*imagining*' a new object.

The nature of electroacoustic music, or '*concrete*' music is referred to in many passages, and can be summed up by the following one example:-



And so Western music, as we have seen, is mainly concerned with the numerical values of pitched sounds. The experiment in concrete music reveals within the ear, and with almost no relationship to the musical ear, a sound eye, sensitive to the form and color of sounds, and also, as there are two ears as well as two eyes, to the three-dimensionality of these sounds. (Page 182)

### 3.8 Summary

The points discussed by the literature in this chapter illuminate many of the key issues in relation to the fundamental questions raised by this thesis. In particular this includes the problem of annotating timbre, and the inadequacy, limitations and consequences of reliance on conventional Western notation. This last point has: -

- exacerbated the predominance of pitch
- encouraged adoptions of tonality such as 12 semitones to the octave and the use of scales (microtonal systems have proved more difficult to notate)
- encouraged a proportional and metrical approach to duration that is also far from exact
- avoided specificity when it comes to timbre and dynamics.

The literature also reveals some of the reasoning behind Schaeffer's concept of '*reduced listening*', both in relation to responding to the issues raised by Western and other notational systems, and the apparent redundancy of the need for visualization. It will be seen however that, whilst it is important to recognize these issues, lack or avoidance of visualization has other implications that have effected compositional activity, and the development and consistent understanding of electroacoustic music.



## 4. Imagining and Discovering New Musical Sound

Visualization as an aid to the better understanding of compositional process, will later be seen to be of value in several not necessarily discrete areas namely description, analysis, prescription and archiving. Firstly however, there is an important aspect of compositional process where visualization can also have some relevance. Imagining and discovering sounds for compositional development are certainly not discrete processes. Whilst it will be seen that both can be described as distinct processes *in theory*, in practice they usually interact together. Visualization however can often assist the act of creating sound purely from aural imagination, and in some instances has often been essential to the development of particular music. In the later work in this thesis on the *Taxonomical Structure of Types of Musical Visualization (Chapter 7)*, this distinction between imagination and discovery relates to what are termed inner hearing and outer hearing. This point is related to Schaeffer's concept of the *abstraite* and the *concrète*. This is an essential part of the conceptual framework outlined in this thesis concerning the visualization of electroacoustic music. It is a fundamental point raised by this thesis that at present, the lack of a clear conceptual framework for the visualization of electroacoustic music hinders the development of aural imagination within the genre. Human imagination thrives on symbols, codes, formalized structures, and all the tools

of representation that can be called upon. These tools help to enable conceptualization and cognition, and therefore greater understanding. At this point however there is firstly an examination of earlier music to place these issues in broader context.

Stravinsky was once reputed to have said that some of his compositions began with imagining a particular group of players about to begin a piece, the sounds of which he had as yet no knowledge. When they were assembled in his imagination, he then began to *imagine* the sounds that they were about to make. Thus this vision of the players became as it were an early part of his composing brief. Elgar on the other hand imagined that the sounds of his compositions already existed as it were '*in the air*', but that they were as yet undiscovered by him. His task was to hear or capture these pre-existing sounds in his imagination.

Elgar in a famous *obiter dictum* once suggested that music could be picked up in the air. The idea is sound, for music, so far as the creative musician is concerned, cannot be thought of in a paper existence. (Young 1955)

Again referring to Stravinsky, he composed at least one of his compositions the *Rite of Spring* using the piano, but it is impossible to know whether he *imagined* the sounds before he played or found them. Alternatively he may have played or *discovered* sounds as the piece progressed, and these then became part of the composition. Perhaps the reality is that both things occurred. There is nevertheless a distinction that can be made between imagination and discovery that has relevance to the composition of

musical sound. It would be possible to give many examples of the different ways musicians have used imagination and discovery in the creation of new music. Imagination and discovery can be seen as two contrasting approaches to the invention of new musical sound, which have both differing and shared characteristics. As stated earlier this may be problematic with electroacoustic music which, without the need for performance, moves directly from imagination or discovery to the final product. In the absence of representation great emphasis is placed on memory alone.

It might be helpful here to examine some other practical examples. Humphrey Searle wrote of his studies with Anton Webern,

His approach was always practical rather than theoretical: he invariably used the piano while composing, trusting to his extraordinarily acute ear as well as to his knowledge of the laws of music. On this point he said to me once, ‘ Don’t trust your ears alone; your ears will always guide you aright, but you must also know what you are doing.’ These twin principles of knowledge and practice were, I believe, the basis of his approach to music. (Searle in his preface to *Wildgans*, 1966)

This quote is interesting, not least because of the nature of Webern’s music itself. The suggestion here is that as Webern worked at perfecting the canonic structures of his music, particularly in the later work (Searle studied with Webern in 1937), he at the same time had vivid aural imagery of his music; and yet he frequently checked and amended this using the piano, thus showing evidence of the symbiotic relationship between imagination and discovery or inner and outer hearing.

Aaron Copland in his book *Music and Imagination* wrote a whole section called *Music and the Imaginative Mind* and a whole chapter entitled *Music and the Sonorous Image*. This image he describes as: -

-nothing more than an auditory concept that floats in the mind of the executant or composer; a prethinking of the exact nature of the tones to be produced. (Copland 1952 Page 21)

Later in the same chapter he writes: -

The ability to imagine sounds in advance of their being heard in actuality is one factor that widely separates the professional from the layman. (Copland 1952 Page 24)

In this chapter Copland principally refers to timbre particularly as applied to the art of orchestration. And even though he makes a distinction between those composers who compose the orchestration simultaneously with the melodic material and those who orchestrate later, both processes involve intentional and considered imagination before any real sounds are made.

- there appear to be two different approaches to the problem of orchestration: one is to 'think in color' at the very moment of composition, the other is to 'choose color' after a sketch of the work is at hand. (Copland 1952 Pages 32 to 33)

It was often said of Mozart (even by the composer himself) that he would imagine, memorize and work out the detail of a complete composition before committing it to paper.

There can be no doubt that with Mozart the creative process was to a very large extent completed before he put pen to paper. The work of recording his ideas was in the main a purely mechanical task, and one that he always tried to postpone to the very last moment. (CBO in *Groves Dictionary of Music and Musicians*)

The way in which, and the speed with which Mozart could complete compositions needing no correction amazed many musicians at the time, and has frequently been documented. This phenomenon even became part of the dramatization of Mozart's life in Peter Schaffer's play and the film *Amadeus*.

Perhaps Beethoven was the most extreme example of the necessity of relying on aural imagination as a means of developing compositions. It is difficult now to make a judgment as to the profundity or otherwise of his deafness. It would certainly appear from most sources that his deafness was virtually total in the last years of his life. In this condition, Beethoven would have had to rely on a vivid memory of the sounds of the instruments of the day both individually and in ensemble. His harmonic and contrapuntal work allows us to make the assumption that his memory and imaging of pitch were in practical terms faultless.

In contrast to these examples however it would be valid to look at the work of musicians who invent music in a much more improvisatory way. A typical if somewhat extreme example that comes to mind is the improvised solo that Miles Davis recorded on his track *Four* from the album of the same name. At times this solo is almost timbral improvisation. Analyzing the pitch development in this solo becomes increasingly so

complex, as to lose the musical meaning of the passage. It is impossible to imagine Miles Davis planning these sounds in advance and then committing them to memory for future performance. These sounds emerge and develop as a matter of discovery of what might be possible, given what has just been played, and risks are taken in the process. There are of course as many examples of music in the world created in this way, as there are examples of music created after it has been part of someone's aural imagination.

The suggestion made here therefore is that we need to re-state what has previously been held to be obvious. Musicians often but not always imagine sounds before they are created (or should we more normally say played). Musicians also discover sounds that they had not predicted in detail before they were created. They also combine these processes. Sounds will sometimes be nearly imagined but not in every detail, with final details perhaps being tried out later when improvements are made or discovered. Conversely a range of outcomes might be imagined, first as part of a process of discovering future musical possibilities. Often the symbiotic relationship between these approaches is almost instantaneous.

If musicians do not intend to create or play sounds immediately, then they may need to notate them before they are forgotten. The early history of European notation indicates a response to this need. For example early European notational systems were at one time based on symbols called neumes. The term neume is derived from a Greek term meaning "nod" or "sign". The Latin neuma meant gesture, sign or movement of

the hand. These early notational symbols were therefore signs or tokens of particular musical events.

This system seems to have developed with regional variants in different parts of Europe, but all had the same fundamental characteristics. Signs were drawn in the manuscripts above the words of the chant to indicate the relative pitches of the notes. Single notes were drawn either as a dot or a line. If several notes were to be sung to one syllable, they were drawn as a connected group (a neume). A long melisma was written as a number of neumes one after the other.

This notation was perfectly suited to its task, which was to *remind* singers of the relative pitches of the notes, the shape of each neume, and the number of notes in each neume or melisma of a melody they had learned earlier. It was not designed to inform people of melodies they had never heard before.

(Yudkin 1989)

Notation here is being used as an aid to memory. In this case the music must have been known aurally before. Even so the aural experience might still have been a matter of that which had only been previously imagined and then memorized. The communication of this music to someone else could not occur merely as a result of using notation such as this. Nevertheless the notation, although incomplete, had its uses.

In the second half of the thirteenth century a modification of the modal-rhythmic system enabled individual note shapes to indicate values by means of their own graphic representation. No longer was the organum style in fashion. The motet was the principal genre, and the three voices of the motet, with their individual texts and different note lengths, could be kept distinct and precisely coordinated. A notation giving all necessary rhythmic information was now at hand. It was the beginning of a time when the notation of composition was not just a memory aid or an act of compilation and preservation, but the presentation of sufficient information so that musicians who had never heard a piece before could perform it. In that sense it was the beginning of the modern era. (Yudkin 1989)

This situation describes notation that is more *prescriptive* as a set of instructions for the future performance of the music. Yet even so such notation could not be understood as a complete *description* of the music including all of its characteristics. Much would have to be left to the experience, memory, guesswork and prior knowledge of the reader.

Of course, in a very real sense the notation of music can never be the actual music itself. There are always aspects of the music that remain unexplained.

All notations are indeterminate in so far as they fail to give a complete specification.  
Conventional notation is indeterminate in matters of pitch, timbre, method of attack.

(Cole 1974 Page 137)

Neither is a musical score a necessary condition for the occurrence of music. A musical score is merely a tool designed to serve particular functions. Two of these have been mentioned above; as an aid to memory and as a prescriptive set of instructions for performance. Broadly we can categorize scores as being prescriptive or descriptive. Prescriptive scores include performance, realization and diffusion scores of all kinds. Descriptive scores include any representation of how particular music has sounded or might sound in the future, and may go as far as to include analysis scores that help to identify trends, structures and characteristics of particular music. Descriptive scores may also exist as a way of preserving or archiving particular music. Sometimes scores are of both types simultaneously. Scores are always visual representations of music, and



as such they are records of musical intentions that have either taken place or are to take place in the future. It can be said therefore that notation can help to clarify and identify that which has been imagined, and describe or record that which has been established or discovered. An example of this is the facsimile below of a folk-song transcription by Bartok. Whilst this is clearly based on conventional western notation, there are additional annotations that clarify tonal inflexions, improvisatory rhythmic elements and transcriptions of moments of de-tuning.



Whilst it has been possible to devise, evolve and adapt useful systems of notation that deal with pitch in music, the same cannot readily be said of timbre. Part of the reason for this may be fundamental misconceptions as to the nature of timbre. In the first place timbre is commonly regarded as a more secondary or even decorative characteristic of musical sound, often very much less important than pitch. (referred to in *Chapter 3* from Boulez *On Music Today* translated by Susan Bradshaw and Richard Rodney Bennett 1971). This however conflicts with the nature of sound waves themselves. Complex waveforms only develop perceivable pitch characteristics when they are more or less periodic. Sounds with significant pitch characteristics are quite a rarity as compared to the totality of sounds in general. Pitch is therefore a sub-set of timbre. A proper understanding of the relationship between timbre and pitch promotes a much better understanding of the nature of music itself, and especially one that more easily embraces all of the many types of music that have so far existed in the world.

The fundamental question therefore is whether it is possible to write down something meaningful, understandable and useful about sound objects that are predominantly timbral, in order to aid the realization of these objects from imagination, particularly when making sound objects electronically. The problems to be overcome concern aspects such as: -

- the nature of sound itself,
- the characteristics of timbre,
- the architecture of particular machines,
- the predictability of machines,
- the characteristics of various types of notation,

- the relationship between imagination and discovery in musical composition
- the invention, and the perception and notation of time in music.

It is possible that producing sound objects from written notation or visualization of some kind, will produce more considered results that more specifically match compositional intentions. Far more detail about each sound object can be considered as part of the visualization process. Sounds are therefore reflected upon and refined in imaginative terms. This has a parallel in compositions where pitch is predominant. Relationships between different objects and their various characteristics are also easier to notice and to formalize. For example the sample roots or envelopes of different objects might relate to each other. There might be similarities or there might be contrasts. Analysis and synthesis can be more considered in this visual environment. Again this is what happens thematically where pitch is predominant. To some extent this is fundamental to musical argument and development of almost any kind. There is therefore some degree of commonality about the ways in which musical processes and argument are developed no matter what musical parameters are involved.

One of the concerns of this thesis is to regard the evolution of electroacoustic music as one of many musical genres. The sounds, structures and syntax of electroacoustic music are rich, diverse and maybe very different to other genres. As already mentioned these differences stem from its origins in the history of recording and broadcasting, the fact that instrumental performance is usually not a feature, and that often the composer produces the final product.

## 5. Case Studies

### 5.1 Introduction and Methodology

As part of this research, a number of interviews and answers to questionnaires have been recorded and collected, particularly from composers of electroacoustic music, who may or may not use visualization as part of the compositional process. In addition, there are people who evidently use visualization as part of musicological study, analysis or pedagogy within the genre. The practice outlined by these results, helped to establish over time the conceptual framework outlined by this thesis, and in particular led to the taxonomical structure outlined in *Chapter 7*. The results also bear out the need for a more systematic approach to, and better understanding of, visualization and representation in electroacoustic music, and especially the composition of such music. This point takes us back to Jonathan Harvey's comments that are reproduced at the end of *Chapter 3* <sup>11</sup>.

The questionnaire and the questions used as a basis for interviews are quoted in the *Appendix*. Where interviews took place, the questionnaire was usually used as a basis for discussion, although not always strictly. It was possible in interviews to delve more deeply into the relationship between visualization and compositional practice, including on a day by day basis, and also closely related activities such as description,

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<sup>11</sup> This refers to the use of *notation* to visualize or capture characteristics of an imagined sound.

archive, analysis and pedagogy. As time went on the questionnaires came to reveal more about this relationship. Contacts with composers also became more fruitful, as other sections of this thesis began to shed more light on the context in which visualization takes place. For example the work on historical case studies (*Chapter 6*) enabled the possibility of seeing a continuity and consistency of practice, since the early days of electroacoustic music. Results or findings were often fed back to composers and sometimes brought forth further information. A particular example of this is the response by Trevor Wishart that is discussed below. The aim of this work and methodology was to discover the true situation in regard to visualization and compositional practice. There were occasions when discussion had to take place to clarify the precise nature of the enquiry. Whilst this was of assistance to the composer, it also proved invaluable to this author, by adding to the understanding surrounding the fundamental research questions.

A fundamental consequence of the collection of data was the subsequent analysis given to it. It is this analysis that began to indicate the contents, connections, shape and design of the taxonomical structure outlined in *Chapter 7*. The data recorded here began to justify a possible structure and the conceptual framework that underlies it. This was not completely apparent in the initial stages, but became increasingly significant as more contacts or interviews took place. This had the effect of focusing the later interviews more specifically, with increasing clarity and understanding of the fundamental questions raised by this investigation. The analysis of historical case studies in *Chapter 6* was further found to illuminate this taxonomical structure.

### 5.1.1 Selection and Method of Selection

The methodology has been focused on an approach to the following composers, who have given some indication of their visualization practice, as part of the compositional process. This has been by interview and questionnaire. In the case of interviews, the questionnaire was used as a basis for discussion. The aim of collecting responses was to discover what part visualization played within each composer's compositional processes; also to discover if this was consistent throughout their work, or applied to specific pieces or circumstances. The notes in this chapter also give some background to them, as well as an indication of why their practice is important to this research. This includes those few composers who state that they make little reference to visualization, and why their reasons for not doing so are also important. The methodology here has been:-

- 1) to select people who were prepared to make a response
- 2) to select people who might or might not use visualization
- 3) to select people who represent a good cross section of work within the genre
- 4) to select people whose compositional work is available and well known
- 5) to select some people for whom compositional work can be placed in a context of other work within the field such as analysis, pedagogy and musicology

Quotes are included where they illuminate their views and philosophy, and how these might be translated into a better understanding of their compositional endeavours. These notes are intended to offer evidence of the diversity of approaches within a wide range of electroacoustic genres.

The focus of the questions whether at interview or by email, was to clarify to the composer the nature of the enquiry. The discussions were aimed at identifying the

complexity of compositional activity, and additionally allowed a composer to reflect on the role of visualization in a considered and measured way. They also were intended to encourage a composer to indicate more precisely where visualization became important in composition.

## 5.2 Individual Case Studies

### Robert Normandeau

The interview with the composer Robert Normandeau was the first such interview conducted on the 7<sup>th</sup> March 2007 at de Montfort University. His response to the first question suggested that he *never* does such a visualization<sup>12</sup>. The interview as a whole developed from this response to the first question (see *Appendix 1*) namely, that he said that he never represents sound in any way when composing. He gave the reason for this as being that acousmatic composition is essentially a practical matter, and devising suitable representations in acousmatic music would take too much time, and interrupt the flow of work. Furthermore he thought that effective or meaningful representation was limited at best, and probably impossible in acousmatic music. He thought that effective correlations between sound and visual images are limited and illusory. Nevertheless as a teacher, and in contradiction to this position, he *does* recommend to his students that they produce some kind of graphic score of their own compositions. An example of such a representation is given below. In this particular example however, it is a student representation of *Figures* by Robert Normandeau himself. It was suggested by him at interview that this is a typically good example of what he had in mind.

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<sup>12</sup> Do you represent sound in any way when you compose? If so how?







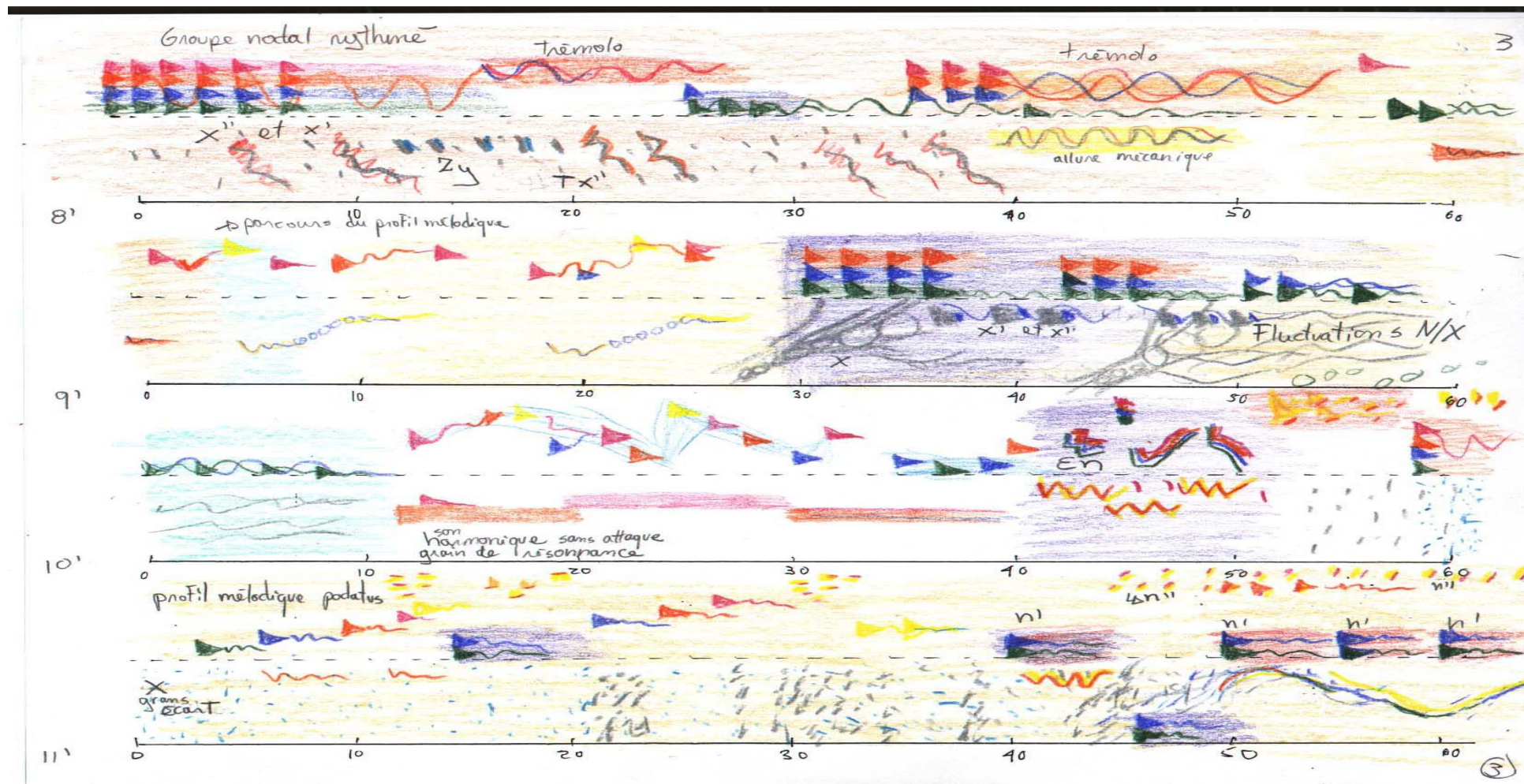


Fig. 5.2 Robert Normandeau Figures 2

Apart from graphic symbols which mostly indicate envelope, polyphony, texture and relationships between one sound and another, text is used to elaborate clarity as regards what is being heard. For example in the opening 20 seconds indications of 'itératif dynamique formée' and 'transposition' are added to clarify graphic intentions<sup>13</sup>. Normandeau felt that in the case of *their own* work, this practice helped students to step back and put themselves in '*the mode of the listener*'. In other words a graphic score in this case aids understanding of the composition by a composer, but from the perspective of the role of the listener. Robert Normandeau confirmed that *reflecting* on a composition is something beneficial to composers, and that this could well include from the perspective of the listener. Again stress was laid on the practical aspects of composition, and this was contrasted with that of the mode of the listener.

When asked about musicology and analysis, Normandeau felt that he would want some kind of score particularly of someone else's music. This would therefore be a descriptive or analytical score as opposed to a prescriptive one. He rarely needs diffusion scores beyond very brief notes. He regarded the composition or 'discovery' of acousmatic music as essentially an act of craftsmanship. When asked about the extent to which he *imagines* a sound before its production, he stated that he '*had no imagination*', and relied on discovering sounds and discovering the ways in which they could best evolve. The starting point for a composition was its title. This informs subsequent decisions and builds boundaries. This tends to give a piece some kind of '*sound signature*'. However he finally stated that he does keep a detailed diary on each piece as it develops. He did agree that these do contain elements of representation at least as far as text is concerned. What is consistent here with the hypothesis of this research is: -

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<sup>13</sup> Other examples of student work are posted at <http://cours.musique.umontreal.ca/mus1217> (last accessed by this author 09/03/2011)

- 1) visualization plays a descriptive or reflective role in the compositional process. This therefore indicates *outer* hearing.
- 2) composing above all stems from audition and evaluation.
- 3) any system of visualization must be quick, consistent, flexible and easy to use.
- 4) visualization must aid composition and not hinder it, or become an end in itself.
- 5) visualization does have relevance to analysis, aural perspective, reflection and evolution of the composition as a whole.
- 6) timbral complexity is a difficulty as regards meaningful representation.

It is the case therefore, that even though Robert Normandeau professed not to use visualization within the compositional process, he acknowledged that there was a need to resort to it when analysis or description was involved. In addition to this, his diaries of composing notes for each piece, demonstrate that visualization of some kind does take place alongside composition.

### John Young

In an interview with the composer John Young (23<sup>rd</sup> May 2007), the composer indicated that he *always* draws informal visualizations in the process of composing sounds. These consist always of pictures of a graphical nature. They tend to visually encapsulate an imaginary concept of a sound. They are sketches to aid memory for later compositional activity, which are inspirational in essence. An example given of this taking place was Track 5 of *La Limite du bruit* entitled *Liquid Sky* (1998). One event that was sketched for example was a '*very distant noisy dot that arrives as rain*'. The representations are always for himself (*aspirational*) and are about what is *going to happen*. Representations particularly assist the understanding of relationships between

sounds. Representations are always very quick and not to be considered an art form or as visual music in themselves. Representations are of inner hearing to facilitate outer hearing and memory. Representations are prescriptive, descriptive and analytical as regards sonic relationships. The focus of any representation was stated as timbral – particularly shape, structure, form and relationships. They are for no-one else but the composer. This response is entirely consistent with several aspects of the proposed taxonomical structure that, at this time was beginning to emerge, and was eventually outlined as in *Chapter 7* namely: -

- 1) visualizations are of inner hearing made *before* production of the sound.
- 2) they are to assist the production of sound and as an aide memoire.
- 3) they are also descriptive and analytical as part of the compositional act.
- 4) they involve graphics.
- 5) they are made by hand.
- 6) they enhance compositional understanding, particularly as regards relationship and compositional development.

The relationship between visualization and composition in this example is essential, and quite clear and unambiguous.

### Simon Atkinson

In response to the initial question regarding whether there is use of representation in his compositional process, Simon Atkinson (interview 23<sup>rd</sup> May 2007) thought that his answer would be poised between *yes* and *no*, although more negative than positive. In his view acousmatic work is essentially aural, and that remembering things aurally is important. A given example of representation referred to organizational matters

concerning folders and sound files. Diffusion scores might be important for other people's music but not his own. Often scores were needed for teaching purposes, more often of other people's work. For Simon Atkinson, any representation mostly focused on organization, housekeeping, classification and musical relationships. Detailed aspects of real sound that are impossible to notate, were regarded as a hindrance and time consuming. Formal matters were regarded essentially as an aural matter, but things might get written down, often as very fragmentary notes perhaps as an aide memoir. Any representation of solely an act of inner hearing involved aspects capable of Western traditional notation. Any other representations that did take place mostly involved text and numbers with some graphics. They could be prescriptive or descriptive, and with some analysis. In summary: -

- 1) representations were essentially concerned with audition including auditory memory (Schaeffer *Chapter 1.4.3*). They are predominantly descriptive, therefore *outer* hearing.
- 2) they were often representations concerned with organization such as folders and sound files, and for the purpose of locating material, usually with reference to relationships and sound typology (refer to the section on Wishart later in this chapter).
- 3) timbral complexity is seen as presenting a difficulty as regards meaningful representation, and is potentially time consuming (refer to the section on Robert Normandeau above).
- 4) representation is often needed for pedagogy.
- 5) representation of imagined sound usually involves traditional notation (presumably pitch elements).

Whilst the responses tended to view visualization as playing a rather minor role in compositional processes, the implications of the taxonomical structure in *Chapter 7* suggest that organizational matters involving classification and sonic relationships are of importance in musical development, including within electroacoustic genres.

### Simon Emmerson

This was a response by questionnaire, with some discussion by interview. Responses here were complex and indicate many points that are in line with the emerging taxonomical structure that follows in *Chapter 7*. Clearly representations are mostly a matter of *inner* hearing of sounds, imagined before they are made. Even if descriptive, they are often of something imagined as opposed to something that has been made already, or as Simon Emmerson has said '*of something I might want to happen*'. Representations are of many aspects of a composition – shapes, form, proportion, durations, timbre and processes may all come into play. Representations sometimes have to be integrated with more traditional notation for live performance. Representations are also about actions taken and sometimes an aid to memory. Audition is fundamental, and remains more important and detailed than visual representation. Some representation is about polyphony and '*montage*'. Representations use graphics, text and numbers, and in part make use of computer software. Many of the questionnaires are quoted in the appendix, but the complexity and detail of this response makes for particularly worthwhile reading. Representations of timbre and noise are usually graphical, numerals are used for durations and pitch tends to use traditional notation however:-

I work [ ] often with instruments/voices notated traditionally with live electronics transforming. In acousmatic works the representations have mostly been 'on screen' in ProTools; my sketches have represented proportions and shapes but not usually details within the sounds. But I use graphics for any composition to get general ideas of shape and form – local and overall.

Representations are identified as a fundamental aid to compositional understanding: -

about shape and form, proportion and duration. Sometimes timbre and processing. They are intended only for the composer, and are prescriptive or descriptive of future intentions –

an 'essential spur to action'. Inner hearing predominantly – what I imagined I wanted (Responses from the questionnaire)

Shown below is a copy of a sketch by Simon Emmerson which does show elements of graphics, text and numbers. It also has hints and suggestions of fragments of conventional notation.



05/03/10

Sound types.

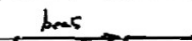
Drums: held, sustained, clear pitch (e) < Slow change >

change colour slowly norm → sud pour

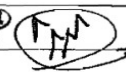
can be harmonic.


Textures / 'disturbances'

Sustained: beats / noise harmonic

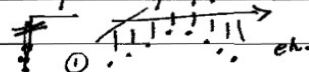
②  beats

③  harmonic

④  clouds. eh. punch with gliss

far harmonic groups (cf. scianm) 

chords / dominant / arpeg.

 eh.


variant

Variant  
full / arpeggio.

Lyric

full tone, melismatic

bel canto

 build in intensity

drumlike with

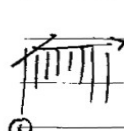


12 types of Textures / disturbances or 4x3


1  
2 1  
3 2 1  
11  
12 - - - - 1

1  
2 1  
3 2 1  
1 4 3 2 1  
2 1 4 3 2 1  
3 2 1 4 3 2 1  
4 3 2 1 4 3 2 1  
1 4 3 2 1 4 3 2 1  
2 1 4 3 2 1 4 3 2 1  
3 2 1 4 3 2 1 4 3 2 1  
4 3 2 1 4 3 2 1 4 3 2 1


1234  
or more 1234 1234

 td  
beats  
clouds?  
min  
cloud  
ingest / disturbance / texture

1  
2 1  
3 2 1  
4 3 2 1  
2 4 3 2 1  
3 4 3 2 1  
4 3 2 1 4 3 2 1  
1 2 3 4 3 2 1  
1 1 2 3 4 3 2 1  
2 1 1 2 3 4 3 2 1  
3 2 1 1 2 3 4 3 2 1  
4 3 2 1 1 2 3 4 3 2 1

 ④ ③ ② ①

Drum ingest

non sp.  within

Can be harmonic  
+ can be chord.

beat  


Fig. 5.3 Sketch by Simon Emmerson

Representations do indicate spatialization if the spatial component is part of the original compositional argument. In summary: -

- 1) representations were of inner hearing of something imagined or intended for the future.
- 2) they were focused on various parameters – shape, form, durations, timbre, processes.
- 3) they are sometimes integrated with traditional notation when live performance is involved.
- 4) there are archives regarding actions taken and these are sometimes used as aides memoires.
- 5) polyphony and montage are factors.
- 6) graphics, text, numbers are all employed.
- 7) there is evident use of software GUIs.

Clearly visualization reflects many of the purposes identified in the taxonomical structure, and is an integral part of compositional process at many levels.

### Leigh Landy

Responses here indicate that currently, because of the circumstances and nature of the work, visualizations mostly emerge from '*story boards*'. This is because of the particular kinds of collaborative projects that Leigh Landy undertakes. These story boards tend to act as a stimulus or trigger for the creation of sound. By their nature they indicate something written before sound is created. Sometimes they trigger or stimulate previous sounds that are remembered, or natural sounds that are remembered and that exist already. Story boards are flexible and not fixed, but are designed to be capable of adaption to suit needs. They can be regarded as, and function as a compositional tool. Story boards have something of a symbiotic relationship with particular compositional

projects. They work, to quote from Leigh Landy's responses, from '*the bottom up and top down*'. They trigger sounds and reflect intentions. They can also be points of discussion with other artists. They use software commonly available such as MS Word. They are mostly textual. They particularly indicate structure. In addition to his many other roles, Leigh Landy is Artistic Director of Idée Fixe an experimental performing arts company that seeks to combine sound, music, image and drama, both in a professional and community arts context. In summary:-

- 1) representations concern inner hearing.
- 2) they act as a trigger or stimulus, therefore *descriptive* of something *imagined*, or of possible intentions for the future (in common with Simon Emmerson above).
- 3) they are often textual in content.
- 4) sound samples can be represented using text.
- 5) they use software that is easily and commonly available such as MS Word.

Apart from the summary statements above, these responses confirm the possibility of using text to describe sound as a *visualization*, in the sense that musical data is *envisaged* more easily<sup>14</sup>.

### Trevor Wishart

These responses followed a lengthy interview in York on the 11<sup>th</sup> July 2009, and detailed follow up to make and edit corrections. They provide valuable insights into Trevor Wishart's thinking as a composer over a long period of time. Representation is his preferred term to visualization, because visualization seems to involve '*seeing something*' and '*because electroacoustic music is fundamentally about listening*'

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<sup>14</sup> Refer to the earlier *Chapter 2.1.1*

However, representation *is 'seeing' the data* in such a way as to enhance understanding. In his view, representation should not be considered *necessary*, because in the case of electroacoustic music not requiring performance, sounds and their derivatives and their sources are always available in the studio for listening. However they need to be located amongst the thousands of working files that come to exist:-

Red Bird has a suitcase of notes – in fact all the compositions do (edited response to the questionnaire verified and agreed by Trevor Wishart)

This is a point stressed in the working manual for *Sound Loom (A Users Guide to the Sound Loom and CDP Sound Transformation Software* Trevor Wishart 2009). The naming of files as mnemonics therefore becomes a process of representation in itself, clarifying aural connectedness, derivatives and compositional history:-

Using names and derivatives that are an evocative aid to memory – aide memoire + historical evolution = creation path. Derivation of the transformation of sounds. (edited response to the questionnaire)

Within the terms of this thesis therefore, we can conclude that such representations are more important than mere mnemonics. At one point they are described by Wishart as '*a poetic insight*'. These representations then are mostly descriptive of sounds already made and actions already taken. Careful notes are made when further changes are made. The following indicates the way this takes place in Sound Loom: -

Paper and machine.

Many dimensions of the composition process are remembered by the Sound Loom.

1. There is an automatically generated “history” of all actions taken, with the ability to recall any of them as a way to remember specific parameter-patches for processes.
2. time-varying parameter-traces are preserved in the textfiles in which they are made.
3. mixing details are preserved in the mixfiles from which they are controlled (and therefore always available for remaking, or reworking plus remixing).
4. this is in addition to the storage of all the sounds, from sources through intermediates to the current state of the piece, on the computer.
5. there’s also a built in Notebook to write down ideas, or remember what one is doing from day to day (essential in a large-scale project).

I also tend to use a scratchpad of paper to jot down ideas that occur to me, do quick calculations, and sketch ideas for improving or creating the software instruments. (edited response to the questionnaire – Wishart 2009)

This confirms that representations are more than mere mnemonics because visualizations, however fragmentary, do take place. Furthermore:-

To understand a piece look at Sound Loom because close study of Sound Loom indicates the thinking behind the piece. CDP [Composers Desktop Project] as a whole + dates is a kind of archive of all of the music. CDP is driven by Trevor’s compositional development. (edited response to the questionnaire).

This last point is critical, and raises issues that are discussed in the *Chapter 9. The Musical Archive* later in this thesis. In the course of this interview Wishart expressed the desire to develop some kind of methodology in order to create a systematic archive of his music, capable of standing the test of time. He was extremely concerned that this should occur.

Representations are also made for spatialization: -

There are diffusion scores or notes. Time line above then key events or textures below. Used for rehearsal in a particular venue. Other changes are then added as well as changes for the particular venue which are added and retained. After 6-8 performances a more general representation emerges about an optimal way to diffuse. (edited response to the questionnaire).

In summary:-

- 1) representations concern outer hearing and are mostly descriptive.
- 2) there is some reference to inner hearing when future intentions are expressed and '*described*'.
- 3) representations do include diffusion.
- 4) they can be seen as an archive of processes.
- 5) they are made on computer using *SoundLoom*.
- 6) paper is used to sketch ideas and make or improve software instruments.
- 7) text and numbers can be involved.

*SoundLoom* itself is more specifically reviewed in *Chapter 8 Software Case Studies*. Wishart laid great emphasis on the importance of *SoundLoom* to his compositional activity, stating that this software *represents his compositional life*. He would agree however, that whilst there is much detailed information in *SoundLoom* about processes, relationships and connectivity, the software would not be sufficient to allow sounds and whole compositions to be re-created should the original sound files no longer exist. Sketching and textual notes continually take place.

Elizabeth Hinkle-Turner

The responses here indicate a highly personal and unusual perspective to visualization, in which in some cases there is a relationship to video as part of the output. It would seem that the representations could almost be classified as '*visual music*' (referred to previously in *Chapter 1.5*): -

I do consider this an artform in itself - [ ] I call this 'docu-art'.

And:-

In another way that I do things, I have done many video pieces [ ] - they are music/video works which take their material (figuratively, not literally) from images and recollections from my life. (responses to the questionnaire)

Apart from the connection with video, pictorial representations are made by hand to indicate auditory intentions for particular sounds, and also forms or shapes for the piece as a whole. This is done as an aid to understanding the piece and the thinking behind it. The highly personal side of these representations is for example expressed as follows: -

These images have – in the past – included quilts that have been created by the women in my family; children's gravestones which I used to visit and study when I had cancer; and ideal/not-so-ideal women's body images. (questionnaire)

In response to who the representations are for: -

- the quilt images were for me because they helped me determine the sequence of sound events and processes and they were for the audience as they contributed to the narrative of the finished piece. (questionnaire)

The representations are described as '*reflective*' rather than analytical, descriptive or prescriptive and above all '*they contribute to the documentary/personal narrative of the piece*'. An interesting facet of the responses is that concerned with representation of polyphony: -

Very much so – the images are literally sewn together pixel by pixel in some parts as a visual representation of what is also happening in the music (I did this rendering live). (responses to the questionnaire)

The genre of these representations is identified as predominantly live processed music and video, which directly relates to the use of the Imag/ine or ImX software

developed by STEIM used by Hinkle-Turner: -

ImX has two main areas of application: live performance on stage (VJ, or as a part of a live music performance) and installation art.

And: -

What set Image/ine apart, and sets ImX apart, is that this is software for video people, not for musicians and not for programmers.

Clearly there is an integrated and close relationship between the video (or representation) and the music in the sense of multi-media output. There is therefore a symbiotic interplay between the two, where each one may trigger or subsequently '*explain*' the other. The co-existence of the video and audio means that in practical terms it may be impossible to determine whether one occurs before the other. In summary:-

- 1) representations are predominantly outer hearing (sometimes inner or the two simultaneously).
- 2) they are descriptive or prescriptive or both and '*reflective*' of events and personal recollections.
- 3) they enhance compositional understanding for the composer and listener.
- 4) they are perhaps '*visual*' music.
- 5) they are done on machine with specific software (see above) and some are by hand.

Gerardo Dirié

These responses were detailed and thought-provoking, and emerge from a compositional perspective such that electroacoustic music is one of many parts of



Dirié's output. A copy of the full response can be viewed in the Appendix. Representations are used frequently, and are of various types depending on the composition and the stage reached within the compositional process:-

Depending on the project, I go through various stages of different types of representations. These may include a set of journal entries with prose descriptions of varied detail, summary graphic representations aimed at inciting new ideas later on or to prescribe specific technical solutions or experimentations to carry on later, and sometimes, but rarely, a more elegant and refined score (combining any time of symbols) for the purpose of symbolic representation as documentation, to symbolic representation combining elements that serve as instruction for live performance components—should there be any. (Response to the first question of the questionnaire)

Clearly text and graphics are used which again, as with respondents above for example Simon Emmerson, appear at times to be descriptive of future intentions. This includes leaving a record or archive of future intentions to stimulate further action. Mention is also made of the use of graphic representations to aid and inform students. Representations are considered to be prescriptive, descriptive and analytical 'depending on the stage and nature of the project'. Some indication of the style or type of representation is given as follows: -

Various, and depending on the conditions stated above. They could range from the metric (such as annotated print out of a spectrogram), to the metaphorical (any sort of drawings, photo collages, keywords to trigger other mental associations,), to the occasional score for performance (when that is the case). On very rare occasions, some sort of graphic representation was needed for 'strategic documentation' (i.e. to show to a readership that is not directly involved nor interested in the sound and art experience per se, but in regard to other concerns). (Response to the questionnaire)

Later responses clearly indicate the use of graphics, text and numbers depending on circumstances. Representation is sometimes used to indicate spatialization.

Many facets of the approach here are shared by other respondents, and are certainly indicated in the taxonomical structure outlined in *Chapter 8*. Representation is

clearly important both as part, and at all stages of, the compositional act, and also as part of teaching composition (similarly referred to by Robert Normandeau above). As part of the '*compositional act*', a term described at interview with this author for this project by Leigh Landy, continual reference is made to the adaption and creation of representational techniques to suit various stages of a composition. This includes the creation of representations, both as text or graphics, in order to trigger further composition at a later date, and also to '*serve as instruction for live performance*'. The responses here indicate a continual symbiotic relationship between representation and the composition of musical sound. This is particularly indicated by the response to the second question of the questionnaire. Representation itself is closely allied to Dirié's concept of musical composition:-

I understand all process of making music as inherently involving a 're-presentation' of sound (i.e. to acquire it from the physical phenomena domain into the abstract processes involved in perception for the purpose of acting on it, or creating an abstract image of it mentally and working into manifesting into the physical domain). (Response to the questionnaire)

In answering the question on whether representations are of what had already happened, or of what was going to happen, they are also seen as a representation of what '*could*' happen (which is a point also made by Simon Emmerson above). Representation as part of the '*compositional act*' is summed up as follows: -

it helped to me to organize my scheduling of tasks, it helped me to make some relevant predictions about timing, resources, dramatic plan, logistics, as there are more symbols that I spread around that are now giving me information feedback that **I wouldn't register if I depended only on one channel of perception**. (My emphasis - response to question 8 above)

This last quotation is really an exposition of the main point of the hypothesis behind this

research. The response to the questionnaire indicates a wide type of approach to representation, depending on particular compositional situations. These include drawings, photo collages, textual triggers, performance scores and other graphic scores. The relationship between representation and compositional understanding is also seen as asking questions about the composition:-

Is this what you mean? Is this what you are really after? Response to the questionnaire)

In some situations representation is undertaken over a substantial length of time in order to '*design and refine*' what is being done.

To summarize: -

- 1) representations are of inner hearing.
- 2) they enhance compositional understanding.
- 3) they are prescriptive or descriptive of future possibilities.
- 4) they include graphics, text, and numbers.
- 5) they include performance scores if for live performance.
- 6) they include spatialization as text or code symbols.
- 7) they are by hand and by machine – sometimes scans of work by hand are integrated into the sound of the piece.

Theses responses clearly indicate that visualization is fully integrated into the compositional work of this composer on many levels, and relates closely to the taxonomical structure in *Chapter 7*, that had by now fully emerged at this stage of the process of analysis.

These responses are very clear and well defined, and closely focused on the questionnaire and therefore the taxonomical structure that follows in *Chapter 7*. The representations are identified as being for himself and for concerts. In the '*studio part*' of the compositional process, use is made of the GUIs associated with the software used for sound production. Representations are of sounds already realized and are identified as being descriptive or even possibly analytical. Diffusion scores are made for concerts and rehearsals. This last point leads to elements of spatial design for a particular venue, including spatial counterpoint. In this regard representations are placed on ten second grids. This process does not *prescribe* spatial moves, but are of assistance during the concerts. This indicates a level of live performance or response to the situation. The response to the question on inner or outer hearing indicates a continuous or even symbiotic process:-

I listened to the piece as I drew it. (questionnaire)

Representations involve graphics and numbers and are focused on duration, some pitch and some texture. They are on paper and by hand. Improving understanding is described as uncertain at the moment, although expected to change as time goes by. Representations are not *visual music* although '*could be*'. Compositions are acousmatic but include live performance.

- 1) representations concern inner and outer hearing – symbiotic but of sounds already made.
- 2) they include graphics by hand and numbers.

- 3) there is use of software GUIs.
- 4) they are descriptive and sometimes analytical.
- 5) they are not visual music but are for the composer's own understanding.
- 6) they include diffusion scores.

The visualization process is predominantly *outer* hearing, although visualizations promote reflection on sounds already made and remembered in the imagination. This is in common with almost all composers.

### Bret Battey

Whilst this composer works within the *visual music* genre, which as stated in *Chapter 1* is not a focus of this research, these responses completed on the 21<sup>st</sup> September 2009 indicate that visualization and representation also take place as part of the compositional process. These responses arose from replies to the questionnaire and as a result of interview. Representations are described as *prescriptive*. They consist of several types : -

- 1) strict music notation, hand written.
- 2) strict music notation, computer.
- 3) proportional music notation, hand written.
- 4) graphic notation, hand written – sometimes at different levels – broad structural features down to localized relationships
- 5) piano roll styled notation. (response to the questionnaire)

The representations are to improve understanding of the work in hand for the composer:-

[they] provided a sense of direction in a time of compositional confusion (response to the

questionnaire), and are also described as offering '*greater certainty in difficult compositional times*'; this is a key point of this research and of visualization as part of the '*compositional act*'. (see earlier in this chapter) The representations are most often of *inner* hearing:-

Almost always inner. Less often I use it to try to understand what is already in a sounding piece of material. In other cases, it must be noted that it is not a function of either inner or outer hearing: it is an imaged structuring of relationships in time without necessarily any real or imagined audio reality of any concreteness. (response to the questionnaire)

Examples of Bret Battey's visualizations are given below. The first three are for *Lacus Temporis Luna Series #2 2010* and the last three are for *Autarkeia Aggretatum 2005-2006*.

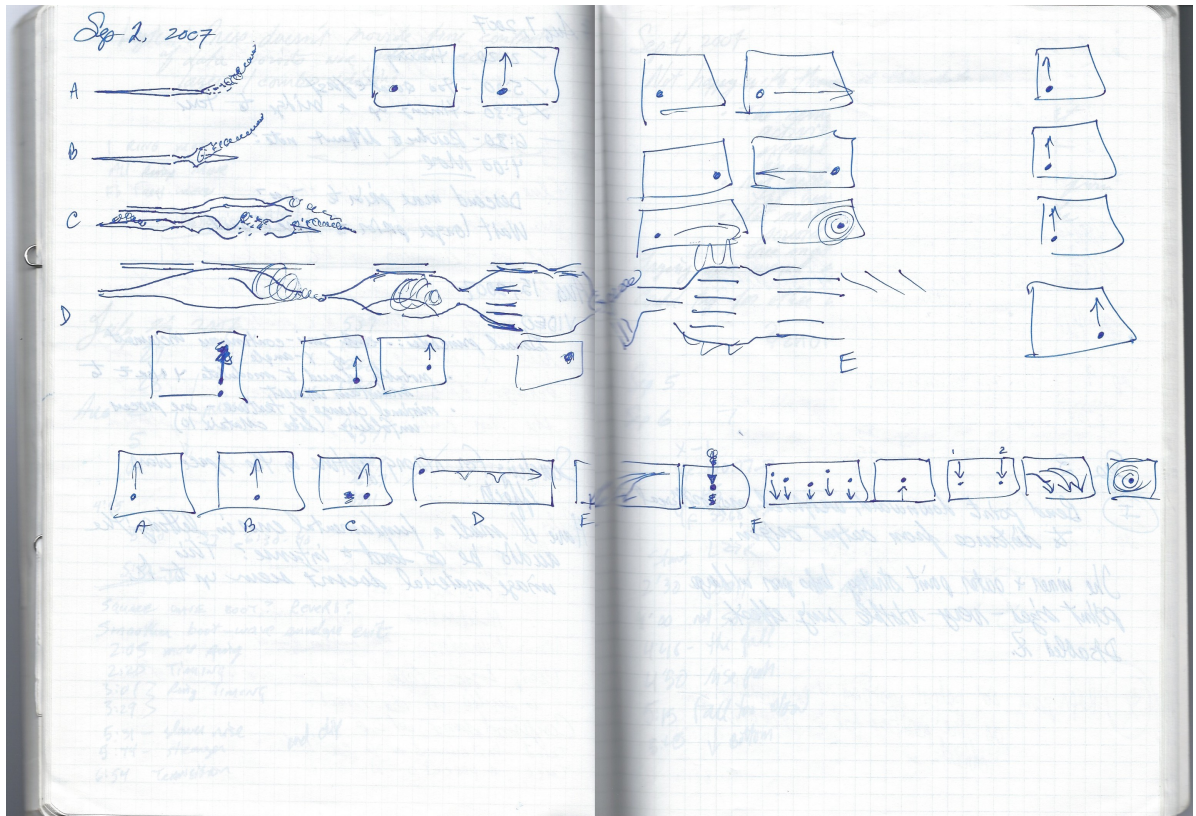


Fig. 5.4 Bret Battey Sketch Lacus Temporis I

Here we see small fragments of traditional notation alongside indications of texture, envelope and movement over time. Dots in rectangles may indicate spatialization and spacial movement.

