NATURE IN ELECTROACOUSTIC MUSIC

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Composition Folio

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Duration: 12' 35
Track 1 – CD 1

Aura (2002)
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Duration: 12'44
Track 2 – CD 1

Erevos (2002)
Electroacoustic music – Stereo
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Night Pulses (2003)
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Duration: 11'30
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Declaration

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Abstract

This thesis accompanies the six submitted works, focusing on the utilisation of nature as a compositional factor, and its appreciation in the context of electroacoustic music. Apart from providing a separate discussion of each work, the thesis introduces a theoretical framework, where nature is defined in different types and sources, and where the idea of 'naturalness' within a musical context is approached through an examination of certain sound-behaviours. Reference is made to compositional methods used in the six works.

Introduction

Nature is a very important feature of electroacoustic music composition. The natural world is often perceived either through *mimesis*[1] or through the existence of recorded natural-environment sounds, which are transferred into a musical context. Reference to nature is not a contemporary innovation, but has been a subject of interest and an inspirational source for composers in the past, especially in the Baroque, Classical and Romantic eras, when harmonic, melodic/motivic, rhythmic and textural materials contributed to the mimetic process. In our times, the electroacoustic medium has brought significant changes in music creation and appreciation, allowing for a different musical experience of the natural world, not necessarily associated with traditional instrumental articulations and vocal utterance[2].

In the following chapters the presence of nature in the composition of electroacoustic music is explored. Chapter 1 focuses on the definition of nature in the real world, and also as a musical term, discussing its relationship to the human factor. Moreover, Chapter 1 introduces a categorisation of sound sources and delineates different manners of appearance and types of appreciation of nature within musical contexts.

In Chapter 2, the ideas of *naturalness* and *natural behaviour* are defined and explored. Certain nature-related behaviours, which appear frequently in the six submitted works, are examined and compared. The idea of mimesis is approached from a closer perspective through an explanation of how nature-related contexts can be created in practice. References to sound-processing are included here, accompanied by sound examples.

Finally, a separate discussion of each of the submitted works is provided, focusing on the role of nature as a structuring element, but also as an inspirational source. The works are approached from a micro- and macro- perspective, and selected extracts are often examined.

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[1] This term refers to the musical imitation/representation of nature.

[2] Instrumental and vocal resources may often be involved in electroacoustic music, but they are utilised differently than in traditional music. See Smalley (1997: 110-111, 1996: 96-99) for further discussion.

Chapter 1: Definitions and Sources

1.1 Introduction

When we listen to the sounds of nature in their real-world environment, we usually connect them to their sources that exist around us. We have to use our imagination if we wish to interpret what we hear as 'music'. In electroacoustic music we are able to utilise nature as a compositional source, either in a *referential* or a *reflective*[1] way. We can use 'captured', transformed or electronically 'imitated' natural sounds in order to indicate real or imaginary sources. Moreover, and most importantly, we can link these sources to our own interpretation and discover intrinsic worlds, but also values or messages beyond them[2].

But what is nature in electroacoustic music? How are we able to sense the natural environment in a 'virtual', recreated sonic world? In order to answer these questions we should first understand how nature functions in reality, in the so-called *real world.*

In the following paragraphs, the involvement of nature in composition is explained through the definition of natural sources and causes, focusing primarily on three fields of interest:

(a) Natural world and human presence

(b) Types of 'nature'

(c) Material sources and sound types

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[1] *Referential* and *reflective* listening is extensively discussed by Katharine Norman in 'Real-World Music as Composed Listening': *...referential listening connects sounds to objects, to measurements of time and space and to learnt 'symbols'..., ...reflective listening is neither a contemplation of an action invoked, nor a meditation on a sound's extra-sonic cultural history, but a creative, enjoyable appraisal of the sound for its acoustic properties* (Norman. 1996: 1-27).

[2] Sound sources of *nature* might be used (or interpreted) in the musical context as 'symbols' to represent ideas associated with the natural environment. For example, the sound of an action associated with birds (flutter-fly) may work musically itself in the context for its qualities, but it could also be appreciated as indicating a symbol of 'freedom'.

In (a), as an initial approach, the natural world is defined through the presence/absence of a human factor, which can either be a receiver or an agent. In (b), nature is explained according to the way we use or refer to sounds from the natural world in the musical context. In (c), sounds we might use to create, represent or imitate nature are categorised according to their source origin. A definition of the natural world and an explanation of sound-sources can help us understand how what we refer to as 'nature' appears in the musical context. The realisation and understanding of nature also constitutes a very important step in the compositional process.

1.2 Natural world and human presence

1.2.1 A 'real world' definition of nature

Real world and *nature* are closely related concepts, which are often confused. 'Real' is something usually defined as '*existent, factual, or underlying appearances*'[3]. Therefore we can regard everything that exists around us that may be perceived through our senses as *reality* or *real world.* When we refer to nature we usually imply everything that exists in reality, independent of the existence of human civilisation or any form of human creation. Most of the published definitions present nature as a '*...whole system of the existence, forces and events of the physical world that are not controlled by human beings...*'(Brooks. 1999: 365). They also usually separate the natural world from human activities. There are, however, theories to contend that everything we can sense around us belongs to nature, and thus it is *natural,* including the actions and creations of human culture. According to the epagogic[4] method of thinking, a 'city' is situated in a 'field', a 'field' belongs to nature, and thus, a 'city' is a part of nature. Syllogistic arguments like this also link human creations to the natural environment: if we accept that 'human' belongs to the natural world, then all human-made material things do as well. For example, a 'car engine' is a human creation, human is a creation of nature, and therefore, a 'car engine' belongs to nature. However, if we accepted all the above arguments as correct, then we would have to face two contrasting conclusions, either that everything is nature, or that nature does not exist at all, and thus, there would be no reason to discuss or define it, which is, of course, an incongruous hypothesis[5]. Philosophical thought can lead to false speculations, if and when philosophical methods are employed and used incorrectly.