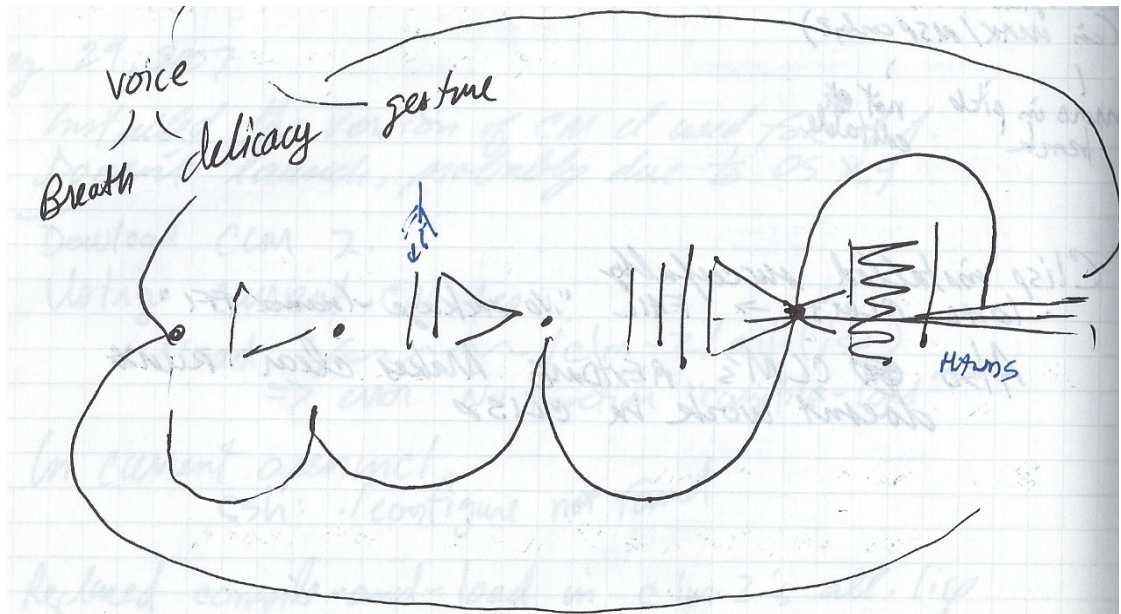


Fig. 5.5 Bret Battey Sketch Lacus Temporis 2

This extract appears to indicate texture and envelope along with some structural development.

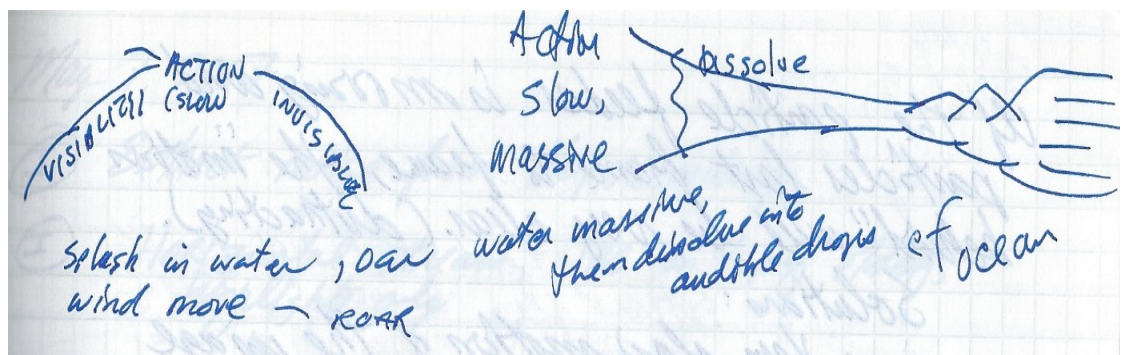


Fig. 5.6 Bret Battey Sketch Lacus Temporis 3

This extract is almost entirely textual, although with some indication of movement or development over time.



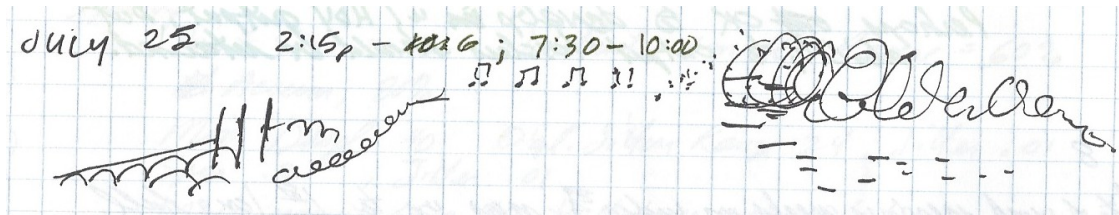


Fig. 5.7 Bret Battey Sketch *Autarkeia Aggretatum 1*

This extract has fragments of traditional notation as well as indications of durations, texture and shape.

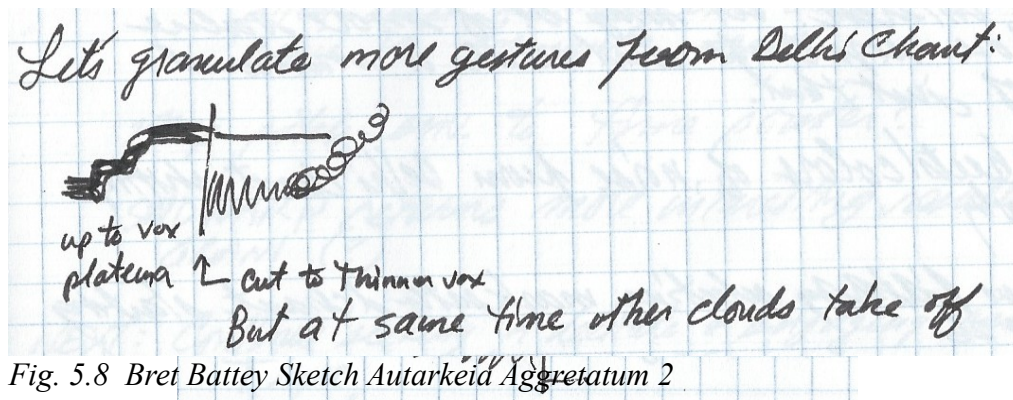


Fig. 5.8 Bret Battey Sketch *Autarkeia Aggretatum 2*

This is mostly textual with indications of action to be taken later. There might also

be reference to later intended visual work.

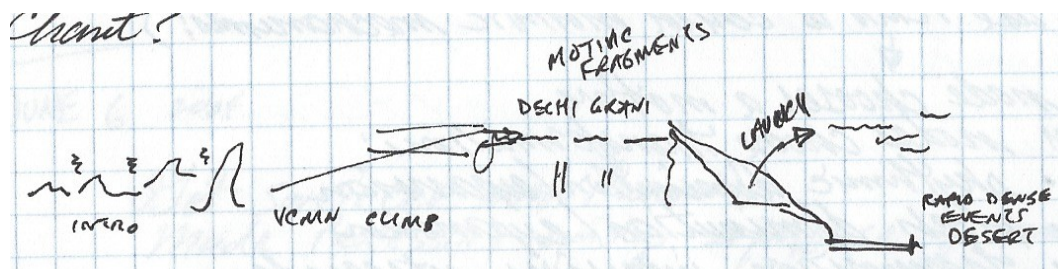


Fig. 5.9 Bret Battey Sketch *Autarkeia Aggretatum 3*

This extract appears to indicate something of the 'narrative' of the piece, maybe as an *aide memoire* for future action.

Generally these extracts are effective examples of a composer making graphical and textual notes to enhance the understanding and process of specific compositions.

To summarize: -

- 1) representations include traditional music notation (hand written and on computer).
- 2) they include graphic notation.
- 3) they are prescriptive.
- 4) they improve personal understanding.
- 5) they are hand written.
- 6) they are polyphonic.
- 7) they are proportional (left to right).
- 8) they are predominantly concerned with inner hearing (some outer).
- 9) they can stimulate or be reflected in future visual material (visual music) as well.

Although sketches like this may look fragmentary, they carry important

information about the compositional processes and intentions. They are important tools of reflection, that allow musical data to be considered away from the studio. Similar sketches could allow processing of information, again without the necessity of studio work taking place; therefore within the composer's imagination. The need for such fragmentary notes is further discussed in the concluding chapter (*Chapter 11*), concerning the paper *Drawing Electroacoustic Music* (Thiebaut 2008).

### Pierre Couprie

The responses to the questionnaire by Pierre Couprie indicate a specific purpose to representation or visualization, namely that of analysis. Indeed his association with, and development of the Acousmographe and eAnalyse, software is intended to aid this particular outcome.

I never represent sounds when I compose. I only use the representation to analyse music (response to the first question)

He also states that representation contributes nothing to the composition itself. However the extent to which analysis can assist the compositional process whilst on going is open to question. Representation however can be quite detailed:-

The representation, and what is represented, depends on your analysis: what do you want to demonstrate with your analysis? You can represent space, morphologies, sound causalities, etc.. (response to the questionnaire)

The response to the issue of *visual music* and whether the representation might be considered an art form in itself was regarded as a '*large question*', with a reference made

to *Portrait Polychromes* (Luc Ferrari) where artistic representation was thought to be the best way to '*figurate the poetry of the music of Luc Ferrari*'. The Acousmographie software is analysed in more detail in *Chapter 8* of this thesis. Suffice it to say at this point, it is a highly developed way of adding a library of graphic symbols, capable of being edited, to a sonogram of the sounds, that moves over time as a particular piece unfolds. To summarize: -

- 1) representation is descriptive for the purpose of analysis, and therefore *outer* hearing
- 2) it mostly uses software designed for the purpose.
- 3) it includes graphics with the possibility of text.

Analysis is an important aspect of compositional process, and can take place whilst composition is taking place. In this context, the boundaries between analysis, reflection and archive are often obscured on a day to day basis. This makes the case that composers frequently analyse as part of their understanding of the work in progress.

#### Ambrose Field

His response by email used the questionnaire as a stimulus, but was a more free interpretation of his use of representation as part of the compositional process. Whilst his work is within the *visual music* genre (usually collaboratively with other artists), he does not use visual representation to compose sounds:-

For me, I always wonder why visualize what we can hear anyway? Why not do something visual that adds to the experience, and does something new? (response to the questionnaire)

This is a position adopted by other composers. However it may be that thinking of visual elements may influence the compositional understanding, not least as regards structure. A particular facet of some of his work, is to develop spatialization of the visual material.

For more experimental work, I'm very interested in the idea of surround video, and developed a system to be able to project 5 video screens at 1k resolution in frame accurate synch. I used this in my piece '1906' for 50 laptop performers in 2007. The visual material here is from the Prelinger Archive – the piece is about the 1906 San Francisco Earthquake, and uses Edison's public domain footage. I edited the piece and distributed it spatially, to gain a sense of the scale of the event. So again, it's a representation of the narrative, or extra musical, that I'm after. (Response to the questionnaire)

It is hard to imagine here that visualization would not have some kind of symbiotic relationship with the composition of sound. To summarize: -

- 1) any visualization is concerned with visual music (in collaboration with others), and may be prescriptive *inner hearing* or descriptive *outer hearing*.
- 2) there is a possible symbiosis between production of visual and audio elements, which could aid however the composition of audio materials.
- 3) as stated by other composers, *auditioning* predominates over representation.

The integration of audio and visual media at least as regards structure does imply at least some relationship between visualization and compositional work.

Gary Eacope

These responses indicate a varied response to representation suited to a particular piece and the way in which the compositional challenges are addressed. Three works are referred to, *Pianotronics*, *Tasteless Curtains* and *The Beach*. The responses are detailed

and, as with some other responses, quoted in full in the appendix. Full use however is made of visualization. In the case of *Tasteless Curtains* and *The Beach* quite unequivocally '*The score IS the piece*' and '*it was the audio that represented the score*'. (questionnaire) The pieces in question are quite different in approach and visualization has been adapted as needed.

Piantronics is a piano and electronics score. It is a combination of standard notation, non-standard notation and graphic scoring where the standard notation is at times as visually graphic as the graphic symbols themselves. Amongst other things, Piantronics used symbols depicting *approximate pitch, duration, crescendos, whooshes, explosions, multi-stranded sounds, particles of sound, vibratos and waveforms*. The piece also used symbols in the piano part to depict '*prepared-piano*' sections and *dumbell shapes depicting approximate note clusters*. [ ]

Piantronics needed a score for the pianist to perform and so was an integral part of the performance and end result.

*Tasteless Curtains* uses a colourful 'sequencer based piano-roll' graphic score consisting of repetitive visual patterns, hence the title. Essentially, the score is an enlarged print-out of a sequencer piano-roll. Each note on the piano-roll triggers various pitches and sounds. The score contains crossing melodic lines, contrasting textures and perhaps most notably my name, Gary, in block capitals. The latter produced an interesting combination of pitches, durations, dynamics and texture. Again, this score is very accurate in that what we hear really is what is written in the score. [ ]

*Tasteless Curtains* was composed with a view to making a graphic score representation. As a result the score is not part of a live performance but it is essentially a 'real' depiction of the audio. Or perhaps it would be more accurate to describe it as the audio accurately representing the patterns, textures and words (my name).

*The Beach* used an artist's 'sound drawings' as a score. The artist had sat on a deserted beach and drawn what she heard as opposed to what she saw. The scribbles were used as input data for a sound synthesis program I wrote. The data controlled various parameters such as pitch, duration and spatialization. [ ]

The foundation of *The Beach* was to use the sound-drawings as a score so once again it was more the audio being a representation of the score as opposed to the other way around. (questionnaire)

Later the visualization is stated as being for the listener and in the case of live performance the pianist as well. The visualization is described as being both prescriptive and descriptive, and in the case of *The Beach*, analytical as well. Several composers have shown unwillingness or confusion when faced with the enquiry as to visualization being prescriptive or descriptive. It may be that circumstances change in a specific composition, or that the relationship between the two is genuinely symbiotic. Visualization was used to improve compositional understanding: -

Piantronics: As this was one of my first graphic scores, it was a valuable lesson in methodology.

I learnt what worked and what didn't work as a graphic score. I felt the graphics in the piano part worked extremely well on the whole whereas the tape part was less well defined.

Tasteless Curtains: This score gave me the opportunity to explore graphic notation in the form of a sequencer. It opened up a whole host of ideas based upon patterns and contrapuntal strands.

The Beach: As the sound drawing was completed first it didn't really have an effect my understanding of the finished piece but it did lead to many, many compositional ideas of which I could only try a few on this occasion. (questionnaire)

Visualization was also used to improve understanding of polyphonic structures and events. There was some indication of spatialization in *The Beach*.

Clearly representation is an important part of the compositional process here, although in one case (*The Beach*) in collaboration with an artist. Traditional notation is used in some cases but adapted and alongside graphic images. In some cases the representations are identified as being *for the listener*; with *Pianotronics* for the performer as well. Responses seem to indicate a symbiotic relationship between

symbols and sound, since representations are described as both *prescriptive* and *descriptive*. Representations are described as '*being the piece*' whilst the audio is actually described as *representing* the score. The collaborative work is very nearly consistent with the concept of *visual music*. Most musical parameters are represented including spatialization when required. There is a close relationship between symbols and sound, even to the extent that visual material is used as data to generate or manipulate sound. In summary:-

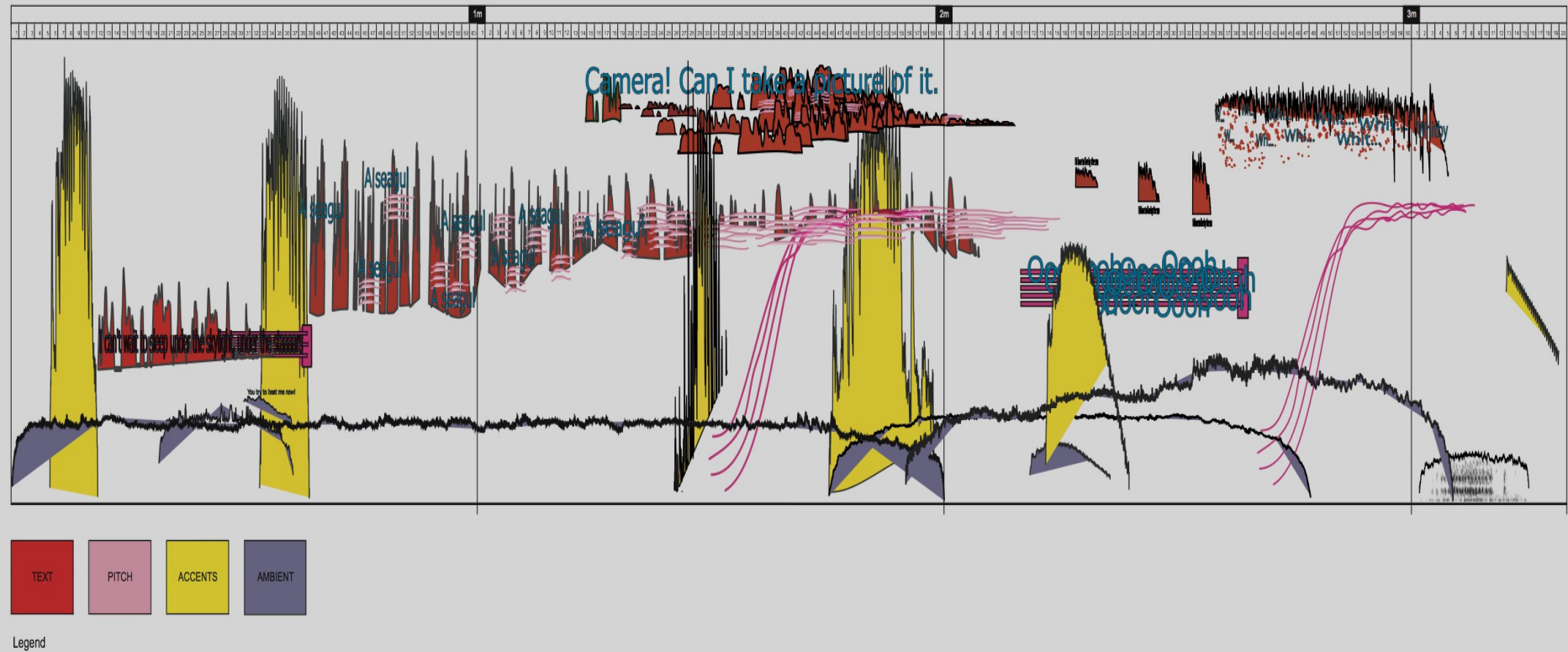
- 1) they are of inner and outer hearing with evidence of symbiosis between the two.
- 2) representations are mostly graphical symbols.
- 3) they are prescriptive and descriptive.
- 4) they include spatialization in one case.
- 5) they are by hand and using software.
- 6) there is use of visual data to produce or edit sound material.

#### Dale Perkins

These were responses to the questionnaire, and again are highly detailed and specific. (refer to the appendix) Representations are graphic for the most part with some text. They were produced for students at university level who were '*unfamiliar with acousmatic music*.' Representations were completed after the composition of the piece, and did not contribute to the compositional process, but were for pedagogical purposes. They are identified as being descriptive and analytical. They do enhance understanding for a *new listener*. Representations are however described as *inner hearing* even though completed after the composition. Presumably this indicates representation produced in response to *completed but imaginary or remembered sound*.



They were all completed using *Adobe Illustrator*. They were '*highly time consuming* (averaging 10 months on a day a week basis) to *complete*', partly because of the visual arts background of the composer. Below is given a graphic score produced using the software indicated.



*Fig. 5.10 Dale Perkins teaching score*

Less detailed scores were produced for diffusion. In summary: -

- 1) representations were of inner hearing but after the composition but after the composition was completed.
- 2) they were descriptive and analytical (for pedagogical purposes).
- 3) they were mostly graphics (with some text).
- 4) they included diffusion in some cases.
- 5) they were produced using software *Adobe Illustrator* (although described as *by hand*)

These visualizations are detailed and for pedagogical purposes, therefore descriptive and used for analysis. They are described as *inner* hearing because they rely on auditory memory. It is not possible to know if they contribute to compositional understanding of current or future pieces, although it is difficult to imagine this not being the case.

#### Katharine Norman

Although this was a brief response, it did contain quite specific and salient points. Representations are mostly textual notes '*research on various apparently unrelated areas, snippets of narrative text etc.*' There are also occasional diagrams. In summary:-

- 1) representations were of inner hearing (or before the composition takes place).
- 2) representations were textual with rare graphics usually to support preparation for the piece.
- 3) they were regarded as an aid to the '*compositional act*'.

The brevity of this response was for practical reasons and time constraints. Nevertheless it indicates a need to record the fact that visualization is an integrated part of the compositional process, in the way outlined above i.e. a representation of something *imagined or intended* using text and graphics, and as part of the *research* into

the piece.

Vivian Adelberg Rudow

A limited response here that indicates the *traditional* approach to visualization and representation of electroacoustic or acousmatic music: -

I don't understand your questions. All music is sound. All sound can be turned into music.

(Response to the questionnaire)

This clearly follows the concept of *reduced listening* as originally outlined by Pierre Schaeffer. However much of the output of this composer is predominantly for acoustic instrumental and vocal resources presumably, in that case, involving traditional notation.

To summarize: - representation/visualization is never undertaken in work relevant to this study.

This is the most limited acknowledgement of the use of visualization. The composers who made a response, were not selected because it was thought that they were likely to use visualization. In addition, relatively few did not respond, and we cannot conclude that of these, *all* made no use of visualization within the compositional process.

Ron Herrema

Representations are made occasionally depending on the piece. Examples referred to were *Streams* which used the UPIC system, and *Delicate Outbursts* which used *AC*

*Toolbox*. In both of these specific cases, sound was *produced* by the graphic images. They were representations of what was going to happen, hence they can be regarded as examples of *inner hearing* although a symbiotic relationship may have been in evidence. Predominantly representations focused in detail on pitch and duration. Other aspects were controlled by text and also using *ProTools*. Representations are identified as prescriptive and descriptive. To summarize: -

- 1) representations were of inner hearing (symbiotic with some outer) – predominantly referring to what was going to happen.
- 2) they were prescriptive and descriptive.
- 3) they involved sound produced by graphic synthesis.
- 4) This involved computer software – *UPIC*, *AC Tools*, software sequencers which are reviewed in the chapter on software in this dissertation.
- 5) they involved graphics with some text particularly as regards programming.

This composer used visualization to *generate* sound. The concept of *drawing* sound is also discussed in *Chapter 11* and the paper *Drawing Electroacoustic Music* (Thiebaut 2008), and following that the software *Music Sketcher* which developed from that paper. Although predictability is the aim, it is not conclusive as to how accurately the resultant sounds can match what was imagined or intended. Such procedures therefore, may be more about *discovery* than *imagination*.

### Mike Gatt

These responses arise from a different perspective because of Mike Gatt's involvement with the OREMA project, which as mentioned in *Chapter 5* is focused on *analysis* of electroacoustic music. ( [www.orema.dmu.ac.uk](http://www.orema.dmu.ac.uk) ) Representations within the compositional process:-

reside in the objective analysis, spectrograms, waveforms etc. that are usually in-built with the software I use (response to the questionnaire)

At interview Mike Gatt described an objective analysis as not being part of the compositional process. However a point of this hypothesis is that an analytical perspective *may be* part of the compositional process, because analysis may assist reflection and compositional understanding. This is stated by Mike Gatt himself in question three of the questionnaire, concerning the use of such representations namely: -

To visually understand dynamical aspects of the sound in order to gauge its use within the composition.

Later: -

It helped me gauge certain sounds in terms of their spectrum and morphology. (Responses to the questionnaire)

The point was also made that the representations were to assist in the compositional process. Representations were identified as *objective*, therefore according to Mike Gatt descriptive. Representations were described as machine produced and automated and within a genre identified as '*computer aided analysis*'.

To summarize: -

- 1) representations are descriptive and even analytical.
- 2) some are computer generated.
- 3) they involve graphics and numbers.
- 4) they are of outer hearing (heard already).
- 5) they do not involve spatialization or visual music.

The relationship between analysis and the compositional process is identified and

further discussed in the chapter on taxonomical structure *Chapter 7*.

Gary Kendall

This response was by discussion and reference to published material. It needs to be set in the context of Gary Kendall's view of the *sound object* as opposed to the more conventional view of the electroacoustic community. This is best summed up by his preference for the term *event* rather than *object*. His view appears to be that the term *object* is too narrow, because it says little about the *effect* of hearing a sound, including its preparatory and other gestures, and its effects on termination. Gary Kendall believes this is significant even in so-called *objective* analysis. It therefore contrasts as it were *subjective* and *objective* analysis. This compares well with the views of Mike Gatt as outlined above.

“The EVENT schema is a dynamic model that includes component parts representing processes and others representing state. The model is dynamic in several respects. First, it is a pattern that executes through time. It changes state during the process of its execution. Second, it has junctures at which the execution can be directed along alternative paths. As shown in Fig. 3, execution runs from beginning to end, but can also include interations and interruptions. This schema also includes steps that are often inaudible such as ‘Enabled’, ‘Preparing’ and ‘Ready’ that capture the preparation for the start of an ‘event’. (Kendall 2008 page 3)

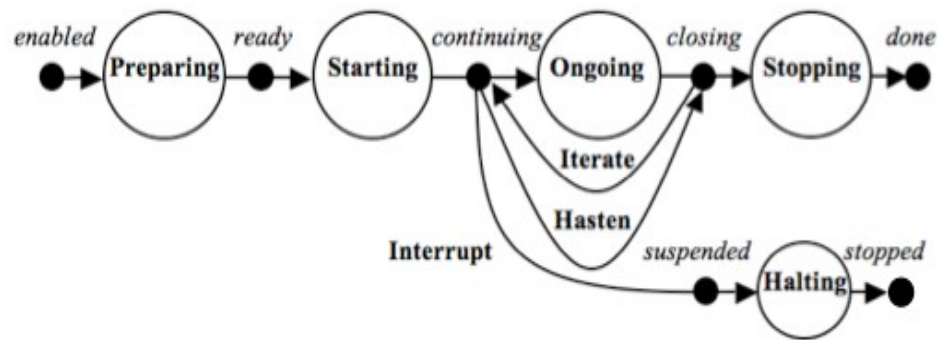


Fig. 5.11 Gary Kendall event schema

Representation of the EVENT schema. Processes are represented as circles and states as dots.

(Kendall 2008 page 3)

This is a significant departure from other approaches and responses, because of the need to capture the *experience* of the sound. This approach is not only compelling predictively, but also as regards description, archive and analysis. It is also important because it recognizes sonic events as a matter of perception, rather than a disembodied conceptualization of changes in sound waves.

To summarize: -

- 1) representations refer to outer hearing.
- 2) representations are analytical – to enhance understanding.
- 3) they are identified as multi-layered.
- 4) they do not indicate spatialization.
- 5) they are graphical.
- 6) they are made using software.

As with other composers who are concerned with analysis, this is speculative as to whether the analysis takes place after composition is completed, or as part of the on-going compositional process. The boundaries between analysis, analytical reflection and



reflection itself are not always capable of clarity of definition.

Denis Smalley

These were highly detailed responses to the questionnaire, with extremely pertinent and reflective points made. There is also an indication of practice having changed over time, partly as a result of changes in technology as regards to sound composition, digitization and storage; visualization by hand on paper is still much preferred.

Visualization whilst composition takes place has involved: -

graphic sketches of the morphologies of sounds – rough shapes showing dynamic envelope and approximate spectral makeup.

The purpose is as a quick aide memoire to relevant features of the sound. These sketches appear on card files that list sounds/their transformations. (response to the questionnaire)

This practice is rarely followed now because of easier search and access to sounds. These days however, there is some use of text to list relevant features, particularly to point out possible relationships between sounds. As one might expect, graphic representations of the 'tape' part are made where instrumental performance takes place, to act as a guide for the instrumentalist e.g. '*audible pitches; significant events; cues for entries; synchronization points*'. Importantly: -

Such transcriptions were partly carried out in sketch form during composition, and then completed and finalized on completion of the work.

Diffusion scores are made once the work is complete.

Events are represented as spectromorphological shapes, with main timings. The scores are

intended to help the diffuser learn the piece quickly; accurate timings are particularly helpful to facilitate any rapid changes at particular points in the piece. (response to the questionnaire)

The suggestion is also made that these scores could be used for the purpose of study such as *investigating form, temporal proportions*. The point is stressed however that spectral accuracy will not be achieved and will at best be approximate.

The point is also made that in acousmatic works, no representations are made in advance of the sounds, even though notes or sketches can be made for later use (*aide memoire*). The situation is sometimes different in the case of *mixed* works. The representations are descriptive and sometimes analytical, particularly where pitch content is involved.

The representations do not directly contribute to the composition:-

- although there may be an effect on the next composition e. g. changes in process or structuring due to increased consciousness of formal practice; also greater consciousness of the role of pitch and pitch centres. (response to the questionnaire)

Generally representations are not that helpful in the contemplation of timbre or the spectral characteristics of sound. Some diffusion scores have been treated as art work and one even exhibited as art. Finally:-

My representations are concerned primarily with sound shapes (spectromorphologies), and possibly, where evident, also the reality of sources, denoted using text annotation (e.g. water, birds). Representation is pragmatic, not an act of individualized or idiosyncratic mental fantasy – and involve graphics and text. (response to the questionnaire)

To summarize: -

- 1) representations refer to outer hearing although to some extent a symbiotic relationship between inner and outer hearing. Ultimately a pragmatic tool to aid to composition, including as an *aide memoire*.

- 2) they include text and graphics.
- 3) they are on paper by hand.
- 4) they are descriptive and analytical.
- 5) they can refer to performance and diffusion.

There are many points here that show commonality with other composers. These especially include pragmatism, description, reflection and analysis, live performance and diffusion, pedagogy and use of visualization as a compositional tool.

### Barry Truax

The response here to the questionnaire, suggests on first reading a certain diffidence as regards the use of visualization. However some 'sketching' does take place, but usually as an 'aide memoire'. Compositional process is regarded above all, as an auditory process:-

The first is the incredible importance of the computer to be able to deal directly with sound. I'm a composer whose music finds its basis, its inspiration, its whole direction, even its structure, in sound. I have to be able to hear it. I do respect abstract thinking and structuring and because of my interest in algorithmic processes I have a great interest in that, but the sound is the basis of everything, and that means being able to design the sound directly. (*Interview with Barry Truax Computer Music Journal 18(3) 1994*)

Sketches are most likely to be graphical with perhaps some text. Sketches take place 'along the way'. To summarize: -

- 1) representations are by hand on paper.
- 2) they take place after sounds are made therefore 'outer' hearing, although 'along the way' suggests a symbiosis between inner and outer hearing.
- 3) they enhance and aid compositional process and understanding, and can be used as an archive.

A key point here, referring to the quote given, is the stated importance of audition

to this composer. Visualization is regarded as intrinsically about *abstract* thinking. Working with aural images in the mind however, seems to this author as far from working in the abstract, and *is* working with musical *reality*. A fundamental point of this thesis is that aural imagery is *concrete*; hence the possibility of representing and manipulating what is being *imagined*.

### Leah Barclay

The responses from Leah Barclay were detailed and indicative of continuous use of, and reference to, visualization. They were identified as for personal use, and also for integrated live performance when required. Visualizations are also used as study and analysis scores. They are described as prescriptive and descriptive as well as analytical.

All sounds present in the compositions are represent[ed] with graphic notation, often I will create a 'graphic language' for each composition – so particular graphics will represent a particular gesture and the variations of that gesture etc.

and:-

I always find graphic scores very useful in my creative process and I'm sure they influence the development of the composition. (responses to the questionnaire)

These are important comments because they indicate reflectiveness in the way in which visualization and the compositional process interact, particularly as regards the invention of graphical symbols. Later responses indicate that this process often took considerable time. There was also a desire expressed in this case to exhibit scores as works of art in themselves. Representations are described as of *inner hearing*.

Given below is an extract from *Wolf Rock* (Leah Barclay 2008) which is a page of the electronic part as indicated.

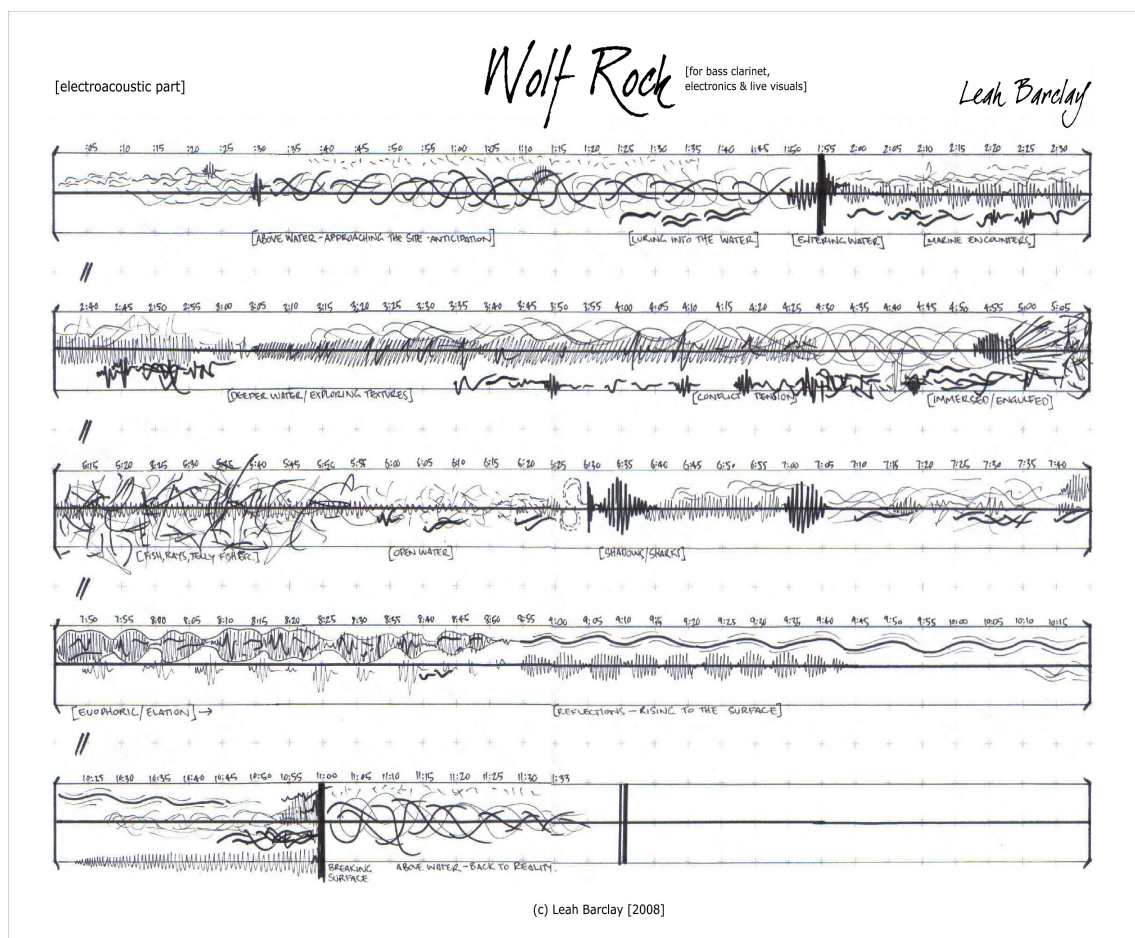


Fig. 5.12 Leah Barclay *Wolf Rock*

To summarize: -

- 1) representations are of inner hearing and are prescriptive.
- 2) they are by hand on paper.
- 3) they are also descriptive and analytical as well as for study.
- 4) they could be exhibited as visual art.
- 5) they are for live performance and include spatialization when required.
- 6) they include graphics, text and numbers.

Clearly visualization is an embedded and intrinsic part of the compositional process, and occurs as a regular and on-going activity.

These responses were as a result of interview, partly in response to the questionnaire. It was indicated that visualization consistently takes place, and this involved graphical images and text in the form of a diary for compositional work in progress. This was undertaken for the composer, and also included material for performance and analysis. The visualizations were identified as descriptive, and in some cases analytical. They also effected compositional understanding by providing reference points for future compositions. In other words they were a record or archive of past compositional activity. The graphics were considered to be an art form in themselves. They were done on paper and were a record of inner and outer hearing.

To summarize : -

- 1) representations are mostly of outer hearing although inner hearing is included
- 2) they are predominantly graphics with some text in the form of a diary
- 3) they are on paper
- 4) they enhance understanding of future compositions by reference to them as an archive
- 5) they are of timbral objects
- 6) they are descriptive and analytical
- 7) they can refer to performance and structural analysis
- 8) they are reflective in that they encapsulate a *stream of consciousness*
- 9) they could be works of art in themselves

### **5.3 Summary and Response Grid**

These responses are summarized in a grid below, that is based on the taxonomical structure outlined in *Chapter 7*. Whilst the responses can be seen to be varied, they also show consistent patterns of approach that seek to accomplish specific intentions as regards the compositional act. Visualization indicating *imagined* or

*intended* sounds or, as this thesis also terms it *prescriptive* visualization, was indicated by just under 50% of composers. Some composers indicated that their visualization was descriptive of *future intentions*. Around half indicated the use of visualization in response to *inner* hearing or visualization completed *before* the sound is made. *Outer* hearing indicates that a visualization has been completed *after* the sound has been made. Just under half are prepared to state that visualization aids compositional understanding.

Just under half indicate that visualization is used to aid analysis, either during the compositional process or for some other reason such as pedagogy, or reflection after the composition is complete. Eight indicate the use of visualization to aid spatialization or diffusion. Most use graphics, slightly fewer text, and fewer still than that numbers. Most work on paper but around half use some kind of software. Six indicated the use of visualization for teaching purposes. Three indicated a connection with their work in visual music. Two perhaps three indicated that visualization is not used at all. Composers who incorporate live performance tended to integrate this by the use of some kind of visualization, often adaptations of or reference to traditional notation.

These responses go a considerable way to answering the main research question as outlined at the start of this thesis namely, does visualization take place, and is it a fundamental omission of the genre? Schaeffer's assertion that the *concrete* in music cannot exist in the imagination, contradicts the evidence of these responses and the practice of nearly all these composers. Even when visualizations occur *after* sounds are made, they are *looked at* by the composer for reasons supporting reflection, analysis and understanding. In many cases, such visualizations preserve an archive or record of the sounds, processes, structures or connectivity within the sonic output. In some cases they

are also looked at in order to inform the work that is to follow.

This research shows that visualization does take place, and is an omission only in a theoretical sense. Composers were approached who it was thought likely to make a response, without predicting beforehand what their response might be. As time went on it became a matter of surprise that almost all use visualization, and as part of the compositional process. That process has many diverse dimensions, and visualization has proved to be a powerful tool in respect to many of those dimensions, thus having an important role to play in compositional output. Better understanding of this role is justifiably a main aim of this research.

In the grid below: -

- Acousmo indicates the use of Acousmographie
- Memory indicates the use of visualization as an *aide memoire*
- Intentions indicates visualization of future intentions
- CDP refers to *Composers Desktop Project*
- Brackets indicate a partial use for a particular purpose, or a response open to an unclear interpretation



	Inner	Outer	Understanding	Prescriptive	Descriptive	Analytical	Archive	Performance	Spatialization	Graphics	Text	Numbers	Machine	Paper	Pedagogy	Visual	No
Robert Normandeau		/			/	/				/	/	/		/	/		/
John Young	/		/	/	/	/	memory			/				/			
Simon Emmerson	/		/	/	intentions		memory + traditional	/	/	/	/	/	/	/			
Leigh Landy	/				intentions						/		/				
Ron Herrema	/	>> (/)		/	/					/	/		/				
Trevor Wishart		/			intentions		/		/	/	/		CDP	/			
Simon Atkinson	/ trad.	/	/ organisation							/				/	/		(/)
Pierre Couprie		/			/	/				/	/		Acousmo				
Bret Battey	/+trigger (/)	/	/	/						/	/		/	/			
Gary Eacope	/	/		/	/				(/)	/			/	/			
Rick Nance	/	/	/		/	/		+/	/	/		/		/	/		
Gerardo Dirie	/		/	/	intentions	/		/	/	/ stimulus	/		/	/	/		
Dale Perkins	/	/			/	/	memory		/	/	/	/	/	(/)	/		
Elizabeth Hinkle Turner (/)	/	/		(/)	/reflective		memory						/	/		/	
Vivian Adelberg Rudow																	/
Ambrose Field			/													/	
Katharine Norman	/		/							(/)	/						
Mike Gatt		/			/	/				/		/					
Gary Kendall		/	/			/				/			/				
Denis Smalley	(/)	< /			/	/		/	/	/	/			/			
Barry Truax	(/)	< /	/				/							/			
Leah Barclay	/		/	/	/	/		/	/	/	/	/		/	/	(/)	
Louise Rossiter	(/)	/	/ (future ref.)		/	/	/	/		/	/			/			

*Fig.5.13 Response grid*

## 6. Historical Case Studies

Historically there are a number of important examples of exponents of electroacoustic music and *musique concrète*, who are no longer available to give a response themselves as to their use or otherwise of visualization or representation as part of their work. Instead we may examine surviving material, and form conclusions regarding its importance and relevance to the specific '*compositional act*'. This chapter therefore seeks to examine in their absence a record of such composers' visualization practice.

The evidence presented by these scores and examples indicate that visualization was often a desired requirement of these composers, to aid understanding at various stages in the compositional process. This is going to be seen as very much in line with the taxonomical structure outlined in *Chapter 7*. In particular there is an expressed or implicit focus on understanding and reflection, preservation or archive, as well as performance if appropriate. As such, these examples serve to confirm the assertions throughout this thesis as regards to the relevance and importance of visualization in clarifying compositional imperatives and needs. The summaries at the end of each section are intended to follow the approach to the responses of living composers in *Chapter 5*.

## 6.1 Pierre Schaeffer

In the case of Pierre Schaeffer we first need to re-iterate a point made earlier in this dissertation about the fundamental approach to *musique concrète*. Schaeffer made two statements in an interview in the latter part of his life: -

(...) After the war, in the '45 to '48 period, we had driven back the German invasion but we hadn't driven back the invasion of Austrian music, 12-tone music.

and -

(...) I was involved in music; I was working with turntables (then with tape recorders); I was horrified by modern 12-tone music. I said to myself, 'Maybe I can find something different...maybe salvation, liberation is possible'. Seeing that no-one knew what to do anymore with DoReMi, maybe we had to look outside that(...)

(Hodgkinson 1987)

More than the simple use of recorded sounds as the musical material, *musique concrète* represents, according to Schaeffer, an inversion of the processes used in the traditional musical approach. In traditional music, which Schaeffer calls abstract music, the composer follows a path from the abstract to the concrete. Its phases comprise: (1) mental conception (abstract); (2) notation; (3) instrumental performance (concrete). In *musique concrète* (the new music) the composer follows a path from the concrete to the abstract. Since the sound material is already preexistent, one can do no better than choose and manipulate the material creating "musical objects. (Guedes, 1996)

Essentially it can be seen from this that, according to Schaeffer, *notation* in traditional music is the means by which abstract thinking in sound is used to bring about the performance or the *concrete* reality of the music. In the case of *musique concrète*, *notation* (if any) is the means by which the concrete reality of the music is made abstract, perhaps for analysis, description, or for the realization of an archive. The presumption here therefore, is that notation or visualization occurs *before* the sound is produced in traditional music, and *after* the sound is produced in *musique concrète*.

These two situations are referred to in the chapter on taxonomical structure and

elsewhere in this thesis as *inner* and *outer* hearing. This thesis has already shown that this situation as regards visualization might not always be the case as described here. Even so, in *A la recherche d'une musique concrète* (Schaeffer 1952) there are examples of visualization given, but in this case only for analysis or explanation to move discussion, as it were, from the concrete to the abstract. The following example is above all a descriptive visualization whose method of presenting data is in three dimensional.

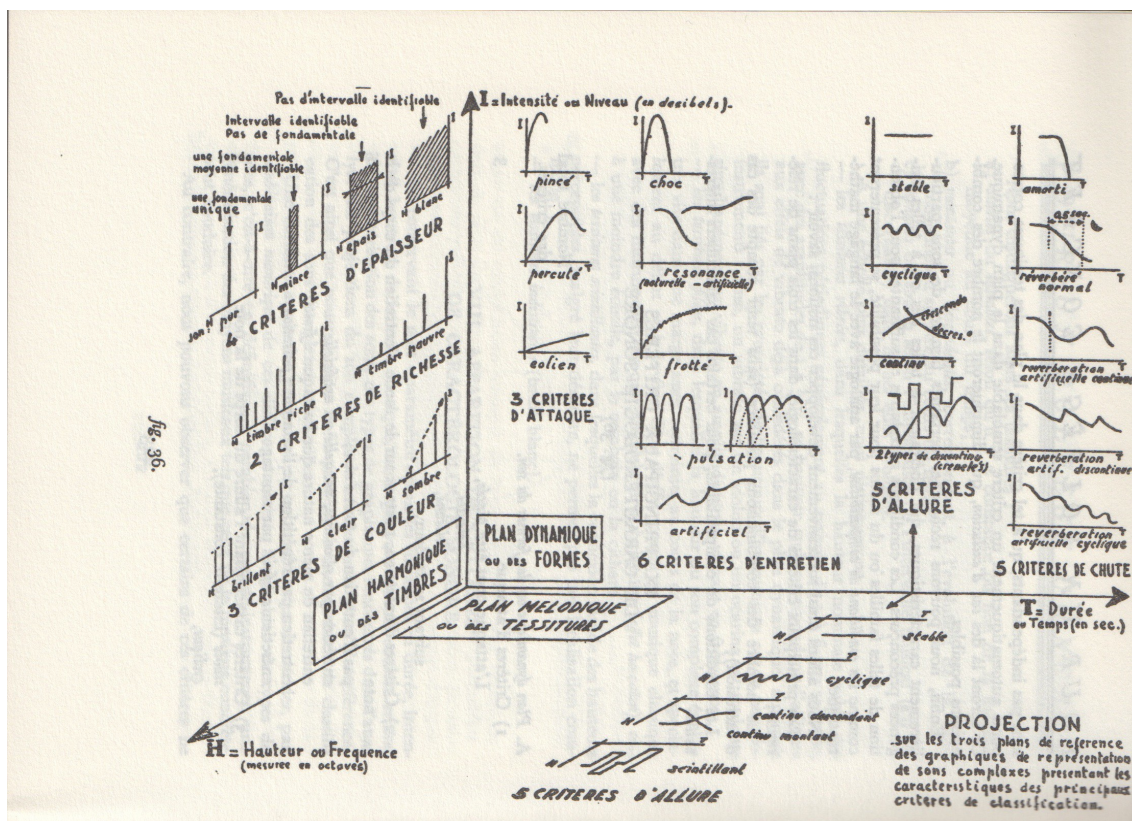


Fig. 6.1 Schaeffer *A la recherche d'une musique concrète*

(Schaeffer 1952 Page 224 fig.36)

In his book *La musique concrète* (Schaeffer 1967) Schaeffer is quite explicit about what a composer should do after arriving in the studio: -

Le musical étant remis en question au niveau élémentaire de l'objet, il est fondamental pour le

musicien expérimental de s'initier tout d'abord à ce travail de base: faire des sons<sup>15</sup> (Schaeffer 1967 Page 42)

In the case of traditional music however, one might counterpose this statement with '*imagine* the sounds and then write them down'. Schaeffer prefers *make* the sounds and then only write them down if necessary for other purposes such as description, analysis or archiving. This relationship between visualization and electroacoustic music is also summarized in the index of the DVD produced by the GRM *La Musique Electroaoustique - représentations graphiques*: -

La musique électroacoustique ne fait appel qu'exceptionnellement à la partition: s'il n'y a pas d'instruments, un code de réalisation n'est pas nécessaire. Toutefois, à l'écoute, l'absence de support visuel est un handicap pour la mémoire et la fixation mentale des événements. Cela est patent pour les pièces mixtes, dans lesquelles un interprète instrumentiste doit pouvoir identifier les événements électroacoustiques avec lesquels dialogue sa partie. On a alors recours à une partition d'écoute – on préfère parler alors de transcription – qui est le reflet de l'écoute singulière du compositeur, ou d'une tierce personne <sup>16</sup> (INA GRM éditions hyptique.net)

This makes clear the position, much as might have been stated by Schaeffer himself, that a score is rarely needed except in the case of the addition of *performed* music, or for other purposes as discussed above. Schaeffer's practice overall can be regarded as consistent with this position. Below is a fragment of score for “Etude aux sons animés” by Schaeffer giving an illustration of '*abstract*' notation most probably for analysis or diffusion. The top half is an early representation by machine. The lower half

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<sup>15</sup> Music being examined at the elementary level of the object, it is essential for the experimental musician to start from the basic work: make some sounds

<sup>16</sup> Electroacoustic music in itself does not call for a score: if there are no instruments, complete notation is not necessary. However, listening without visual support handicaps the memory and the mental fixation of events. This is obvious for mixed parts in which an instrumentalist interpreter must be able to identify electronic events with which his part is in dialogue. He then uses a listening score - we prefer to talk about transcription - which is reflective of that heard by the composer, or other third person.



is drawn by hand. Schaeffer intended machine based representation to be further developed in his studio.

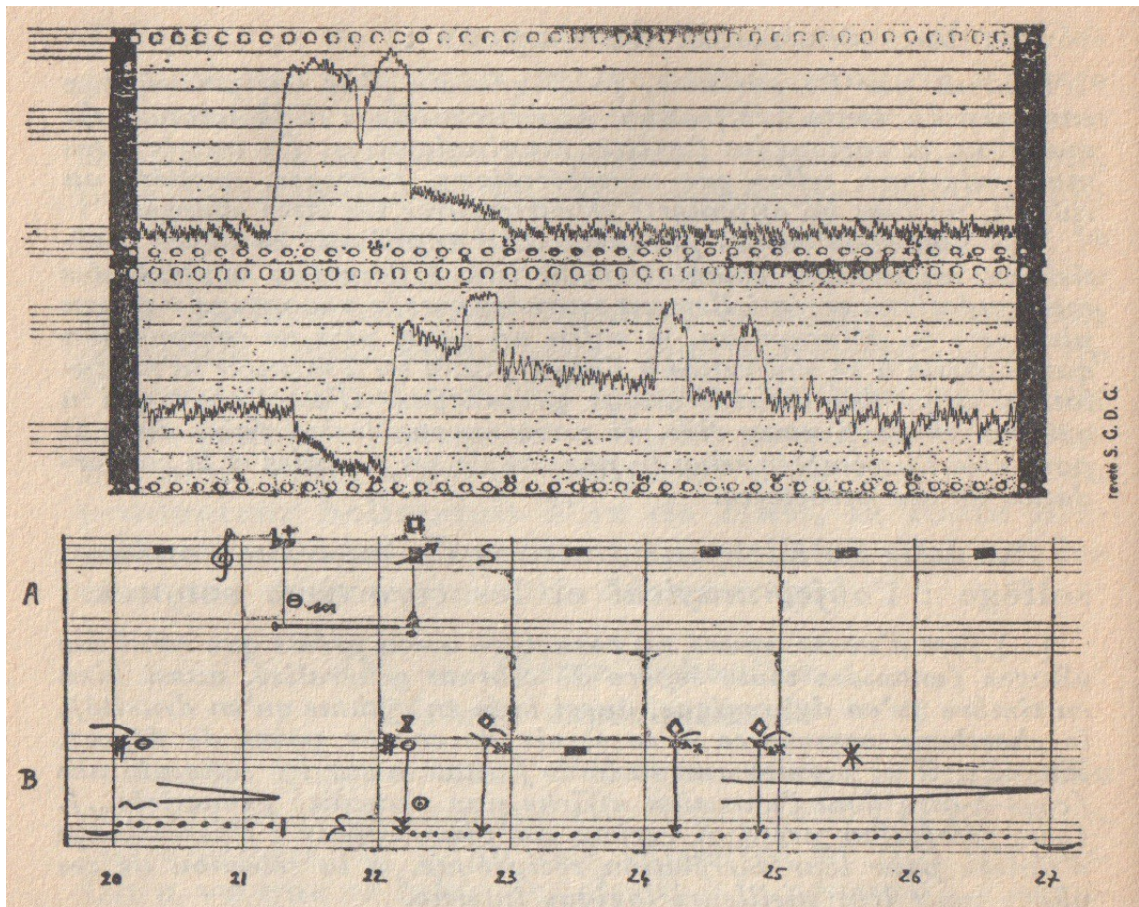


Fig. 6.2 Schaeffer *La musique concrète I*

(Schaeffer 1967 Page 76)

To summarize: -

- 1) visualization rarely if ever needed *before* composition
- 2) sometimes used however to enhance understanding for description or analysis

- 3) by hand using graphics, text and numbers – sometimes derived from *conventional* symbols as in *Fig.6.2* above. There was some experimentation with machine based visualization.

## 6.2 Edgar Varèse

A quite early example is that of Edgar Varèse, and in particular the composition he produced for the Philips Pavilion entitled *Poème électronique* (1957-1958). This is well documented in the book *Space Calculated in Seconds* (Marc Treib 1996 with Musical Analysis by Richard Felciano). From the outset, an important facet of the piece was that of spatialization, planned to integrate with the architecture of the building. The project was intended to be collaborative, designed by Le Corbusier (and in part by Iannis Xenakis).

From the very origin of the Philips project, Le Corbusier had proposed the creation of an electronic poem [ ]. This work, intended to be a new genre, would utilize, publicize – and stimulate – the technical potential of the Philips corporation, and would synthesize light, color, sound and rhythm. Sound, for the most part, was left entirely to Le Corbusier's collaborators Edgar Varèse and Iannis Xenakis, who would compose the primary eight-minute score and the two-minute interlude respectively. (Marc Treib 1996)

Many scores and sketches formed an integral part of the composition of the piece, and are predominantly representations of '*inner hearing*' produced *before* the production of the music. They follow closely the evolution of the compositional intentions of the piece, and are in part responsible for them. This is true of more fragmentary sketches and of more finalized '*scores*'.







The sketch above - appears to contain notes on the character of various 'sound objects' to be pre-recorded, then later mixed together. Elements such as rhythm and tempo are indicated, for the most part with great precision, suggesting that Varèse knew exactly what he wanted as far as the basic musical impetus of the objects was concerned. (Marc Treib/Richard Felciano 1996 Page 184)

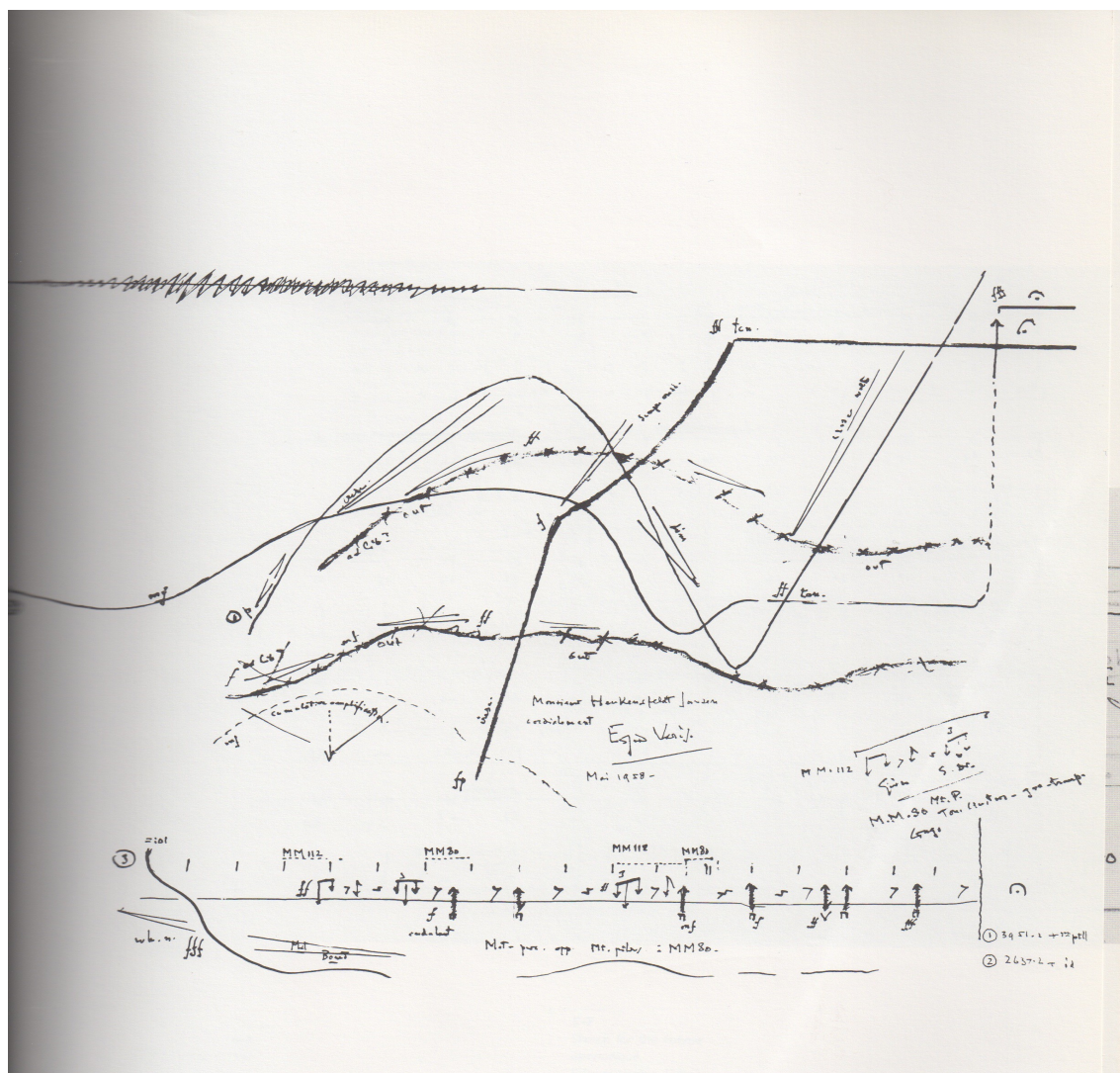
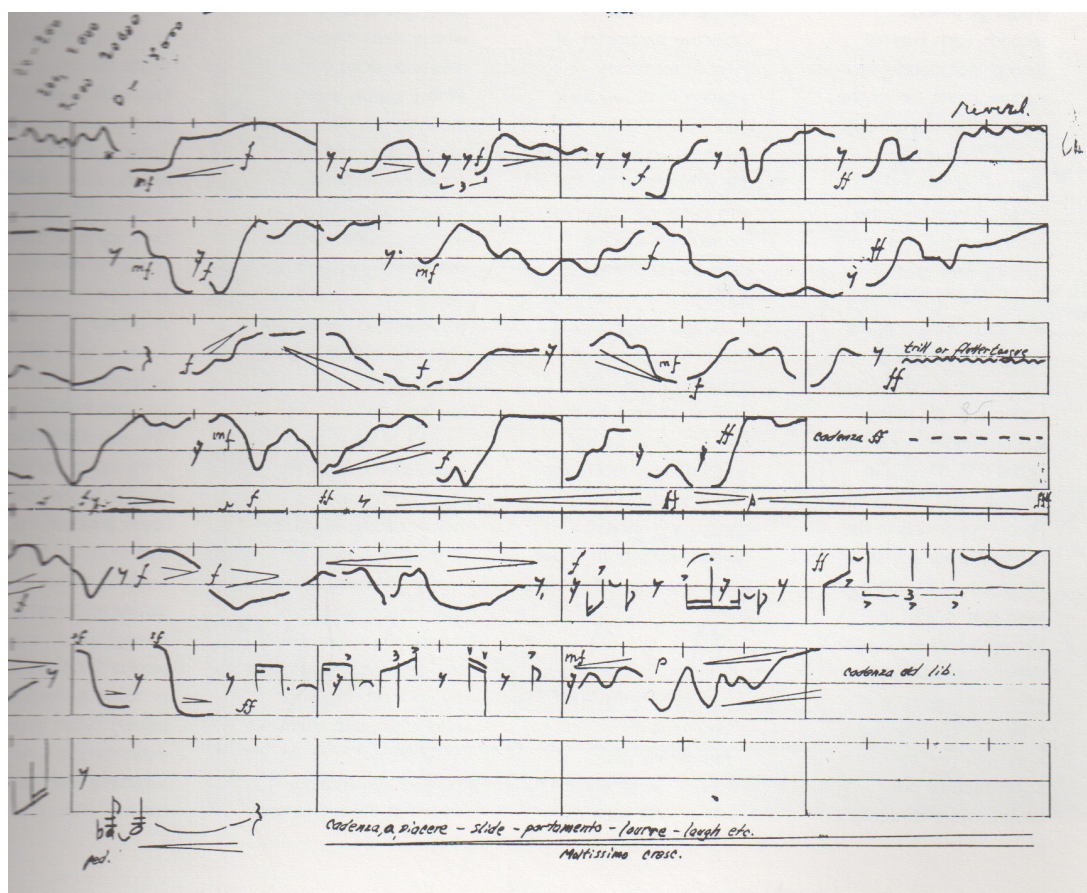


Fig. 6.4 *Poème électronique 2*

*Fig.6.4* - appears as a clear attempt to deal graphically with the shifting planes and sound masses of which Varèse often spoke. It may also indicate something about the sound trajectories within the building - (Treib/Felciano 1996 Page 188)



*Fig. 6.5 Poème électronique 3*

Marc Treib and Richard Felciano's notes are very detailed as regards to *Fig. 6.5*, and include specific references to Pitch (referred to as a '*continuum of availabilities from low to high* - rather than a selection from a limited scale of finite pitches'; hence '*pitch is indicated by continuous, wavy contours above and below the centre-line.*' Time

*'is conceived more in terms of duration in seconds than traditional notation; when the latter occurs, it is of strictly local significance -'. Dynamics are shown in the traditional manner except that there are notes indicating a 'dynamic scale', for example *f* given a value of +4dBs. Timbre 'sound quality, and specific sound-object identification also occur here, some of the [eight tracks] beginning with indications as to the type of sound employed -' for example 'Track 5: pulses of a sawing machine - (Treib/Felciano 1996 Page 200)*

Below is given a more detailed score, although whether this is a diagram of the resulting composition is unclear. In this case this would be a *descriptive* score completed after the production of the music although it might well have been used to assist or clarify diffusion. It appears to indicate the intended synchronicity of the linked tape machines. It must be remembered that descriptive scores of any kind can always aid understanding and reflection.

Having utilized a multitude of sound sources joined through electronic collage, Varèse realized this work this work to a large degree through trial and error, constantly adjusting each aural element toward the goal of an integrated work. (Treib 1996 Page 202 and 203)



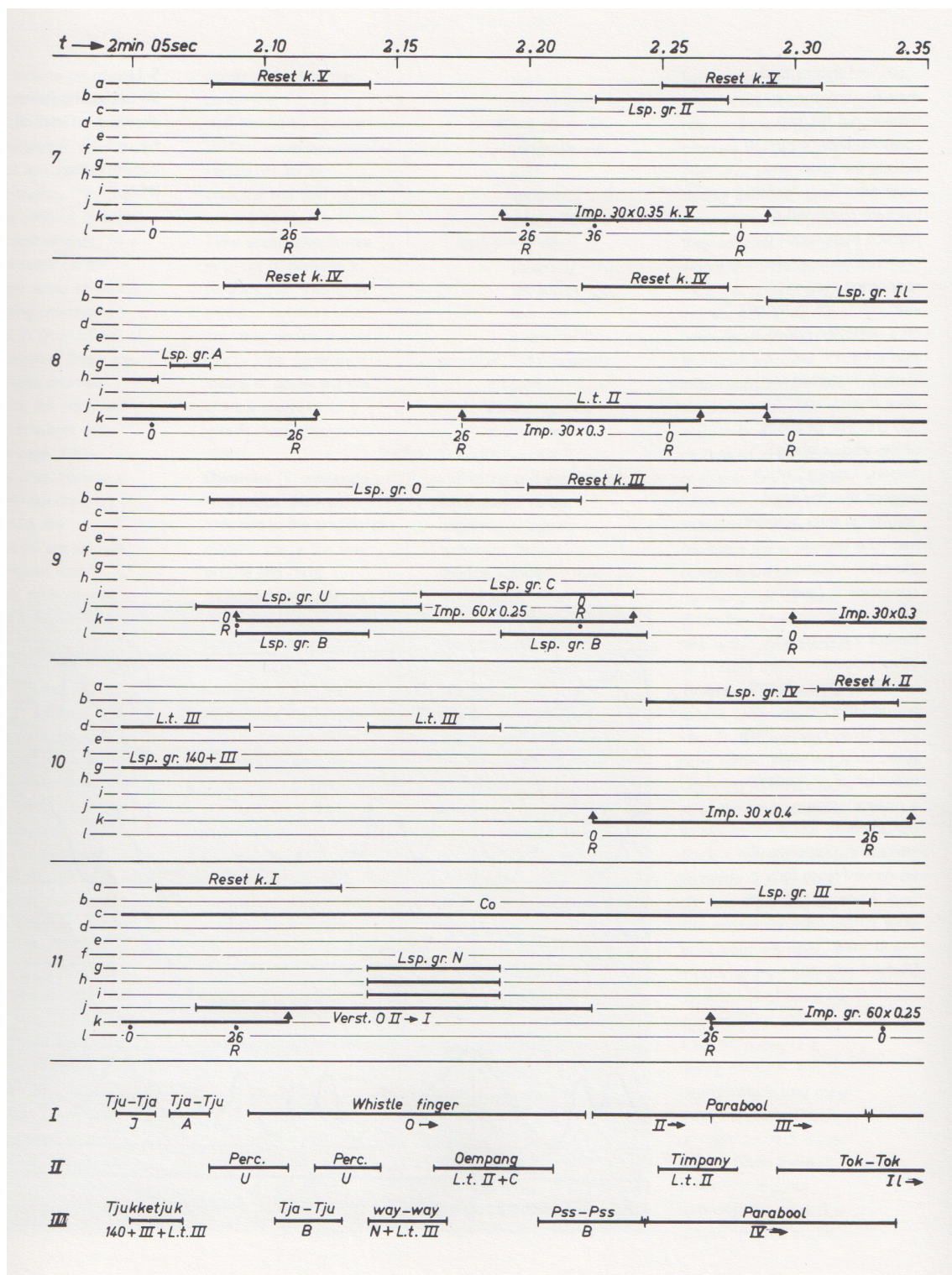


Fig. 6.6 Poème électronique 4

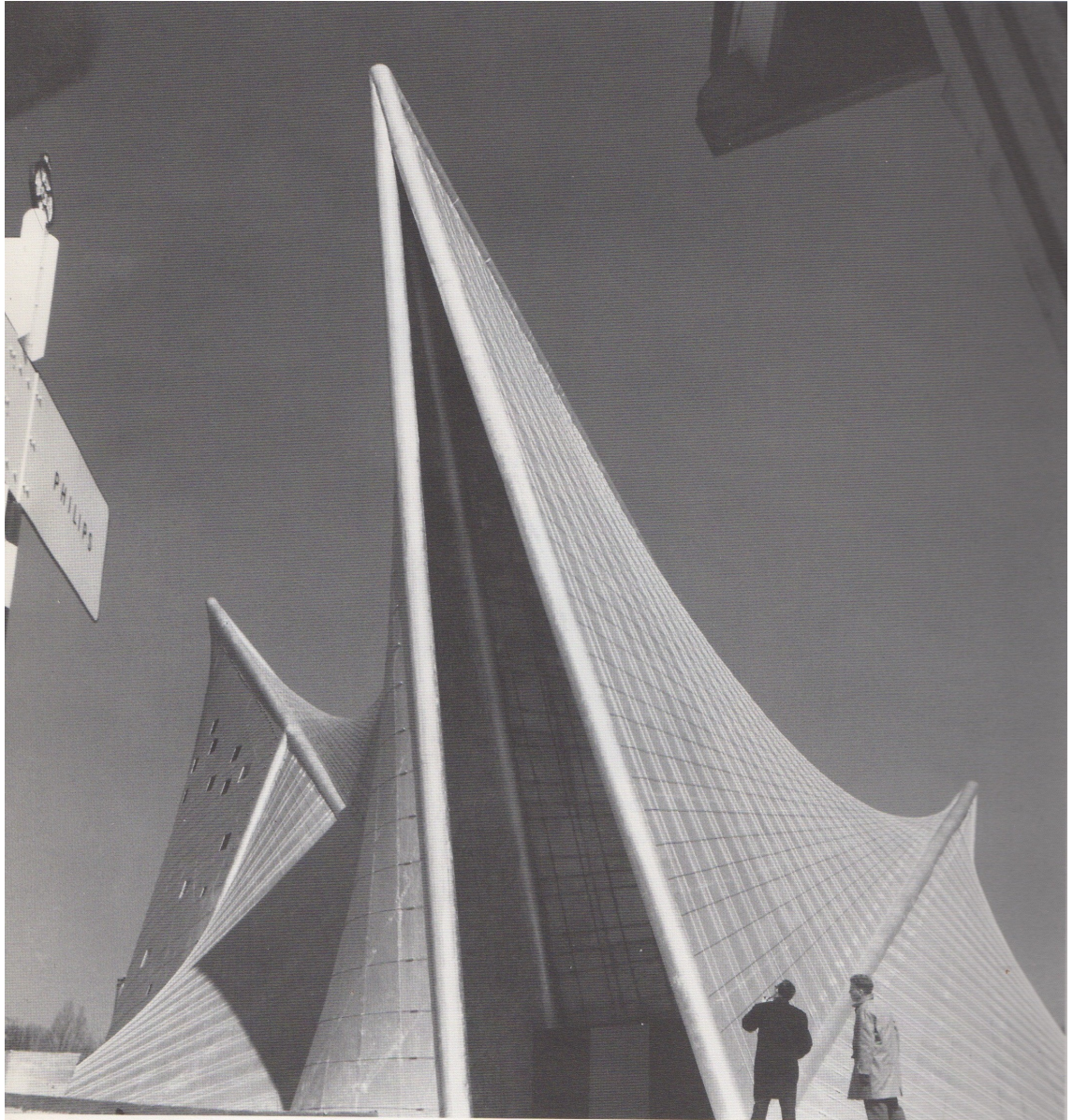
These *sketches* indicate the continuous use of visualization throughout the process of composition and involve both *inner* and *outer* hearing in a symbiotic relationship. Evidently visualization was also used to clarify mixing and the complex approach to spatialization, given that this was achieved using multiple synchronized tape heads and output to some twenty amplifiers. Clearly visualization enhanced, and made explicit for others involved in the project, levels of understanding of the music.

To summarize in relation to the taxonomical structure: -

- 1) visualization to enhance compositional understanding
- 2) by hand using text, graphics and numbers
- 3) for analysis and diffusion
- 4) prescriptive and descriptive – inner and outer hearing



## The Philips Pavilion<sup>17</sup>



*Fig. 6.7 The Philips Pavilion*

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<sup>17</sup> An image of the building is shown to offer some insight into the complexity of the placement of loudspeakers built into its complex structure.

### 6.3 Iannis Xenakis

Iannis Xenakis was also a composer for whom visualization can be seen as an integral part of the compositional process. This is perhaps inevitable given his architectural work, and the philosophical background to his creativity in general.

In retrospect, I think it was more natural for me to draw. Sometimes, I would draw and my drawings represented musical symbols. - I started imagining sound phenomena with the help of drawings: spirals, intersecting planes, etc. - Graphics are indispensable ; there are things that can be more easily manipulated through drawing. I acquired this experience during the twelve years I dealt with architecture with Le Corbusier. (quoted in Kanach 2009 Page 90)

Historically, of particular importance, is the fact that much of his visual material has been meticulously preserved as archives in the Bibliothèque Nationale de France in Paris, during the composer's lifetime and with his consent.

He wanted musicians to be able to consult them. He knew that they contained a treasure trove of vital information for the better understanding not only of his work, of his works, but also, of the art/science of making music in general.

All his creative life, Xenakis meticulously kept and filed his papers – perhaps as a professional reflex from his days in Le Corbusier's where he witnessed his employer's near-maniacal collection of all written traces of thought – be it notes, a rough sketch, preliminary drawings, a perfect technical plan, even a doodle.

Later we read of '*his necessity to record every step of his thinking/creative process and to keep them*'.

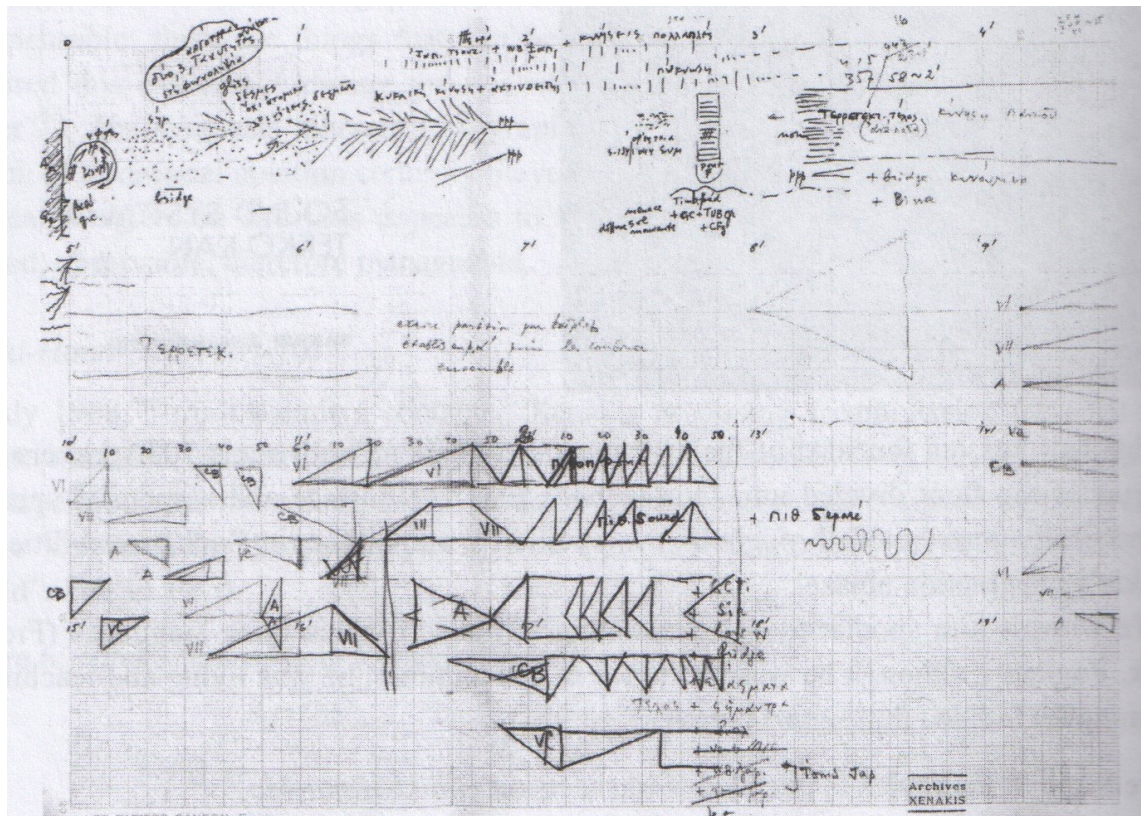
(Kanach 2009 Page 83)

This is very much in line with the thesis presented in this research in the chapter

on *Musical Archive*; especially the view that an archive is not only a record of a finished product but also a record of *thinking in progress* both for the composer and others.

*Hibiki Hana Ma* or *Reverberation-Flower-Interval* (1969-70) was composed for 8-channel tape for the 1970 Osaka World Fair, and was composed using the UPIC system, the graphical input device that Xenakis invented. It uses recordings of an orchestra, biwa and a snare drum. This piece is an example of electroacoustic work, although it uses material from earlier orchestral recordings. Many and various visualizations exist including structural sketches, work sheets for instrumentation and spatialization, preliminary scores and traditionally notated scores. (see following *Figs. 6.8 to 6.11*)





*Fig. 6.8 Hibiki-Hana-Ma 1*

*Fig 6.8* is a collection of structural sketches (Kanach 2009 Page 92)

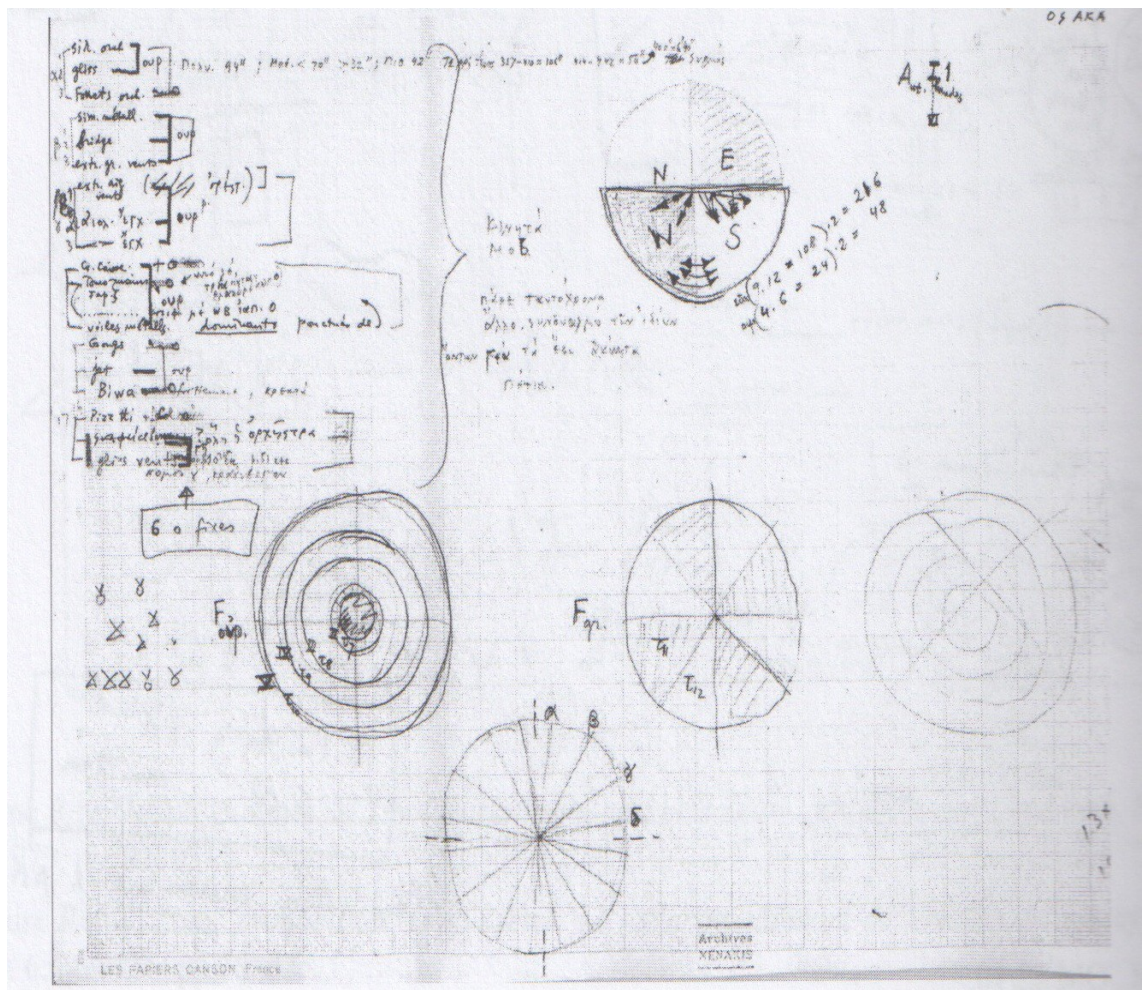


Fig. 6.9 Hibiki-Hana-Ma 2

These sketches indicate instrumentation and spatialization (Kanach 2009 Page 92)



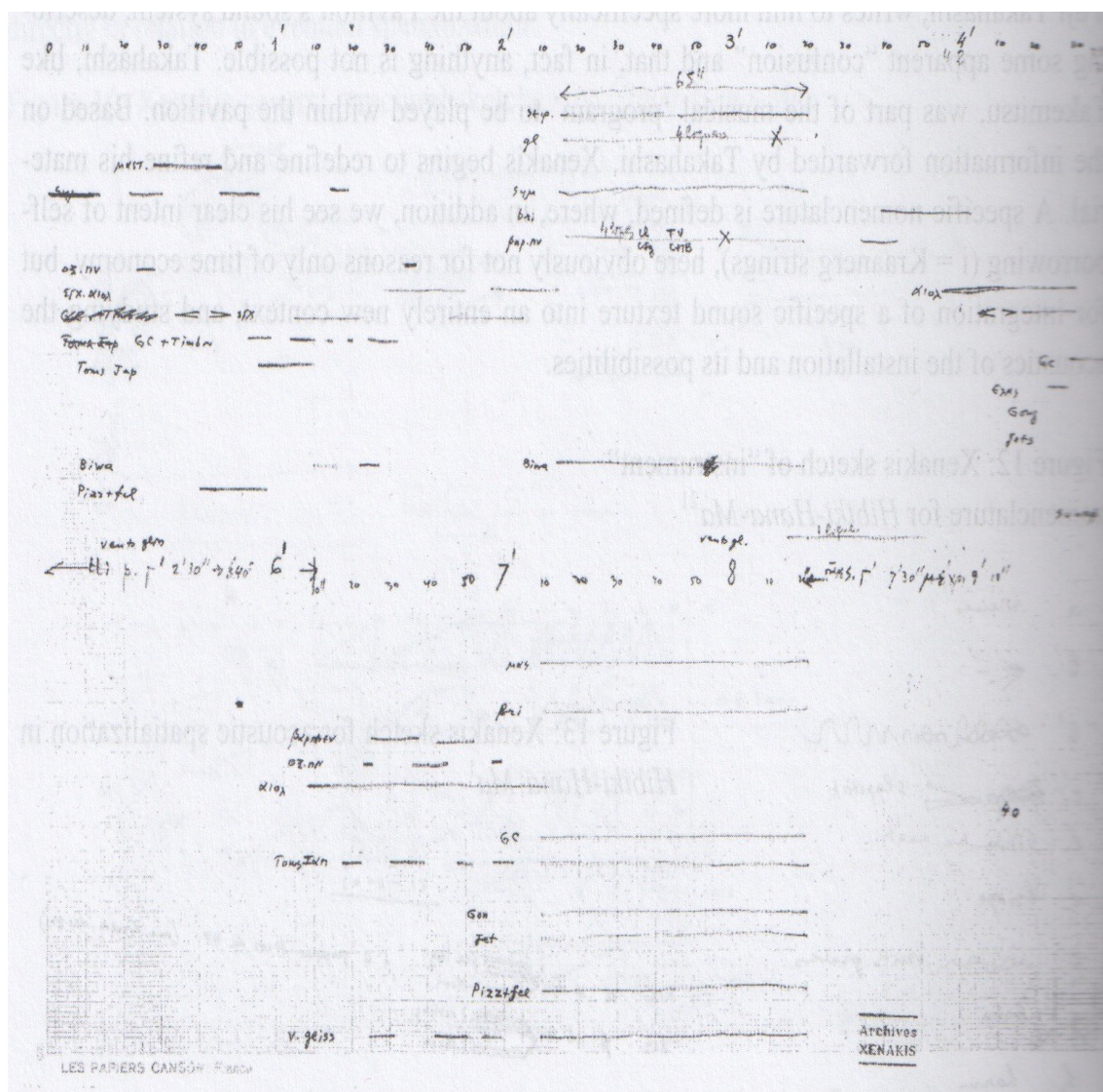


Fig. 6.10 Hibiki-Hana-Ma 3

This is an example of a preliminary score from (Kanach 2009 Page 94)





Fig. 6.11 Hibiki-Hana-Ma 4

*Fig 6.11* is a notated score from (Kanach 2009 Page 94)

These few examples briefly demonstrate the extensive use of visualization made by Xenakis at many stages in the compositional process, and the variety of information and methods used to capture such data. This includes form and structure, spatialization, and intended material including pitch and timbre (*instrumentation*). In terms of the taxonomical structure of *Chapter 8*, there is evidence of visualization of inner and outer hearing, prescriptive and descriptive approaches, diffusion, compositional process, enhancement and clarification of understanding, analysis, archive and performance. In most cases this visual material indicates a continuous symbiotic process between musical thinking, visual representation and auditory production.

The drawing and the thinking of the sound-image go hand in hand, the two can't be separated (Varga 1996)

To summarize : -

- 1) visualization to enhance compositional understanding and intentions
- 2) by hand using text, graphics and numbers
- 3) for analysis and for diffusion

- 4) prescriptive and descriptive – inner and outer hearing

#### 6.4 Olivier Messiaen and Pierre Henry

*Timbres-durées* was an important collaborative example of *musique concrète*, produced by Olivier Messiaen and Pierre Henry in 1952. The precise contribution of Henry is unclear, but at least seems to have involved the production or identification of musical samples from GRMC for Messiaen to work on. In *Olivier Messiaen: The Centenary Papers* edited by Judith Crispin (Cambridge Scholars Publishing 2010) there is much information about the nature of the relationship between visualization and *musique concrète* at that time, as exemplified by this piece. The quotes below are included because they encapsulate many of the issues raised by this chapter, and perhaps the whole thesis and the main research question.

Although composing a piece of *musique concrète* rarely required a score, several types of notation were occasionally used. Indeed, representing "objets concrets" was a concern at GRMC. Schaeffer hired someone for the purpose of sorting out the numerous recordings of concrete sounds—Shellac discs and magnetic tape. This person, Michelle Henry, also had the task of researching the graphical representation of *musique concrète*. As early as 1948, Schaeffer had attempted to use notation, and he embarked, with the collaboration of Abraham Moles, to find a technical, or rather, scientific way of representing sounds. Other early examples of scores from the Paris School were the 1952 studies by Pierre Boulez, which are a relevé of the transposition operations done with the phonogène over time, and *Antiphonie* by Pierre Henry, a serial experiment also from 1952.

In any case, although I started this research on the Messiaen piece armed only with these fragments of scores and a recording of the piece, I quickly began to look for other documents. They were ultimately found in the personal archives of Pierre Henry, who lives and works in a private house in Paris. There, with the help of the composer himself and of his assistant, Bernadette Mangin as well as Isabelle Varnier, a number of unpublished documents were found. Above all, the score was uncovered. To my surprise, it differed from the published fragments, but, to my relief, both matched. Another discovery was that there wasn't only one score, but three. They were all hand written. To distinguish between them, I will name them: composition score, realisation score, and diffusion score.





The realization score: -

is a graphical representation of the whole piece [ ]. It is composed of a single temporal line. There is no time indication other than the tempo, but each sound is represented along with its code name and its duration expressed in length of tape. The linear score is composed of eleven sheets. (Crispin Page 29)



**OLIVIER MESSIAEN**  
**Timbres - durés**  
(musique écrite à 1 voix)

$\text{♩} = 144$

The score is a handwritten musical manuscript for a single voice. It consists of ten staves of music. Each staff contains a series of rhythmic notations (vertical lines with flags) and pitch indications (letters like E, F, G, A, B). The notation is highly detailed, with many dynamic markings (pp, p, mf, f, ff) and performance instructions in French. The score is divided into four measures, each marked with a circled number (1, 2, 3, 4). The final measure ends with an arrow pointing to the right, indicating continuation.

Fig. 6.13 Timbres-durées 2

The diffusion score: -



author between visualization and composition, is also born out by Crispin (quote above Pages 27-28)

## 6.5 Pierre Boulez

The notes above refer to two early studies by Pierre Boulez composed in 1951/1952 that evidently had some kind of score.

Even more exploratory, the second of these *Études*, composed in 1951, displays seven sources, with intricate resonance and inter-play, likewise intensified and developed through variation, complying with a format of durations, established prior to performance. (Françoise Bayle (*The Visitors and Concrete Adventure Archives* GRM CD booklet trans. Abbaye 2004)

It is difficult to speculate on the precise nature of these scores, but they are likely to have involved visualization *before* sound production, which again needs to be seen in the context of much of the *controversy* surrounding the relationship between visualization and earlier *musique concrète*. This point appears to be confirmed by the following highly critical comments of Pierre Schaeffer.

Pierre Boulez and his friends, from among the thousands of sounds in our armory, deliberately chose the most unprofitable, cut them into a complete mess, only having regard for the series which they had calculated in advance. (Schaeffer 1973)

Whilst Schaeffer evidently had a view as to the auditory significance of a score by Boulez, this author has at least anecdotally encountered various views from musicians of all kinds, as to the extent to which Boulez had an aural image of material that was

written down.

## 6.6 Karlheinz Stockhausen

The position of Karlheinz Stockhausen in relation to musique concrète is not straightforward, not least because he did not pursue the genre in what might be described as with *purist* intentions. He did in fact have only a somewhat distant relationship with its exponents, particularly in later years.

Stockhausen moved to Paris in January 1952, where he spent fifteen months studying under Olivier Messiaen at the Paris Conservatory, while at the same time he worked in the concrete music studio of Radio France. Here, under the leadership of Pierre Schaeffer, he carried out spectral analyses of different sounds. Here, too, he made his first experiments in the field of synthetic sound production. The composition *Étude Concrète*, which has not been published, was one of those experiments<sup>18</sup>. (Heikinheimo 1972 Page 13)

Below, quoted in various sources, is Stockhausen referring to the way in which he worked on this piece: -

I then chose, according to my score, one of the tapes having a certain sound transposition, measured the notated length in centimetres and millimetres, cut off that length, spliced it with a little piece of the splicing tape onto a lengthy piece of white leader tape, and wound the white tape plus the first little piece of magnetic tape around the metal hub on the nail. For this I used a pencil which was inserted into the outer hole of the hub. (Stockhausen 2001)

Elsewhere, in the same source, he refers to the quite limited time offered in the studio, and how he had to improvise ways of working with tape in his student accommodation in preparation for his studio access. He does however refer here to a

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<sup>18</sup> This has now been published



score which seems to have guided his progress, and also gives an indication of the need for a score in Stockhausen's case. *Étude Concrète* has now been re-issued, at the instigation of Stockhausen himself, and the quotes are taken from the accompanying CD booklet. (Stockhausen 2001)

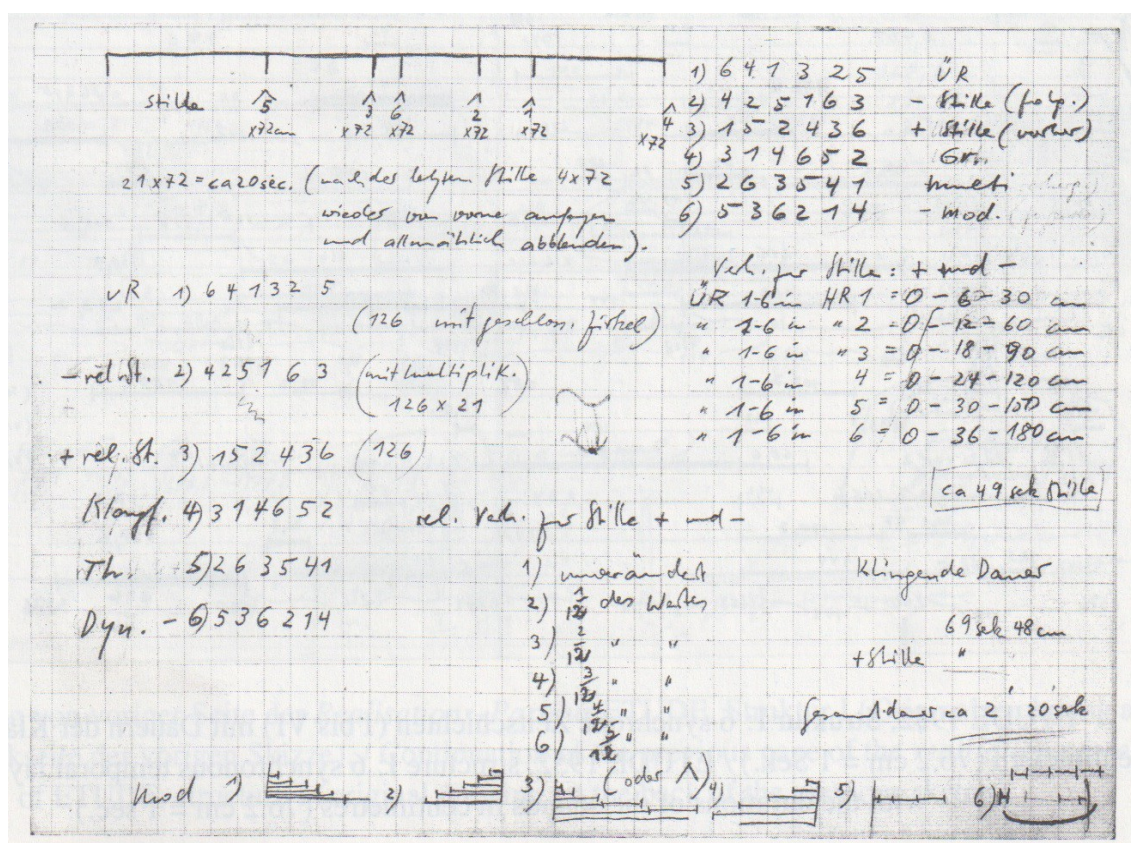


Fig.6.15 Stockhausen *Etude concrète 1*

(Stockhausen 2001)

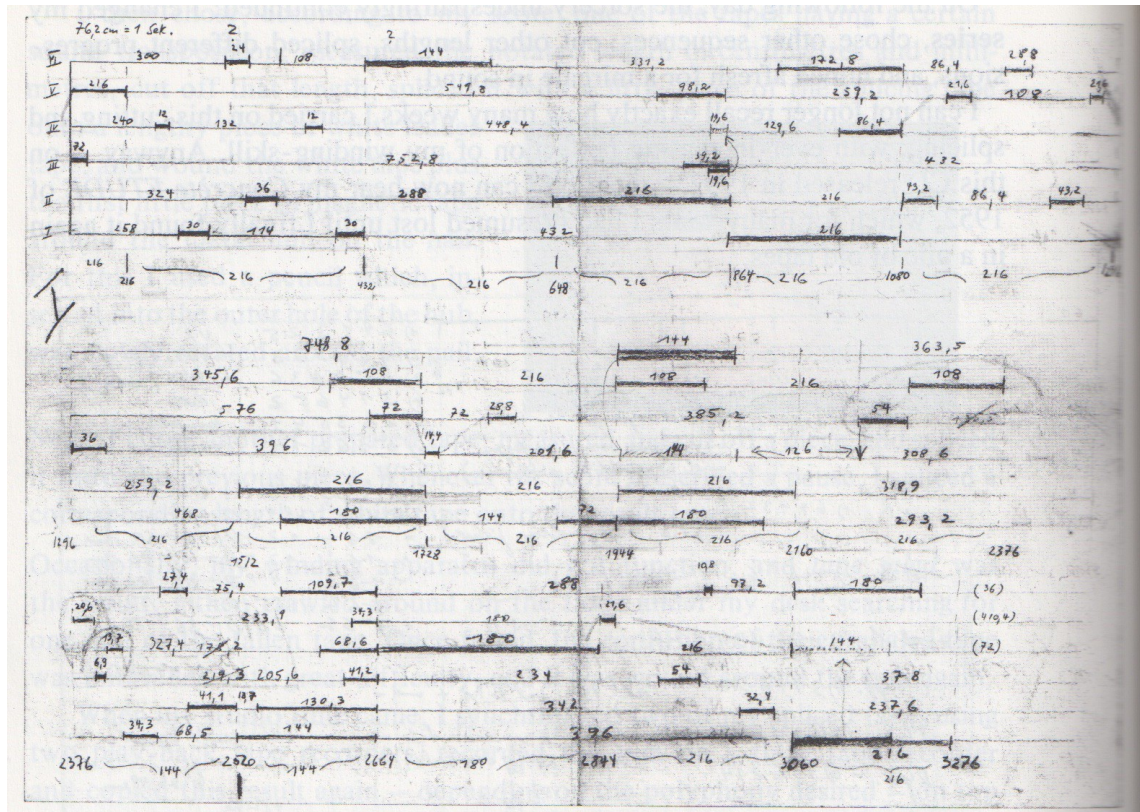


Fig. 6.16 Stockhausen Etude concrète 2

(Stockhausen 2001)



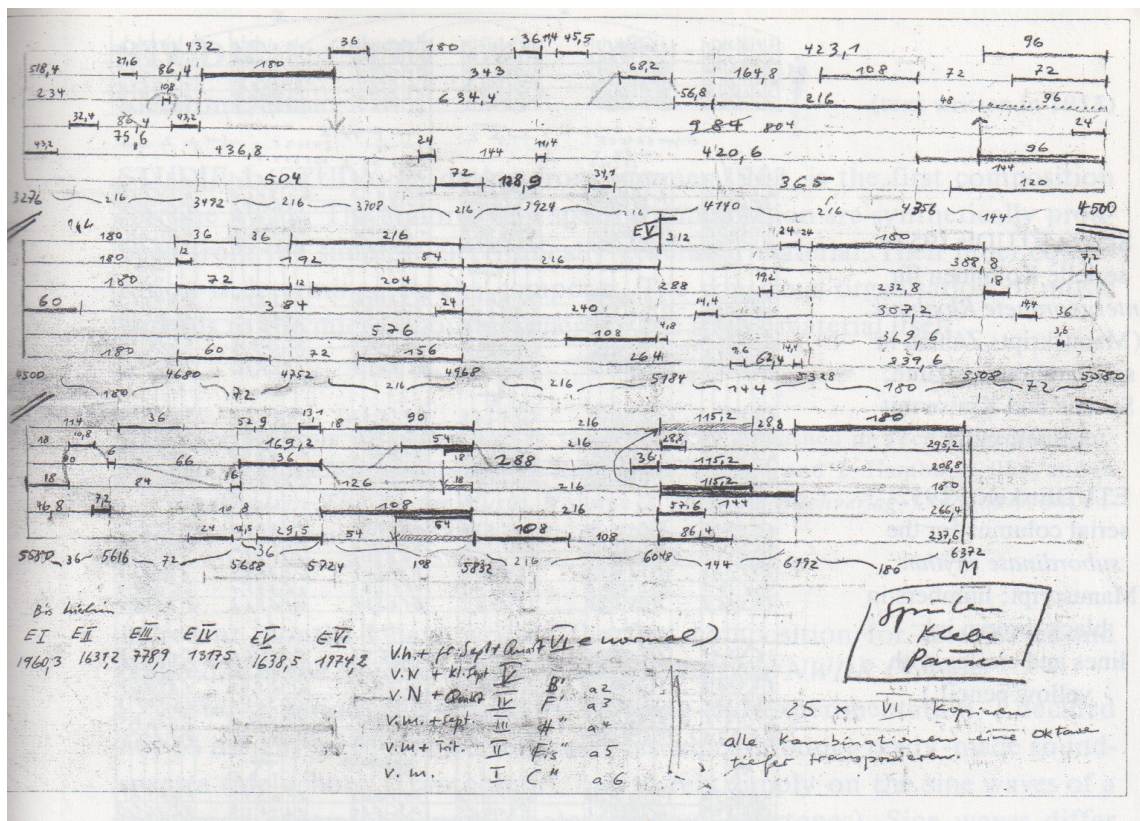
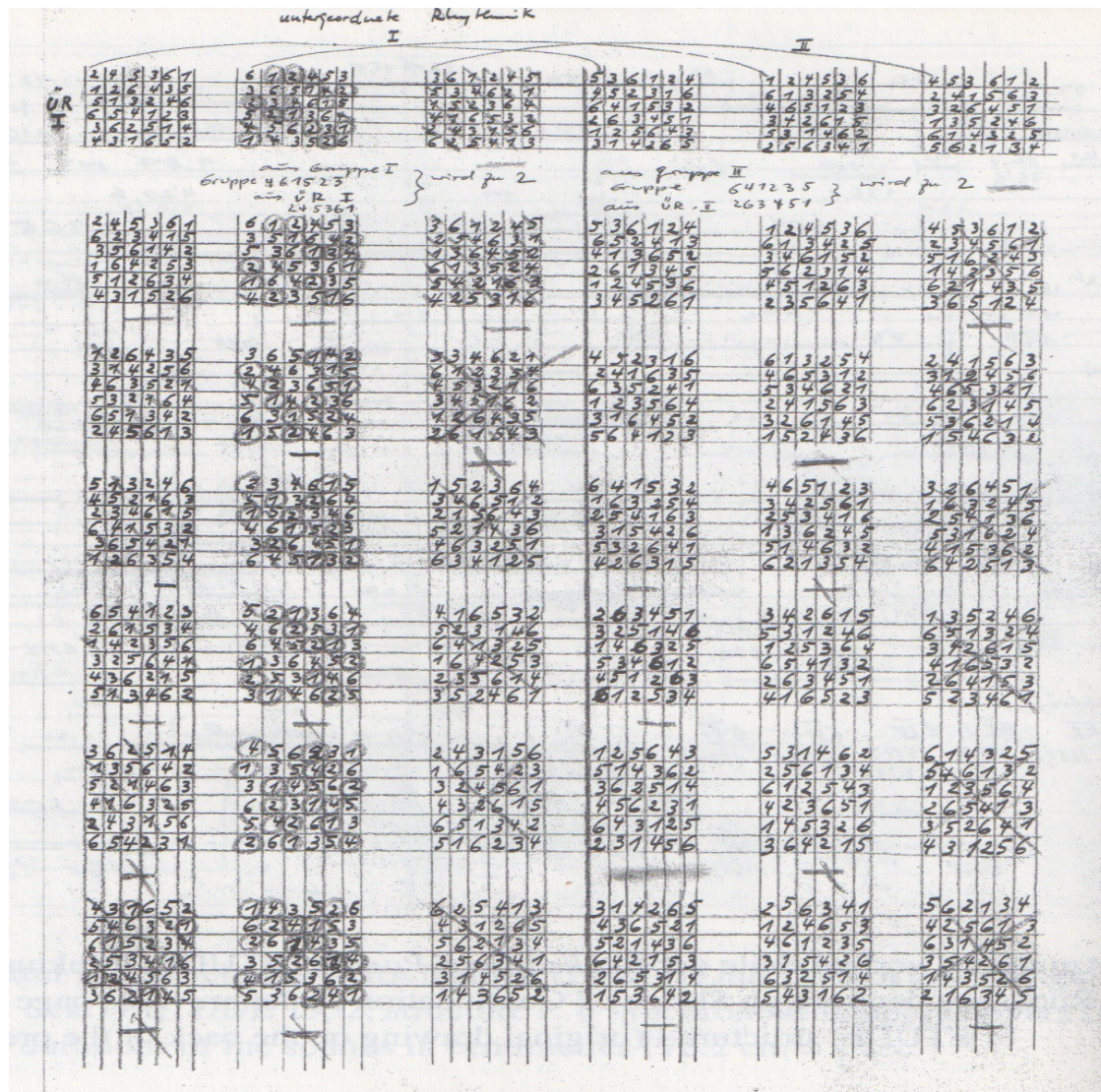


Fig. 6.17 Stockhausen *Etude concrète 3*

(Stockhausen 2001)

These images Figs. 6.15 to 6.17 are *sketches*, and then pages from what is referred to by Stockhausen as the '*realization*' score. The final sketch below is of serial columns for the subordinate rhythm, giving an indication of the kind of detail involved in the planning of the music *before* its production.





*Fig. 6.18 Stockhausen Etude concrète 4*

(Stockhausen 2001)

The extract above raises a fundamental and some would say controversial issue, which is also referred to by Pierre Schaeffer below; that of the tradition of serialization of all possible aspects of a composition. Many see this as incompatible with the aesthetic traditions of *musique concrète*.



Clearly at various times the electronic studio was a valued resource for Stockhausen, but was not often used in the way that was followed by Pierre Schaeffer and Pierre Henry. Stockhausen's approach to the use of electronics may even be reflected to an extent by his continuous use of visualization. He planned, he notated and he wrote down for future reference, often as a matter of *inner* hearing, as opposed to Schaeffer's '*faire des sons*'. He also systematized, and in particular thought that electronics allowed the systematization of timbre.

Stockhausen has won a notable place for himself in music history as a result of this systemization. For the first time timbre is coming into being as a result of the composer's deliberate decisions, without being dependent upon the pre-set limitations of instruments (Heikinheimo 1972 Page 36)

These decisions refer to what is imagined *before* the sound is made.

Such detailed annotations as well as visualizations also exist for the composition of *Studie I*. The following images are also taken from the accompanying booklet to the CD referenced above. They are the first two pages of the score. Detailed explanatory notes follow in the booklet. These need not concern the substance of this thesis, except that the score and the notes indicate again the extent to which visualization was a *record* or *archive* of what had been, or was *being imagined*.

# Partitur STUDIE I, Seite 1 / Score of STUDIE I, page 1

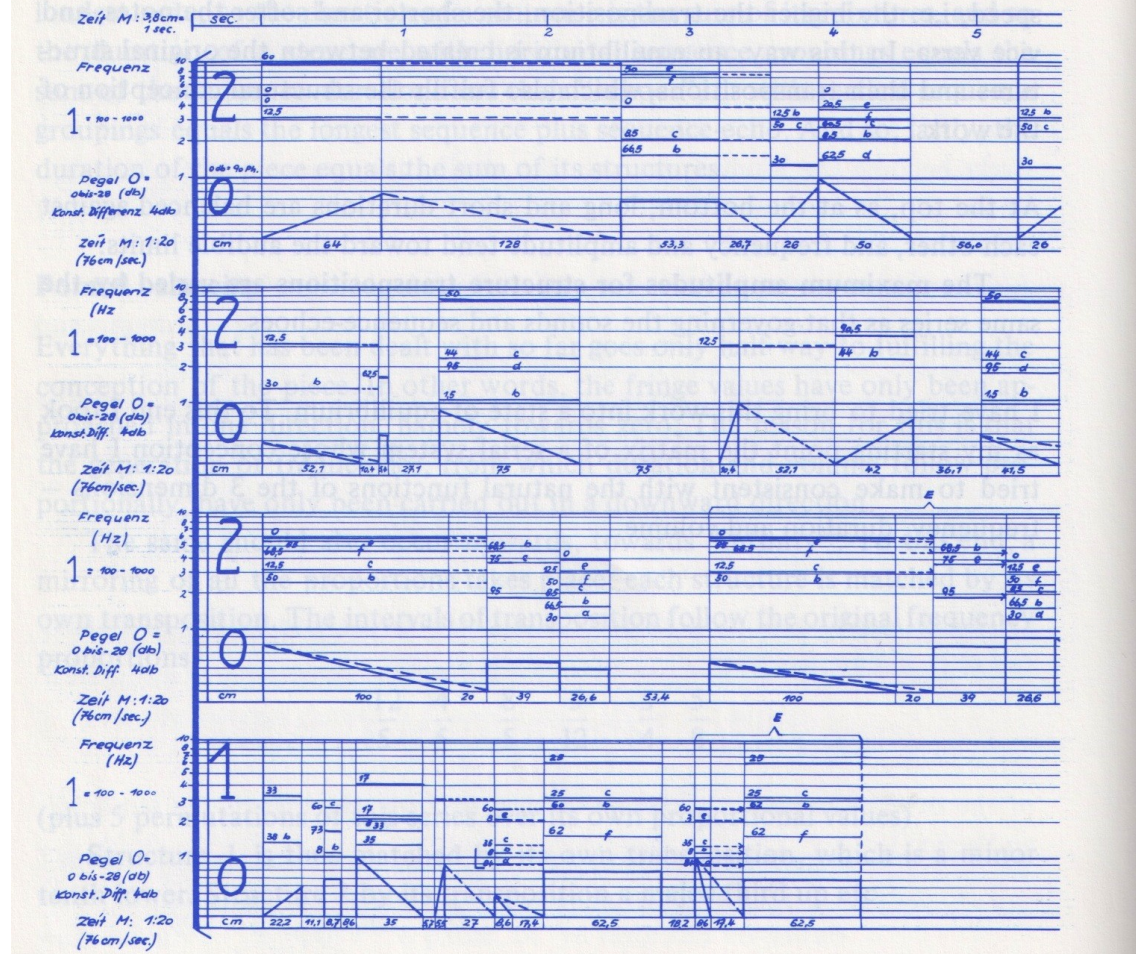


Fig. 6.19 Stockhausen Studie I Page 1

(Stockhausen 2001)



There follow on page 43 detailed analytical notes as to the frequency material used for the piece. Importantly however for this thesis there is a score: -

The score is not needed to perform music from it, but instead of that, contains all the information that a recording technician needs to reproduce the composition. The second purpose of the score is more traditional: it can be used in conjunction with listening to the composition to show the listener what he is hearing. (Heikinheimo Page 44)

The image below is a page from the score of *Studie II* (Heikinheimo Page 56)

According to that author each page represents seven seconds of the music, and there are twenty six pages in all. There is no need here to analyse this score in detail, except to confirm that this is an example of a visualization produced *before* the sounds are made, and also for the purpose of achieving an archive. The piece is distinctive because it was, according to Heikiheimo, the first electronic score to be actually published.



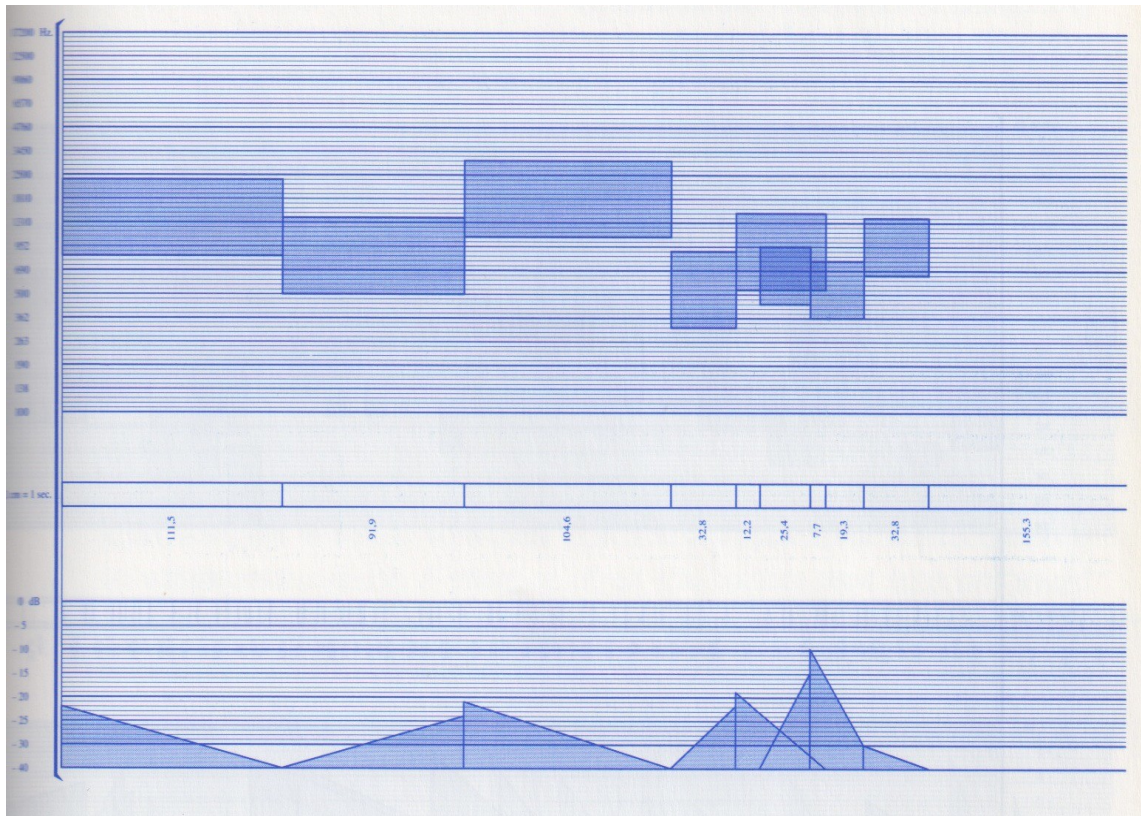


Fig. 6.21 Stockhausen Studie II Page 1

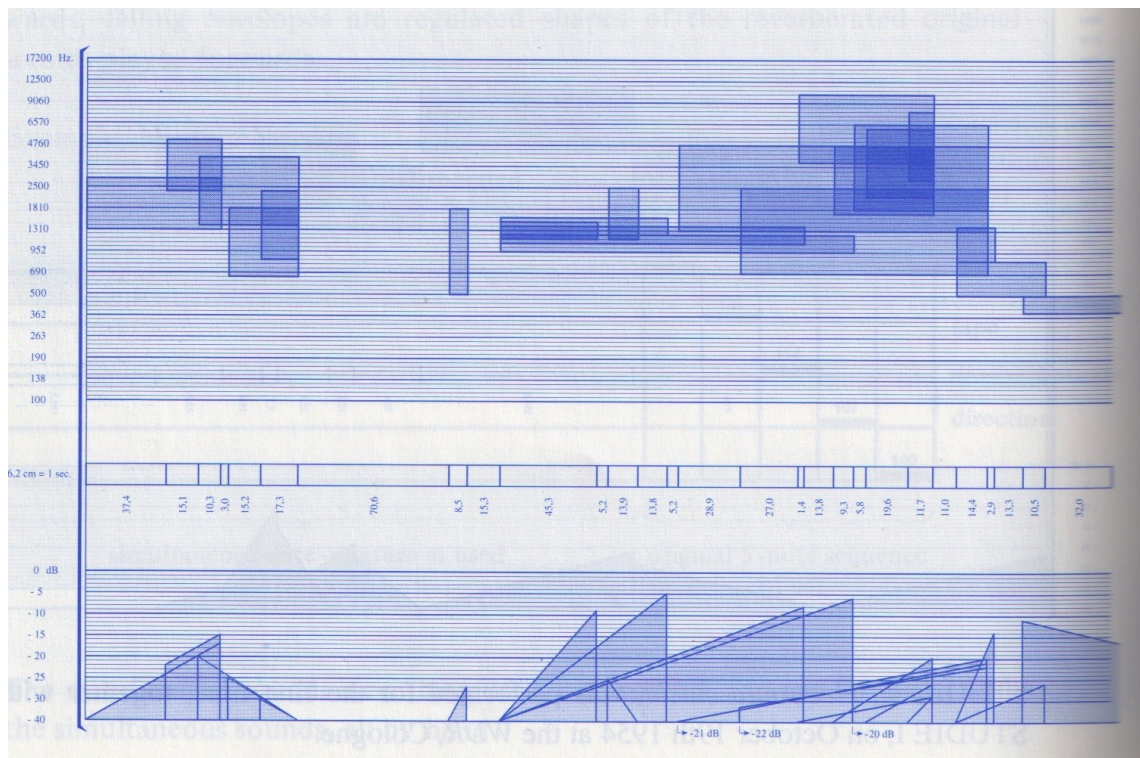


Fig. 6.22 Stockhausen Studie II Page 2

(Stockhausen 2001)

*Gesang der Jünglinge* appears to be influenced by electroacoustic techniques, namely manipulation and processing of recorded samples. The starting point for the composition was 'the idea of unifying vocal sounds and electronically produced sounds: -'. (Stockhausen 2001 Page 135) However, this undergoes systematic control according to intended principles, sound imaging and often annotated plans and visualizations. Sounds: -

- were to be so fast, so long, so loud and so soft, so dense and interwoven and hearable in such small and large pitch and timbre proportions as required by the chosen musical order. (Stockhausen 2001 Page 152)

The pages following this quote give detailed notes on these principles and procedures including on page 153: -

In order to use the extremely complex phonetic structure of speech in terms of serial composition, one needs varying numbers of intermediate steps between the single sounds of the given phonetic system [ ] in order to be able to select regular scales of timbres from a continuum [ ]. This is only possible -[ ] - with electronic sound production. [ ] A sound family can only be experienced as homogeneous if, at a given point, sung speech-sounds seem to be electronic sounds, and electronic sounds seem to be sung speech-sounds. (Stockhausen 2001 Page 153)



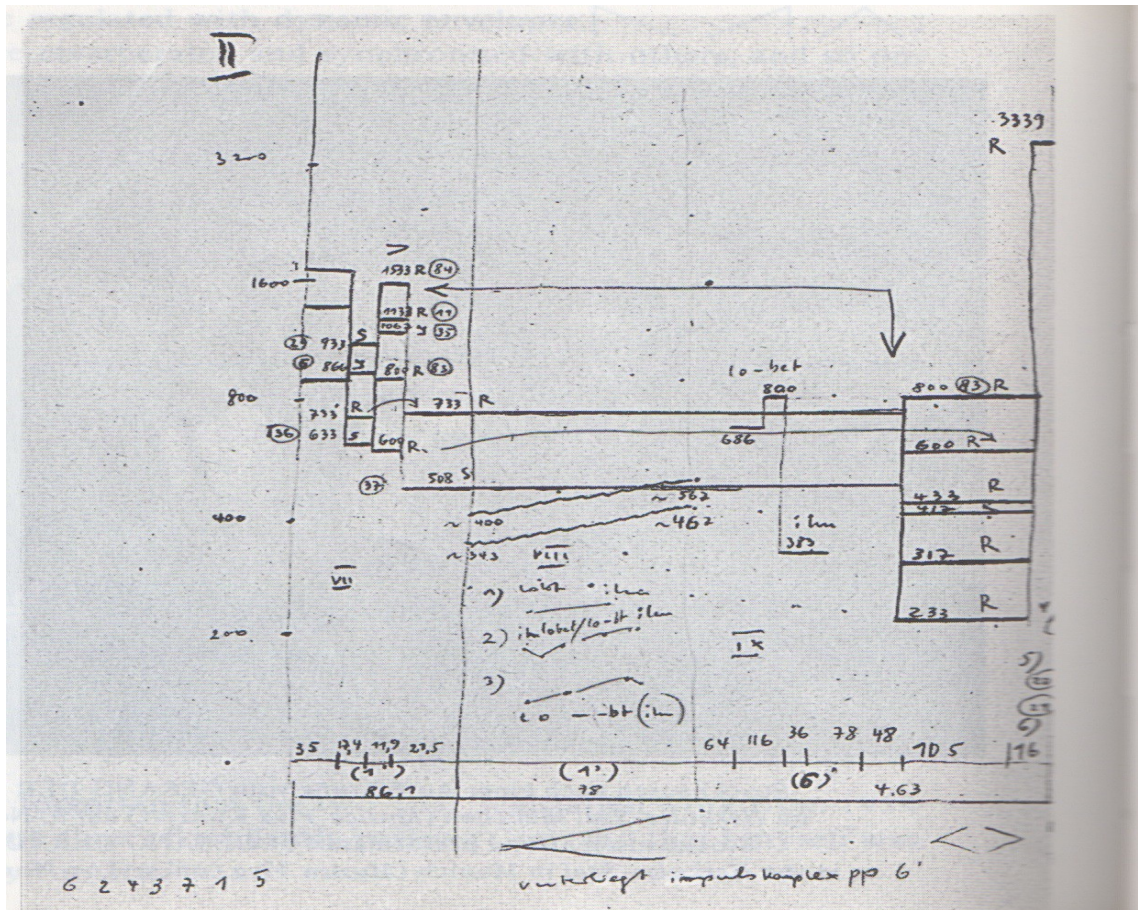


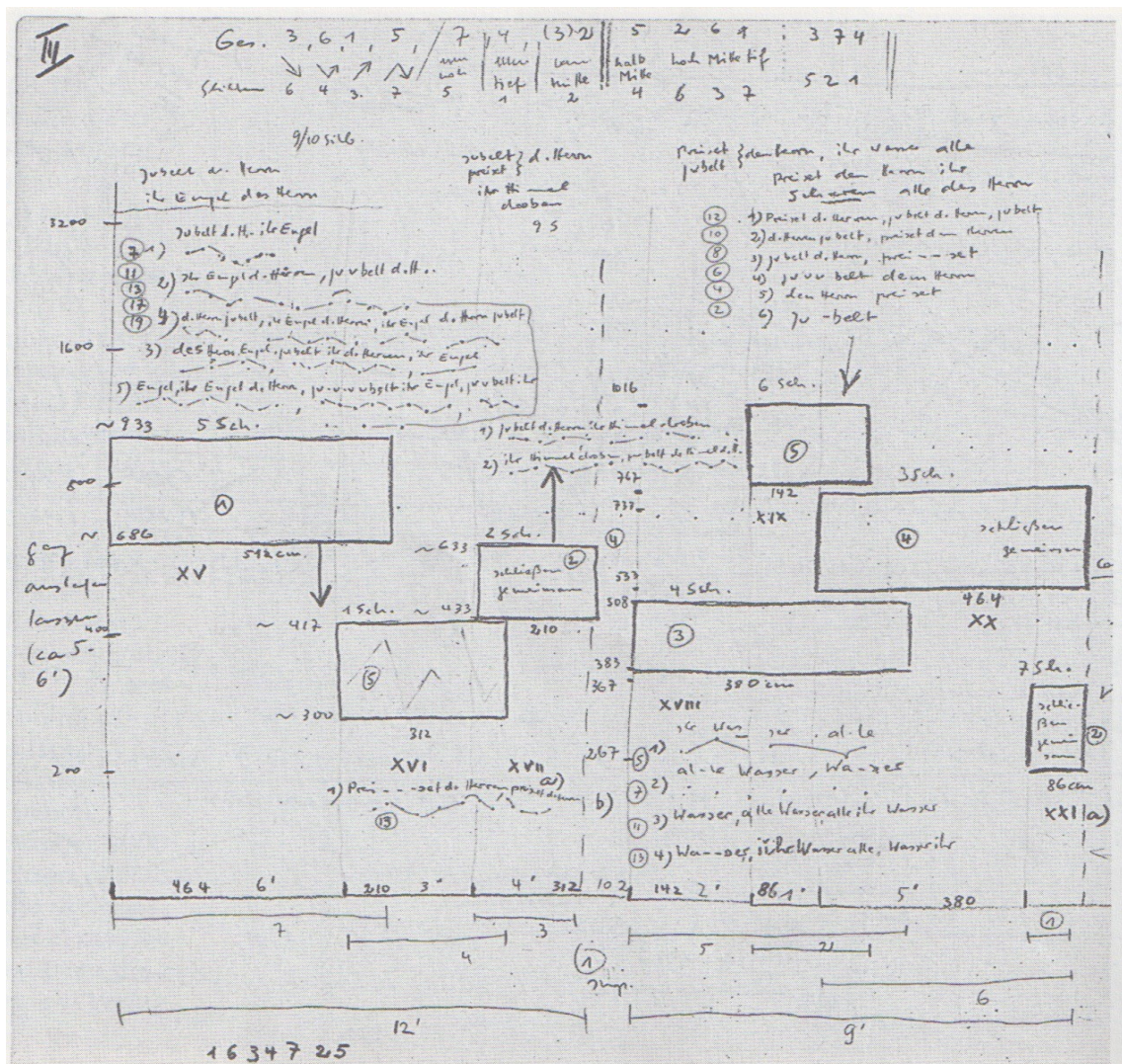
Fig. 6.23 Stockhausen Gesang der Jünglinge 1

(Stockhausen 2001)









*Fig.6.25 Stockhausen Gesang der Jünglinge 3*

(Stockhausen 2001)

*Kontakte* exists in two versions, a 4 track version which is purely electronic (2 track for recordings and broadcasts), and a second version with the addition of

instrumentalists (piano and percussion)

From February 1958 to 1959, I made and processed the electronic sounds at the *Studio for Electronic Music* of the *West German Radio*, Cologne. Concurrently, I wrote and drew a **realization score**, which contains the precise descriptions of the sound production – manipulation and tape montage – and of the spatial projection.

In addition, I drew a simplified graphic representation of the electronic part, together with the notation of the instrumental parts, which I designated as **performance score**. (Stockhausen 2001)

This quote indicates the importance of visual representation in Stockhausen's compositional processes. Indeed Simon Emmerson has often referred in conversation with this author to Stockhausen's continual emphasis on the use of the score, and furthermore to *Kontakte* itself as definitely electroacoustic music. This gives an indication of Emmerson's views that *Musique Concrète* is 'an expression of attitude to work, in that sounds are forgotten as to origin' (Meeting at de Montfort University February 2012) This presumably is the situation with *Kontakte*.

Given below are pages taken from the *performance* score. It has been pointed out elsewhere in this thesis, that a performance score is likely to be necessary when live instrumentalists are involved. What is interesting here is the level of detail and the innovative graphics employed by Stockhausen. This author would wish to suggest that Stockhausen's habitual use of visualization as part of the compositional act, has itself given rise to this level of detail. In many ways this is considerably more than a performance score produced simply for the purpose of integrating live performance. The number of pages of the score included in the CD booklet suggests that Stockhausen may



also have wished the visualization to act *as an aid to listening*.

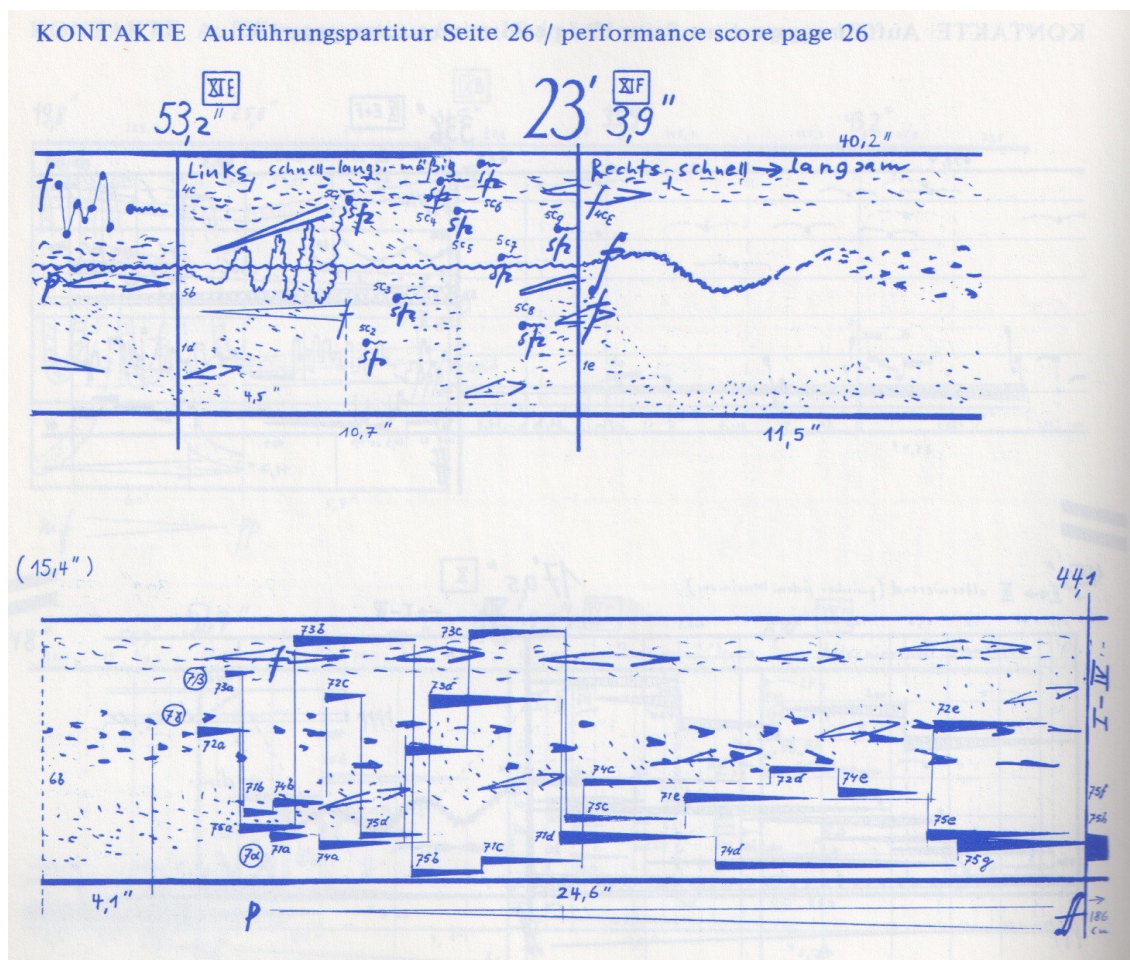


Fig. 6.26 Stockhausen Kontakte

(Stockhausen 2001)

To summarize the Stockhausen examples: -

- 1) visualization to enhance compositional understanding, intention and conceptual framework
- 2) by hand using text, graphics and numbers
- 3) for archive, analysis and diffusion
- 4) prescriptive and descriptive – inner and outer hearing

Overall the material in this chapter has served to confirm the findings and conclusions arrived at in *Chapter 5*, and is consistent with the taxonomical structure outlined in *Chapter 7*, as well as the issues identified by that structure. There can be no doubt therefore, based on these examples, that there are substantial reasons and justification for the continued use of visualization as a component part of the process of composition. These examples indicate visualization taking place in order to contribute to the compositional process. This is in terms of understanding and reflection, with the addition of analysis, archive and where necessary performance. This involves both prescriptive and descriptive visualizations, in some cases indicating intentions, and in some cases visualization of what has already occurred. Most examples make use of graphics, text and some numbers as well.

## 7. A Taxonomical Structure of Visualization and Representation in Electroacoustic Music

### 7.1 Introduction and Definition of Terms

A major part of this research has been to study the current practice of composers in the various electroacoustic genres regarding visualization and representation, as part of the compositional process and compositional understanding. This study was partly carried out by means of interviews and a questionnaire. Quite early on, it was realized that responses to this process would bring forth both similarities and differences in the approach to representation, including more explicit visualization. As mentioned earlier, it has been possible to classify responses according to the way in which specific compositional, analytical, preservation and performance needs are met. As a result of this, it has been possible to devise a taxonomical structure that summarizes many of these practices. This structure is in itself a representation of the significant processes, and how they relate to each other. This structure is effective in identifying the extent to which particular approaches work towards achieving either aims stated by the composer, or perceived aims after analysis by this author, with respect to enhanced compositional understanding. An outline of this structure is shown as *fig. 7.2* at the end of this chapter.

Broadly the structure separates the *why*, *what* and then *how* of visualization. Embedded in the conceptual framework of *why* will be the notion of *who* for and for *what purpose*. This structure is not a definitive solution, but its formulation points to what kind of processes visualization of electroacoustic music might entail. The evidence from the questionnaire indicates that most composers do use visualization of some kind within the compositional process or subsequently, although some do not. The *how* also refers to whether visualization is hand written or by machine normally using some kind of software.

There is of course a relationship between *why* and *what*, because the needs and reason for visualization will determine the kind of visualization that is developed. A specific example of this is referred to in *Chapter 8.3*, that being the *Acousmographie* software developed by GRM, and the later *EAnalysis*. Pierre Couprie has indicated in *Chapter 5.2*, that the *why* that led to the software's development is the need for analysis. (Indicated in response to the questionnaire quoted in the appendix). Archive or preservation is an issue that receives further discussion in *Chapter 9*, but it carries with it a need for permanence, or at least a need for retrieval of information at a later date within the compositional process. Preservation is probably a more accurate term in this case. The need to preserve enough information about a composition to enable it to be re-created later, suggests a level of permanence that is as yet not easily achievable in electroacoustic genres, or indeed any music that is predominantly timbral and completed in the studio. Trevor Wishart is a rare example of a composer who has expressed a need for this level of permanence<sup>19</sup>. It may be that the difficulties of archiving timbral events

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<sup>19</sup> See *Chapter 5*

has deterred composers from thinking that this can be usefully achieved.

Whilst outside the central concerns of this thesis, sometimes annotations of some kind are needed for performance. Particularly common for example are diffusion scores, but also some kind of visualization might be needed if live interaction or instrumental performance is involved<sup>20</sup>. The extent to which these needs are answered, may determine whether a visualization is prescriptive or descriptive.

Inner and outer hearing have been referred to earlier in the initial chapters, with particular reference to Pierre Schaeffer and also in *Chapter 4 on Imagining and Discovering New Musical Sound*. In this thesis 'inner hearing' refers to that part of the compositional processes where sound exists in the imagination before the sound comes to be made, for example in the studio. 'Outer hearing' refers to that part of compositional processes where sound has already been composed, made or discovered in the studio. For reference to be made at a later date to sound created as yet only in the *imagination*, visualization is essential either in the form of an archive, *aide memoire*, for analysis, or indeed for performance (in the sense of '*how is this sound to be made and what might its relationship to other sounds in the piece be*'). This is an essential part of the conceptual framework of this thesis concerning visualization and electroacoustic music. It also makes clear how visualization can play an essential role in the on-going compositional process. Alongside this point, prescriptive representations involve annotations that specifically refer to how a sound *is to be made*. This can be contrasted with representations that involve annotations that describe how a sound *was* made. Of

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<sup>20</sup> e.g. S.Emmerson in *Chapter 6* and also Stockhausen *Kontakte* UE



course some representations may in practice fulfill both these functions. These points are also important because they enable comparisons to be made with visualizations of other types of music, including long established traditional notation of Western classical music.

In some cases, visualizations produced for the purpose of analysis or archive are used for broader tasks within musicology and also pedagogy. Robert Normandeau's encouragement of students to produce visualizations of their compositions is an example of pedagogical practice, and is dealt with in *Chapter 5*.

*What* kind of visualization of course arises from the *why* issues mentioned above. Broadly there needs to be a distinction made between visualizations produced by hand and those produced by machine, for example in the form of software. Apart from obvious examples such as *Acousmographie* or *EAnalysis*, it is to be noted that most commercial sequencing and sampling software involve some kind of visualization. *ProTools* for example offers an arrange window where sound objects, MIDI sequences and audio tracks are placed in position, and can to some extent be edited as a result of what can be *seen* on the arrange window, and the subsequent windows that follow from this. This can be contrasted with common technologies from the previous two decades<sup>21</sup>, where a graphical interface or GUI such as offered by *ProTools* and others was sorely missed and made editing sounds extremely difficult.

It has been stated elsewhere in this thesis that a visual representation for

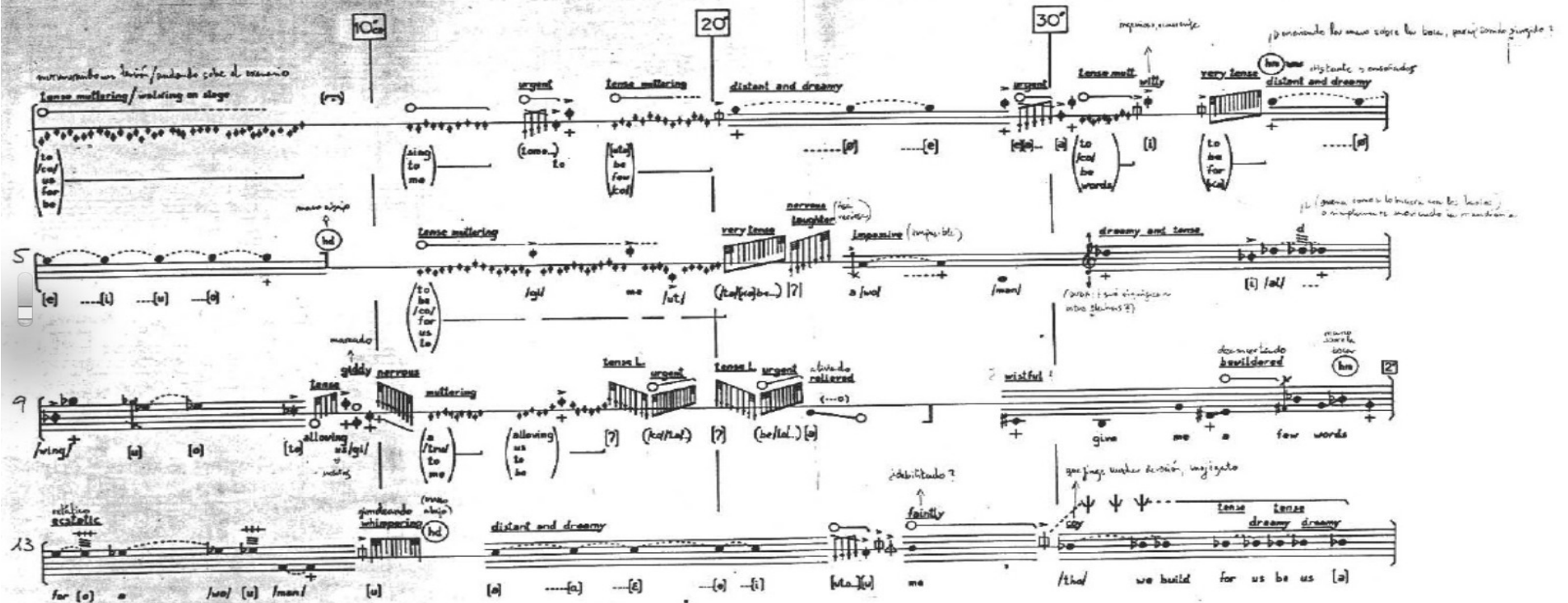
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<sup>21</sup> Such as the Kurzweil K2000 or Yamaha DX7

whatever reason may involve any of text, graphics and numbers. This is shared in common with other systems and genres such as Western classical music and indeed its derivatives such as current adaptations for annotating pop, rock, world music, and jazz and fusion. A good contemporary example of this is Berio's score for *Sequenza III* for unaccompanied voice. An extract of a page of the score is given below.

**per voce femminile (1966)**

**text: markus kutter**



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In this case text in the form of notes on the score and interpretive instructions both for the score and the music. Graphics in the form of gestural and other interpretive symbols, sometimes involving the invention of new symbols or new symbols adapted from more traditional notation, and in a few cases numbers to indicate proportions perhaps as related to durations.

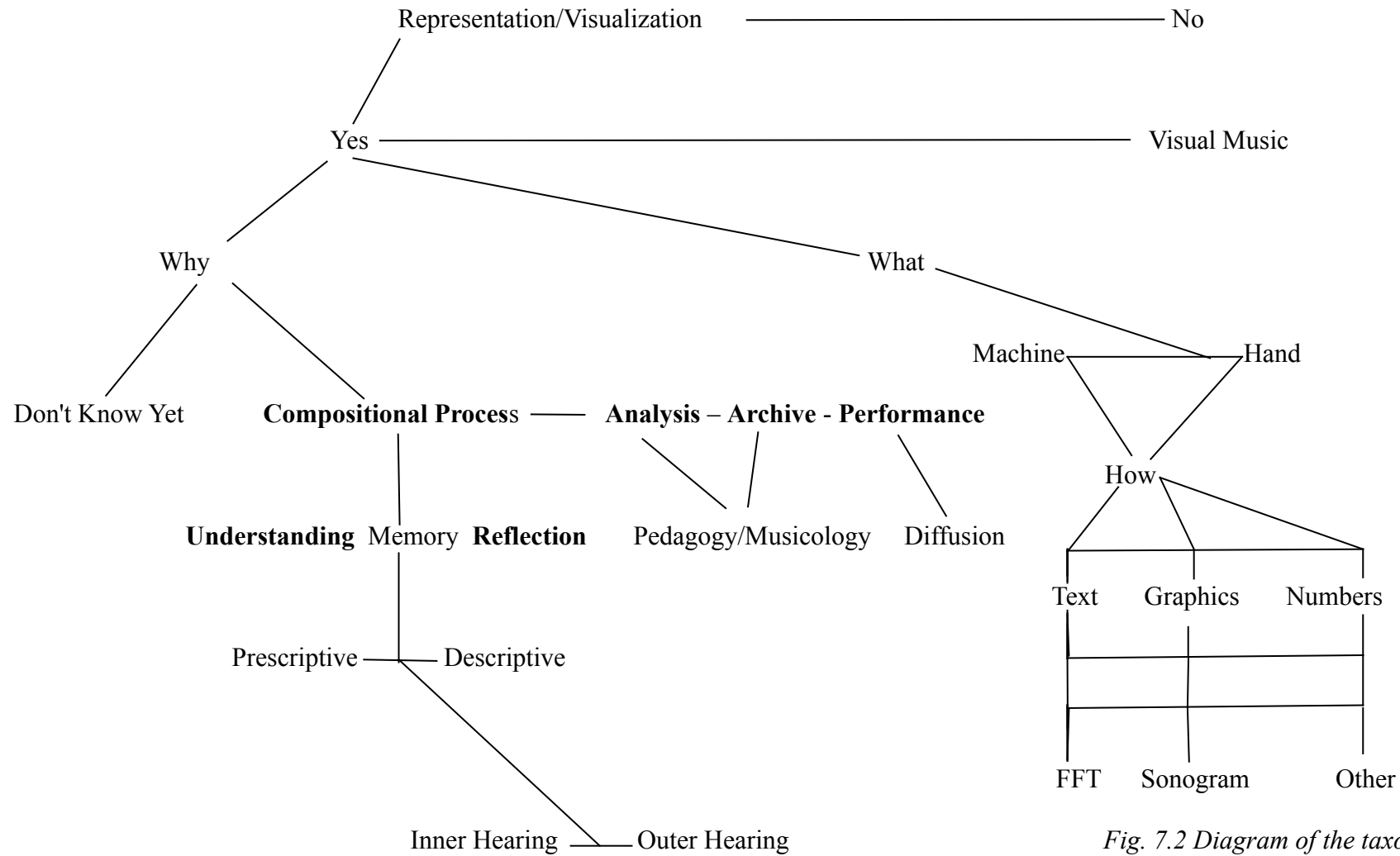
This outline of a *taxonomical structure* is an attempt to summarize visualization activity as it might be applied to the composition of electroacoustic music. It is informed by what composers have indicated that they do, as well as by what written studies have shown to be the issues. It also indicates why visualization, as developed in software, is formulated to achieve particular results: results that are frequently taken for granted, sometimes almost without question.

This taxonomy is both logical and justifiable, and consistent with observed practice both in visualization and compositional process. It is also consistent with compositional process in other musical genres, and other types of music. Like other kinds of music, electroacoustic music has particular styles, resources, parametrical focus and presentation of performance. It is however music, and is understood and responded to as such. I would argue that much of what Trevor Wishart terms sonic art is thus music, and thus there need be no distinction between the two.

The *diagram 7.2* below emphasizes the significance of visualization to the compositional process in promoting compositional understanding and reflection, particularly as regards to work in progress. It also emphasizes the importance and significance of visualization to a composer's analytical needs, the need for preservation or archive, and any performance needs that a particular composition may require. These issues are highlighted in order to clarify their importance. This author believes that the research has revealed and clarified the significance of these issues within the compositional process, not only of electroacoustic music, but of music generally.

## 7.2 Diagrammatic Representation of a Taxonomical Structure

## TAXONOMICAL STRUCTURE of VISUALIZATION and REPRESENTATION in ELECTROACOUSTIC MUSIC



*Fig. 7.2 Diagram of the taxonomical structure*

## 8. Software Case Studies

Examples of software, used at least in part for visualization and representation, have been referred to elsewhere in this thesis. This section discusses more specific issues concerned with such software, and the way it is used for representation, particularly in the light of the existing taxonomical structure as presented in the previous chapter. In some cases the software, or at least aspects of the software, have been specifically designed to achieve a representation of the music, sometimes for a particular purpose. Many composers who have made a response outlined in *Chapter 5*, have indicated use of software, again usually to achieve an identified purpose. The categories of software below cannot typically be described as exclusive to particular functions, and in any case composers have sometimes adapted or programmed software to achieve their own purposes. Trevor Wishart's *SoundLoom* is one example of this. In the process of this review, it has become evident that all software becomes descriptive of what has occurred compositionally, some goes further from description to be effective as an archive, and some can be used for analysis. Software that can be used to *prescribe* or *generate* compositional outcomes is much rarer within electroacoustic genres. It is a main aim of this thesis to explain and examine why this is might be so. This being the case, it is useful to examine issues concerning software being used prescriptively first. This in turn may add further clarity to what is meant by prescription



within the compositional act.

Software is being continually produced and adapted, and this section cannot aim to be a definitive review of all the possibilities. Given statements in the previous paragraph, it is important to distinguish between software packages that produce synthesis and those that do not. Software that produces synthesis probably needs good visualization to be used predictively. Nevertheless software that produces synthesis, but whose perceived outcomes are unknown is also important.

## 8.1 Predictive Use of Software

Software that can be used predictively includes software used to capture aspects of compositions or compositional intentions *before* they are produced. Often such software will be used to represent *imagined sound*, although can include attempts to encapsulate future intentions, for example as regards structure or relationships to, for instance, visual or dramatic media. This could be as straightforward as a simple text file, perhaps with a few additional graphic images. To this end, any word processing program or commercial graphics program could be used. An example of this type of work would be that of Leigh Landy<sup>22</sup>. Below however is an example of work by the author of this dissertation of *Open Office Word* being used, including hyperlinks to specific sound objects. Of course hyperlinks could also be added to the audio of the sound objects themselves. The idea of this is that an overall *duration* score indicates the

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<sup>22</sup> Referred to in *Chapter 5*

position and relationships between sound objects. Hyperlinks indicate more detailed information as to the origins and composition of particular events. This has been generated predictively in some instances, but becomes descriptive after completion. This could also be useful for analysis or as an archive of work done.

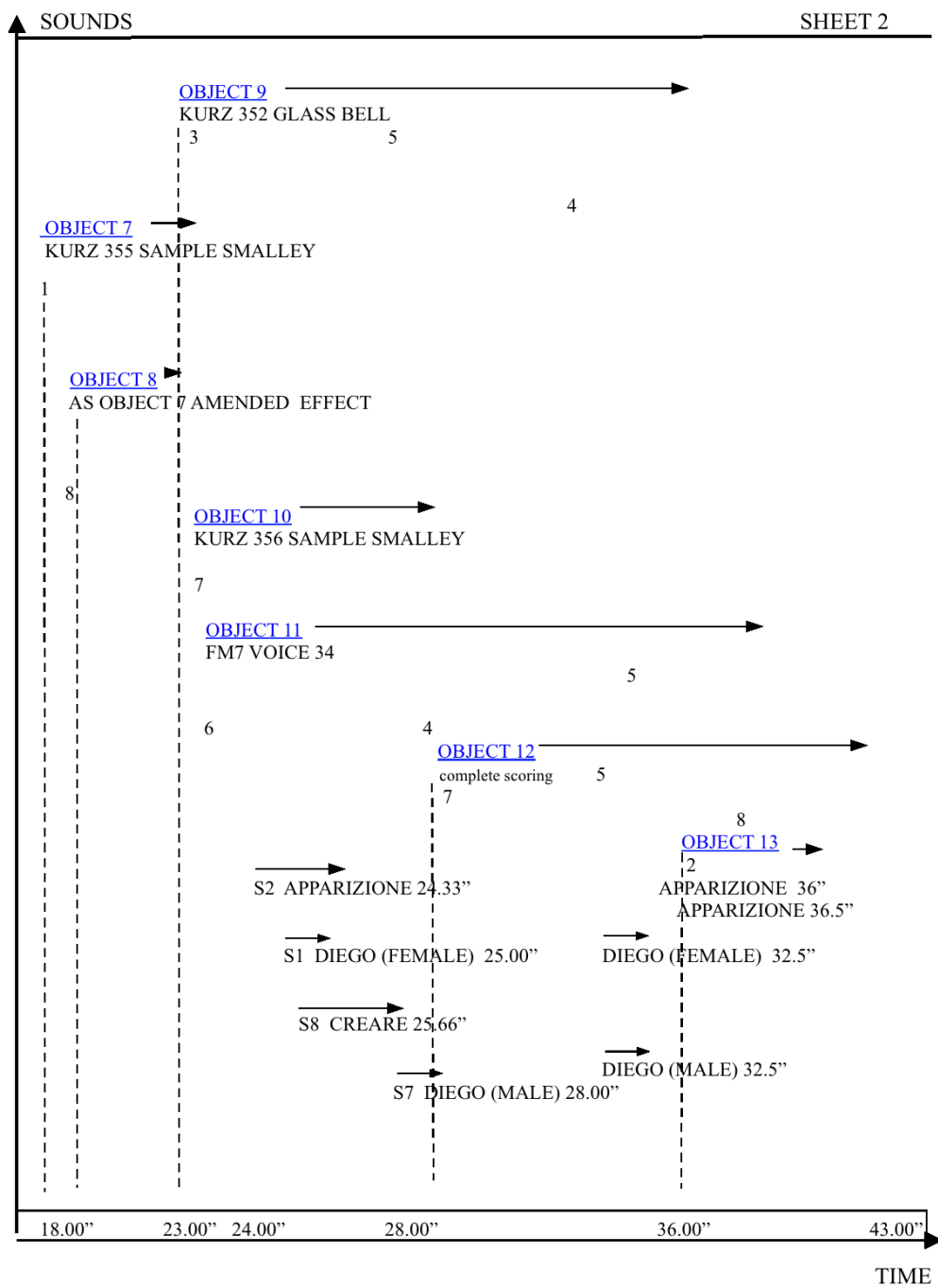


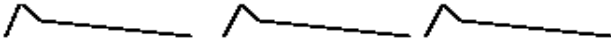


Fig. 8.1 Duration score in Word

Below is a Hyperlink to Object 9<sup>23</sup>

TIMBRE		OBJECT 9			
Noise Inharmonic Harmonic					
Formants/Components (Sub-envelopes)					
		E 2	B <sub>2</sub> 2	D <sub>2</sub> 1	
Controllers	None				
Algorithm	Kurzweil 4 Frq Paratreble Coarse E2 82hz; Amp +3db; Frq HiPass E2 82hz; Amp +18db				
Sample	Kurzweil Bellfile -1 Keymap 902 Chime				
Envelope					
Vibrato/Tremolo	As sample				
Effect	40% reverberation				
TIME	23.25"                      28"                      32.5 "                      38"				
	<p>Very low metallic bell particularly on the attack/trigger</p> <p>Very low percussive thud on the attack</p> <p>Very slow tremolo</p> <p>Reverberation - hollow depth</p> <p>MIDI velocity 90</p> <p>Source/cause – low soft chime</p>				

*Fig. 8.2 Hyperlink to a specific event in Word*

<sup>23</sup> An audio file of this sound object is appended on CD

The first score sheet is a *duration* score showing the relative position of the various events in real time, as well as an indication of spatialization. It also gives some indication of the origin of the samples or method of synthesis. The 2<sup>nd</sup> (Hyperlink) sheet gives more information as to sound origins, processing, relationship with other events and descriptors of the sound.

### 8.1.1 GUIs as Predictive Software

Prediction could also be included in the way *Sound Loom* is used, although it is not usually used in this way<sup>24</sup> (Wishart 2009). Below are three screen shots of *Sound Loom* again referring to a composition by this author (Figs. 8.3 to 8.5) The first is the initial workspace window loaded with sound files for a particular composition. Clicking on any of these plays the sound file in a similar way as to a hyperlink in *Word* or *Open Office*. The second is the first process window when a sound file selection is placed into 'Chosen Files' mode, which opens up the possibility of processing. The third is an example of an edit window where a process can be configured. Further windows open on request to enable the user to *see* particular processes at work. Predictive thinking from imagination will take place when processes are selected and sounds are edited. At the end of a session, when *Sound Loom* is saved, it becomes an archive of what has taken place.

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<sup>24</sup> Sound Loom is the graphical user interface devised by Trevor Wishart for the Composers Desktop Project

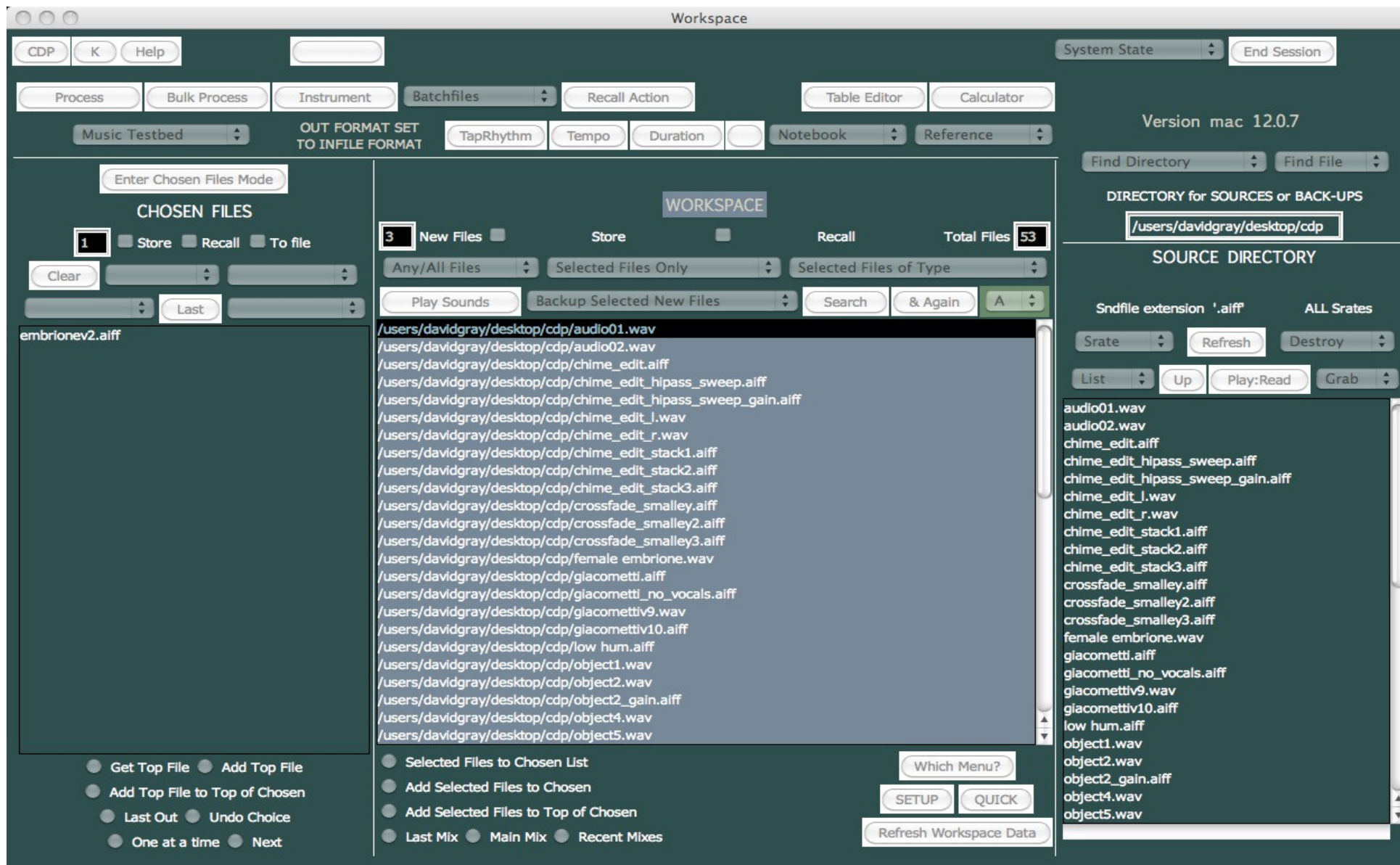


Fig. 8.3 SoundLoom Workspace window

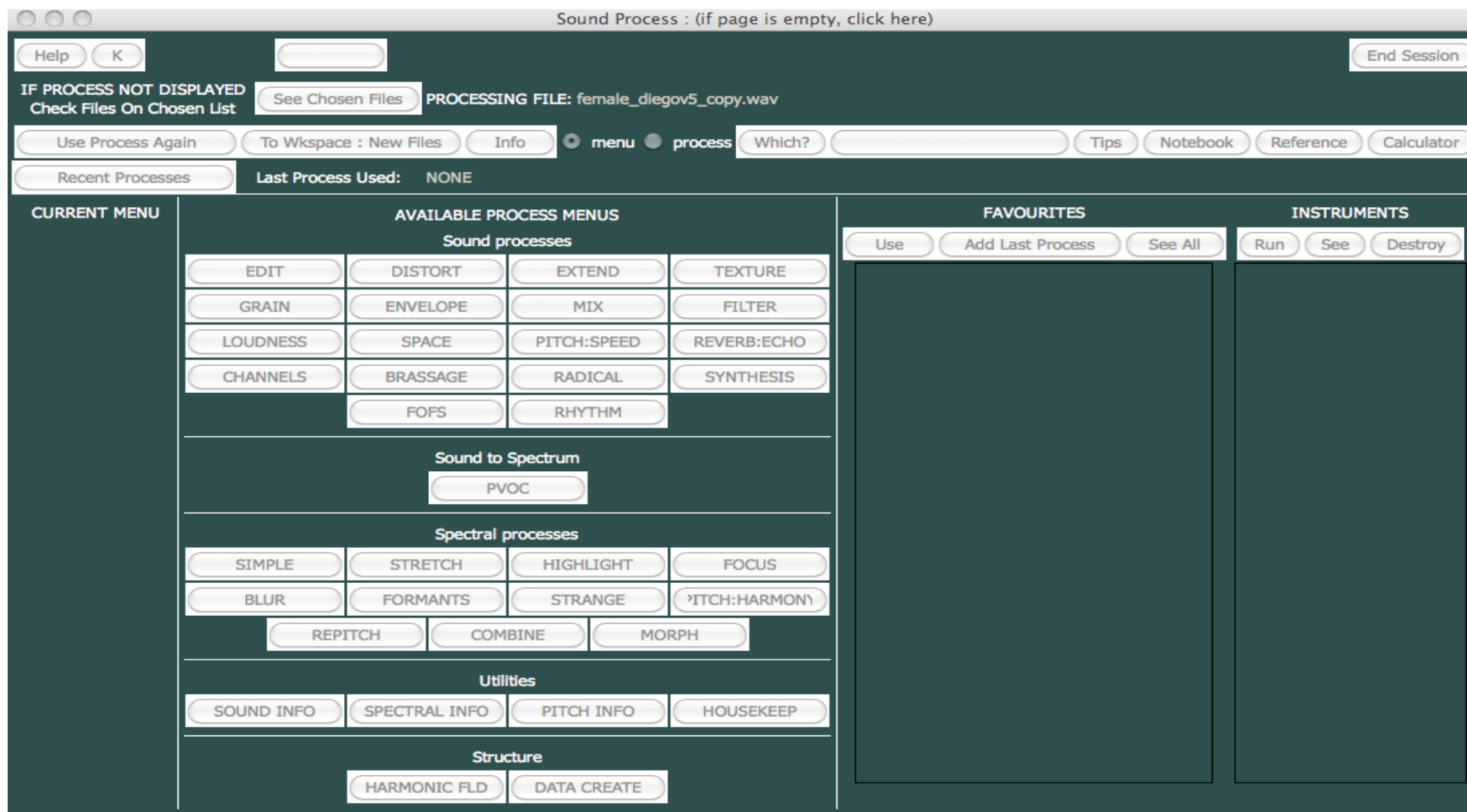


Fig. 8.4 SoundLoom Sound Process



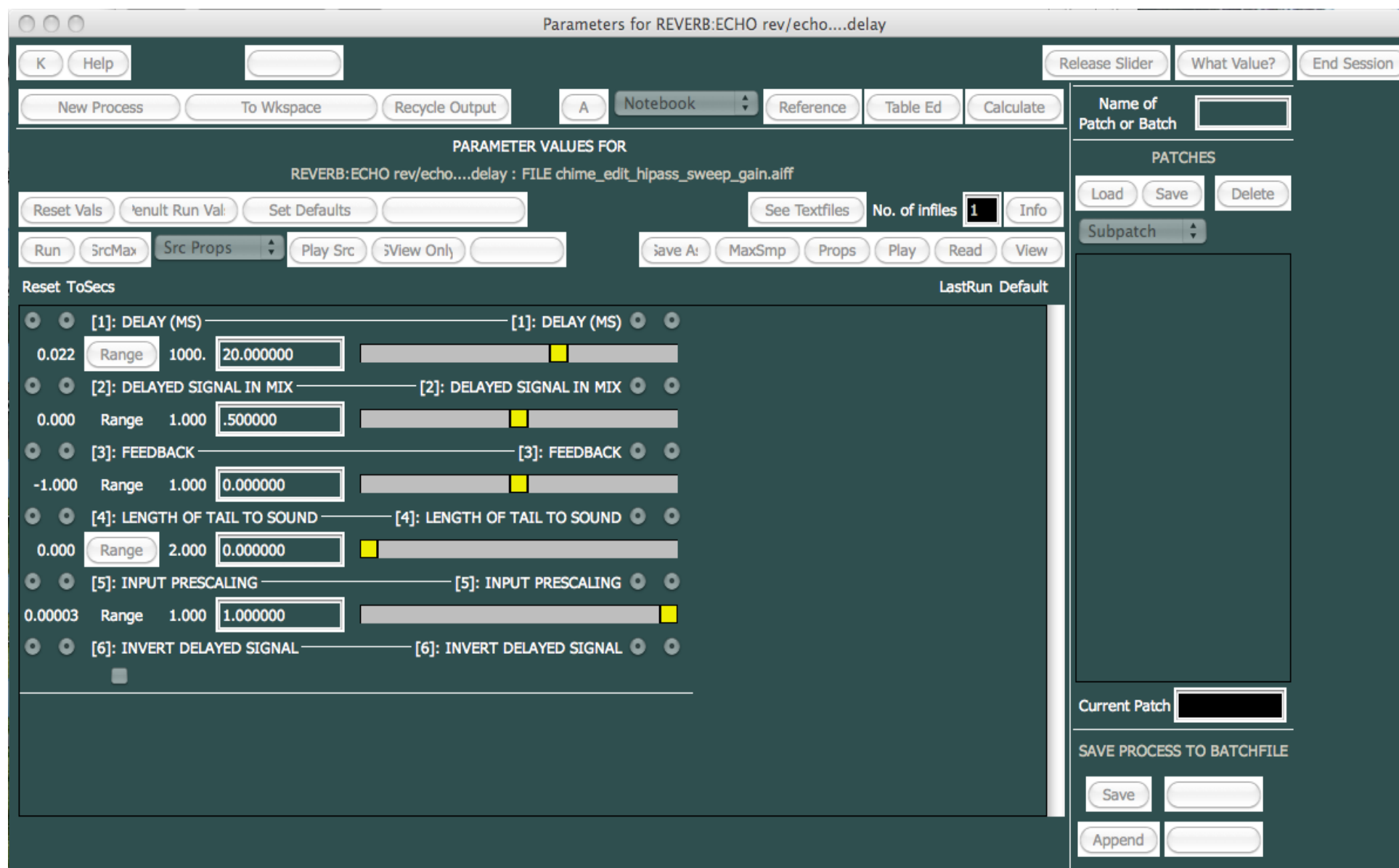


Fig.8.5 SoundLoom Parameter page

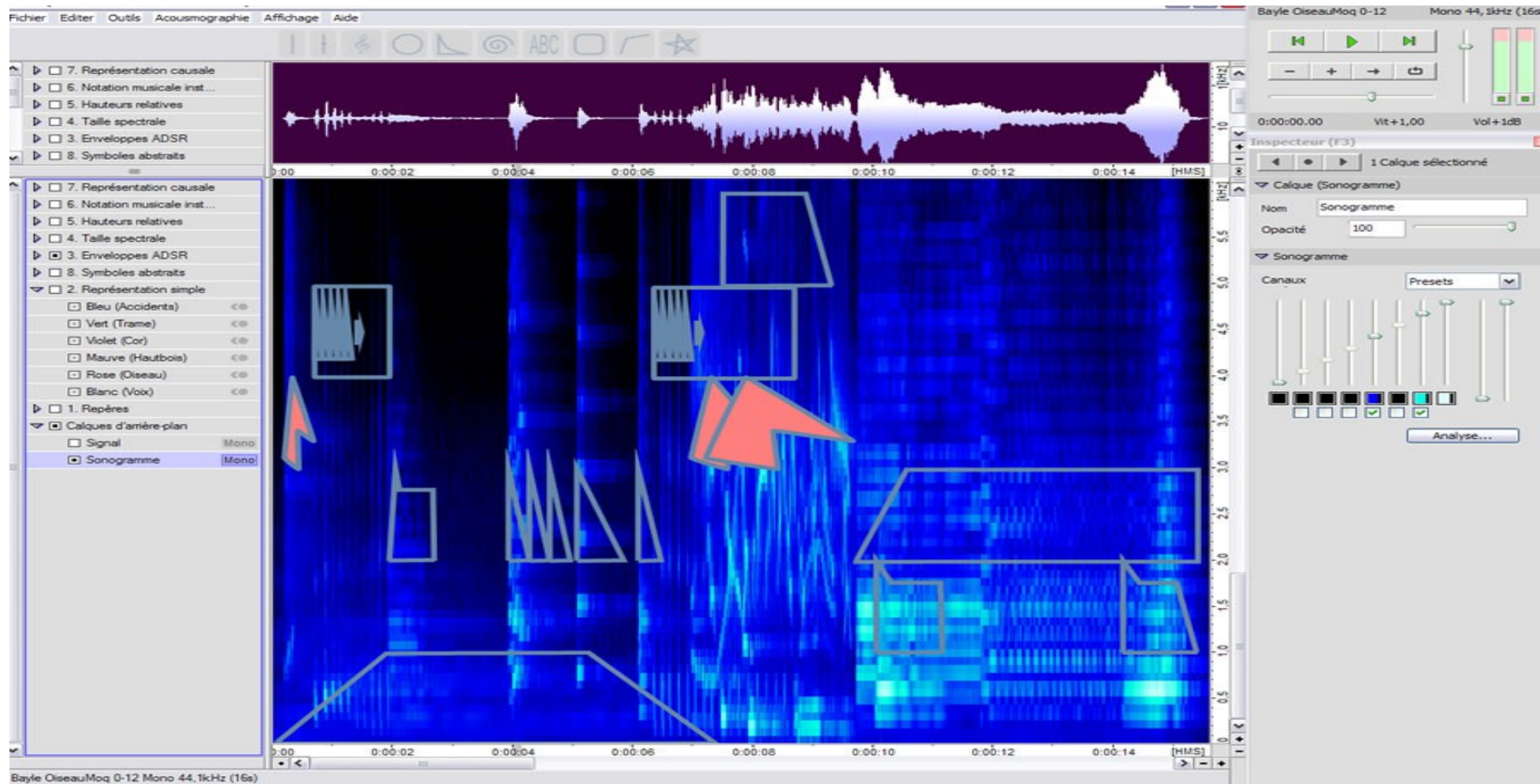


Fig.8.6 Acousmographe

Likewise *Acousmographie* (Fig. 8.6 above), although designed for analysis, could consist of predictive text or graphic symbols, or be used as descriptive of something *imagined*, added to an empty sonogram, whose actual composition could occur later. Above is a simple screen shot of *Acousmographie* with a symbols developed from the library. Clicking on the symbols allows them to be edited and given more detail in the *Inspector Window* on the right. As a sound file is composed, its sonogram can be added in a lower panel, and the symbols then moved and edited to synchronize with the various events as they occur.

Many conventional audio/sequencing programs such as *ProTools*, *Logic*, *Ardour* (Open Source for *Linux*), or *Cubase* visually show how sounds are integrated together, both in temporal position, polyphonically, spatially, and mixed down in other ways. Most composers will use such visual tools intuitively to manipulate results that are being at least partly imagined. There are also graphical windows that assist with processing sounds, and give an indication of what results can be predicted with each process. Given below is another excerpt from the composition by the author quoted earlier as it exists in *ProTools*<sup>25</sup>. Overlaid on the basic window is the reverb. unit and the mix edit window. All of these *sequencing*, *multi-tracking* and *sampling* programs emulate the processes of tape splicing and manipulation that occurred historically in electronic and electroacoustic music.

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<sup>25</sup> An audio file of this extract is appended on CD



Fig. 8.7 ProTools



A somewhat negative comparison can be made here with earlier generations of synthesizers, such as the *Yamaha DX7*, *Kurzweil K 2000* or *Fairlight CMI*, usually with very limited GUIs. This made processing extremely difficult to predict, even given close knowledge of the machine and its manual, which often used terminology specific to the machine or manufacturer.

- an algorithm is the 'wiring' (signal path) of a sample to the audio outputs, through a series of digital signal processing (DSP) functions that you select. The DSP functions are the core of Variable Architecture Synthesis Technology. The DSP functions are synthesis tools (filters, oscillators, etc.) that you assign to the various stages of the algorithm. The DSP functions you choose determine the type of synthesis you use." (Avenmarg *K2000R Musicians Guide* Tech.Cetera USA August 1992 Page 6.3)

Below is an actual size screen print of one of the edit windows of the Kurzweil K2000R: -

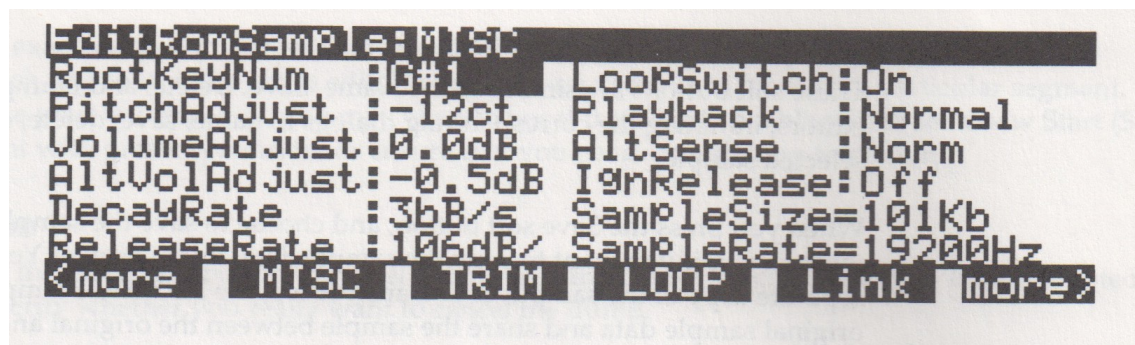


Fig. 8.8 Kurzweil K2000 sample window

(SMP Sampling Options Version 2 Software Page 14)

MIDI sequencing if used can of course be more predictive, only because it is based on traditional notation, and often the piano keyboard itself. *Sibelius*, *Finale* and *Rosegarden (Linux)*, (all of which *only* process MIDI) as well as *Logic*, *GarageBand*, *ProTools* etc. all have this facility, although it is still true to say that some are better for audio processing and some better for MIDI processing.

*Audacity* on the other hand would be an example of software that cannot process MIDI until it is rendered as audio. Its GUI initially is limited to a sonogram of an existing sound, and therefore cannot be used predictively at first. However the sonogram can be used visually to edit sounds, and subsequent windows appear for the various processing options. This is demonstrated in a screen shot below<sup>26</sup>.

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<sup>26</sup> An audio file of this extract is appended on CD

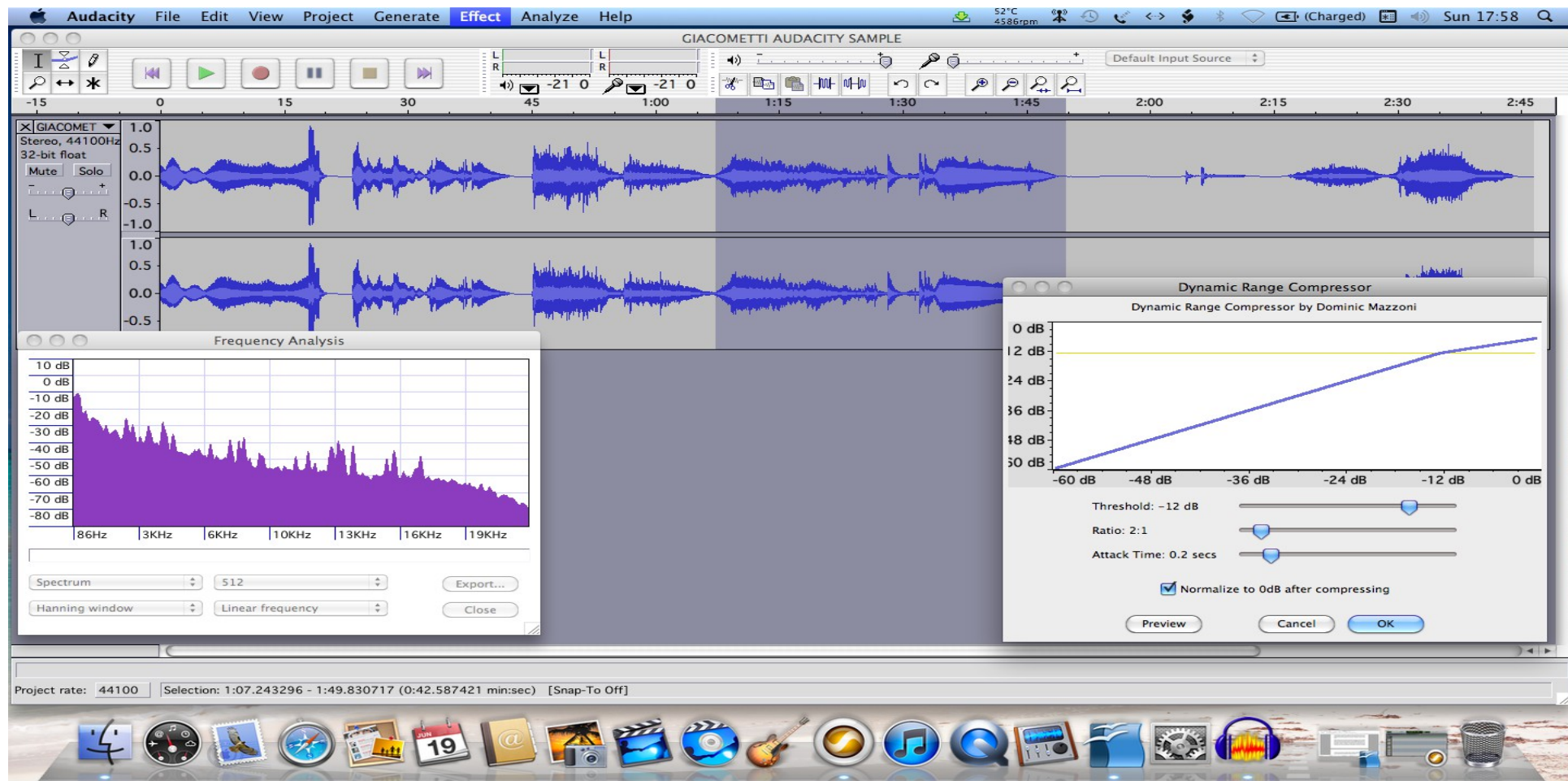


Fig. 8.9 Audacity

Here a section of a wave form is selected and a spectrum analysis window and the window that opens for applying compression are overlaid onto the

sonogram.

### 8.1.2 Software for Conventional Notation

On the other hand *Sibelius*, *Finale* and so on are examples of the way software can be used to produce conventional notation, including for publication. It can be used however for electroacoustic music, particularly where live instrumental sounds are involved. In this case, such notation *could* be a representation of imagined sound. Below is an extract from the opening of *Kontakte* by Stockhausen that integrates traditional notation typesetting with graphic representations of electronic sounds. (published by Universal Edition A. G. Vienna. This extract is taken from page 165 of *Notation in New Music* by Erhard Karkoschka translated by Ruth Koenig – English Translation Universal Edition 1972). The parts for the two players are written below a representation of the electronic sounds for four groups of loudspeakers. Nowadays this could well be typeset in *Sibelius* or the equivalent.



The image displays a handwritten musical score for Karlheinz Stockhausen's 'Kontakte'. The score is organized into measures with time markers at the top: 0,9, 15,7, 22,1, 24,3, 25,5, 27,2, 28,7, 33,6, 35,5, 39,3, 46,1, 47,3, and 49,4. The instruments and their parts are as follows:

- Flöte (Flute):** Located at the top, it features abstract, scribbled notation in several measures, with dynamic markings like *f* and *mf*.
- Klavier (Piano):** Positioned in the lower middle, it contains complex, dense musical notation with various dynamics including *f*, *mf*, *ff*, and *pp*.
- Trümpf (Trumpet):** Indicated by a circle and a vertical line on the left, with a note 'Trümpf (Flöte)'.
- Viola (Viola):** Shown in the middle right, with musical notation and a 'rit.' (ritardando) marking.
- Percussion:** Represented by various symbols like circles, squares, and lines, often with dynamic markings like *f* and *pp*.

Other annotations include 'In allen Verschiedenes' and 'Alternierend' at the top, and 'In allen das Gleiche' on the far right. The notation is highly experimental, combining traditional musical symbols with abstract graphical elements.

Fig. 8.10 Kontakte integrated notation

### 8.1.3 Object Orientated Predictive Software

There are a number of software examples that are very close to computer programming or programming languages, such as *Pure Data*, *Csound* (*Cecilia*), *Max* (*MaxMsp*, *jMax*). Here '*patches*' are visual devices that replace programming commands or lines of code as a way of processing data. Of course this *data* does not have to be auditory, but could consist of any data and processes. This is somewhat the case with *Pure Data*. They are all however a visualization of lines of code that could be in any computer language such as C or C++, or even in machine code. Objects are represented visually, so that processing and processing paths can be more clearly *seen* and understood. In any event these can be regarded as predictive, since programming and the compilation of *patches* has to be related to the compositional intentions. That is to say programming takes place to achieve sounds that are imagined, even if this *imagery* is of something *remembered* from before. Of course it must be noted that all *imagined* sounds are ultimately based on things that are *remembered*.

Now that you've seen some essential audio processing functions encapsulated as subpatches, we'll look at them as they are used in a main patch. This main patch will also be instructive regarding one way to organize multiple audio processes. In this example we set up a situation in which many different types of audio processing are available, but we select only one at a time. I call this a "parallel, selective" model, in which all processes are in theory running simultaneously in parallel (i.e. side by side), yet only one is selected for activation at any given time.

( <http://music.arts.uci.edu/dobrian/IAP2004/MSPEexamples.htm> – Christopher Dobrian)

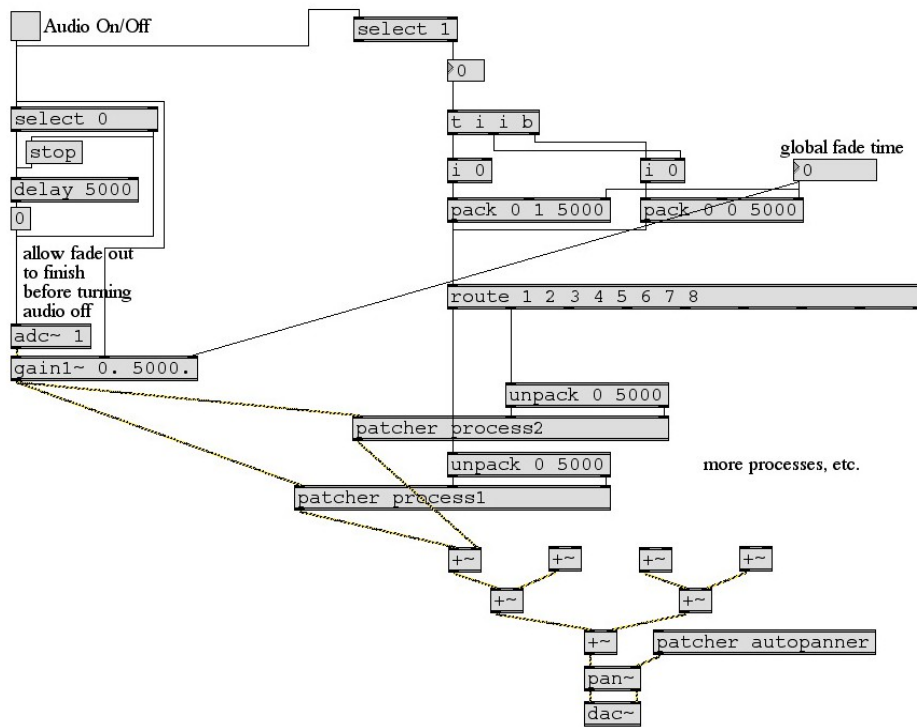


Fig. 8.11 Early Max Patch

The main patches show common devices and processes such as delay, gain, pan, adc and dac. Given below is a quadrophonic spatialization patch taken from the *Max 6* example folder. This has a much improved visualization as a GUI, as is common with *Max 6* and *7*.

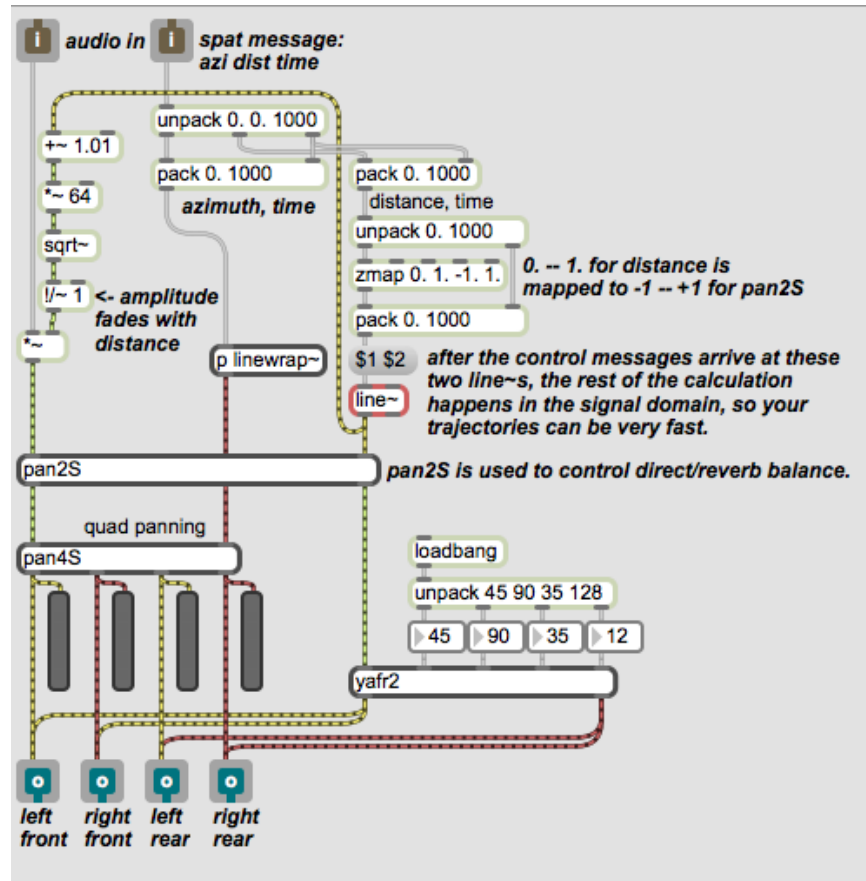


Fig. 8.12 Max 7 Patch

It is possible for such programming languages, either using lines of code or visualized *patches*, to generate audio processing live as part of a performance. This is discussed more fully in a later section of this chapter.

*AudioMulch* (Interactive Music Studio Copyright © 1997-2009 Ross Bendna) is processing software for audio that makes extensive use of visualization to enable the user to *see* what processes are going to take place. This also uses *patches*, but considerably developed visually from those outlined in the previous examples such as *Pure Data*. Like *Pure Data* and others, the processes are implemented afresh each time the program runs and is applied to a sample; and the visualizations are a record of intentions as regards what is going to happen to that sample. Many software examples *represent* sound processing as a by-product as it were of the processing itself. *AudioMulch* has visualization as a fundamental part of such processing, such that it is impossible to carry out the processing without editing and manipulating the visual tools. Below is an example of avocal trigger being processed in *AudioMulch*<sup>27</sup>. The list of processes are on the far left, those selected are placed towards the middle and a graphical display of possible editing processes are on the right.

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<sup>27</sup> An audio file of this extract is appended on CD.

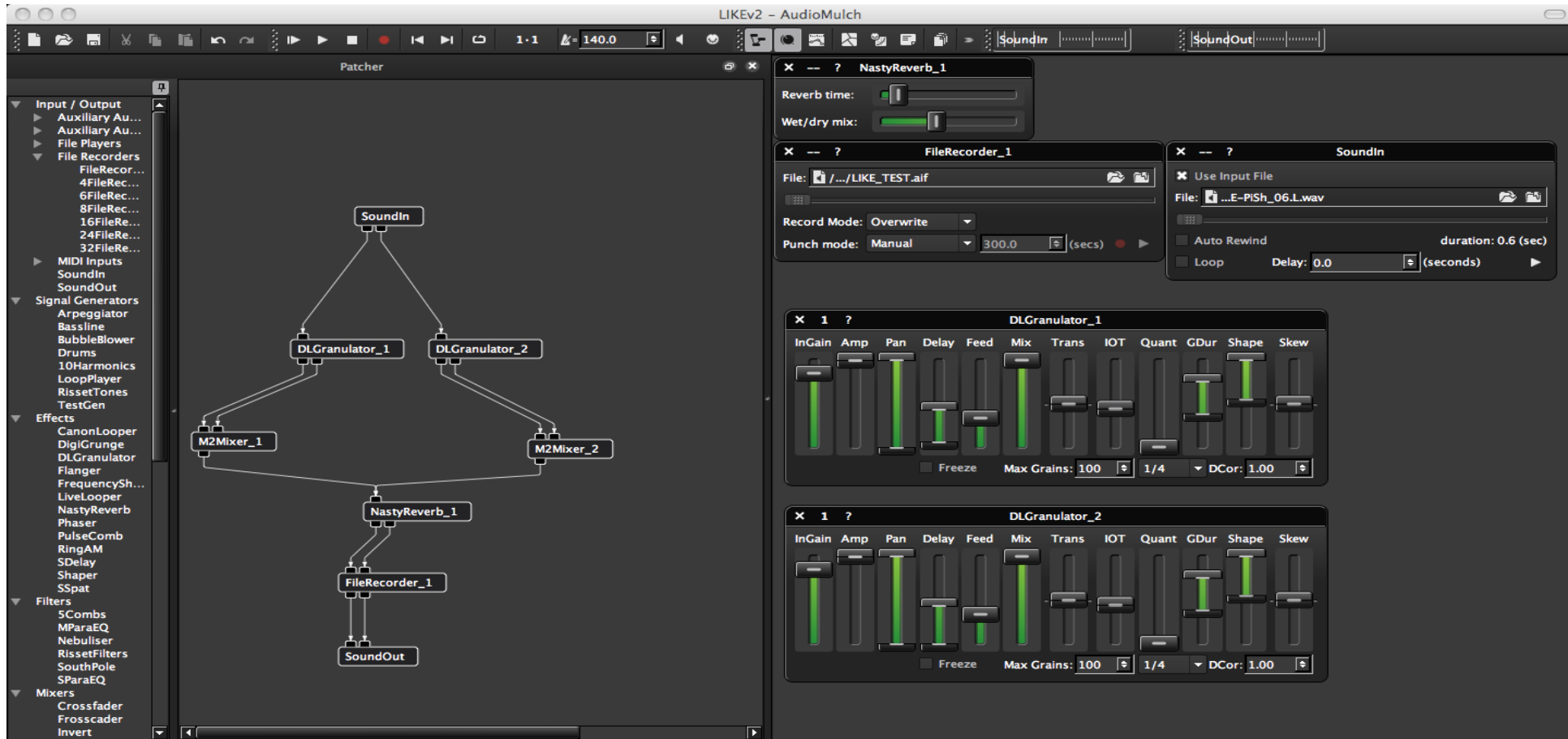


Fig. 8.13 AudioMulch

Visualization is also the way in which processing takes place in *Metasynth* (U and I software), using particularly advanced graphical techniques: -

## The Image Synth

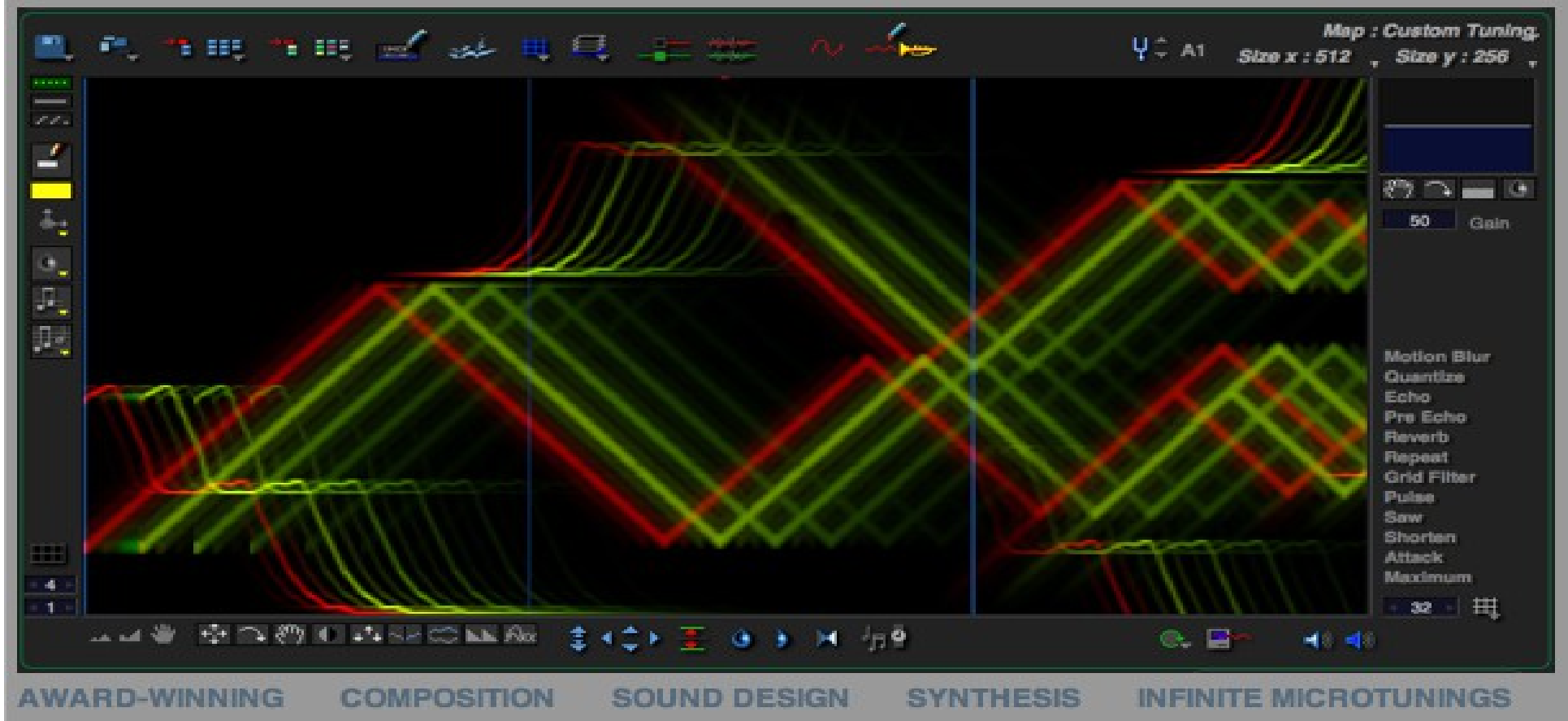


Fig. 8.14 Metasynth Image Synth



The approach to composition of sound is referred to by *Metasynth* as '*paint sound*'.

The Image Synth is a composition and sound design environment where you paint music and sound. The canvas area can be thought of as the score, a super-sonogram, or a twisted version of a piano-roll style sequencer. Each pixel is a synthesizer activated as the playhead passes over it. Color is interpreted as stereo placement. Brightness is loudness. And you can define any tuning space you can imagine. The Image Synth provides a wealth of synthesis methods that include additive, FM, phase distortion, pulse width modulated, and sample-based synths. You can create slamming beats, abstract washes of sound and anything in-between. It is not MIDI plug-in. You can use your creations in MetaSynth's Montage Room or export your results as audio files.

( <http://uisoftware.com/MetaSynth/rooms.php> )

These processes can be used predictively in the first instance, especially when the software becomes more familiar to the user. As with other examples of software, work that is saved can then be viewed descriptively, as an archive, or even analytically. Visualization is adapted for each window (referred to as *rooms*) and as each sound process is applied. Final collation of a sequence is achieved in the *montage* room. An image of this is given below:-

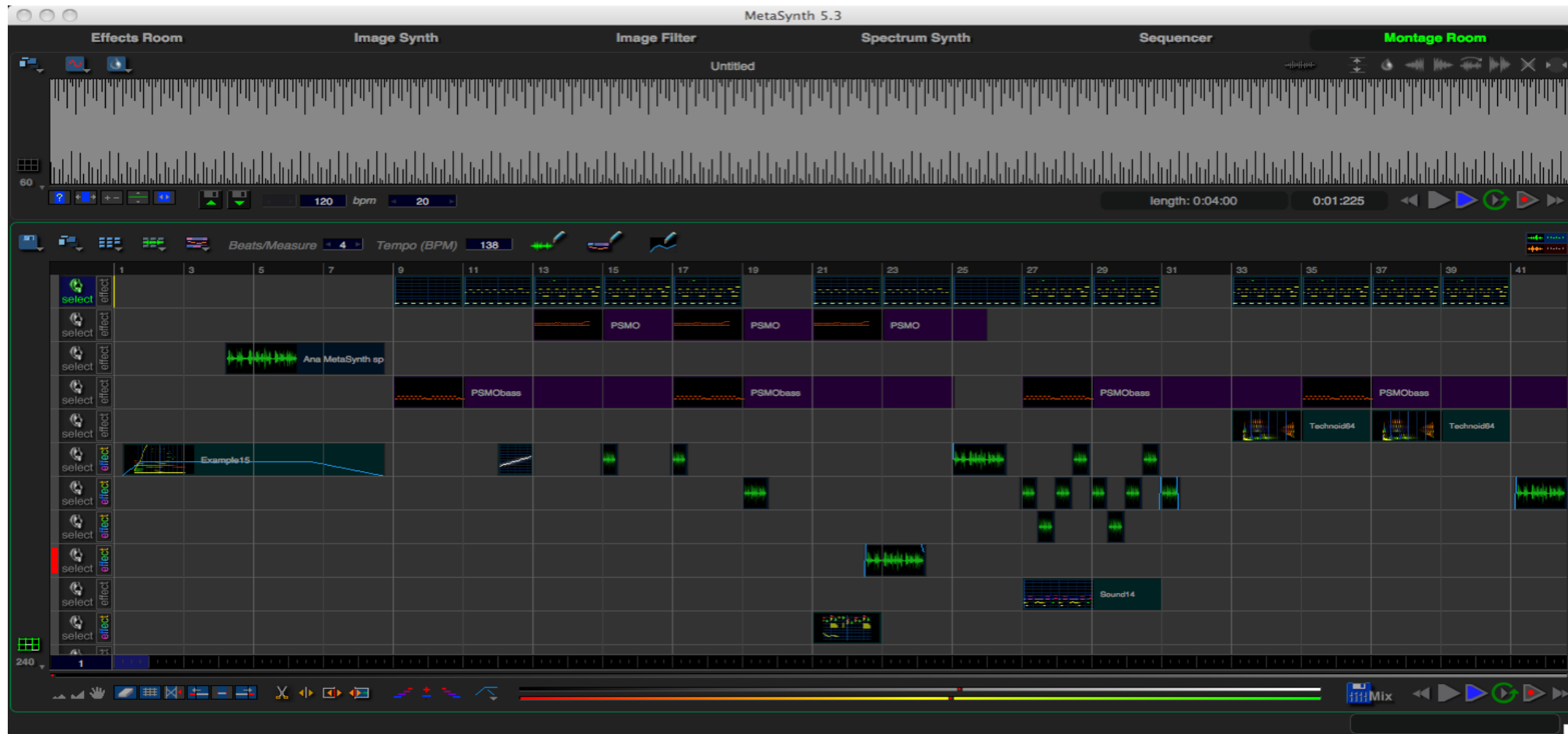


Fig. 8.15 Metasynth Montage Room

The *UPIC* system, referred to by Ron Herrema in *Chapter 5*, is software based on a graphical system of input. The clarity and precision of its predictability might be called into question by some, since as suggested below the software gives an *interpretation* of the graphics. The system was first developed by Iannis Xenakis in the 1970s and *Mycenae Alpha* by Xenakis was the first work composed entirely using the system:-

The UPIC system was conceived by Iannis Xenakis in the early 1950s; the first version of UPIC was built by Xenakis' research center, the CEMAMu, in the late 1970s, and the system continues to be developed to this day. Instead of a keyboard to perform the music, the UPIC's performance device is a mouse and/or a digital drawing board. These are used to trace the composer's graphic score into the UPIC computer program, which then interprets the drawings as real time instructions for sound synthesis-the composition/performance of a graphic musical score and real-time sound synthesis are unified by the UPIC's approach. (Dan Warburton, *The Wire*, 2001 CD program note - Xenakis, UPIC, Continuum - Electroacoustic and Instrumental works from CCMIX Paris).

The system is still currently developed by CCMIX in Paris. This point is further developed by Aleks Kolkowski in an introduction to a London South Bank project *ETHER 2011: YOUNG XENARCHITECTS – PAINTING WITH SOUND*

A desire to draw sounds in the draftsman-like manner of an architect led Xenakis in 1977 to devise [\*UPIC\*](#)(*Unité Polyagogique Informatique du CEMAMu*), a system where sounds were created, drawn and arranged on a computer screen using an electromagnetic pencil.

and following on from these systems:-

Today's modern audio painting software using graphic tablets and touch screens all descend from *UPIC*, but the origins of sound painting goes back much further than Xenakis, to the early methods of visualising sound through the chladni plates, phonautograms and harmonographs of the 18th and 19th centuries. (Aleks Kolkowski Ether project *Young Xenarchitects at Southbank Centre 2011*)

One example of such modern software is *HighC* (© Thomas Baudel 1992-2011 <http://highc.org> ) which is dealt with more fully in the section on Pedagogical Software later in this chapter. As has been said, these systems lack the kind of precision that conventional notation has accustomed us to for several reasons namely:-

- 1) conventional notation has developed over 900 years and followed or led developments in compositional language and techniques.
- 2) conventional notation is predominantly concerned with pitch and duration as opposed to timbre which is usually a primary focus of electroacoustic music.
- 3) conventional notation is *learnt* and adopted by people *in a position to know and understand* the system thereby adding to its predictability.

## 8.2 Descriptive Use of Software

Some software used descriptively often includes a sonogram of the audio, which is played alongside the visualization. In general terms, the approach to representation as part of descriptive processes in composition is quite different to prescription. Description in this thesis is thought of as taking place *after* a sound is created, hence the possibility of a sonogram. In practice however, prescription and description are often not completely distinct as compositional acts, and there is usually a symbiotic relationship between them. In any case, as has been stated, prescription can be thought

of as a description of *something imagined* (not yet made except in the mind). It is likely therefore that some software used for prescription can be used for description although perhaps in different ways and with different intended outcomes.

Conventional text and graphics software can be used for *description*, which can include something *imagined*, almost without adaption. Thinking descriptively however will probably mean that different things are written, different perspectives and contexts are established, and different kinds of graphics are produced. A descriptive representation of something that already exists can be far more detailed, or far more focused on specific aspects of the sound. If description moves to a more objective or *analytical* position, this again will produce changes of perspective or context. Reference could again be made to the earlier examples (*Figs. 8.1 and 8.2*).

Sequencing software is not usually used descriptively, but nonetheless as with all software, *becomes* descriptive once sounds are made or positioned and referred to. This will also apply, although quite differently, in conventional notation software such as *Sibelius* or *Finale*. As has been said, those in a position to know such notation can *see* what has taken place. Work completed in *AudioMulch* and *Metasynth* also becomes descriptive of *what has happened* and can be *viewed* as such. (*Figs. 8.13 – 8.15*) This is also and particularly the case with *Sound Loom*, where processes can be identified and preserved, and more detailed notes left as to what has taken place, what the results are, and what relationships and connections with other sounds or events might be in evidence. As often happens, such results form something of an archive of what has

taken place, either within the compositional process or after a composition is complete.

Examples referred to elsewhere in this dissertation of graphic notation by students of Robert Normandeau, could also be examples of software in use to produce descriptive visualizations of electroacoustic music. (*Figs. 5.1 and 5.2*) Again this work might form the basis of an analysis or archive, although it was not intended to do this; rather, as stated by Robert Normandeau, to put oneself '*in the mind of the listener*'.

*Acousmographie*, which can include a sonogram, is descriptive, although its intention is that it be used for more objective analysis. *UPIC*, and its derivatives, are all descriptive once their task of generating sound is complete, because they are a record of how such sounds came about, and of how activation of the software will produce the sounds in the future. In every case however, descriptive characteristics can only be understood by those sufficiently familiar with the software and its intentions. Understanding and familiarity is particularly required in the case of programming software such as *Max/MSP*, especially as regards being clear about the descriptive characteristics revealed in the music.

Given that *all* software becomes descriptive of sounds in some way, it is important to bear in mind the potential of such software in this regard.

### 8.3 Analytical Use of Software

Software in this category is sometimes a development of, or identical to, descriptive software. Usually however it can be regarded as more objective in its approach than simply a descriptive compositional act. As has been said earlier, *Acousmographe* has been designed for analysis of electroacoustic music. However it can easily be used prescriptively, descriptively or as an archive of particular music. *Acousmographe* is an example of software that plays an audio file at the same time as a sonogram that is displayed in real time. There is then the option of adding graphical symbols and text, again in real time, against the audio file and sonogram. (Figure 9.6) However, if over time the library of graphical symbols were developed consistently to represent particular types of sound<sup>28</sup>, the software could be used to prescribe, describe, analyze and archive quite meaningfully by common agreement, and people in a position to know these symbols. This would especially be the case if hyperlinks to windows giving more specific detail could be implemented. This is of course not unlike the position with regard to conventional notation. As stated elsewhere in this thesis, it is likely that some agreement would also have to evolve about types of sound or more specifically timbre. This is discussed more fully in the concluding chapter. There are parallels to be drawn here with the evolution of traditional notation, including the way in which such notation has tended to model the kind of music being visualized. (refer to *Chapter 3.2*)

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<sup>28</sup> As suggested by Leah Barclay in *Chapter 5*



Analysis can of course be outlined using conventional text and graphics software. Many analytical examples are being developed by the *OREMA* software environment created by Mike Gatt (referred to in *Chapter 5*) and some of these use and will use, conventional text and graphics. Whilst this is predominantly analysis of other peoples' compositions, there is no reason why composers could not apply such analytical techniques to their own work, either as part of the compositional process or after a composition is complete. Such analysis might then feature as a component part of an archive of their work, during some part of the compositional process. Importantly, *Acousmographie* is also used in this environment. Below is a screen shot of an analysis by Ambrose Seddon of Andrew Lewis's *Penmon Point* as it appears in the *Orema* Project, and produced using *Acousmographie*. The visualization supports and follows up the paper *Investigating recurrences in Andrew Lewis's Penmon Point*<sup>29</sup> Here in this example there is a stated focus to the analysis, in this case to visualize recurrences and connections between the various materials. A stated focus is usually the case with analysis of any music.

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<sup>29</sup> Proceedings of *Sound, Sight, Space and Play 2010 Postgraduate Symposium for the Creative Sonic Arts* De Montfort University Leicester, United Kingdom, 2-4 June 2010

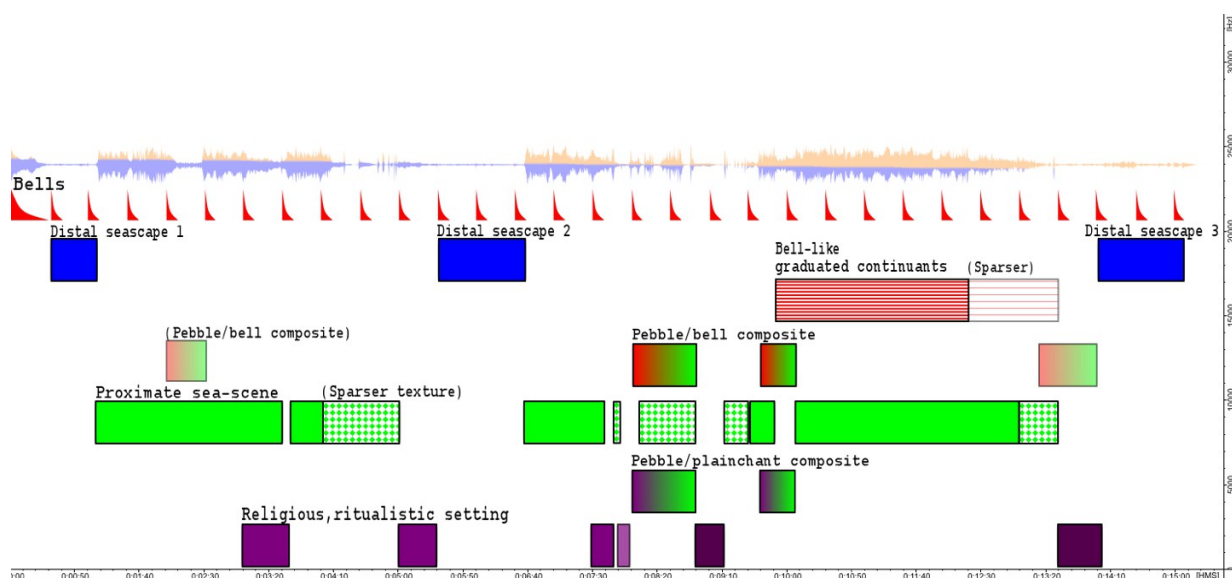


Fig. 8.16 Seddon Penman Point analysis Acousmographe OREMA

It should not be forgotten that analysis is a potential and important part of the compositional act, even whilst composition is on-going, and it is often the case that software of many types will be used to achieve this. Composers do need to understand what they are doing as work progresses, and analysis can be a fundamental and often intuitive part of this process. Analytical questions with specific focus tend to arise continually whilst composing takes place, usually with the aim of a better understanding of the musical material and its possibilities as it evolves.

## 8.4 Archival Use of Software

This is a use of software that seeks to preserve information for future reference

either within the compositional process or when composition is complete. The archive as a process is also dealt with in the next chapter. At this time a fully detailed and sufficient archive is not possible, and cannot replace the audio of a composition as a *final representation* of a complete piece. The archive presented by conventional notation only becomes such because of the intervention and interpretation of performers. As has been said however *Sound Loom*, particularly as used by Trevor Wishart is one example among others of software that can be regarded as a partial archive. In fact it could be said to have been designed for this purpose.

### 8.5 Software Used for Diffusion Scores

Many commercial programs such as *ProTools* allow diffusion and the possibility of *seeing* how such diffusion is to take place. This is also the case in the *Max 6* example quoted earlier<sup>30</sup>. Diffusion is also included in the OpenOffice example referred to earlier. (*Fig. 8.1*) However in this case diffusion such as this would be carried out during a *performance* or presentation of the music, perhaps working from notes and sketches created by the composer. Most responses from composers in *Chapter 5* refer to diffusion scores that will lead to this type of *live* diffusion in performance.

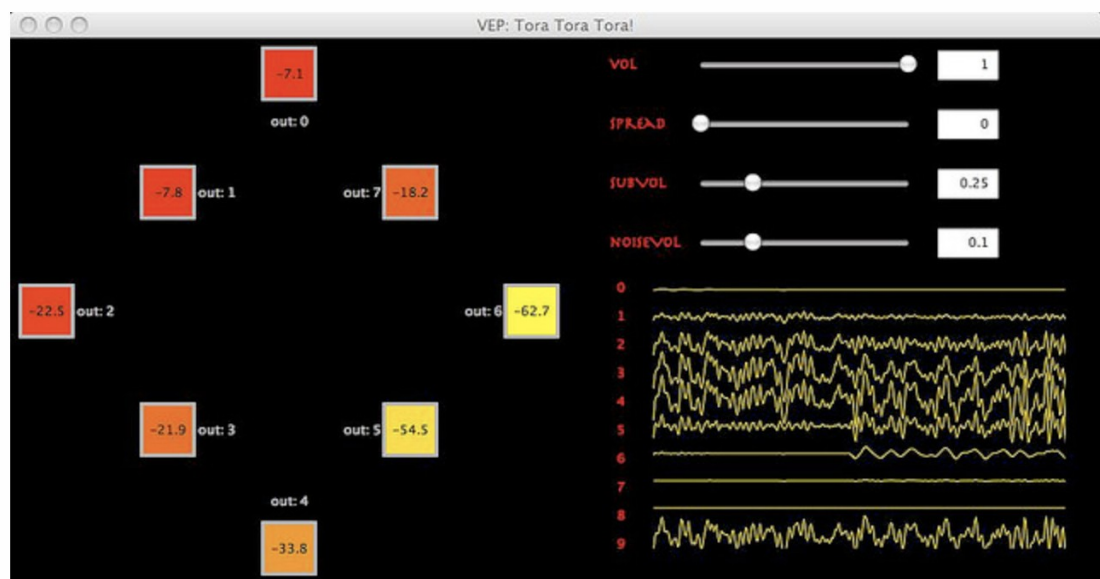
### 8.6 Software Used for Performance or Live Interaction

This includes software that produces a *score* for live (instrumental) performance,

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<sup>30</sup> The quadrophonic spatialization patch taken from the *Max 6* example

as well as software that enables programming to take place in order to edit material during the performance. This can even be machine code or more commonly the use of a programming language such as C++. *SuperCollider* (Open Source software - James McCartney and others from 1996) is a programming environment particularly suited to live interaction.



### vepGui161209

The GUI controlling the SuperCollider VEP application. 8 channels placed in a ring are displayed, with color scale representing dB levels. Waveforms of 10 channels are represented on the side (chan 9 is a mixdown for sub). Sliders are used to control different params of signals (spatialization, volume).

*Fig. 8.17 SuperCollider*

Leah Barclay's *Wolf Rock*, referred to in *Chapter 5*, is also a good example of a representation of such interaction.

## 8.7 Pedagogical Use of Software

Again the work mentioned earlier in this thesis and in *Chapter 5*, by students of Robert Normandeau is a particular example of how proprietary software could be used in this way pedagogically. (*Figs 6.1 and 6.2*)

*HighC* is software that has developed from initiatives such as the *UPIC* project. However it is simple and intuitive to use, and can be used to introduce younger students to graphical manipulation of electronic sounds. Below is a simple example of the basic window with two renditions of an imported audio file, and an indication of some of the wave forms and envelopes available in the basic set-up, as well as the way in which a pitch framework is outlined. The software is worthy of significant course elements being developed from it at almost any level of education, where a basic level of computer literacy can be assumed. It could also teach aspects of computer literacy itself quite eloquently.

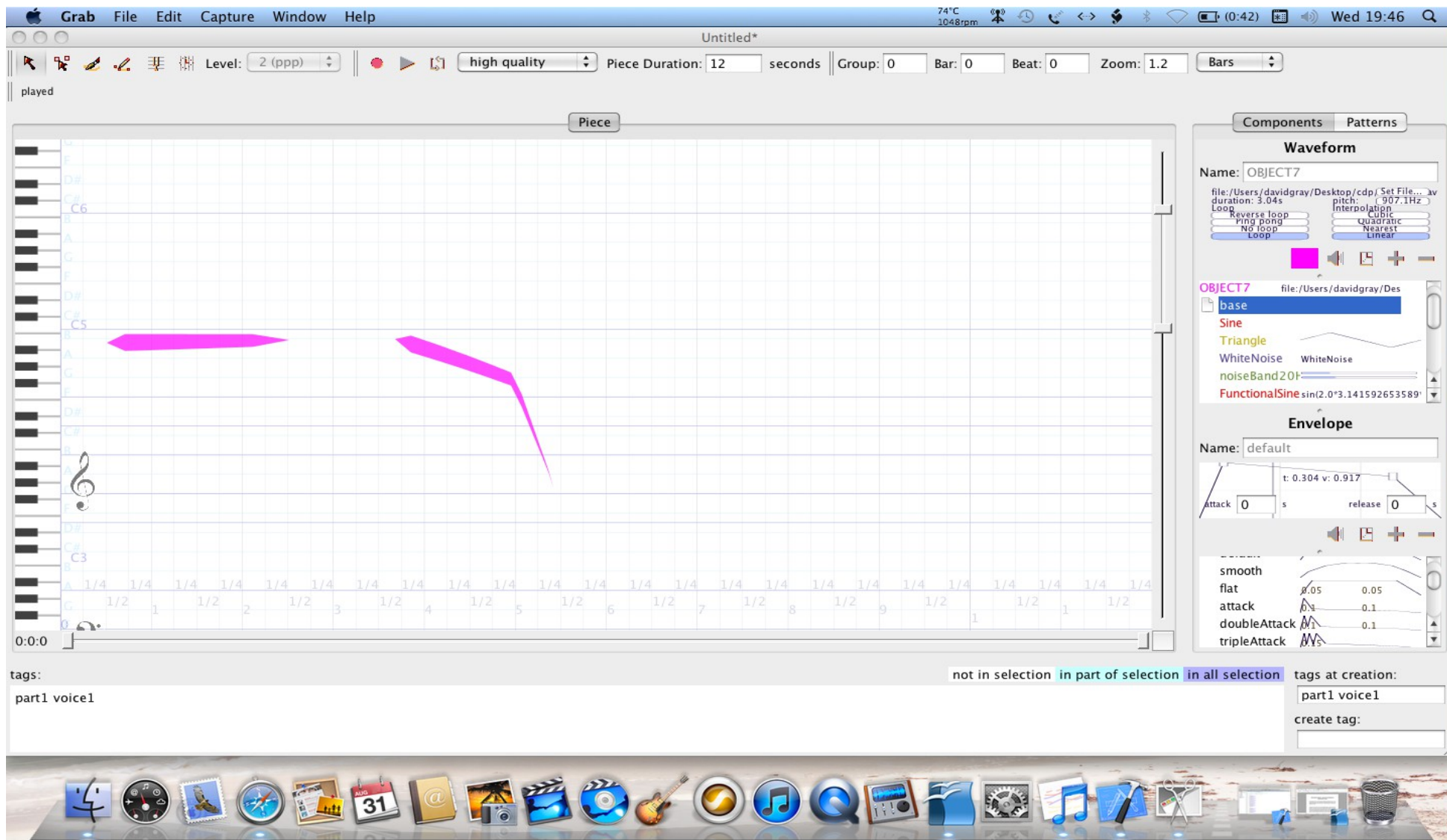


Fig. 8.18 HighC screenshot

## 8.8 Visual Music

Whilst visual music can be regarded as outside the scope of this thesis, work by Bret Battey referred to in *Chapter 1.5* is an example of visualization being produced as part of the complete artistic endeavour.

## 8.9 Sonic Visualization Apps.

A more recent initiative in software development has been the creation of various apps. for iPhone, iPad, and other tablet devices. These apps. may not as yet have a clearly defined purpose as far as the compositional process and taxonomical structure outlined in this thesis are concerned, and many of them might be considered as entertainment or *games*, and indeed may have been devised as such. All of them link visualization with sound however, although in most cases the sonic possibilities are limited. This is because of the methods of synthesis being employed or the sampling limitations. Many of them are more focused on pitch, and some are intended to create a visualization or visual effects from sonic input, or after the sound has been made, and as live interaction between the two. It is likely that these initiatives represent the early stages of creative and compositional implications that could be far reaching. A reference to this is made in the concluding chapter of this thesis. The developer Alexander Zolotov has a series of such apps. of this kind, the most developed being SunVox. More unusually this is multi-platform software for *iOS, Mac, Windows, Palm OS* and *Linux*. The specification and description for SunVox are given in the *Appendix C*. Below is a

screenshot from the SunVox website showing one of the processing windows.

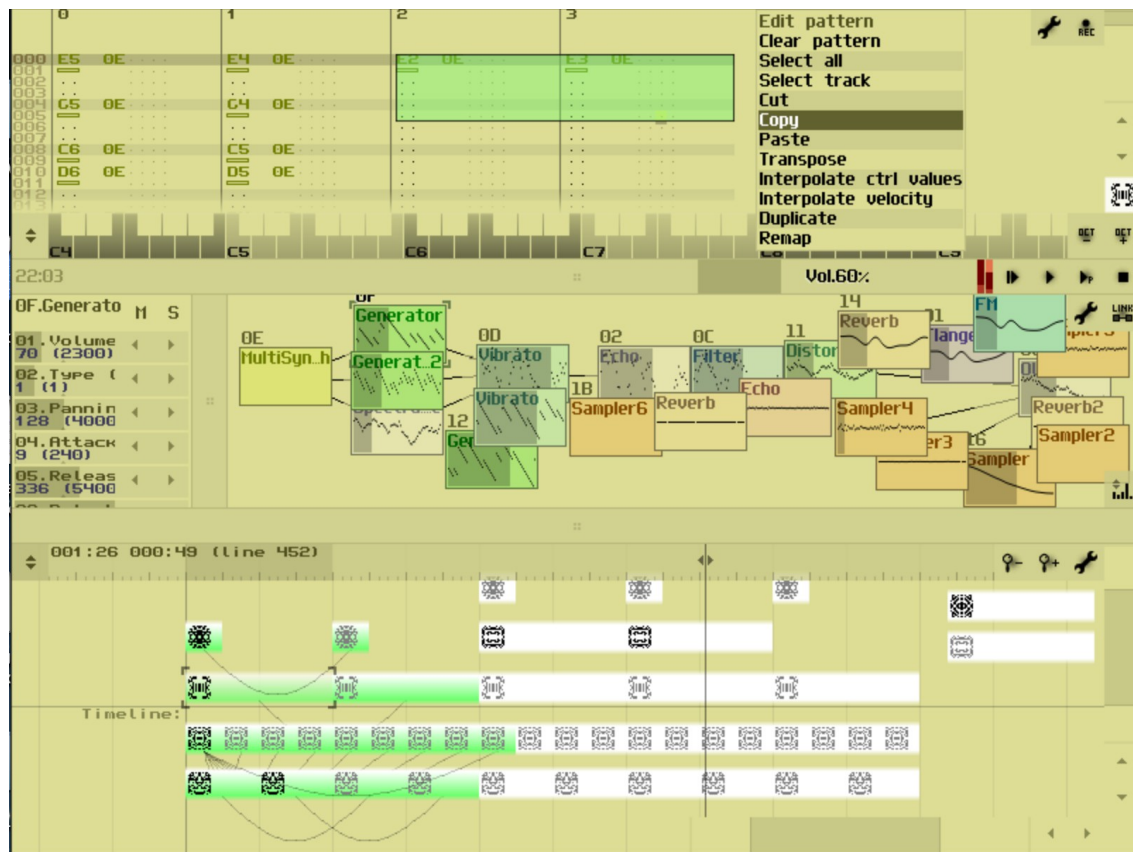


Fig. 8.19 SunVox

The centre panel shows the various process modules and how they are linked. The lower panel indicates the patterns on a time line. Clicking on any of the module icons opens up further edit windows with a range of editing options. In software such as this, visualization is used to facilitate the composition and processing of sound.



## 8.10 Music Information Retrieval

Music Information Retrieval and its relationship to the storage and retrieval of musical metadata has important implications for this research, particularly as regards the creation and preservation of a compositional archive. The techniques of MIR when applied to timbral descriptors, tags or metadata would enable the creation of an archive, either of work in progress or of completed sound files or whole compositions. It could also be the basis or the focus of particular descriptions and analyses. This will also assist musical reflection and compositional understanding. Meta-datum strategies and appropriate software could be used to store, describe and locate existing sound files, such they can inform later work in progress in a meaningful way, and assist with the creation of new material. A record of relationships between sounds and possible connectivity can be an important part of the compositional process for most if not all composers. Some of these issues are dealt with in the following chapter, as well as in *Chapter 11 Conclusions*.

The timbral attributes outlined in *Chapter 10.3.1* by Robert Erickson, and later in that chapter by this author, could form the basis of tags that would respond well to music information strategies that are not usually used in this way. The screenshot below shows one of the process windows, that is taken from *Sound Palette* developed as part of the *Cuidado* project. If adapted, it could store and reference sound files for future reference or retrieval<sup>31</sup>. Additional windows also include a sonogram and editing

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<sup>31</sup> Updated information about the project can be found at ( <http://www.ircam.fr/cuidado>). The CUIDADO project is funded by the Information Science and Technology Program of the European Commission.

options.

The CUIDADO Project (Content-based Unified Interfaces and Descriptors for Audio/music Databases available Online) aims at developing a new chain of applications through the use of audio/music content descriptors, in the spirit of the MPEG-7 standard. The project includes the design of appropriate description structures, the development of extractors for deriving high-level information from audio signals, and the design and implementation of two applications: the Sound Palette and the Music Browser. These applications include new features, which systematically exploit high-level descriptors and provide users with content-based access to large catalogues of audio/music material. The Sound Palette focuses on audio samples and targets professional users, whereas the Music Browser addresses a broader user target through the management of Popular music titles. (Hugues Vinet IRCAM, Perfecto Herrera IUA-Universitat Pompeu Fabra, Francois Pachet Sony-CSL 2002)

# Sound PALETTE

Browse

Search

Classify

Preferences

Help



**Hugues Vinet**

- Cart
- Stored queries
- + Partner
- IRCAM
- + SoL
  - Harp
  - Violin
  - Viola
  - Cello
  - Double bass (5 strings)
  - Flute

---

**System categories**

- + Instrumental sounds
  - + Chordophones
    - + Lutes
      - + Instrument
        - Violin
        - Viola
        - **Cello**
        - Double bass (5 strings)
        - Guitar
      - + Playing mode
    - + Harp

**System categories: Instrumental sounds: Cello**



Samples 1-10 out of at least 200

					Duration (s)	Format	Size (b)
				cello, non vibrato. C # 2 pp	8	AIFF	7.009.344
				cello, non vibrato. D natural 2 pp	8	AIFF	7.009.344
				cello, non vibrato. F natural 2 pp	7	AIFF	6.734.484
				cello, non vibrato. E natural 2 pp	8	AIFF	7.696.548
				<b>cello, non vibrato. E flat 2 pp</b>	9	AIFF	8.383.752
				cello, non vibrato. F # 2 pp	7	AIFF	6.665.760
				cello, non vibrato. G natural 2 pp	7	AIFF	6.649.956
				cello, non vibrato. A natural 2 pp	9	AIFF	7.783.884
				cello, non vibrato. B flat 2 pp	7	AIFF	6.514.776

**cello, non vibrato. E flat 2 pp**

*SoL filename: vrf\_nv\_c\_pp\_mib1*

Belongs to:

SoL: Cello

Is linked to:

- System categories: Instrumental sounds: Cello
- System categories: Instrumental sounds: non vibrato
- System categories: Instrumental sounds: Dynamic: Pianissimo
- System categories: Instrumental sounds: E flat

Fig. 8.20 SoundPalette

## 9. The Musical Archive

### 9.1 The Archive as a Part of Compositional Development

The term *archive* is best understood in the context of this thesis as a preservation. Composers use visualization and representation to preserve something about their music as a part of the compositional process, especially to refer back to later as that process develops. This can include decisions, evolution of sounds and the processes involved and relationships between material or aspects of the material. This preservation may be for future reference as an on-going part of the compositional act, or some kind of permanent record of aspects of the work when completed.

Musically the archive was something of an imperative before recording. This may account in part for the particular relationship traditional notation has with much western classical music, which relies for its production on the performer as an intermediary. Electroacoustic music is a genre made possible by and emerging from recording. However, in electroacoustic music the archive is still thought to be necessary by some composers and practitioners, partly because preservation of digital data can be problematic in that it degrades over time, and then requires re-copying and, more importantly, verification. Additionally some kind of preservation may be necessary as a reference point when work in progress is returned to. The separation from the pragmatic

necessity of the hard copy required by much earlier music, not least because of its performance, has caused the electroacoustic genre to free itself from many of the representational constraints demanded by hard copy archiving. It has to be remembered that when live performance is involved with electronics, then usually some kind of representation becomes necessary. The extreme position, for example as stated by Simon Emmerson at the 2007 EMS Conference at de Montfort University, is to say that the problem of preservation, of this and other new music is '*becoming a redundant and obsolete idea*'. Indeed, it was suggested at the time that composers who seek final preservation of their work, perhaps cease to exist in the future and become somewhat '*a thing of the past*'. (*Where Next? New music, new technology* Emmerson 2007) Certainly at least, we can say at the moment, that the development of recording has altered the way in which composers and other practitioners put preservation into practice. Later in subsequent meetings with this author, Simon Emmerson refined these assertions to suggest that 'preservation will increasingly happen automatically'.

The need to preserve or create an archive, has been stated for example by Trevor Wishart in an interview given to the author in July 2009. This might be seen in contrast to his ideas expressed in *On Sonic Art* discussed elsewhere in this thesis. Archiving was also raised by Michael Young and Barry Truax at the 2007 EMS Conference. (Young '*Aur(or)a':Exploring Attributes of a Live Algorithm* and Truax *The Analysis of Electroacoustic Music as Soundscape* 2007). It has also been indicated in some of the responses in *Chapter 5* received by the author from composers, such that representation

of music as data is a way of working towards preservation of an archive of such music<sup>32</sup>.

Wishart's response to this is discussed later in this chapter in relation to *Soundloom*.

## 9.2 Software Used for Archival Preservation

The *Caspar* and *Mars* projects, and to a certain extent *Acousmographie* (at least originally) and Wishart's *Soundloom* (graphical interface for the *Composers Desktop Project*) are at least in part contributions to finding solutions to archiving.

Acousmatic works are defined at INA/GRM as pure recorded (tape) music that is without live instrument or electronic interaction. Usually, the archive of those pieces consist on a single final tape and its security copies, nowadays a single digital file.

In the framework of the CASPAR project [2], we focus on long-term preservation. And then, we have to preserve the intelligibility of a work over the long-term. Thus, it appears to us that it is very important to archive more elements of an acousmatic piece, i.e. the final mixing session and their variant, and furthermore the source elements. This is proposed mainly to ensure the possibility of enhancing the sound quality in further times.

It means that we need a model to describe this kind of work, to architecture this information into an archive. This paper proposes such a model. We will present our methodology (starting from the files we collect) and the generic model we obtained which is based on a life cycle representation. (N. Esposito and Y. Geslin - *Long-term Preservation of Acousmatic Works: Toward a Generic Model of Description*)

In the *Caspar* project the model outlined focuses on preserving the processes by which the work comes about. The paper as presented concerns itself with a particular work, Hans Tutschku's piece *Distance Liquide*. The essence of the method as outlined is to document and preserve the ways in which the work came into existence. Importantly

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<sup>32</sup> Refer to the grid in *Chapter 5.3*

this can be done during the process of composition, as well as after the work is completed. Equally important is how the way in which procedures develop one from another is recorded. The screen shot below gives an indication of the files referenced as resources for the archive. It also indicates the relationships between the audio files and processes.

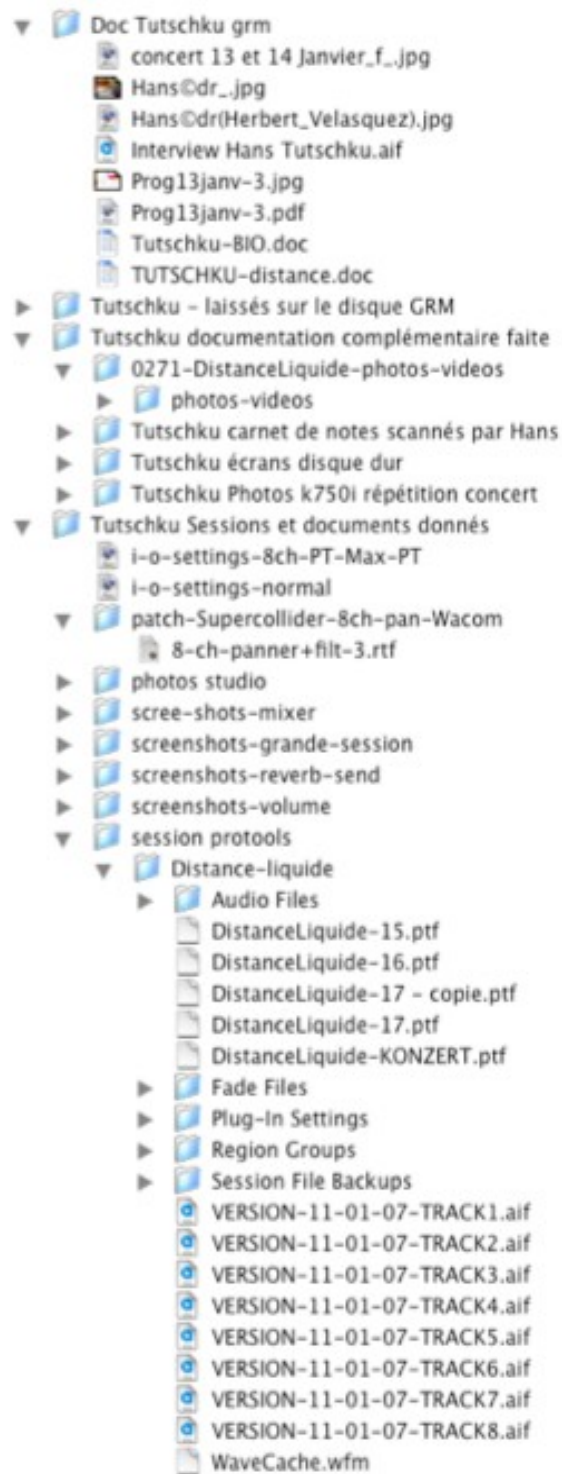


Fig. 1. Collected files for *Distance Liquide*.



Fig. 9.1 CASPAR Distance Liquide 1

The second screen shot indicates the way in which files and processes are traced from one to another, and where they are to be found.

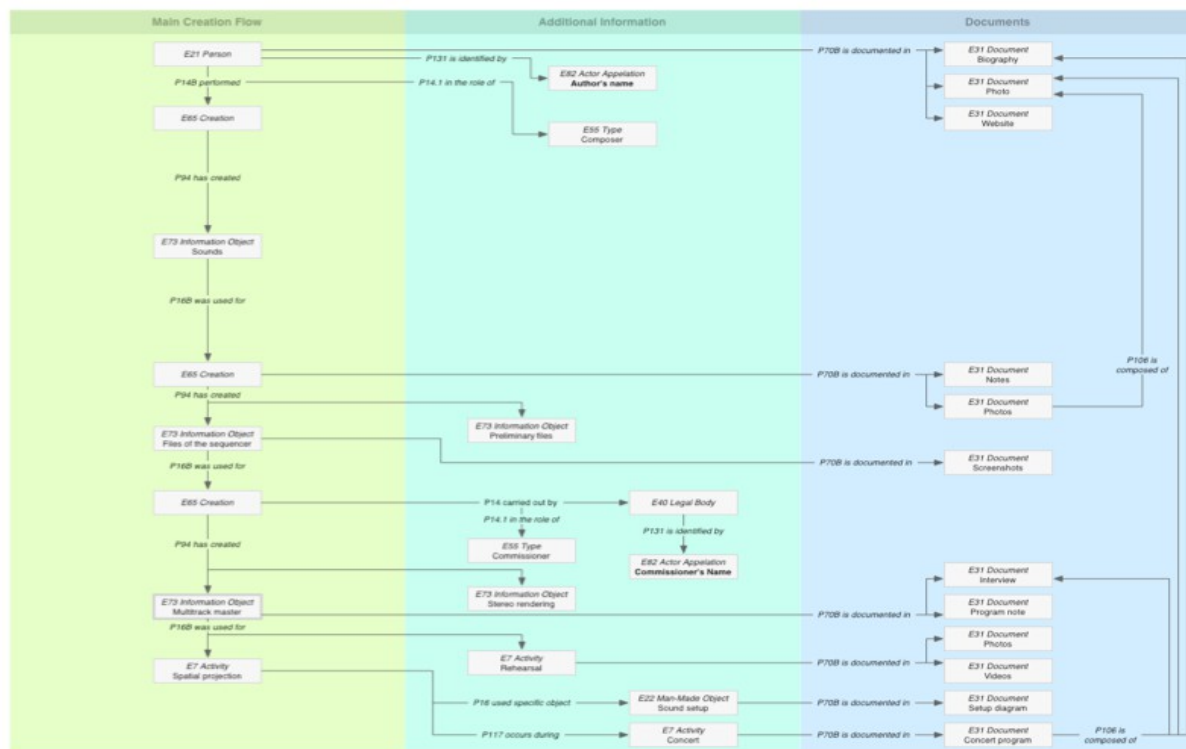


Fig. 3. Graphic representation of the acousmatic model (italic: CIDOC CRM classes and properties).

Fig. 9.2 CASPAR Distance Liquide 2

The final screen shot shows how an effective GUI model can be extrapolated to achieve

an archive of a complete project, and where material is to be found.

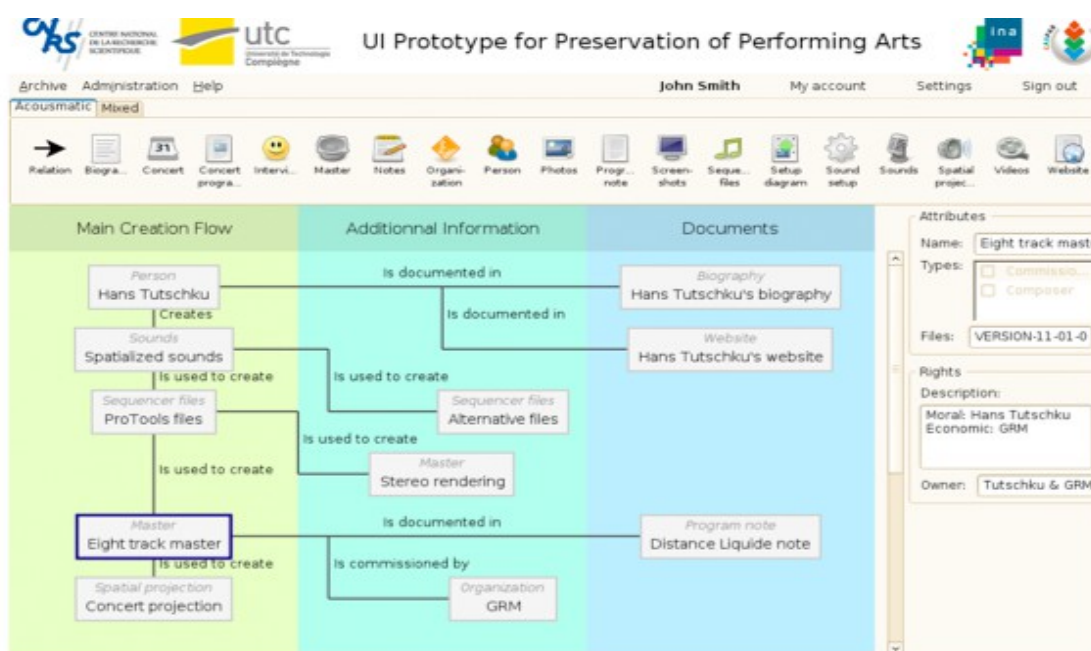


Fig. 4. Prototype of a user interface for an archive producer.

Fig. 9.3 CASPAR Distance Liquide 3

Whilst the archive is informative as to origins and connections of compositional material (as is also the case with *Soundloom*), it does rely on preservation of audio files and sequencer information and screen shots from *ProTools* for example. This has to be questioned, given that a hard copy archive is potentially more enduring than one that is

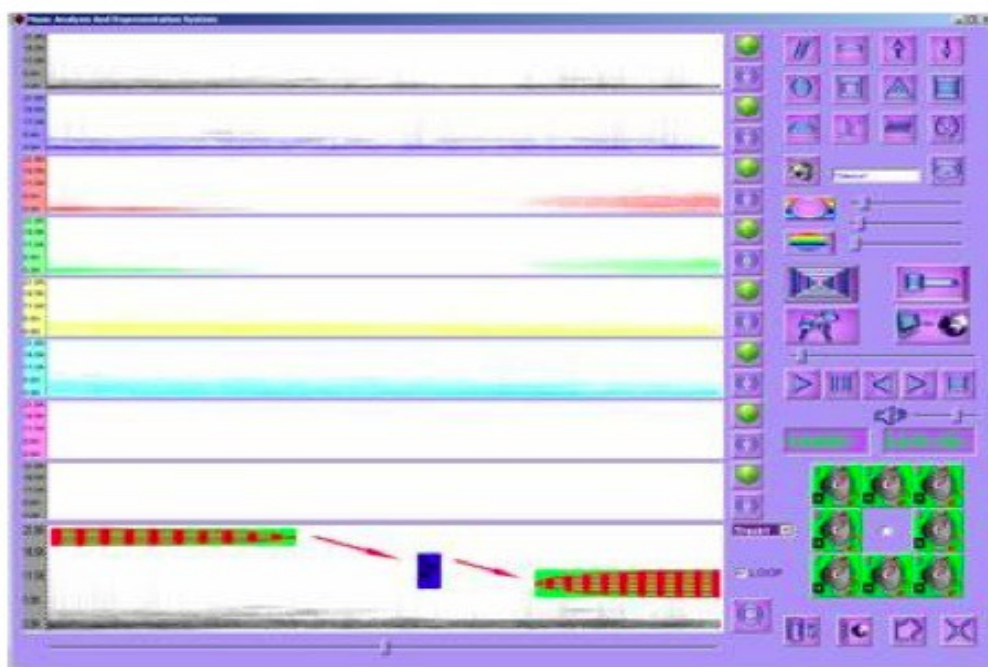
predominantly reliant on digital data. However, understanding and analysis of compositional process in a particular piece, must give such a representation some compelling validity as a preservation. *CASPAR (Cultural, Artistic and Scientific knowledge for Preservation, Access and Retrieval)* is 'an integrated project co-financed by the European Union within the Sixth Framework Programme (Priority IST-2005-2.5.10, 'Access to and preservation of cultural and scientific resources'), that started on 1 April 2006.'

*MARS (Musical Analysis and Representation System* date unknown) is another and earlier software project that has been developed, and that could be effective in producing an archive of electroacoustic music.

The Musical Analysis and Representation System (MARS) is designed for the purpose of documenting, analyzing, searching electroacoustic compositions for the collaboration of researchers in a distributed setting being connected via the Internet. In figure 1 the user interface can be viewed. Here, the user can visualize the electroacoustic music in the sonogram window for each different audio track. The user can freely annotate the electroacoustic music files by using the predefined annotation symbols, like straight line, bend line, circle, etc. In addition, there are options to zoom, mute, solo etc for each different audio track. By using the setting option, the user can freely change the MARS setting like, changing the color for sonogram, etc. Even more, the user can freely operate the multi track audio player by using the buttons like, play, pause, stop, loop, etc. (*Informatik 5 – Information Systems* Prof. Dr. M. Jarke RWTH Aachen University)

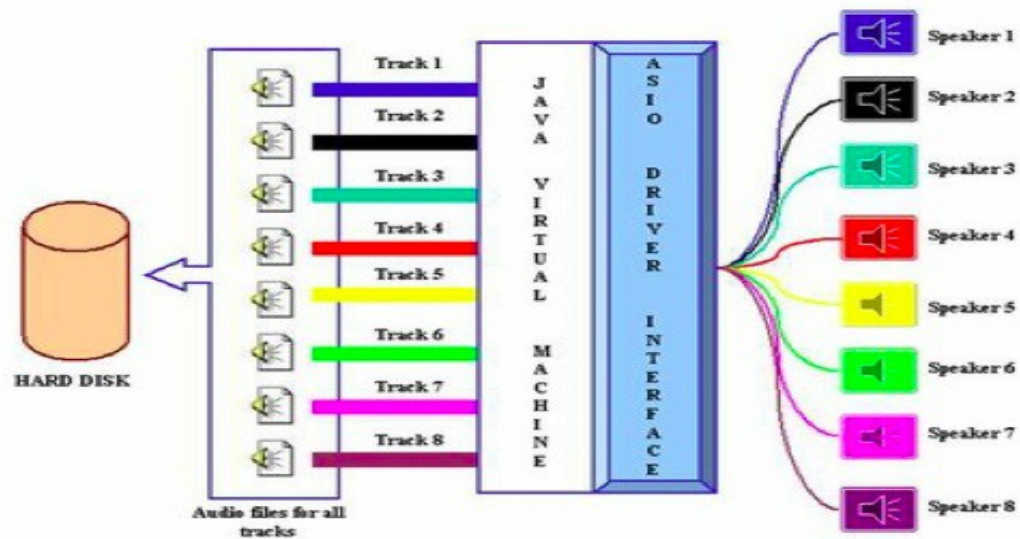
Clearly *MARS* is also dependent on the preservation of digital data. However it does offer the possibility to link with other relevant data such as audio files that can then be represented graphically, and as XML and other network data. This is something that might be beneficial in *Acousmographie* which is discussed below, for instance in the

form of *Hyperlinks* to *Word* documents. Both *CASPAR* and *MARS* indicate something of an imperative as regards the preservation or archiving of electroacoustic music, that is undoubtedly composer driven. The four screen shots below are taken from the *Informatik 5* paper quoted above. A characteristic that *MARS* shares with other systems such as *Acousmographie*, is that the representation is seen alongside a sonogram of the sounds to which they relate. Likewise of course, all studio applications such as *Pro Tools* or *Logic* all have at least some kind of visual representation in the various edit windows, to assist the work in progress. Screen shots of these are shown in *Chapter 8*.



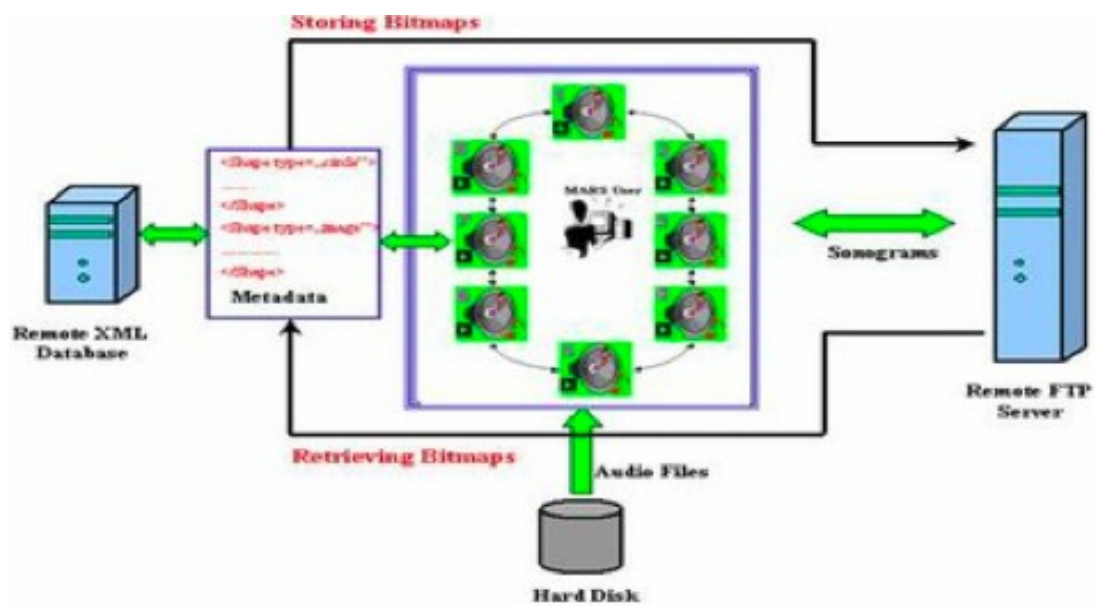
**Figure 1: Musical Analysis and Representation System (MARS)**

Fig 9.4 MARS 1



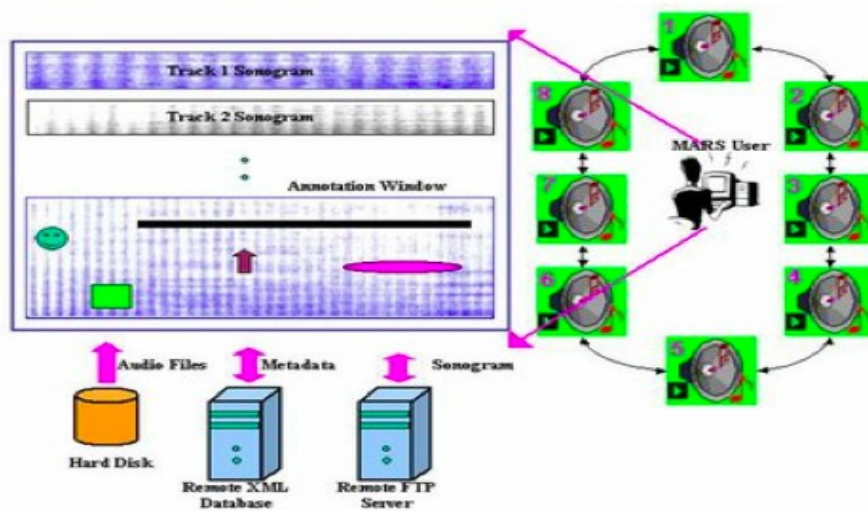
**Figure 2: Eight channel sound card control with with java**

Fig.9.5 MARS 2



**Figure 3: Meta data management in MARS**

*Fig. 9.6 MARS 3*



**Figure 4: User interaction with MARS**

*Fig.9.7 MARS 4*

*Soundloom* is a GUI developed by Trevor Wishart as part of York University's

*Composers DeskTop Project*. This project has evolved over thirty or more years, originally for the *Atari* series of computers, but now available for Windows and Mac. *CDP* features numerous sound processing tools that can be used specifically for the composition of electroacoustic music. *Soundloom* as a GUI allows a composer to track the application of such processes and importantly, leave detailed notes about what has taken place. Wishart has expressed the view to the author that his own *Soundloom* files are a complete record of his compositional work going back over many years, with reference to hundreds of thousands (perhaps millions) of sound files. It also includes detailed notes as to the origins, manipulation and relationships between these files. Screen shots of SoundLoom are shown in *Chapter 8.1.1*.

*Acousmographie*, and its derivative for *Mac* computers *EAnalyse*, is designed to facilitate analysis. It has the potential however to retain enough information to be able to act as an archive or preservation within the compositional process. *Acousmographie* is discussed more fully elsewhere in this thesis, but in essence permits an audio file, including a complete composition, to be heard and presented alongside its sonogram, and a compilation of graphical symbols and textual material that represents the audio. In *EAnalyse* there are now various other graphic tools to aid different types of analysis, some of which can preserve different aspects of the audio data.

These examples share a common conceptual framework in that they are a systematic attempt to develop ways of preserving enough meaningful data about



musical composition, either as it is in production or as completed projects<sup>33</sup>. Composers however are often less systematic, and sketch graphics, scribble text and other material, which is nevertheless significant as reference points for composition that is underway or fully completed. Whilst representation for analysis and representation to preserve an archive have much in common, analysis seeks to preserve specific types of data in order to explicate particular characteristics of a passage of music. The preservation of an archive seeks to retain particular types of data in order to give insights into the thinking behind a particular moment, passage, or complete composition. At best and perhaps only as an ideal, the retention of data *might* permit the reconstruction of the piece. Traditional notation allows us to assume the possibility of this, but only because the piece is reconstructed because the act of performance occurs subsequently to the act of composition.

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<sup>33</sup> Refer also to notes on metadata and *Cuidado* in Chapter 8.10

## 10. The Perception, Cognition and Visualization of Musical Timbre

### **10.1 Instruments, Virtual Instruments and their Historical Importance to Musical Development**

Machines or implements that make sound for music, are as old as music itself. How old that may be is doubtless a matter of prehistory and archeology. Music has always been fashioned around its implements, and sometimes these implements have been fashioned to make particular kinds of music happen. Sometimes therefore these implements have actually caused the character of music to change, whilst at other times they have been developed in order to bring about the changes in the character of particular music. An example of this would be the addition of valves to natural brass instruments in order to to accommodate more complex tonality in the Romantic Period. In this respect electric instruments, virtual or otherwise, are no different to acoustic instruments. It should be no surprise therefore that electronic machines and software should have changed the nature of the music for which they were intended to generate or adapt sounds. Whilst these changes are profound enough to have involved consideration of the aesthetic fundamentals of music and the musical experience itself, development of acoustic instruments has also sometimes posed similar questions. One

good example of this would be the role of the *Sonatas* by Beethoven in the development of the piano in the 18<sup>th</sup> and 19<sup>th</sup> centuries. In this case, experimental work with piano technology was closely bound up with the possibility of new piano sonorities as a fundamental compositional element.

## **10.2 The Role of Timbre in the Hierarchy of Musical Parameters**

All musical parameters have been affected by electronic technology. However the sonic possibilities that electronics have made available, have made necessary a reappraisal of the role of timbre in music, and even of what timbre as a phenomenon actually is. Perhaps this is not surprising since timbre is in some ways now revealed as the most fundamental of all musical parameters, and the one from which all others are derived. It is true to say however that this is not commonly accepted. Certainly, given the development of musical history, we could be forgiven for thinking that pitch and duration predominate over timbre. However there can be no pitch without timbre, and for timbre and sounds to exist at all, they have to take place over time, or have duration. It is necessary in searching for the truth to the structure of musical hierarchies, namely pitch as a sub-set of timbre, to view all of the contributory factors that have made music possible. Musicians have always concerned themselves with things like the manufacture and design of suitable instruments, and the evolution of sonic structures. These types of decision have normally been made before music is composed or played. Ultimately therefore music is a sonic art, and it derives its meaning from sounds over time.

### 10.3 Timbral Definitions and Perception

An adequate definition of timbre has been the subject of considerable debate, the classical one being: -

-the characteristic of a tone that can distinguish it from others of the same frequency and loudness. (Backus 1969 page 107)

This however is somewhat negative, far from sufficient, and derives from Backus' concept of a musical tone namely, a sound produced by instruments lasting long enough and steadily enough for the ear to ascribe the characteristics of loudness, tone quality and pitch. It is more or less identical to the American Standards Definition 12.9 which describes timbre as:-

-that attribute of sensation in terms of which a listener can judge that two sounds having the same loudness and pitch are dissimilar. (American Standards Association 1960)

McAdams and Bregman described timbre as:-

the psychoacoustician's multidimensional waste-basket category for everything that cannot be labeled pitch or loudness. (McAdams and Bregman 1979)

Timbre is therefore commonly described, as in the quotes above, as all those qualities of a sound *left over* as it were, after pitch and loudness have been excluded.

Timbral identity however has more positive and meaningful perceptual significance than this. Timbral perception has been characterized as involving:-

-correlating a number of factors of the tone, including the nature of the attack, the harmonic content, and the tuning of the partials. To some extent the amplitude, pitch, and temporal aspects all contribute to our characterization of timbre. (Dodge and Jerse 1985 page 59)

### 10.3.1 Timbral Attributes

Robert Erickson (1975) listed and identified the following subjective and objective qualities that could be responsible for the perception of timbre:-

#### ***Subjective***

Tonal character, usually pitched  
Noisy, with or without some tonal character, including rustle noise  
Coloration  
Beginning/ending  
Coloration glide or formant glide  
Microintonation  
Vibrato  
Tremolo  
Attack  
Final sound

#### ***Objective***

Periodic sound  
Noise, including random pulses characterized by the rustle time (the mean interval between pulses)  
Spectral envelope  
Physical rise and decay time  
Change of spectral envelope  
Small change (one up and down) in frequency  
Frequency modulation  
Amplitude modulation  
Prefix  
Suffix

*Fig. 10.1 Erickson Sound Descriptors*

This corresponds closely to the timbral attributes later identified by this author in this chapter. It would be an assertion of this thesis that a visualization methodology might be effectively approached, by establishing and agreeing on ways to represent these attributes. Further issues concerning the visualization of these attributes are also dealt with in a later sub-section.

In the *Prelude* to his book *On Sonic Art* Trevor Wishart (Wishart 1996) states his wish to avoid the debate concerning what counts as music that he had often encountered in relation to his own work, by giving the book the title it has and developing the concept of sonic art. What he thereby avoids is the necessity of justifying music where pitch and duration are predominant features. In particular he quotes and later criticizes Boulez in *Boulez on Music Today*. This has been given earlier in this thesis<sup>34</sup>

Wishart goes further and writes:-

It is notability which determines the importance of pitch, rhythm and duration and not vice versa and that much can be learned by looking at musical systems without a system of notation. (Wishart 1996 pages 6 and 7)

Pitch therefore is a sub-set of timbre, and only a minority of timbres will produce identifiable pitch components. A complex waveform will give rise to pitch components only if certain conditions are met. Acoustically the waveform must be periodic and be sustained for long enough to be perceived as pitch. The length of time is very brief and varies with the frequency in question. According to John Backus quoting from H. F. Olson a frequency of 100 Hz requires a tone lasting at least .04 seconds whereas a frequency over 1000 Hz requires at least .03 seconds (Backus 1969:128). There are also other factors that effect our perception of pitch from the periodic frequency of the waveform. These are frequently considered to be subjective. However

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<sup>34</sup> 'Pitch and duration seem to me to form the basis of a compositional dialectic, while intensity and timbre belong to secondary categories. The history of universal musical practice bears witness to this scale of decreasing importance, as is confirmed by the different stages of notational development. Systems of notating pitch and rhythm always appear highly developed and coherent, while it is often difficult to find codified theories for dynamics or timbre which are mostly left to pragmatism or ethics.' (Boulez 1971)

all sensation of pitch is the subjective outcome of the physical phenomenon of frequency.

Pitch is our subjective evaluation of the frequency of the sound; for any given frequency there will be perceived a certain pitch, but the perception may be different in different situations, so that a specific frequency will not always have the same pitch. (Backus 1969 page 128)

Because of the reliability and sensitivity of normal hearing within the audible frequency range, it has become common to regard pitch and frequency as virtually synonymous. Yet it is necessary to remember the possible effects of phenomena such as missing fundamentals and differences in intensity to the perception of pitch.

The fact that pitch is a sub-set of timbre however, cannot detract from the power and significance of pitch in many musical experiences. Timbral composition on the other hand *counts* as musical composition, and does not need to seek justification in the aesthetics of musical hierarchies, and concerns over the apparent domination of pitch and duration structures. Additionally of course timbral composition in itself is not confined to so-called timbral compositions. Part of Wishart's argument is that much of the predominance of pitch and duration is caused by the apparent ease with which these musical parameters can be notated (or visualized as it has been referred to elsewhere).

The principal point I am going to develop is that the priorities of notation do not merely reflect musical priorities – they actually create them. (Wishart 1996 page 11)

This point contrasts strongly with the more conventional view. For example Carl

Seashore had no doubts about the hierarchical predominance of pitch.

Since pitch is the fundamental character of a tone, and pitch discrimination is a measure of the capacity of this sense, it ordinarily may be regarded as the most basic measure of musical capacity that we have. It determines not only what we shall hear, but fundamentally what we shall remember, imagine, and think, and, most important of all, it determines in large part what emotional reaction we shall have for the tone. (Seashore 1938/1967 page 63)

If this is true, then we must listen to music differently to the way in which we listen to other sounds. In some ways this seems to be reflected in the two ways in which the human voice communicates meaning. Linguistically (speech) the human voice appears to be predominantly timbral, whereas musically (song) it appears to be predominantly melodic. This is not to deny of course that most languages contain at least some elements of pitch when spoken, and vocal music always has some timbral qualities.

Some recent developments in the way in which pitch is structured in contemporary classical music, as for example evidenced by the work of Pierre Boulez referred to above, have become so complex that pitch seems to be subsumed into creating what are really timbral effects. This is also the case with composers such as Takemitsu and Messaien. In these circumstances, meaningful pitch identity seems to require some kind of melodic or harmonic characteristics. It seems that the more these are denied, then the more timbral the music becomes. And it can often be the case that timbre will dominate a musical experience, even when pitch is clearly discernible and important. There are good examples of this to be found in contemporary music of all kinds, and some have been referred to in other parts of this thesis (e. g. Stravinsky's *Rite*



of *Spring*). To take one more specific example, much of the musical significance of *Le marteau sans maître* by Boulez seems to rest in its timbral qualities. In spite of some of Boulez's assertions to the contrary, the sequences of pitches and intervals are often far too elusive to be followed, in such a way as they may become cognitive. Cognition of pitch/interval sequences is what is meant by melodic qualities in music. Just as pitch is hierarchically a sub-set of timbre, so melodic qualities only occur when sequences of sound meet certain conditions. What is important about pitch, if it is to predominate as a musical parameter, is that it must be meaningful aesthetically. The *Le marteau sans maître* is a good example of music whose meaning as aesthetic experience, is at least as much, and often more so derived from its timbral qualities.

There need be no requirement in the perception and cognition of musical parameters for there to be an identical response in all listeners. This is because there can be no expectation of an identical aesthetic experience either on a cause or effect basis. This is not to say that composers do not try to organize or predict aesthetic outcomes. In reality one can suppose that musicians have what might be described as a '*band-width*' of expected aesthetic outcomes. It is quite common in the arts however for these outcomes to be challenged<sup>35</sup>.

Timbre then is the most difficult and fundamental of the musical parameters. It is multi-dimensional and therefore difficult to notate or visualize. However it is often likely to give aesthetic character to music over and above the other parameters of pitch

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<sup>35</sup> This is why assessment of artistic endeavour for example in education is so problematic.

and duration. The exposition of timbre and timbral objects mark out the passage of time in music, time or duration being the other most fundamental parameter, paralleled by space in the visual arts. Music is a sonic art consisting of sounds or timbre over time, as opposed to the visual arts, which can be understood as colours and shapes in space. Giving consideration to our aesthetic experience of time and space in this way will perhaps require understanding of the cosmological and scientific relationship of time and space. Consideration of these philosophical problems is firstly essential if we are ever to overcome some of the practical problems of making electronics more predictable and comprehensible in its creation of timbre. The nature of space/time, aesthetic experience, musical hierarchies and knowledge perception and cognition are all matters that will be involved in the better understanding of musical timbre.

To summarize these issues: -

- Timbre is important enough to predominate in some compositional work
- Timbre is multi-dimensional and therefore difficult to visualize
- Pitch is a sub-set of timbre in that only certain sounds possess pitch characteristics
- The predominance of pitch may be a result of its comparative ease of notation
- Electronic technology has increased the potential of timbre as a musical parameter to effect or even dominate compositional development
- Electronic and acoustic instruments and sounds have the same potential relationship with compositional and timbral development

## 10.4 The Fast Fourier Transform as a Device For Performing Notational Tasks in Music

This section outlines why the visual representation of a waveform, such as for example an FFT or spectrogram, is largely inadequate as a visualization for compositional purposes. *Seeing* a waveform in this way offers little relevant information to address the categories suggested by the taxonomical structure presented in *Chapter 9*. There is an indication of amplitude and to a certain extent texture, as well as the some clues as to positioning of various changes. Timbral quality and significance is largely obscured however.

This thesis has argued that the role of visualization in the composition of music fulfills any or all of four possible main functions: -

- a) as a means of prescribing what is to take place.
- b) as a means of describing what has or is going to take place
- c) as a means of analyzing what has or is to take place and
- d) as a means of preserving some kind of a permanent record or archive of particular music.

Analysis and preservation are made possible by prescription and description, and are therefore subsidiary to them. It needs to be stated again that musical visualization is never synonymous with the music itself, and for it to be so would make the development and existence of musical sound unnecessary. This last point tends to be

forgotten when the manipulation of so much musical material takes place with the aid of notation or other visual tools.

In conventional western classical music it can be taken for granted that traditional notation will deal with the manipulation of pitch and duration in most circumstances required for compositional, performance, analytical and archival purposes. However it can be well argued, and has already been stated elsewhere in this thesis, that musical development itself has been constrained by what traditional notation makes possible. The fact that Trevor Wishart's book *On Sonic Art* (Wishart 1996) avoids any reference to music in the title, is a reflection on his part of the fact that the difficulty of notating timbre is a contributory cause for many to doubt if timbral composition counts as music at all. On the other hand it is also the case that folk or world music, which rarely relies on notation, is often notated in some way only when it is the subject of study by musicologists. Musical notation and visualization is therefore and should remain, merely a pragmatic solution for assisting with certain compositional problems. And there are problems in the *composing of timbre*, referred to in the next paragraph, that could be aided by notation or visualization, given that prescribing, describing, analyzing and archiving are what will be required of such a system.

#### 10.4.1 Timbral Composition and Composing Timbre

It is necessary at this point to draw a distinction between timbral composition and

composing timbre. To take the former, it seems to this author that timbral composition is composition of musical sound through the manipulation of timbral elements for musically aesthetic or musically discursive reasons. Composing timbre on the other hand involves the actual *imagining* of timbre to some extent, for musically aesthetic or musically discursive reasons. The relevance of aural *imagination* in the compositional process is discussed in *Chapter 4*. In practice these two approaches may well be indistinct at times, in the way that they might occur in particular music, but they nonetheless can remain as contrasting approaches to musical composition. Essentially composing timbre involves the same kinds of musical thinking as does composing pitch and/or duration, particularly as regards *thinking* of the sound imaginatively. It is likely to involve elements of prescription, description, preservation and analysis, in order to manipulate organizational structures so as to carry out some kind of musical argument, all of which might be assisted by some kind of visualization. As far as the resulting timbre is concerned, the structures will have different *qualities* to those of other musical parameters, but the same kinds of processes occur. These can be summarized as: -

- a) establishment of identities (motifs, objects, events)
- b) comparisons as to similarity or dissimilarity of identities
- c) establishment of relationships between identities
- d) analysis of identities sometimes to form new ones
- e) synthesis of identities sometimes to form new ones
- f) transformation of identities
- g) more general evolution of new identities having a relationship with existing ones.

#### 10.4.2 The Unpredictability of FFTs

It is well known that the correlation between the visual appearance of a given waveform and the sound it appears to produce, is in most cases so unpredictable as to be virtually useless for the purposes described above. A Fourier or Fast Fourier Transform can accurately represent any waveform and its spectrum, but given the lack of obvious correlation between the signal and resultant sound, it will lack most of the attributes commonly looked for in a system of visualization. In other words an FFT does indeed describe the waveform and spectrum, but does not by its visual appearance meaningfully evoke a great deal about the sound itself. The prescription or description of a constantly moving complex sound imagined but yet to be created using a Fourier or Fast Fourier Transform, would be virtually impossible to imagine. There are 3D FFTs that move over time, and FFTs in general can reveal spectral density, as well as filter out information to reveal things that might be useful in a visualization. In the general case, Fourier demonstrated that any signal, regardless of whether its waveform is periodic, can be described either by its pattern of amplitude versus time (its waveform) or by its distribution of energy versus frequency (its spectrum). Either form of this dual representation is sufficient to describe the signal completely to a physicist. Thus it is common to speak of the two domains in which a signal can be described: the time domain and the frequency domain. (Dodge and Jerse 1985) It is important always to make the distinction between describing or prescribing the signal rather than the sound itself, since the two are, as indicated above, not synonymous. Sound is a *perceptual*

construct, and only exists as a result of its being heard. The *physical* events that eventually create sound are waveforms and their attendant spectra.

Visualization in *musical* terms is therefore a process for prescribing, describing, analyzing and archiving these perceptual constructs, when they give rise to musical and musically aesthetic experiences. In more practical terms it is to be hoped that systems of timbral visualization might go some way to assist in the actual process of synthesis as well as analysis of musical timbre.

Whilst FFTs are indeed a visual representation of sound waves including musical ones, they do not offer sufficient scope to musicians for enhancing the compositional understanding of such sound waves to any useful extent. It might be possible for an FFT to be used to *reproduce* a waveform given sufficiently accurate processing. In that event it could then be said to be an archive of such a waveform.

### **10.5 Verbal and Graphic Descriptions of Sound Objects**

A sound object is a conceptual or cognitive construct derived from perceptual processes. Sound itself owes its existence to perception, and sound is not synonymous with the sound waves or air pressure variations that give rise to our perception of sound. There can be no such thing as a sound that is not heard. This would force us to contemplate the notion of sound that is silent. Sound waves become sound when they

interact with an appropriate receptor of some kind. Describing or identifying sound can only be done in the context of its reception, even if this reception is conditional or imagined in some way. As the perceptual processes that give rise to sound acquire cognitive contexts, the sounds become increasingly identified as sound objects. Things like identity, recognition, significance, comparisons, direction, source, origin or cause, as well as beginnings, middle and endings then become more appropriate. I could give as an example here a single note on a Breton bombarde. The significance and meaning of this single sound object is greatly enhanced by existing knowledge, for example as to what kind of sound source it might be and its means of production, and where and in what circumstances it or something similar might have been heard before, as well as the fact that it is a musical instrument, with expressive characteristics, possibilities and limitations.

Therefore describing the physical phenomena or the sound waves themselves that give rise to the experiences that are sound, says little about the perception and cognitive understanding of the sounds themselves. Describing the *experience* of sound is more significant, and will firstly depend on some kind of interpretation of what we perceive. Describing sound objects will be a more cognitive activity, that should be both more accurate and capable of being readily understood and agreed upon by other people, as well as by the person making the description at a later date. It is important to differentiate between the perceptual and the cognitive, whilst recognizing that in practice they coexist in the same continuum and react rapidly and continuously together



to create the significance and meaning of sound as an experience. In practice therefore, it may often be difficult to determine what are perceptual interpretations of sound and more cognitive descriptions of particular sound objects. The experience that is sound is therefore usually enhanced by the cognitive identification of sound objects. It is only when significant sound experiences begin to have aesthetic dimensions that they become musical.

One of the differences between the cognitive and perceptual in the experience of sound is that the cognitive appears to be more objective and the perceptual more subjective. Cognition is more likely to involve a measure of public agreement, whilst perception need not involve public agreement. This has important implications when considering the potential validity of methods of describing sound in any meaningful way, either verbally or graphically. Commonly more formalized descriptions of sound objects assist the prescription or description of such objects, and additionally perhaps analysis or preservation. All such descriptions are dependent on accepted codes or conventions if they are to be meaningful. These codes or conventions must be reliant to a certain extent on public agreement about sound or types of sound object. It is perfectly reasonable to expect these conventions to have to be learned and to derive from knowledge held by people in an appropriate position to hold such knowledge. (Hamlyn 1970)

All of these conditions apply to conventional music notation, even though this system of visualization can hardly be described as perfect. There is no way that an untrained person can derive anything meaningful about sound from conventional notation. And even with training there is much that is omitted from this notation, and in no sense is such notation the same as the sounds themselves. So just as sound waves are not sound itself, so neither are they descriptions of sound either formalized or informal. In conventional notation this is even true of pitch and duration which are handled more accurately by this system than other parameters. And in any case these parameters cannot exist in isolation from timbre, dynamics and spatial characteristics. Conventional teaching of music often treats the notation as if it were the music itself. Having said this however, conventional notation can in some circumstances give more information about these parameters than one might think. As discussed earlier Stravinsky's score of the *Rite of Spring* is an example of conventional notation that with adequate training will provide descriptions of the resultant sounds which can be predominantly pitch, duration or timbre or any of these in various combinations; timbre however only if the observer is sufficiently knowledgeable about the orchestra. Scores like this therefore exist within a highly codified descriptive system, which will only be fully understood by people with specific skills<sup>36</sup>.

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<sup>36</sup> Stravinsky's *Rite of Spring* (1913) is probably as complex a sequence of musical sound objects that conventional notation has sought to describe. It is essentially motivic, if motives are key events that act as tokens of the work's aesthetic evolution. However these motives are by no means all melodic. Many are entirely timbral, or entirely rhythmic, or some way between the two. There are some melodic motifs as well, but these rely heavily on their timbral identities. Perhaps the uniqueness of this piece, especially at

It is difficult to imagine how this piece could have come into existence or be performed without the aid of notation, which as has been said is an imperfect, highly codified graphical description of the resultant sound. Much as one must wary of allowing the notation to determine what counts as music, this music at least does owe its existence to the graphical system that describes it. (Trevor Wishart *On Sonic Art* 1996)

It is also important to note that this score is a practical example of timbre being described and notated, even though the system employed is predominantly used for pitch and duration.

Conventional music notation is one of many systems of describing what are in fact sound objects for specific purposes. Of necessity both music and the spoken word have developed highly codified systems that apart from anything else are graphical descriptions of particular sound objects. These systems are often closely allied to the development of the morphology of the music or language in question. Language is a very special case because its use and dissemination occur through speaking, listening, reading and writing, which is in fact how they are taught. A word can exist therefore as a spoken or written object, and can be transmitted or received in either or both formats whilst still having the same meaning. In certain circumstances of course the spoken word can express a different meaning to the written word because of the inflection of the voice. This is more prevalent when encountering sequences of words. However we

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the time it was written, is the way different musical parameters are integrated together and become completely inseparable and interdependent, and the way in which parametric hierarchies shift almost seamlessly and priorities are changed as the piece unfolds.

often turn to the written word for the complete meaning of a linguistic passage. It is easy to fall into thinking that music or sound itself can be meaningful in the same two ways.

## **10.6 Musical Meaning**

It is necessary at this point to consider in what ways music or sounds are actually meaningful. This has been a notoriously difficult question to deal with. The significance or meaning of sound is difficult enough, but with music one encounters problems involving the philosophy of aesthetics. In a previous paper, this author devised a possible model of musical experience, which has close parallels with what has been stated above concerning the relationship between perception and cognition in the experience of sound. (*Appendix B*) In particular, the way in which what we know from previous experiences informs current aural experiences, which in turn greatly influences our interpretation of what we are hearing or listening to.

This model seems to be much in line with the neurological findings expressed in Eduardo Miranda's paper *A Neurotechnological Approach to the Analysis of Electroacoustic Music: A Proposition*, given at de Montfort University on the 12<sup>th</sup> June 2007. Here Miranda proposes tools for the representation and analysis of electroacoustic music based on neurological principles.

Firstly I describe the journey that sounds take through the auditory pathways from the ears to the auditory cortices and then I enumerate the sorts of tools that could be developed based on the various stages of this journey and the types of information that they would elicit. (Miranda 2007)

The key processes described here that relate to the model in Appendix B particularly refer to sound intensity, frequency, onset timing, sound source and aspects of spatialization. There are also important references made to attention, hearing and listening, integration with the visual systems of the brain, auditory *Gestalten* and the evident continuous interplay between perception and cognition, or perhaps cognition made ready and possible by perception.

These issues are not simply a matter of aesthetics as is the case with music, but can be a matter of our survival, as is the case with sounds emanating from predators or audible warnings of approach from different types of vehicle. So it is possible to reinterpret this model of musical experience to more closely fit all aural experience. This model acknowledges the difference between sound waves and sound, and makes clear that sound is at least the result of perceptual processes, which can also be effected by cognitive processes as well. For most people in practice and in most circumstances, the *Musical Coherence* in the *Model of Musical Experience* probably fits somewhere between the *Sound* and *Sound Object* in the *Model of Aural Experience*. It also has to be said that these are idealized models intended to rationalize and theorize experiences, which in practice one would expect to change in emphasis rapidly.

It would also seem to be the case that the analytical '*tripartition*' (*poietic*, *esthetic* and *trace*) outlined by Nattiez (and earlier by Molino) which was referred to earlier, has at least some correspondence with the *Model of Musical Experience* in *Appendix B*. In Nattiez the traditional model of producer    message    receiver is replaced by producer    trace    receiver (trace being the musical material). In other words what is heard in a musical experience is acted upon by what we know about it and similar experiences.

Therefore any meaning or significance given to sounds is something that arises from the body of knowledge possessed by whomever or whatever heard the sounds in the first place. The generation of meaning is a reciprocal process in that it adds to the body of knowledge that created the meaning in the first place. Higher levels of applied consciousness can therefore generate greater levels of meaning and significance. Any verbal or graphical descriptions of sound or sound objects need to support or enhance, and be an integral part of this significance or meaning. They will arise from and contribute to the cognitive processes involved. Hence in musical terms we again refer to description, prescription, analysis and preservation.

## **10.7 Musical Attributes**

In order to devise a system for visualizing sound, it would seem necessary to outline what attributes any sound might have. Producing written graphical or verbal

descriptions of these attributes ought to get closer to a useful record of intended or already produced sounds. It is possible to list common attributes of musical sounds. Given that a musical sound is any sound whose acoustic characteristics are explored and exploited as musical parameters and in musical ways, these characteristics must also be applicable to any sound object or sequence of sound objects. The following is a possible list of musical parameters and their component attributes commonly in use today. The timbral characteristics were also referred to in *Chapter 10.3.1*

TIMBRE	PITCH	DURATION/TIME	DYNAMICS	SPACE
Harmonicity/inharmonicity	High/low	Fast/slow	Loud/soft	Left/right
Noise	Intervals	Long/short	Crescendo	Front/back
Formants	Scales/modes	Grouping structures	Diminuendo	Diversity/singularity
Envelope	Chord clusters	Proportional changes	Sudden changes (attacks)	
Component/sub-envelopes	Tonality	Rhythmic patterning		
Vibrato	Atonal systems	Metre/pulse/beat		
Phrasing typologies	Temperament	Tempo		
Reverberation				
Means of production/source/cause				

*fig. 10.2 Musical Attributes*



This list is not predetermined or fixed in any way, and new aspects or attributes could be added at any time. This has always been the case. For example, the list of attributes belonging to dynamics would have been far more limited or expressed differently before the time of the Mannheim orchestra in the early Classical period. Others such as '*atonal systems*' are relatively recent additions. Temperament would have been a very contentious issue in the Renaissance period. A specific piece of music may not necessarily use all the listed attributes or aspects, or even all the parameters. In addition, some of these attributes are bi-polar and some are not. Those that are bi-polar are more easy to divide up into fixed points of reference, which greatly aids comparisons (e. g. the high/low of pitch can produce scales, and dynamics can be marked out approximately from soft to loud). Some attributes are perceptual and some cognitive, and some are not clearly defined as either one or the other. Also the extent to which they are either one has changed, and may change over time. In any case in practice, the separation of human cognition from human perception is never as clear as psychological theory would have us believe, largely because cognition and perception are interdependent.

So for each musical experience, parameter maps have to be produced either consciously or unconsciously which makes the parameters explicit or understood intuitively, and which gives them a hierarchy appropriate to the piece or to the listening experience. This hierarchy is what composers and musicians work with. They may create these hierarchical maps afresh or keep within expectations of some kind, or more probably fall some way between the two. The problem of expectations relates very

closely to the question of public agreement raised earlier (Hamlyn 1970), because musicians will inevitably reach a view as to '*those in an appropriate position to know about*' the particular music they are engaged in. This can apply to all music of whatever kind. One of the ways musicians challenge their audiences aesthetically is to map out hierarchies that are comparatively unexpected. Even more importantly if rarely, new attributes to parameters can be evolved.

It has to be said that for many people hierarchical parameter/component attribute mapping is of a comparatively limited or narrow nature, and for the most part subconscious, but it is nonetheless a reality to be taken seriously. For other people their capacities and response to musical mapping in this way will be much broader, stronger and perhaps (but not necessarily) more cognitive. It also goes without saying that what is being discussed here is a model for all musical experience no matter how trivial or how profound.

The model outlined in *Appendix B* depicts musical experience as aesthetic experience. Musical understanding, content and meaning are achieved as a result of the perception of some kind of musical coherence, and the resulting aesthetic experience adds to our existing knowledge of ourselves and the world we find ourselves in. However our existing knowledge also informs and uniquely enhances our aesthetic experience, and our musical understanding and existing knowledge go on to inform what it is we know about the musical coherences we encounter. As stated earlier this 'knowing about' includes timbre. Thus there are continuous and complex interactions at

work whenever musical experiences of either a trivial or profound nature are taking place.

All musical coherences have some kind of timbral events organized into some kind of formal structure by way of the duration/time parameter. There may also be events within the pitch, space and dynamic parameters. Theoretically at least, a minimum musical coherence could consist of a single timbral object of a given duration, placed in a context of surrounding silence. What would differentiate this from the simple audition of any sound would be the attention given to it, and the aesthetic intentions that lay behind it. The hierarchy of musical parameters as expressed here in this model is what occurs as it were 'by default', although, as has been said, musicians and listeners may have to re-order the priority of these parameters according to musical and aesthetic need.

It has to be said again that the role of timbre is therefore far more important than conventional musical studies would normally indicate. Its role in hierarchical parameter mapping is normally a higher priority than tends to be assumed, and is often the highest of all, given that it might in some basic respects be taken for granted. It is rarely taken for granted however in the expressive, performance and cognitive aspects of music, where it plays an essential role in bringing about effective and memorable musical understanding and experience, which mere pitch and duration/time work cannot really do alone.

## 10.8 Existing Notational Systems

To follow on from the last section, it is beneficial to consider some further aspects of the nature of sound itself, and additional ways in which visualization could be of value in a musical context. It is also of value to review some aspects of traditional notation, and in particular its relationship with the music it represents.

As pointed out in the last chapter, there are of ways of representing sound that may be of some value to an engineer or mathematician, but these may have limited value to anyone else, particularly in terms of understanding the sound in question for musical purposes. To reiterate, the Fast Fourier Transform mentioned in *Chapter 10.4* is a mathematical algorithm that has an application in producing a spectrum analysis. However as was stated, because the resultant visual output is of relatively limited value in understanding the nature of the sound under analysis, this does not make for an effective visualization. The main reason for this is that a spectrum analysis is only indicative of a certain point in time i. e. amplitude plotted against frequency; and it assumes a periodic waveform. Information about the attack, overall envelope, source/cause, texture, reverberation, vibrato and position of the sound in relation to others, are some elements that are largely missing. 3D FFTs will track sounds over time, and can be expected to show elements such as vibrato. This is presumably why musicians adopt some kind of sonogram or even graphical symbols such as in *Acousmographie* and *eAnalyse*, in preference to and as an enhancement of a spectrum analysis.

Here we encounter a further problem that makes the visualization of sound, and musical sound in particular, especially problematic. There is little agreement about what elements, perceptually or cognitively, actually define a sound and the extent to which some kinds of universal descriptors might be applicable. Whilst this is seemingly irreconcilable, this may not unduly effect the value of a visualization, providing that the relevant or applicable elements in a specific case of visualization are identified clearly. The relevant and applicable elements need separate attention and study in themselves.

The type of visualization that is taken for granted in traditional notation has evolved over a long period of time. The limitations of the system are widely accepted, and yet it is still common to encounter a view that such notation *is* the music. Furthermore, it is as if only music that can be written down in a commonly understood system, such as in traditional notation, can count as music. Whilst we may make assumptions about the elements of music visualized in this way, *agreements* about these assumptions are not necessary to the value of such music, or the experience of it. Any chosen musical elements can therefore be represented appropriately in a visualization, and understanding of these elements can thereby be potentially enhanced. The important thing therefore, is to be precise about what it is in the music that is being visualized. Traditional notation has tended to encourage us to look for generic systems of visualization of sound and music, and perhaps encouraged us to evolve music to suit the system of visualization. As mentioned earlier, Trevor Wishart has written extensively about this in his book *On Sonic Art*. For example: -

Undoubtedly, musical notation, like 'speech-notation', originated first as a mnemonic device for already well-established musical practice, but, like writing, it quickly grew to dominate that musical practice. (Trevor Wishart 1996 page 18)

and even after the beginnings of traditional notation: -

- music continued to convey its alternative messages and holy men (like St. Augustin) were obliged to admonish themselves before God for being seduced by the 'mere sensuous quality of musical sounds'. This feeling that attention to aspects of sound beyond those which are capable of description, and hence prescription, in writing (and later in musical notation), is lascivious or morally harmful is a recurring theme of scribe-dominated societies. (Wishart 1996 page 15)

A striking example here is the case of duration in music. It is now almost impossible to imagine music that involves what we would recognize as a melody or a tune, without sensing a metrical structure derived from the familiar proportional time values, measured against notional beats. It was some time before commercial software, such as early versions of *Sibelius*, could deal with such complexities as triplets, or 2 against 3, and more complex tuplets. The default position of such software is that there must be bar lines and a time signature. Sometimes envisioning durations in real time therefore is extremely difficult and, as a compromise, is often aided by interpreting seconds as something like crotchet beats moving at a metronome speed of crotchet = 60. This of course avoids the central issue of hearing sounds as they actually are, not as they might relate to each other in traditional notation.

Traditional notation is of course dominated by the parameter of pitch as well as rhythm. In an earlier quote by Boulez, he stated that pitch and duration can be seen to dominate the parameters of music, as evidenced in part by the ways in which traditional

Western notation has developed<sup>37</sup>. In particular he identifies traditional notation as evidence of *codified theories* of pitch and duration, which are lacking in dynamics and timbre. So we can say therefore, that traditional notation is a form of visualization that conceptualizes sound structures dominated by pitch and rhythmic characteristics of a particular kind, and that behave in particular ways. It is also increasingly the case that as soon as such music begins to have characteristics that behave in other ways, then the visualization that is notation has to be increasingly adapted, sometimes until the point where the necessary common frameworks are no longer easily understood. Erhard Karkoschka deals with many examples of this in *The Notation of New Music* (1966). However in contrast to Wishart, who following Schaeffer and others, seeks to distance *the necessity* of notation from the art of composition, Karkoschka seems to say that notation as a visualization, is essential to compositional development<sup>38</sup>. Some of the examples given by Karkoschka cannot be understood without an explanation of the symbols deployed in the particular piece. This is perhaps of greater importance in a predictive or indicative score. However such explanation might be considered as a textual part of the score itself, and therefore a valid part of the visualization. Of course, traditional Western notation would need considerable textual outlines, were it not for the fact that so much of its tradition has been learned so well, and by so many people.

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<sup>37</sup> Pitch and duration seem to me to form the basis of a compositional dialectic, while intensity and timbre belong to secondary categories. The history of universal musical practice bears witness to this scale of decreasing importance, as is confirmed by the different stages of notational development. Systems of notating pitch and rhythm always appear highly developed and coherent, while it is often difficult to find codified theories for dynamics or timbre which are mostly left to pragmatism or ethics. (Boulez 1971)

<sup>38</sup> The main purpose of musical notation is to make possible the construction, preservation and communication of more complex kinds of music. The technical possibilities of a notation system also influence the act of composing – the entire musical way of thinking of all musicians – so that the aural image of a musical work in every epoch is characteristically related to its visual configuration (Karkoschka trans Koenig 1972)

Perhaps a more telling and complex example is *Sequenza III* by Luciano Berio. In this score, many of the symbols are recognizable as belonging to or adapted from traditional notation. However extensive use is made of symbols that are invented for this piece. In addition there are two pages of explanatory text that can be regarded as part of the score as well. This is particularly necessary because the score is predominantly predictive in character. In all of these examples the mediating role of the performer, which makes the notation necessary, should not be forgotten.

The comparisons that are to be made with traditional notation can be summarized as follows: -

- traditional notation primarily answers the needs of performance
- it allows other processes to be carried out by those familiar with it, such as description, archive and analysis
- it is limited in its focus on specific parameters such as pitch and duration
- it becomes much less specific when timbre and dynamics are concerned
- more experimental music requires additional symbols, sometimes requiring explanation for the piece in question

This chapter has placed some important issues in the context of the questions raised by this thesis. Firstly the relationship between instruments as timbral devices and their historical importance to musical development. This then allows the consideration of the place of timbre as one of the musical parameters, capable of carrying out musical argument and generating aesthetic experience. There is a sharper focus on the nature of timbre and possible definitions, along with what timbral composition can mean. This is summarized in a *Model of Musical Experience*. The difficulties of visualizing timbre and



some existing methods of achieving this are placed within the context of this thesis and the questions it seeks to answer.

## 11. Conclusions

It is clear from this investigation, that in spite of the aesthetic philosophy of Schaeffer and others, visualization has been continually used as part of the composition of electroacoustic music. However, and this is known at least anecdotally, we are a long way from visualization being easily used as an archive capable of preserving the means to *re-create* compositions, with anything like enough *prescriptive* detail. Yet this would seem to be desirable, given the insecurity of the long term preservation of data. In the case of electroacoustic music, many will think that this is because electroacoustic music is usually predominantly timbral. As was seen in *Chapter 10*, the multi-dimensional nature of timbre makes it extremely difficult to notate these complex events, that may be continually changing over time. A visual analogue of such an audible passage of time seems so complex as to be impractical.

In conventional Western classical music, an archive is possible because procedures concerning performance are fairly well agreed upon, and can be learnt. The use of notation also assumes that the act of performance is going to mediate in order to finally create the music. This is possible because the notation of pitch and duration are to some extent agreed and understood beforehand, and for the particular musical style in question. Timbre and dynamics are determined by the instruments selected for

performance, and the ensembles created with those instruments. The re-creation is therefore achieved by performers following these specific annotations. This has of course become a complex fine art in itself, and this includes the arts of orchestration and conducting, and interpretation in general.

To refer to another issue, there have been machines or software in the past, often complex in nature, that nonetheless produced quite limited and predictable results, that sought to create sound from a visual stimulus. This was discussed in *Chapter 1.6*, some responses to the questionnaire in *Chapter 5.2* and referred to in *Chapters 8* and *9*. The preservation of complex auditory data therefore, with the possibility of accurate re-creation in the future remains a problematic issue. As has been said, concerns over this issue were outlined to this author by for example Trevor Wishart (*Chapter 5.2*). It might be possible to leave sufficiently detailed visualizations to lead the way to such a re-creation, providing that the conceptual framework on which they are based could be sufficiently clear, rigorous and most importantly, also agreed upon<sup>39</sup>. But at the moment it would be a potentially time consuming and lengthy process. This was touched upon by Robert Normandeau and others in *Chapter 5.2*. It would also require a measure of agreement as to the meaning of various symbols. And the desire to reach this agreement might well tend to limit the nature of the resultant sounds.

The other activities outlined in this thesis such as description, analysis, understanding and reflection can clearly be assisted and enhanced by effective and

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<sup>39</sup> This refers to public and intersubjective agreement - Hamlyn 1970

suitably designed visualization. Some kind of visualization of an as yet only imagined timbre is clearly possible, and in fact regularly takes place as part of the compositional act.<sup>40</sup>

Therefore it is fundamental to the compositional act, that auditory structures ultimately need a representation that allows them to be grasped and understood in their entirety. We need to *see* the musical meaning of these structures as a Gestalt, precisely because in their real essence they evolve over time. The passage of time over a work needs at some point to be grasped as a single entity, if understanding of the work is to be totally complete. The grid and the responses in *Chapter 5*, and the historical evidence reviewed in *Chapter 6*, lead me to conclude that almost all composers revert to visualization, even if they wish or would hope to avoid this. It is as if in music it is the passage of time itself that demands the visualization, in order to encapsulate the whole thing as a complete entity. Visualization is likely to be an essential precursor to the final *auditory* experience, and that experience in all its complexity only takes place over time. Auditory experience is elusive because its frame of reference or inhabited dimension is *time*. And at the moment, it is only the perception and cognition of *space* that allows us to *see*, represent, and fully understand the many aspects of time.

Visualization and representation of electroacoustic music would be a *fundamental* omission of the genre, if it had ever really taken place. In spite of the urgings of Pierre Schaeffer, this has never happened. It is a conclusion of this thesis that

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<sup>40</sup> See various responses in *Chapter 5.2*

given that visualization has always taken place, a clearer recognition of this by electroacoustic composers would allow a more effective conceptual framework to develop, which in turn would allow a better understanding of the role of visualization as a valuable aid to the composition of electroacoustic music. It might also allow the development of better tools to achieve this.

To put these points more exactly, visualization of timbre and therefore electroacoustic music does not have a shared network of symbols, or a shared agreement as to how such visualization should take place. In any case, timbre has notorious difficulties as regards visualization because, as has been stated, it is multi-dimensional in character. Whilst this is not insurmountable as regards description, analysis, some archives, *aide memoires*, or simply reflection, it is not currently possible to leave a sufficiently detailed, prescriptive and meaningful archive, capable of allowing sounds to be re-created in the future in all circumstances. As soon as re-creation is required, the type of sounds become constrained by the technology imposed by the visualization, even if that technology is simply pencil and paper, perhaps even offering technological instructions.

Consideration needs to be given to whether this assertion alone constitutes a fundamental omission of the genre. There is much that can be accomplished with the aid of visualization, but as yet not that completely prescriptive archive which is perhaps so desirable. It would seem likely that technology may answer this demand in the

future.

## 11.1 Future Implications and Possibilities

Artificial Intelligence techniques may play a role here. To a certain extent AI software could already be programmed to *learn* and *predict* a composer's intentions. In a paper entitled *Enhancing Sound Design with Conceptual Blending of Sound Descriptors*, a new method is outlined:-

for sound synthesis using concept description of sounds. Sound descriptions are blended to form a new description, which inherits properties from the former entities as well as having an emergent structure of its own. Such blends are then synthesised to become a potentially new sound.

This work applies the system Divago, which is based on a general purpose computational model of Conceptual Blending. (Martins, Pereira, Miranda 2004)

This is very much in line with the software proposals suggested later in this chapter. The problems of attribute identities, agreements and definitions have already been discussed in this thesis, and are also discussed in the paper quoted above.

[Timbre] - identifies the sound source and is the most tricky attribute to quantify as it depends on many different characteristics. Another problem is that there is no uniform set of concepts to identify and classify timbre.

(João M. Martins , Francisco C. Pereira , Eduardo Reck Miranda , Amílcar Cardoso 2004)

The matter referred to in the last sentence has been discussed in this thesis and already

in this chapter, in relation to *public agreement* (Hamlyn 1970), with particular reference to attribute definitions and symbols that might be assigned to timbral qualities.

### 11.1.1 Textual Descriptors

The following quote is from *Sound Synthesis and Musical Timbre: a new user interface* (Allan Seago 2011). It is a paper that also proposes the possibility of using textual descriptors applied to AI techniques.

Much research has been focussed on the design of systems whose interfaces connect language with synthesis parameters. [ ] Many of these systems draw on AI techniques and encode rules and heuristics for synthesis in a knowledge base. Such systems are based on explicitly encoded rules and heuristics which relate to synthesis expertise ('bright sounds have significant energy in the upper regions of the frequency spectrum', 'a whole number modulator/carrier frequency relationship will generate a harmonic sound'), or to the mapping of specific acoustic attributes with the adjectives and adverbs used to describe sound.

At the ISMIR conference of 2011 a paper was presented that followed experimental work into the use of verbal descriptors applied to specific timbres, with an analysis aiming at investigating common terms and *public agreement* on terms. (*An Investigation of Musical Timbre: Uncovering Salient Semantic Descriptors and Perceptual Dimensions* Zacharakis, Pasiadis, Papadelis, Reiss, 12th International Society for Music Information Retrieval Conference ISMIR 2011)

For the purpose of this study a listening test exploiting a variation of the Verbal Attribute Magnitude Estimation [ ] method was designed and conducted. The subjects were provided with a pool of 30 Greek verbal descriptors and were asked to describe timbral attributes of 23 sound stimuli by choosing the adjectives they believed that were more appropriate for each case. Once a subject chose a descriptor he was further asked to insert its amount of relevance on a scale

anchored by the verbal attribute and its negation, such as “ not brilliant - very brilliant”.

Below is a list of the chosen timbral descriptors: -

Brilliant	Deep
Hollow	Distinct
Clear	Dry
Rough	Light
Metallic	Messy
Warm	Empty
Smooth	Dirty
Thick	Compact
Rounded	Dark
Harsh	Soft
Dull	Nasal
Thin	Full
Shrill	Dense
Cold	Bright
Sharp	Rich

There could be much debate about the inclusion of each of these descriptors, and the method of data analysis. However this need not be seen as significant in this thesis. In general terms, as long as each composer uses descriptors consistently for the most part within their individual archive, this would enable such a potential archive to locate previous material effectively.

### 11.1.2 Representation Using Graphics

Experimentation with '*drawing sound*' apps on tablets seem promising at first, but at the moment tend to limit the creative auditory possibilities<sup>41</sup>. As an example, the

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<sup>41</sup> Refer to *Chapters 8.9, and 8.10*



artist David Hockney exhibited work at the Royal Academy of Art in 2012, which was produced on the iPad using the app *Brushes* (Taptrix, Inc). Hypothetically for the time being, this quality of work and such software, show that there might be ample scope for detailed graphical images to be saved and linked to sound objects or events. These could be retained for future use with the possibility of editing, mixing and polyphony. New events that are thereby created could be linked to new drawings. Some graphical images could also be linked to sound editing processes. This would result in a meaningful archive of work done, with graphical images identifying sound events. New *imagined* sounds could be searched for and retrieved from the archive using graphical referencing. This could also include added textual material such as tags and descriptors, which would assist the accuracy of the search and sonic retrieval.

In a paper entitled *Drawing Electroacoustic Music* (Thiebaut, Healey and Kinns, University of London 2008) a study is made of the evident need to *sketch* electroacoustic music.

The initial stages of creative design often involve sketching. Electroacoustic composition is no exception to this. Paradoxically, the technologies that enable this form of composition provide little support for the sketching process itself. In this paper we first present evidence for the importance of paper-and-pen sketching in current practice and discuss two strategic representational functions it serves: vagueness and ambiguity. Current music programs offer a variety forms of visual representation but offer only limited support for these functions.

The paper goes on to present the *Music Sketcher* program which aims to bridge the gap between paper-and-pen sketching and the final realization of a piece. There is also a review of the strategies of other software, some of which have been reviewed in this thesis. However:-

although visual means are at the heart of the design to support music composition, these programs do not address the issues of indeterminacy and vagueness, which are integral to the way paper-based sketches are used for music composition.

(Thiebaut 2008)

Great emphasis is laid here on the value of *vagueness* as an approach to visualization, particularly at the early stages of the compositional process. Furthermore, visualization of this type is seen as a significant omission in electroacoustic music, which is an important part of the argument of this thesis. The program is intended to integrate or communicate with other software. Later versions of *Music Sketcher* as evidenced on *YouTube* demonstrate the ability to link drawings with sound files. This was suggested earlier in this thesis (*Chapter 8*), in relation to *Acousmographie* and also examples of the author's own work.

## 11.2 Summary

It remains to briefly summarize the findings of this investigation. Firstly it is evident that visualization has been continually used to facilitate the composition and understanding of electroacoustic music. Methods of visualization have been many and varied, partly linked to the particular task that practitioners were seeking to clarify. This has involved working by hand and also using software applications, at least in part designed to achieve those specific tasks. It would appear that the main issues and difficulties centre on the predominantly timbral nature of electroacoustic music, and the

difficulty of creating archive material capable of re-creating the original work at some time in the future. It is evident that visualization is used to expedite clarity and comprehension with respect to compositional understanding, reflection, description and analysis, *aide memoire* and archive, pedagogy and some preservation of data<sup>42</sup>. It is the contention of this thesis that clearer conceptualization of these various compositional processes, and the relevance of visualization, will lead to more effective and more valuable results within this genre.

The future implications of these findings are hard to predict as regards to a prescriptive archive for the purpose of recreating compositions. This would need to be based on more advanced technology, precisely focused on the task of generating such an archive, and subsequent re-creation of the composition. Aside from this issue, evidence from this research shows that visualization has much to offer other parts of the compositional process. It very nearly achieves the elusive task of prescription.

The opening title of this thesis is headed '*Knowing the Unknown*'. Musical visualization has much to do with compositional *knowledge*, as a vital component to successful compositional endeavour. This does not mean the avoidance of the instinctive and the intuitive, but it does mean that results may be better understood and reflected upon with appropriate and effective use of visualization.

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<sup>42</sup> Refer to the taxonomical structure outlined in *Chapter 7*

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<http://RhythmicLight.com> ((colour organs))  
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<http://www.ears.dmu.ac.uk/FILES/Truax/index.html> *The Analysis of Electroacoustic Music as Soundscape* Truax, Barry EMS2007 conference  
<http://www.ems-network.org/spip.php?article224> (Francois Bayle paper)  
[homepage.eircom.net/~musima/visualmusic/visualmusic.htm](http://homepage.eircom.net/~musima/visualmusic/visualmusic.htm) (Maura McDonnell)

## Appendix A1 Blank copy of the questionnaire

### **QUESTIONS ON THE REPRESENTATION OF SOUND IN ELECTROACOUSTIC MUSIC**

In participating in this process, I would like your permission to use the results with appropriate acknowledgment. You are free to withdraw this permission at any time.

Do you represent sound in any way when you compose? If so how?

In a particular composition to what extent have you represented sound?

What was your representation for?

Who was your representation for?

Was it a representation of what had already happened or of what was going to happen?

Was the representation: - prescriptive \_\_\_\_\_ descriptive \_\_\_\_\_ analytical \_\_\_\_\_

What did the representation contribute to the composition?

What aspects of the sound did you represent and in what detail?

To what extent did it improve your understanding of what you were doing?

Are there any aspects of the composition that the representation did not help or perhaps even hindered?

Did the representation take a long time?

To what extent might it be considered an art form in itself?

To what extent was the representation polyphonic or multi-layered?

How did you indicate duration?

Did you indicate spatialization? If so how? Did the representation assist development of



spatialization?

Was it a representation of an act of inner hearing or outer hearing?

Indicate if the representation used: - text\_\_\_\_\_ graphics\_\_\_\_\_ numbers\_\_\_\_\_

Indicate the focus of the sound representation: -timbre\_\_ pitch\_\_ electronic\_\_ other\_\_

Broadly indicate the genre.

Indicate if the representation was on paper or using a machine. If machine was this automated or by hand?

## **QUESTIONS ON THE REPRESENTATION OF SOUND IN ELECTROACOUSTIC MUSIC**

### **Do you represent sound in any way when you compose? If so how?**

Simple graphics for timbre, noise; numerals for parameters such as duration. Pitch usually in standard staff form or general contour graphics.

### **In a particular composition to what extent have you represented sound?**

Actually the answer to the above question is complex as I work so often with instruments/voices notated traditionally with live electronics transforming. In my acousmatic works the representations have mostly been 'on screen' in ProTools; my sketches have represented proportions and shapes but not usually details within the sounds. But I use graphics for any composition to get general ideas of shape and form – local and overall.

### **What was your representation for?**

To aid thinking about shape and form, proportion and duration. Sometimes timbre and processing;  
also general frequency (high/low) contour.

### **Who was your representation for?**

Only myself as composer. Though I might occasionally use representation in articles etc. after the event.

### **Was it a representation of what had already happened or of what was going to happen?**

What was going to happen (maybe – it's a sketch).

### **Was the representation: - prescriptive \_\_\_\_\_descriptive \_\_\_\_\_analytical\_\_\_\_\_**

Prescriptive – or at least descriptive of something I might want to happen.

### **What did the representation contribute to the composition?**

Whatever the final ratio of accepted to rejected sketches, the representation was an essential spur to action; also importantly a memory aid to help combine actions (sounds) already completed -  
montage.

**What aspects of the sound did you represent and in what detail?**

Relatively little detail – general shapes, contours, patterns. (If we include numerals then also proportion or phrase length numerical sequence – specifically in instrumental works).

**To what extent did it improve your understanding of what you were doing?**

A fundamental part of it – understanding is not the right word. It's a practical tool which you use as an aid to action and memory.

**Are there any aspects of the composition that the representation did not help or perhaps even hindered?**

Good and difficult question: *listening* corrects gross errors and should put you right but sometimes with live instruments you are creating a score and the time domain aspects may not be known till rehearsals – and you realize the representations are 'outside time'.

**Did the representation take a long time?**

Not a realistic question really – some did, some didn't – though usually fast and furious.

**To what extent might it be considered an art form in itself?**

Not if confined to the artists sketchbooks – I am not Paul Klee!

**To what extent was the representation polyphonic or multi-layered?**

Two kinds of representation. One individual and centred on the individual sound object or texture. The other kind about montage and combination – hence polyphonic.

**How did you indicate duration?**

Sometimes loosely – when looking at individual sounds. Sometimes strictly – when looking at combinations and montage.

**Did you indicate spatialization? If so how? Did the representation assist development of spatialization?**

Certainly – though only when the work included a spatial component as part of its original and basic 'argument' – which actually happens quite consistently in live electronics.

**Was it a representation of an act of inner hearing or outer hearing?**

Inner hearing predominantly – what I imagined I wanted.

**Indicate if the representation used: - text\_\_\_\_\_ graphics\_\_\_\_\_ numbers\_\_\_\_\_**

Graphics and numerals often. Occasionally descriptive text. In addition text is used in the form of narrative in my sketch books and is not about individual sounds but ideas overall (though sometimes referring to sounds).

**Indicate the focus of the sound representation: -timbre\_\_ pitch\_\_ electronic\_\_ other\_\_**

Shape, contour, direction; also pitch/timbre but in general terms. Also duration and spatial direction. Nor all of these at the same time!

**Broadly indicate the genre.**

Instruments and live electronics; some acousmatic elements and works.

**Indicate if the representation was on paper or using a machine. If machine was this automated or by hand?**

Predominantly on paper in sketch form. (ProTools printouts from computer course).

## QUESTIONS ON THE REPRESENTATION OF SOUND IN ELECTROACOUSTIC MUSIC

In participating in this process, I would like your permission to use the results with appropriate acknowledgment. You are free to withdraw this permission at any time.

Do you represent sound in any way when you compose? If so how?

Yes. Below are a few differing examples:

Piantronics is a piano and electronics score. It is a combination of standard notation, non-standard notation and graphic scoring where the standard notation is at times as visually graphic as the graphic symbols themselves. Amongst other things, Piantronics used symbols depicting *approximate pitch, duration, crescendos, whooshes, explosions, multi-stranded sounds, particles of sound, vibratos and waveforms*. The piece also used symbols in the piano part to depict *'prepared-piano' sections and dumbbell shapes depicting approximate note clusters*.

Tasteless Curtains uses a colourful 'sequencer based piano-roll' graphic score consisting of repetitive visual patterns, hence the title. Essentially, the score is an enlarged print-out of a sequencer piano-roll. Each note on the piano-roll triggers various pitches and sounds. The score contains crossing melodic lines, contrasting textures and perhaps most notably my name, Gary, in block capitals. The latter produced an interesting combination of pitches, durations, dynamics and texture. Again, this score is very accurate in that what we hear really is what is written in the score.

The Beach used an artist's 'sound drawings' as a score. The artist had sat on a deserted beach and drawn what she heard as opposed to what she saw. The scribblings were used as input data for a sound synthesis program I wrote. The data controlled various parameters such as pitch, duration and spatialisation.

What was your representation for?

Piantronics needed a score for the pianist to perform and so was an integral part of the performance and end result.

Tasteless Curtains was composed with a view to making a graphic score representation. As a result the score is not part of a live performance but it is essentially a 'real' depiction of the audio. Or perhaps it would be more accurate to describe it as the audio accurately representing the patterns, textures and words (my name).

The foundation of The Beach was to use the sound-drawings as a score so once again it was more the audio being a representation of the score as opposed to the other way around.

Who was your representation for?

Piantronics: Pianist and Listener.  
Tasteless Curtains: Listener.  
The Beach: Listener.

Was it a representation of what had already happened or of what was going to happen?  
Was the representation: - prescriptive \_\_\_\_\_ descriptive \_\_\_\_\_ analytical \_\_\_\_\_

Piantronics was prescriptive and descriptive in that the piano part was 'going to happen' and the electronic had essentially 'already happened'.

Tasteless Curtains was also prescriptive and descriptive in that it prescribed what the audio was to be but was also descriptive in that it showed what was happening when listening.

The Beach was all three in that it controlled the audio and could be viewed / interpreted by the listener.

What did the representation contribute to the composition?

Piantronics: the graphic elements of the piano part contributed a more electro-acoustic approach to what is a traditional instrument.

Tasteless Curtains: The score IS the piece.

The Beach: Again, the score IS the piece.

What aspects of the sound did you represent and in what detail?

Piantronics: I represented every sound I possibly could. Though I think the more distinct shorter events were notated in greater detail than the longer continued events.

Tasteless Curtains: It was 'the audio that represented the score'.

The Beach: Again, it was 'the audio that represented the score'.

To what extent did it improve your understanding of what you were doing?

Piantronics: As this was one of my first graphic scores, it was a valuable lesson in methodology.

I learnt what worked and what didn't work as a graphic score. I felt the graphics in the piano part worked extremely well on the whole whereas the tape part was less well defined.

Tasteless Curtains: This score gave me the opportunity to explore graphic notation in the form of a sequencer. It opened up a whole host of ideas based upon patterns and contrapuntal strands.

The Beach: As the sound drawing was completed first it didn't really have an effect my understanding of the finished piece but it did lead to many, many compositional ideas of which I could only try a few on this occasion.

Are there any aspects of the composition that the representation did not help or perhaps even hindered?

Piantronics: The only thing is that the performer would have liked the tape part to have been more distinct in representation as opposed to looking pretty.

Tasteless Curtains: No.

The Beach: No.

Did the representation take a long time?

Piantronics: In relation to the actual compositional time I would say the representation was as expected. No different to having scored a traditionally notated piece.

Tasteless Curtains: Essentially was the longest part of the compositional process as it was the the composition. The it was a simple case of selecting desirable sounds and playing the score back for recording.

The Beach: As far as I'm aware it took the artist about 10-20 minutes to draw. However, it took me many hours to create a sound synthesis program into which I input the sound drawing information.

To what extent might it be considered an art form in itself?

Piantronics: As a musician I see it only as a representation of the music albeit sometimes a pretty representation. Though I feel it would be very interesting for a visual artist to draw what they heard as both a static drawing and a dynamically moving score.

Tasteless Curtains: As above.

The Beach: Here the music really was a representation of visual art. So yes, the score / sound drawing was indeed a piece of art. Though as it was a first attempt by the artist it wasn't the prettiest visual work. The music is far more enjoyable and intellectually complete than the visual art was. But the idea does have real potential.

To what extent was the representation polyphonic or multi-layered?

Piantronics: The score had many strands of activity occurring simultaneously.

Sometimes very structured in a pitch or rhythmic sense and sometimes in a more electro-acoustic sense with events occurring in counterpoint ...diverging, converging, morphing, etc.

Tasteless Curtains: This score would develop from a single line into many strands of polyphony via patterns, interlocking strands and indeed a word (my name) written in the score. The latter started off with a very thin texture in a middle register right on the left edge of the letter 'G' and broadened into a thick almost overwhelming texture following two multi-stranded lines of pitch ...one going up and around the top of the 'G' while the other descended down and around the bottom of the 'G'. This effect continued for each letter of my name. A very interesting result and something I wish to explore further in the future.

The Beach: This score or 'sound drawing' had several blocks of activity. There were the waves, the wind, the rushes and the birds. Each block had pitches, a rhythm of sorts, dynamics and texture. Furthermore, each block had it own distinct sounds that I created to evoke the feeling of a deserted beach.

How did you indicate duration?

Piantronics: With traditional notation and graphic symbols. The latter was literally longer if the sound was longer and shorter if the sound was shorter. So the symbol would begin and stop at the precise point on the 'timed-score' where the sound would begin and stop.

Tasteless Curtains: Using sequencer piano roll lines. Quite simple.

The Beach: The sounds would represent the sound-drawing as it was. So short lines would be represented audibly by short sounds and longer lines would be represented by longer lines.

Did you indicate spatialization? If so how? Did the representation assist development of spatialization?

Piantronics: No.

Tasteless Curtains: Yes. Stereo panning was indicated by the sequencer 'pan lines'.

The Beach: Spatialisation was controlled by lines in the sound-drawing.

Indicate if the representation used: - text\_\_\_\_ graphics\_\_\_\_ numbers\_\_\_\_

Tasteless Curtains: Graphics.

The Beach: Graphics.

Indicate the focus of the sound representation: -timbre\_\_ pitch\_\_ electronic\_\_ other\_\_

Piantronics: Mainly Timbral representation along with other elements such as pitch, rhythmic and dynamics.

Tasteless Curtains: Mainly represented with pitch. Other elements included rhythm, dynamics and spatialisation.

The Beach: Mainly represented with pitch. Other elements included duration, dynamics and spatialisation.

Broadly indicate the genre.

Piantronics: Electro-Acoustic

Tasteless Curtains: Electro-Acoustic

The Beach: Generative Music / Soundscape

Indicate if the representation was on paper or using a machine. If machine was this automated or by hand?

Piantronics: Paper

Tasteless Curtains: Computer Sequencer. Input by hand ...Automated on play-back.

The Beach: Paper. Sound-drawing sketched on paper and then fed into computer as control data for soundscape.



## QUESTIONS ON THE REPRESENTATION OF SOUND IN ELECTROACOUSTIC MUSIC

In participating in this process, I would like your permission to use the results with appropriate acknowledgment. You are free to withdraw this permission at any time.

Do you represent sound in any way when you compose? If so how?

**On occasion I have produced iconic graphic scores by visually representing salient areas. Graphics were abstracted from sound analysis representation by using the software 'praat'. The images were compiled in Adobe Illustrator.**

In a particular composition to what extent have you represented sound?

**All salient sonic elements.**

What was your representation for?

**The score is used for pedagogical purposes.**

Who was your representation for?

**Undergraduate and postgraduate students who are unfamiliar with acousmatic music.**

Was it a representation of what had already happened or of what was going to happen?

**The piece was completed before the score was produced.**

Was the representation: - prescriptive (No) descriptive (Yes) analytical (Yes)

What did the representation contribute to the composition?

**In that it would hopefully inform the listener of form and key events. So more of an understanding of the composition as a new listener.**

What aspects of the sound did you represent and in what detail?

**Ambience, text, pitch and accents. Score and mp3 attached to give you an idea.**

To what extent did it improve your understanding of what you were doing?

**Not applicable really as the score was produced for pedagogical purposes.**

Are there any aspects of the composition that the representation did not help or perhaps even hindered?

**The whole notion and process of presenting a composition graphically was difficult as key decisions had to be made as to what to leave in and take out. Representation**

Did the representation take a long time?

**The process was highly time consuming and took 10 months to complete (averaging one day per week).**

To what extent might it be considered an art form in itself?

**Having also a visual arts background I found this very important. This was probably a hindrance given I was also considering visual appeal and aesthetics.**

To what extent was the representation polyphonic or multi-layered?

**The score represents the general polyphony of the piece.**

How did you indicate duration?

**Duration was indicated proportionally to actual events. Aspects were blocked out on a spreadsheet first where each cell represented one second. Accuracy was less important for small events (e. g. textural events).**

Did you indicate spatialization? If so how? Did the representation assist development of spatialization?

**I produced an experimental diffusion score that represented space using overly and transparency. Detail was less important. It helped give an idea as to what I would be doing, but this is stereo piece and had to be diffused over a 5.1 system which was not ideal.**

Was it a representation of an act of inner hearing or outer hearing?

**Inner hearing.**

Indicate if the representation used: - text \_\_\_\_ graphics \_\_\_\_ numbers \_\_\_\_

**Graphics and basic text.**

Indicate the focus of the sound representation: -timbre \_\_ pitch \_\_ electronic \_\_ other \_\_

**Mainly intensity for the iconic score.**

Broadly indicate the genre.

### **Soundscape**

Indicate if the representation was on paper or using a machine. If machine was this automated or by hand?

**All done by hand using Adobe Illustrator apart from the graphic initially abstracted from the sonic elements.**

## Appendix A5 Trevor Wishart

Interview with Trevor Wishart in York on Saturday 11<sup>th</sup> July 2009

### QUESTIONS ON THE REPRESENTATION OF SOUND IN ELECTROACOUSTIC MUSIC

In participating in this process, I would like your permission to use the results with appropriate acknowledgment. You are free to withdraw this permission at any time.

Do you represent sound in any way when you compose? If so how?

*Yes. Using names and derivatives that are an evocative aid to memory – aide memoire + historical evolution = creation path. Derivation of the transformation of sounds. Clarify connections and relationships. If you can't tell, then sounds are not connected. A parallel was drawn and accepted with Beethoven. Referred to as aural connectedness.*

In a particular composition to what extent have you represented sound?

*Depends on the composition. Red Bird was pre-digital. Sounds were described and categorized closely. As against Imago which involved derivatives in the spectral domain.*

What was your representation for?

*Myself*

Who was your representation for?

*Myself*

Was it a representation of what had already happened or of what was going to happen?

Was the representation: - prescriptive \_\_\_\_\_descriptive \_\_\_\_/ \_\_analytical \_/ *as a poetic insight*\_\_\_\_

What did the representation contribute to the composition?

*aide memoire.*

What aspects of the sound did you represent and in what detail?

*As all sounds and their sources (and all intermediate stages of making them) are always available for listening, no representation is necessary. However, good names for sounds makes it easier to find them, especially as one can very quickly generate thousands of soundfiles. The names are “mnemonics” rather than “representations”.*

To what extent did it improve your understanding of what you were doing?

*Memory particularly as related to derivatives, compositional history and aural connectedness.*

Are there any aspects of the composition that the representation did not help or perhaps even hindered?

Did the representation take a long time?

To what extent might it be considered an art form in itself?

To what extent was the representation polyphonic or multi-layered?

How did you indicate duration?

Did you indicate spatialization? If so how? Did the representation assist development of spatialization?

*There are diffusion scores or notes. Time line above then key events or textures below. Used for rehearsal in a particular venue. Other details are then added as well as changes for the particular venue which are added and retained. After 6-8 performances a more general representation emerges about an optimal way to diffuse.*

Was it a representation of an act of inner hearing or outer hearing?

Indicate if the representation used: - text mostly graphics \_\_\_\_\_ numbers some  
*but see below*

Indicate the focus of the sound representation: -timbre \_/\_ pitch \_/\_ electronic \_\_\_\_\_ other \_\_\_\_\_  
= sonority

Broadly indicate the genre.

Indicate if the representation was on paper or using a machine. If machine was this automated or by hand?

*Paper and machine.*

***Many dimensions of the composition process are remembered by the Sound Loom.***

- 1) There is an automatically generated “history” of all actions taken, with the ability to recall any of them***

- 2) *a way to remember specific parameter-patches for processes*
- 3) *time-varying parameter-traces are preserved in the textfiles in which they are made.*
- 4) *Mixing details are preserved in the mixfiles from which they are controlled (and therefore always available for remaking, or reworking plus remixing).*
- 5) *This is in addition to the storage of all the sounds, from sources through intermediates to the current state of the piece, on the computer.*
- 6) *There's also a built in Notebook to write down ideas, or remember what one is doing from day to day (essential in a large-scale project).*
- 7)

*I also tend to use a scratchpad of paper to jot down ideas that occur to me, do quick calculations, and sketch ideas for improving or creating the software instruments.*

#### ADDITIONAL NOTES

*Red Bird has a suitcase of notes – in fact all the compositions do. To understand a piece look at Sound Loom because close study of Sound Loom indicates the thinking behind the piece. CDP as a whole + dates is a kind of archive of all of the music. CDP is driven by Trevor's compositional development. The start of a piece has a poetic and technical orientation.*

*“if I know how to make a piece then it's boring. There has to be an aspect to the piece that I don't know how to do. This involves a way of working with sound such that an pre-image of the sound is impossible.” (Trevor Wishart July 2009)*

*Representation as a term is preferred to visualization which seems to involve something to see. Sound Loom involves specific and nested directories. Sound names are given that are as explicit as possible and directories are evocative. Representation is preferred because electroacoustic music is fundamentally about listening. When working with sounds you don't know what they'll do. This is unlike traditional notation – you have to be very open. Trevor always has at least a vague notion of the shape of a piece. He has a musician's understanding of musical form, for example repetition of important things or climatic points. Notes are made in Sound Loom. You are listening to electroacoustic music all the time. Trevor says that he has a structural memory.*

*Archiving – the piece itself + lecture notes + diffusion. There is no score for the music except perhaps diffusion. Making sounds ~~as instruments~~ do exactly what you want **often** ~~can~~ involves **building or modifying the instruments used (these are software instruments so this could be called “software engineering”)**. Don't confuse the use of numbers in a representation with software code. **Software code is a ‘machine for making sounds’, like a violin is a machine for making sounds. Neither is a representation of what is made. It's like the difference between the DNA and the baby!***

*Archiving is becoming very important to Trevor.*

[Bold texts are Trevor's edits]

## QUESTIONS ON THE REPRESENTATION OF SOUND IN ELECTROACOUSTIC MUSIC

**In participating in this process, I would like your permission to use the results with appropriate acknowledgment.**

**You are free to withdraw this permission at any time.**

**Do you represent sound in any way when you compose? If so how?**

1. *When composing* I have sometimes used graphic sketches of the morphologies of sounds – rough shapes showing dynamic envelope and approximate spectral makeup. The purpose is as a quick aide memoire to relevant features of the sound. These sketches appear on card files that list sounds/their transformations.

I rarely use such sketches these days since it is easier to access the sounds directly and quickly on disc to remind oneself of, or check, their features, as opposed to analogue days. I might, however, list relevant features in text form, particularly to highlight how relations might be created among sounds/sound files.

2. With works including (solo) instruments (*Clarinet Threads*, *Piano Nets*) graphic representations of main features of the "tape" part are used as a guide for the instrumentalist - cues to keep track of the progress of the "tape" e.g. audible pitches; significant events; cues for entries; synchronisation points. Such transcriptions were partly carried out in sketch form during composition, and then completed and finalised on completion of the work.

3. Diffusion scores of acousmatic works designed once the work is finished. Events are represented as spectromorphological shapes, with main timings. The scores are intended to help the diffuser learn the piece quickly; accurate timings are particularly helpful to facilitate any rapid changes at particular points in the piece. Sometimes, but rarely, indications have been provided about when levels might need to be adjusted in performance e.g. exaggerate climaxes.

These scores might also be used for study purposes (e.g. investigating form, temporal proportions). However, they can rarely be spectrally accurate: spectral positioning on the vertical axis is often approximate, reflecting the main registral emphasis of an event or passage.

Such scores might be quite detailed, depending on the nature of the sounds; however, textural structures are likely to be fairly generalized.

I no longer design such scores for my multitrack works, where there is very little active diffusion to be done in performance (and only small adjustments to dynamic levels), since the spatial disposition/distribution of the sounds is composed into the work itself

i.e. diffusion is integrated into the work.

**In a particular composition to what extent have you represented sound?**

This is probably answered above.

**What was your representation for?**

Answered above

**Who was your representation for?**

Answered above.

**Was it a representation of what had already happened or of what was going to happen?**

Question is not entirely clear. With acousmatic works no representations were made in advance of the sounds' existing. With the "tape" part of mixed works some sketching might precede actual realisation in sound where such sounds had to be composed specially to fit into the work, as opposed to their already existing prior to being placed/mixed into the work.

**Was the representation: - prescriptive \_\_\_\_\_descriptive \_\_\_\_\_analytical\_\_\_\_\_**

Descriptive. However, on one occasion pitches were "analysed" in more detail than would be necessary for diffusion (pitches not necessarily in the foreground of perception) so that I could discover the pitch content/form of the piece, and the pitch connections over a longer timescale. Thus part of a consciousness-raising act.

**What did the representation contribute to the composition?**

Nothing concrete, although there may be an effect on the next composition e.g. changes in process or structuring due to increased consciousness of formal practice; also greater consciousness of the role of pitch and pitch centres.

**What aspects of the sound did you represent and in what detail?**

Answered above

**To what extent did it improve your understanding of what you were doing?**

With diffusion scores it becomes easier to understand how the larger-scale form has worked, and it can assist in cross-referencing relations in the piece. However, these days, interactive analyses/paradigmatic charts, like those of Michael Clarke, are better for this purpose.

**Are there any aspects of the composition that the representation did not help or**



**perhaps even hindered?**

Not that helpful for contemplating the “timbre” / spectral character of sound.  
Useless for shedding light on aspects of spatiality – only direct experience can do that.

**Did the representation take a long time?**

Detailed diffusion scores, yes.

**To what extent might it be considered an art form in itself?**

My older diffusion scores have been treated as “art works” and at least one has appeared in an exhibition.

**To what extent was the representation polyphonic or multi-layered?**

In diffusion scores and mixed work representation an attempt is made to make them multi-layered if that is pertinent to the music.

**How did you indicate duration?**

In seconds.

**Did you indicate spatialization? If so how?**

Very occasionally some general verbal suggestions in diffusion scores, but usually no indications.

I do not consider spatialisation in the abstract (using diagrams of settings, trajectories etc).

“Spatialisation” is a very limited way of thinking about the wider issue of spatiality – all those features that contribute to qualities and types of space, and their population.

**Did the representation assist development of spatialization?**

N/A

**Was it a representation of an act of inner hearing or outer hearing?**

Don’t quite understand what is meant by “inner” and “outer”. My representations are concerned primarily with sound shapes (spectromorphologies), and possibly, where evident, also the reality of sources, denoted using text annotation (e.g. water, birds). Representation is pragmatic, not an act of individualised or idiosyncratic mental fantasy.

**Indicate if the representation used: - text\_\_\_\_\_ graphics\_\_\_\_\_ numbers\_\_\_\_\_**

Graphics and text

**Indicate the focus of the sound representation: -timbre\_\_ pitch\_\_ electronic\_\_ other\_\_**

Answered above

**Broadly indicate the genre.**

Answered above

**Indicate if the representation was on paper or using a machine. If machine was this automated or by hand?**

By hand on paper, but the works concerned are older, before sonograms really came to be widely adopted. Sonograms are rarely useful for my purposes – and such tools as the acousmograph remain somewhat cumbersome and subjective: drawing by hand can often be better!

I also note, and agree with, Stéphane Roy's statement (somewhere in his analysis book, I think) that for analytical purposes making a score by hand is the best way to fix a work in memory, and it also requires you, yourself, to make decisions about musical pertinence.

However, certain pertinent features will always resist visual representation e.g. the spatiality of sounds.

## QUESTIONS ON THE REPRESENTATION OF SOUND IN ELECTROACOUSTIC MUSIC

In participating in this process, I would like your permission to use the results with appropriate acknowledgment. You are free to withdraw this permission at any time.

Do you represent sound in any way when you compose? If so how?

*Yes, I almost always create a graphic score of the composition and a range of graphic sketches for various gestures.*

In a particular composition to what extent have you represented sound?

*I have created full graphic scores for compositions such as 'Wolf Rock' (2008), Cypress Trilogy (2010) & 'Transvergence' (2011). I have also created sonograms and spectrograms of the electronic parts of these compositions to assist the performers.*

What was your representation for?

*The representation was for my own personal use and to be used as a performance score for the performers involved in the piece. They are also created to be used as study and analysis scores.*

Was it a representation of what had already happened or of what was going to happen?  
Was the representation: - prescriptive \_\_\_\_\_descriptive \_\_\_\_\_analytical\_\_\_\_\_

*I use representation in all three cases, so I would have to say all three in most of my compositions in various formats.*

What did the representation contribute to the composition?

*They assist me in the compositional process (graphic scores for structure), they assist performers and function in the same way as traditional scores in a performance context and they form accessible documents for analysis.*

What aspects of the sound did you represent and in what detail?

*All sounds present in the compositions are represented with graphic notation, often I will create a 'graphic language' for each composition – so particular graphics will*

*represent a particular gesture and the variations of that gesture etc.*

To what extent did it improve your understanding of what you were doing?

*I always find graphic scores very useful in my creative process and I'm sure they influence the development of the composition.*

Are there any aspects of the composition that the representation did not help or perhaps even hindered?

*I don't think so.*

Did the representation take a long time?

*Yes – sometimes I spend hours and hours creating graphic scores (in the same way I use to invest hours in creating traditional scores), but these are always the final performance or analysis scores. My initial scores are always brief sketches to assist my process.*

To what extent might it be considered an art form in itself?

*I would like to hold an exhibition of my graphic scores at some point in the future so I do feel like it could be considered as a art form in its self (this is very inspired by conversations I had during lessons with alcides lanza).*

To what extent was the representation polyphonic or multi-layered?

*Always multi-layered.*

How did you indicate duration?

*Timeline above the score.*

Did you indicate spatialization? If so how? Did the representation assist development of spatialization?

*By using large format page and spreading the gestures across the page.*

Was it a representation of an act of inner hearing or outer hearing?

*Inner hearing.*

Indicate if the representation used: - text \_\_\_\_ graphics \_\_\_\_ numbers \_\_\_\_

*All of the above.*

Indicate the focus of the sound representation: -timbre\_\_ pitch\_\_ electronic\_\_ other\_\_

*All of the above, plus rhythm, sound source etc.*

Broadly indicate the genre.

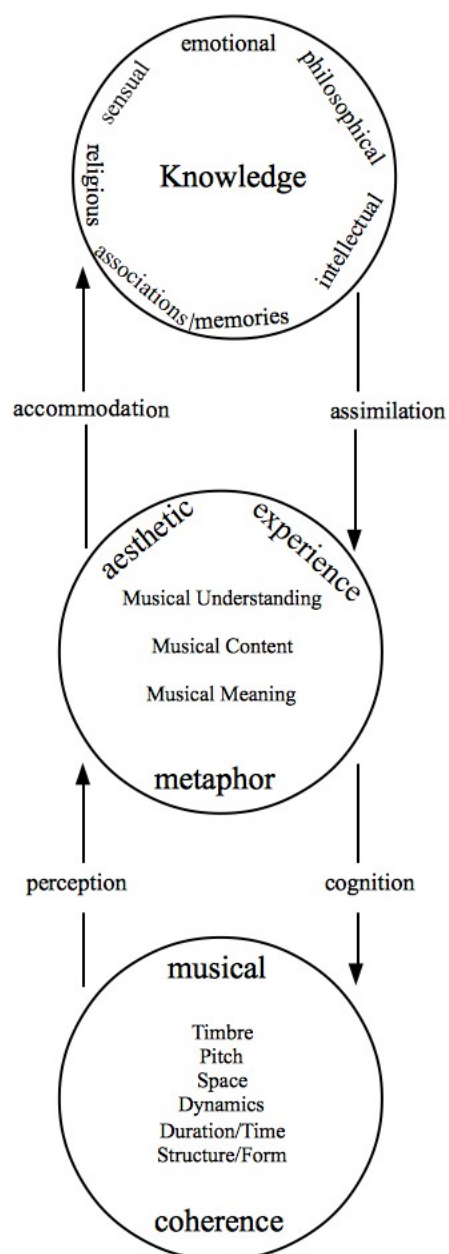
*Electroacoustic.*

Indicate if the representation was on paper or using a machine. If machine was this automated or by hand?

*On paper by hand.*

## Appendix B

### A Model of Musical Experience



## What is SunVox

SunVox is a small, fast and powerful modular synthesizer with pattern based sequencer (tracker). It is a tool for those people who like to compose music wherever they are, whenever they wish. On any device. SunVox is available for Windows, Linux, Mac OS X, Windows Mobile, PalmOS, Maemo, Meego, iOS and Android.

Key features:

Modular interface.

Highly optimized synth algorithms.

Flexible architecture: SunVox works on a variety of devices. For example: pocket computer with slow CPU - 13bit sound (fixed point arithmetic); or a big PC with a powerful CPU: 32bit sound (floating point arithmetic).

Official SunVox page: <http://www.warmplace.ru/soft/sunvox>

### Minimum system requirements

#### Windows:

no special requirements.

#### Linux:

any Linux distribution (x86 or x86\_64);

SDL library (version 1.2 or later);

ALSA.

#### Mac OS X:

x86\_64 architecture;

Mac OS X 10.6 or later.

#### Android:

Android 2.3 or later.

**Maemo:** (tested on Nokia N900)

libsdl1.2;

libosso1.

#### Meego:

ARM CPU;

libsdl1.2;

libasound2.

#### Windows Mobile (WinCE):

ARM CPU.

**PalmOS:**

ARM CPU;

PalmOS 5.0;

FOR T1T, T2 and ZIRE71 USERS: Please, install FHR (Fargo Heap Resizer) before running SunVox. FHR page: <http://fanoush.wz.cz/palm/fhr.html>

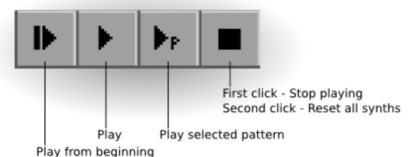
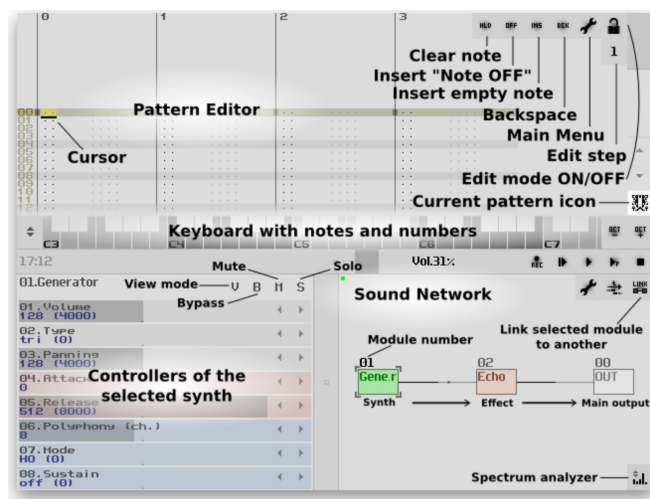
**Mobile version**

Mobile version (ARM-based) of SunVox has fixed point integer audio engine (4.12 bits). This means that you hear the 13-bit sound on mobile devices. It is fast but with slightly audible quantization noise. Rendering to WAV also has this noise, but no more than that. For example, if you hear some glitches due to lack of CPU power, these glitches will not be present in the WAV-file after rendering. In other words, the result of WAV rendering will be the same on different devices with ARM CPU.

In spite of the mobile version noise, 32bit WAV export may be with better quality due to the absence of audio overflow.

### Interface description

First click on the Stop button – stop playing. Second click – reset all SunVox activity and switch the engine to standby mode.





## Appendix D Full Notes on Composers and Contacts

### Selection and Method of Selection

The following composers have given some indication of their visualization practice, as part of the compositional process. This has been by interview and questionnaire. In the case of interviews, the questionnaire was used as a basis for discussion. The aim of collecting responses was to discover what part visualization played within each composer's compositional processes; also to discover if this was consistent throughout their work, or applied to specific pieces or circumstances. The notes in this chapter give some background to them, as well as an indication of why their practice is important to this research. This includes those few composers who state that they make little reference to visualization, and why their reasons for not doing so which follow in *Chapter 6* are also important. The methodology here has been:-

- to select people who were prepared to make a response
- to select people who might or might not use visualization
- to select people who represent a good cross section of work within the genre
- to select people whose compositional work is available and well known
- to select some people for whom compositional work can be placed in a context of other work within the field such as analysis, pedagogy and musicology

Quotes are included where they illuminate their views and philosophy, and how these might be translated into a better understanding of their compositional endeavours. These notes are intended to offer evidence of the diversity of approaches within a wide range of electroacoustic genres.

The focus of the questions whether at interview or by email, was to clarify to the composer the nature of the enquiry. The discussions were aimed at identifying the complexity of compositional activity, and additionally allowed a composer to reflect on the role of visualization in a considered and measured way. They also were intended to encourage a composer to indicate more precisely where visualization became important in composition.

### **Individual Notes on Respondents**

#### *Robert Normandeau*

As evidenced by the comments below, Robert Normandeau is an electroacoustic composer (and teacher) who has worked with GRM and is a founder member of CEC. He has produced some work in other genres but is now acousmatic in focus. He composes music for theatre and incidental music - “his compositions employ aesthetical criteria whereby he creates a ‘cinema for the ear’ in which ‘meaning’ as well as ‘sound’ become the elements that elaborate his works” . He professes not to use representation.

His work with the Canadian Electroacoustic Community dates from 1987. From 1986 to 1993, he was an active member of the Association 'pour la création et la recherche électroacoustiques du Québec (ACREQ)', where he produced the *Clair de terre* concert series at the Montréal Planetarium. In 1991, he co-founded Réseaux, an organization for the production of media arts events, notably the acousmatic concert series *Rien à voir*.

After a certain interest in instrumental and mixed works, his current endeavours are focused on acousmatic music. More specifically, his compositions employ esthetical criteria whereby he creates a 'cinema for the ear' in which 'meaning' as well as 'sound' become the elements that elaborate his works. Along with concert music he now writes incidental music, especially for the theatre.

He is Professor in electroacoustic music composition at Université de Montréal since 1999.

(Sleeve notes from the CD/DVD ROM "Puzzles" Empreintes Digitales IMED 0575 2005)

### John Young

As shown below, John Young is an electroacoustic composer (and teacher) who often makes use of environmental sounds, where there is an interplay between natural sounds and computer based transformations. He has been a visiting composer at GRM. He professes to *always* use representation.

In 2000 he became a Senior Lecturer with the Music Technology Innovation and Research Group at De Montfort University in Leicester, United Kingdom. His main interest in composition continues to be in acousmatic music, particularly forms based on the interplay between recognisable natural sound sources and computer-based studio transformations. (Sleeve notes from the CD "La Limite du Bruit" Empreintes Digitales IMED 0261 2002)

### Simon Atkinson

Simon Atkinson is a composer and teacher who, as shown in the quote below, is also involved in community and public arts projects and installations including collaborative work. He views sound as a mediator '*between material and imaginative worlds*'. His work has included recorded sounds over loudspeakers, local radio and work in education.

**Simon Atkinson** is Senior Lecturer and subject leader for Music, Technology and Innovation at DMU. For some years he has concentrated his energies on working with recorded sounds which are projected over loudspeakers. Of particular interest to him are the possibilities offered in a listening situation that tends to highlight the power of sound to act as a mediator between material and imaginative worlds. Recent work has divided between concert hall and collaborative community arts projects. Closer to home, *Indriya*, a collaborative installation with Ashok Mistry (Rangoli), Dipak Joshi (video) and John Richards (music) was commissioned by Leicester City Council Museums and installed at New Walk museum from June-August 2002, attracting over 60,000 visitors. Simon contributed to the *Chime Lines* public art installation in the towpath of the Grand Union Canal in Leicester Frog Island and *Being Heard*, a large community art project featuring the recorded poetry of pupils from five of Leicester's secondary schools, an attempt to capture every language spoken in the City. It ran at Phoenix Arts and was supported through broadcast and web content by BBC Radio Leicester. A concert piece made from this material, *tinguell, maungira, aawaaz* was premiered at Edinburgh's *Soundings* festival last year. (Profile notes published on the MTI website of de Montfort University)

### Simon Emmerson

Simon Emmerson is a composer, researcher, author, teacher and academic. His electroacoustic work has combined live performance and electronics. As a tutor he has therefore been available for in-depth interview, with availability of written resources and references. He has worked with GRM. The quote below is taken from the opening of his book *Living Electronic Music* and, apart from the intentions of the book, gives an insight into his own approach to composing electroacoustic music.

This book is intended for anyone interested in contemporary music, but most especially in what has been called *electroacoustic music* – a music heard through loudspeakers or sound made with the help of electronic means. But that definition is extended here to include amplified acoustic music where the amplification changes, in essence, the experience of the sound and is integral to the performance. The discussion [ ] remains focussed on the *musical experience*. This in turn is a product of *performance* – but extended to embrace all possible spaces and places, personal and public. [ ] - more and more music is being made and listened to without any recourse to *mechanical* production beyond the vibrating speaker cone. Most music now heard appears to present little evidence of *living presence*. Yet we persist in seeking it out. (Emmerson 2007 page xiii)

### Leigh Landy

Leigh Landy is involved with collaborative mixed arts projects both at a professional and community arts level. Specifically he tends to work using '*story boards*' as triggers and structural outlines, which can indicate models and intended actions. This approach is not replicated by other contacts in this research. He uses commonly and readily available software such as *Microsoft Word*. Leigh Landy is also a teacher, academic and researcher.

Leigh Landy is best summed up or profiled by his work as artistic director of Idée Fixe.

(Idée Fixe) is a performing arts company which draws from a collaboration of like-minded artists possessing a range of different backgrounds to create performances where sound, movement, image and drama are imaginatively conjoined using relevant technologies. Each work the company makes is based on a theme from daily life: a day in anyone's life, the rooms of a block of flats, the fun and perils of travel. Objects (sound, visual) from everyday life are combined in an experimental performance context. This is done to make works particularly tangible and user-friendly. Stage designs not only act as décor, but also as sound installations triggered by movement in entertaining and challenging performances. One of the company's key aims is to set an example and facilitate active participation in art-making on as wide a scale as possible. It stands for an artistic process based on working with people, not at or on them. This process is founded on developing devising as a working practice where individuals all contribute to and can be identified in collaborative creative work. The company encourages and facilitates a range of community-based activities, all of which are custom-made for each host taking into account group and individual needs. It seeks convergence between the arts and amongst professional and community arts contexts.

### Trevor Wishart

A composer who importantly has focused his work almost exclusively on composition and related matters over a long period of time. This includes close involvement in the Composers Desk-top Project almost since its inception, and more

specifically the graphical user interface Sound Loom. This has become something of an archive of his material and processes. He does engage in software engineering to solve compositional issues:-

if I know how to make a piece then it's boring. There has to be an aspect to the piece that I don't how to do. This involves a way of working with sound such that a pre-image of the sound is impossible. (Wishart questionnaire response to this author 2009)

A significant recent composition entitled *Encounters in the Republic of Heaven* summarizes one of the most important parts of his compositional approach.

“Encounters” is an exploration of the music inherent in everyday speech. It brings together stories told by adults and children, revealing their melodies, rhythms and sonorities in an 8-channel surround-sound presentation.

Beginning with the sound of the wind, formed from tens of thousands of human voices, the stories of fishermen, farmers and city-dwellers gradually unfold, accompanied by imaginary musical instruments derived directly from the speaking voices we hear. As each story subsides we encounter a sea of human voices organised in surprising ways – speech that waltzes, speech that harmonises, clouds of speech which circle around the audience, culminating in speech which transforms into song.

Trevor Wishart, a composer whose work focuses on the human voice, and the use of computer technology to enhance and transform it, collected recordings from home, schools, and meeting-places in the North East of England, and developed the software to make this piece possible -

(From the booklet accompanying the CD)

### Elizabeth Hinkle-Turner

A composer who's work is focused on multi-media presentations including live performance. She indicates that she has a highly personal and reflective approach to visualization as part of compositional work. This includes the use of specific software

from STEIM called *Imag\ine*. She also sketches by hand. This is specifically designed for integrated video and aural work. Hinkle-Turner's work might better be classified as '*visual music*'. She is also a teacher.

### Gerardo Dirié

An Argentinian composer of electroacoustic music, choral, vocal, stage and instrumental music. He is also a conductor, performer and teacher. His responses outlined in *Chapter 6* indicate a sense of perspective and integration musically, where electroacoustic music is one component part of his output as a composer, musician and educator. His responses are very detailed and thought-provoking and quoted in full in the appendix.

Gerardo Dirié's works for electroacoustic media, chamber ensembles, choir, and the theatre have been presented in broadcasts and stages internationally [ ]. Besides his career as a composer, Dr Dirié has been an active clarinet player, bass player, conductor, percussionist, and Early Music performer. (from the website [www.griffith.edu.au/music/queensland-conservatorium/staff/dr-gerardo-dirie](http://www.griffith.edu.au/music/queensland-conservatorium/staff/dr-gerardo-dirie))

### Rick Nance

A composer and teacher (currently of composition, psychoacoustics and spectromorphology). This includes electronic music integrated to live performance. Software used has included open source software such as Ardour written for the Linux operating system. He has also taught classical guitar, trumpet, drums and music theory to younger students. His compositional profile is listed as acousmatic, tape music, electroacoustic and experimental. He has edited his *MySpace* profile to include:-

Performer on trumpet, classical and electric guitar, and composer of electroacoustic music, primarily acousmatic. [ ]. Presently guest composer in the studios of Birmingham Southern College. On the prowl for a new improv group.

Amongst his influences listed on the same profile he includes George Crumb, Pierre Henry, Adrian Moore, Stockhausen, David Berezan, John Young, John Richards, Ligeti, Pierre Schaeffer and Lutoslawski.

### Bret Battey

A composer of *visual music* who nonetheless also uses visualization and representation as part of the compositional process. He has been clear in his discussions with this author to differentiate between visualization that informs the composition as work in progress, and visualization that is created as part of a complete creative product and experience.

Bret Battey (b. 1967) creates electronic, acoustic, and multimedia concert works and installations, synthesizing diverse experience in music composition, computer programming and graphic design. A major focus in his work has been the crafting of integrated sound and image compositions. He pursues research in areas related to generative techniques, digital signal processing, image and sound relationship, Indian classical music, and expressive synthesis — laced with a overarching fascination with feedback processes and emergent behavior. He often frames his artistic work as a way of evoking experiential analogs to distinctive ways, philosophically, of being in the world. (From the website [www.mti.dmu.ac.uk/~bbattey/profile.html](http://www.mti.dmu.ac.uk/~bbattey/profile.html)) last accessed 09/03/2013)

### Pierre Couprie

Pierre Couprie is a researcher, musicologist and programmer working in the electroacoustic field. He has worked extensively with GRM and elsewhere to develop software and procedures, particularly for the analysis of electroacoustic music. This



began with *Acousmographie* but now the latest version is entitled *eAnalyse* which specialises in electroacoustic music. *iAnalyse* is a version for what might be described as conventionally notated music. As the names suggest, Couprie's interest is in developing tools for the analysis of electroacoustic music, alongside music in general. However his software is capable of being used for other and varied compositional processes such as archive and description. His de Montfort University profile lists his interests as composition and improvisation, electroacoustic music studies, pedagogy, and software and multimedia development.

### Ambrose Field

As evidenced by his responses to this author and the notes below, Ambrose Field is a composer, teacher, researcher and academic working in the field of *visual music*, but in the case of these responses, collaboratively as far as the visual elements of the work are concerned. However the following profile notes indicate significantly wider interests as a composer, including live performance

Ambrose Field is a composer motivated by innovation and a human approach to digital technologies. Field's recent large-scale piece 'Being Dufay' is a new setting of fragments of medieval song (John Potter, tenor) within lush, contemporary electronic soundscapes. Being Dufay is published by ECM Records (ECM 2071). Being Dufay is currently touring as a live performance (which premiered at Vienna Konzerthaus in January 2009).

[ ] Ambrose is particularly interested in the impact of interactive digital technology on musical performance. His piece World Facts [ ] employs live data feeds from the internet to influence the real-time composition of a multi-channel, immersive audio piece.

[ ] Ambrose's research interests are in Composition, Postmodernism, Crossing Genre and Style Boundaries in Music, and the production of next-generation immersive media.

Field has instigated a number of high-profile projects which directly involve partners from Industry. In 2006, he developed the Worldscape Laptop Orchestra, an ensemble of 50 wireless

musicians investigating the large-scale application of digital technologies to creativity.

(Taken from his University of York profile)

[www.york.ac.uk/music/staff/academic/ambrose-field](http://www.york.ac.uk/music/staff/academic/ambrose-field) /last accessed 09/03/2013)

### Gary Eacope

Gary Eacope is a composer and instrumental teacher in schools. He studied electroacoustic music at university, and continues to work independently of academia. His response to visualization and representation indicate a thoughtful approach, which has been arrived at as a matter of pragmatic necessity, and in response to the challenges of the compositional processes presented by each particular piece. His response to the questionnaire is detailed and reflective as regards to the compositional process, and in this particular case focuses on three specific compositions. The three types of visualization for each composition are outlined below.

*Piantronics* is a piano and electronics score. It is a combination of standard notation, non-standard notation and graphic scoring where the standard notation is at times as visually graphic as the graphic symbols themselves. Amongst other things, *Piantronics* used symbols depicting approximate pitch, duration, crescendos, whooshes, explosions, multi-stranded sounds, particles of sound, vibratos and waveforms. The piece also used symbols in the piano part to depict '*prepared-piano*' sections and dumbbell shapes depicting approximate note clusters.

*Tasteless Curtains* uses a colourful '*sequencer based piano-roll*' graphic score consisting of repetitive visual patterns, hence the title. Essentially, the score is an enlarged print-out of a sequencer piano-roll. Each note on the piano-roll triggers various pitches and sounds. The score contains crossing melodic lines, contrasting textures and perhaps most notably my name, Gary, in block capitals. The latter produced an interesting combination of pitches, durations, dynamics and texture. Again, this score is very accurate in that what we hear really is what is written in the score.

*The Beach* used an artist's '*sound drawings*' as a score. The artist had sat on a deserted beach and drawn what she heard as opposed to what she saw. The scribbles were used as input data for a sound synthesis program I wrote. The data controlled various parameters such as pitch, duration and spatialization.

(From the response to the questionnaire)

### Dale Perkins

Dale Perkins is an electroacoustic composer and teacher who uses visualization for pedagogical purposes. Notes on his work and more particularly his contacts with the electroacoustic *community* are indicated below. His graphic images are produced using *Adobe Illustrator*.

Dale is an electroacoustic composer and his music is performed both nationally and internationally on a regular basis. [ ] His research interests are electroacoustic music composition and compositional analysis. Dale is also the Director of the electronic music ensemble n.one which has been host to a number of [ ] high profile composers over the last decade; guest composers have included Trevor Wishart, Pete Stollery and Alejandro Viñao. He is also the founder of the International Forum for Innovations in Music Production and Composition [ ] where guest speakers and artists include David Toop, Leigh Landy, Bill Drummond, Jazzie B, Michel Chion and David Vorhaus (White Noise).

Dale Jonathan Perkins was awarded a First Class BA (Hons) in Music with Film and Television Studies. [ ] He is an active member of the Composers' Desktop Project along with leading electroacoustic composers such as Trevor Wishart and is a Fellow of the Higher Education Academy. (Taken from [www.daleperkins.co.uk](http://www.daleperkins.co.uk) last accessed by the author 10/03/2013)

### Katharine Norman

To quote from her own website: -

A composer, writer, teacher and sound artist – in no particular order.

This is indicative of a multi-disciplinary approach where the various activities are of equal importance. The notes below are taken from the following website, which was last accessed on 09/03/2013 [www.dmu.academia.edu/KatharineNorman](http://www.dmu.academia.edu/KatharineNorman)

Coming from a background as an instrumental and electroacoustic music composer, Katharine Norman's more recent research preoccupations encompass digital writing and creative uses of sound. She has a particular interest in exploring 'sonic psychogeographies', encompassing such research areas as acoustic ecology, autoethnographic writing, and philosophies of space and place.

An established composer and sound artist, and writer about sound, she has a second, related interest as a creative writer in the digital domain. [ ] Published writings include *Sounding Art* (Eight Literary Excursions through Electronic Music), an unconventional monograph on listening and digital music (Ashgate, 2004), and several commissioned essays on sound, most of which are also available online. [ ] - her significant body of music for solo piano has been performed worldwide. She is on the board of the journal 'Organised Sound' (Cambridge University Press) and a regular contributor and invited speaker at conferences in this area.

### Ron Herrema

A composer, teacher and researcher: -

He composes both acoustic and electroacoustic music, specializing in algorithmic composition and in interdisciplinary approaches to music composition. In recent years he has also been creating photographic art and generative graphics. He has presented papers and published articles on the relationship between music and architecture, on music technology and politics, and on the evolving relationship between composers and programming. (Quoted from his own website)

It will be seen in the next chapter that he uses specific software to pursue a direct relationship between graphic images and sound production.

Ron Herrema is a freelance composer of music, sound and image. He composes both acoustic and electroacoustic music, as well as both still and moving image. He has a particular (but not exclusive) affinity for algorithmic techniques in both realms. In 2008 he began his study of Deep Listening practice with Pauline Oliveros and continues to look for ways to flow musically into, with, and through the world. ( <http://ronherrema.net> last accessed 10/03/2013)

### Mike Gatt

A composer and researcher currently leading the *OREMA* project which focuses

on analysis of electroacoustic music. He has worked previously at GRM on the CASPAR project alongside Pierre Couprie, which focused on techniques and solutions for the archiving of electroacoustic music. Below is an introduction to Mike Gatt's analysis of *Étude aux Chemins de Fer* taken from the *OREMA* website

Chion discusses three stages in applying the typo-morphology of sound objects within the Guide Des Objets Sonores: identification, classification and description (Chion 1994: 124). I used this methodology to segment and apply the typo-morphology analysis. For each of these stages I had to adopt a reduced listening approach to distance myself from the causality of the sound objects and focus on their functions and type. I also tried to add a musical dimension to the analysis, as typo-morphology only concerns individual sound objects and not their relation with one another. Something that Schaeffer admitted, as he did not have time to create a *Traité des Organisations Musicales* (Schaeffer 1966: 663).

I don't believe that this is a definitive application of Pierre Schaeffer's typo-morphology for this composition, rather it is my interpretation of both the work and the implementation of typo-morphology. ( [www.orema.dmu.ac.uk](http://www.orema.dmu.ac.uk) )

### Gary Kendall

A composer and researcher who has worked in a variety of genres including work for film and TV. Amongst other issues he has focused on spatialization, sound installation projects and mixed vocal and electronic music. He places his work in a spiritual context: -

My current spiritual work has focused around working at sacred sites around the world. My wife Ulla and I work to assist the Earth's evolution to its next stage of evolution.

We also practice as an energetic healer working with clients to heal the non-physical body.

Music plays a central role for me in capturing and expressing my experiences and I look to bridge the gap between the traditional acoustic technology of the Shaman and the modern technology of electroacoustic music. ( <http://www.garykendall.net/spiritual.html> )

In his paper *What is an Event? The EVENT Schema, Circumstances, Metaphor and Gist. Proceedings of the 2008 International Computer Music Conference*, Belfast, UK, he presents a view that differs from the concept of the 'sound object' in that he believes that the term *object* does not present a sufficiently detailed and experiential view of our analysis and perception of sound.

### Denis Smalley

Denis Smalley is predominantly a composer of electroacoustic music, but also a researcher and teacher. Apart from his musical works he has published important books, chapters and papers on the subject of electroacoustic music, and over many years. His research interests can be summarized as:-

- electroacoustic music, particularly acousmatic music
- the sound world in general (not only music)
- sound and space
- music perception, reception, and listening strategies

Some of his compositions have involved electronics and live performance, and as such have been published. Apart from the wide acclaim attributed to his compositions, he has made a notable contribution to the thinking behind electroacoustic music including listening, perception, spectromorphology and spatialization.

He has made original contributions to thinking about electroacoustic music, in particular his investigations into the listener's perception of electroacoustic music, and his development of the notion of spectromorphology (the shaping of sound spectra through time). His most recent major writing has been concerned with the spatial image.

### Barry Truax

Barry Truax is a Canadian composer, teacher and researcher. He has specialized in granular synthesis, often using sampled sounds, and soundscapes. In *Wings of Nike* he was the first composer to use samples as the source of granular synthesis. Instead of 'grains' or 'wavelets' of 10-50 milliseconds common in granular synthesis, these samples were around 150 milliseconds. He is an original member of the World Soundscape Project. As well as teaching electroacoustic music and computer music, he is also described as teaching acoustic communication. Of granular synthesis he has said: -

I started working with it in real time and heard the sound, it was rich, it was appealing to the ear, immediately, even with just sine waves as the grains. Suddenly they came to life. They had a sense of what I now call volume, as opposed to loudness. They had a sense of magnitude, of size, of weight, just like sounds in the environment do. And it's not I think coincidental that the first piece I did in 1986 called [\*Riverrun\*](#), which was the first piece realized entirely with real-time granular synthesis, modelled itself, as the title suggests, on the flow of a river from the smallest droplets or grains, to the magnificence, particularly in British Columbia, of rivers that are sometimes very frightening, they cut through mountains, they have huge cataracts, and they eventually arrive at the sea. Well this is broadly speaking the progression of the piece, creating this huge sense of volume and magnificence from totally microscopic and trivial grains. (Interview with Barry Truax *Computer Music Journal* 18(3) 1994). This quote also reflects his interest in integrating soundscape and granular synthesis.

Truax teaches both electroacoustic music and computer music and acoustic communication at Simon Fraser University. He was one of the original members of the *World Soundscape Project*.

### Leah Barclay

To quote from her own web-site: -

Leah Barclay is a composer, sound artist and curator working at the intersection of art, science, technology and the environment.” She: - “creates complex sonic environments with a strong focus on the textural and timbral properties of sound. These works are realised through immersive

performances and multi-sensory installations drawing on environmental field recordings, multi-channel sound diffusion, live performers and ephemeral projections.

This is to say the least of it, because she has travelled and sought out various environments throughout the world in which to place her work, and used the inspirations of these environments to generate her work. She has also studied Western classical music and ethnomusicology. It may be that these studies mean that visualization is an intuitive and important of the compositional process. A recent album (2010) is entitled *Transient Landscapes*: -

a collection of works from the installation Sound Mirrors [-] and immersive environment that responds to significant rivers across the world. Throughout 2009 and 2010 [she] travelled Australia, India, Korea and China capturing the sound of rivers and their surrounding communities. The resulting work is an ephemeral experience that slides through vivid landscapes and rich cultural traditions. ( <http://leahbarclay.com/watch-listen/> )

### Louise Rossiter

Louise Rossiter is a composer and researcher whose research interests, apart from composition and acousmatic composition, include musicology, music education, music and philosophy, musical aesthetics, music and mathematics, music technology in education, acousmatic sound, acoustic ecology and expectation within electroacoustic music. As with other composers, research topics of this nature can be regarded as a strong influence on her compositional activity.

The contribution of these composers has greatly assisted this research, and revealed a fundamental truth, namely that visualization in relation to musical composition happens for reasons other than performance, as is the case with more



traditional classical music. There are several other reasons why visualization is desirable, helpful and effective in enhancing compositional understanding at various points in the process of composition. These are more fully revealed in the following two chapters. Thus it will be shown that electroacoustic music shares a common need for visualization with other musical genres.