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[3] 'real, a.' *Oxford English Dictionary*. Ed. J. A. Simpson and E. S. C. Weiner. 2nd ed. Oxford: Clarendon Press, 1989.

[4] 'Epagoge' is a term used in Aristotelian logic. The 'epagogic' method is a syllogistic argument, where induction-inference is used to define the truth. The opposite term is 'apagoge', according to which the truth is defined through 'abduction' of thought.

[5] According to the 'apagogic' Aristotelian method, this speculation is incorrect, because it is not possible to have two correct-opposite explanations.

Therefore the definition of the term 'nature' involves a dilemma: should we regard human presence as belonging to the natural world or not? We can certainly accept that the human belongs to the natural world as a live organism, but this does not apply to all human creations and activities. The natural environment existed long before the appearance of human civilisation. We cannot deny that humans evolved in the natural environment through time, but we should accept that human creations did not do so. The human being has always adapted the environment to his needs, transforming and often destroying nature to achieve this. Human civilisation works as the 'human natural environment', and it has often – especially in our times – been catastrophic for the natural world around it. Human creations are made for human purposes and thus human civilisation develops as a result of human intelligence. Everything created in the human environment serves a human purpose, but it does not necessarily belong to nature.

Nature involves creative forces beyond the range of human activity. It involves the evolution of the whole universe, the power of creating and generating life in the 'cosmos'[6], where human presence plays an insignificant role. While nature has been determinant for human evolution, however, creating nature is beyond human abilities. At this point, we could regard 'nature' as *the creative and regulative physical power conceived of as operating in the material world and as the immediate cause of all its phenomena, as opposed to human creations or civilisation*[7].

The problem we face in modern society is that we cannot clearly experience 'pure nature', because human activity is spread throughout the sensible world. However, the fact that we cannot experience it does not indicate that it does not exist. Beyond our civilisation and our 'fabricated' reality, nature is a concept that exists, evolves and circulates independently of our activities.

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[6] The original Greek meaning of 'cosmos' refers to the *real world* as an ordered whole, a harmonically ordered system of existence, where everything exists for a reason (logos).

[7] This discussion does not seek to prove what nature actually is in the real world. For the purposes of this thesis, the above, rather traditional definition should be accepted axiomatically, though any arguments to suggest that human civilisation is part of nature may seem logical.

1.2.2 Nature – an electroacoustic music definition

In our human intelligence nature can be an 'idea' that may be used to represent values or principles. When we perceive nature in the actual, real environment, or when we experience it in our minds through our imagination, it is we who determine the impact it has on our perception. Consequently, the human experience of nature involves the connection of elements from the natural world to our senses and our imagination. Such an experience can be broadly expanded and celebrated in electroacoustic music. The wide sonic world of electroacoustic musical contexts can help us achieve a deeper experience of nature through our imagination, and assist in discovering inner worlds beyond the sound itself.

However, defining nature musically is a necessary step before we decide to utilise any materials from the natural environment in composition. The perception of the natural environment in electroacoustic music is often associated with the existence either of a human agent or a human receiver, and therefore, an understanding of the relation between *natural world* and *human presence* is essential for an understanding of nature in the sounding content of electroacoustic works.

The existence of a human being in association with material sources of the natural environment is usually a determining factor in the way nature functions in a musical context. For example, a human walking in a forest is an event, which combines the human action of walking with the natural environment, and thus places the 'forest' image in time. Being 'placed' in the natural environment, the human being can be appreciated as triggering sonic events, interacting with natural materials by actions such as 'pushing', 'dragging', 'hitting', 'scratching', 'dropping', 'throwing' and more: such types of actions involve human *gesture*[8] for sound production, in which case, the energy coming from the human body is 'transmitted' to the natural source, which vibrates and produces sound. Changing the amount of energy applied to a source provides different results, and thus, different types of gestures accordingly result in different types of sounds. For

[8] *Gesture* will be separately discussed in the following chapter (see 2.3.2.1), as a determining factor for appreciating the *behaviour* of natural sources, a field closely associated with the fields of *time, space, energy* and *motion*.

example, the sound produced by scratching the trunk of a tree differs from the sound produced by hitting it: in this case the difference between the two sounds indicates different actions (scratching-hitting), in which different types of gesture are involved and employed in the sound production.

However, the existence of the human being in the natural environment can also be presented and appreciated differently: in the context of certain electroacoustic works, the human being is presented as 'imitating' the natural sounds (such as the sounds produced by birds), or as interacting with natural materials using the human voice. In other contexts, the natural world is revealed to the listener through the use of human speech, which usually works as a 'code' for interpreting the sounds and relating them to natural actions-images, and often messages associated with the natural sources. For example, words like 'forest' or 'dawn' direct our imagination and relate to general images of nature, while in other cases, words like 'fly' indicate a bird-related action, which may be symbolically associated with ideas like 'liberation' or 'freedom'[9]. In the above-mentioned examples human *utterance* is used by composers in different ways and forms in order to reveal the existence of the human being in the natural world, and also to create relationships between human-nature-ideas. Consequently, utterance is a very important factor for understanding and interpreting the natural world in the context of electroacoustic works, and it should be appreciated together with gesture in the definition of what is regarded as 'human presence'.

According to the above-mentioned examples we may regard the human being as being related to the materials of nature through certain human behaviours, such as gesture and utterance, and this relationship can finally be translated into our musical experience, as indicated in Figure 1.1.

Human presence in the natural world can be *active*, through human utterance and gesture, or *passive*, in reception via the human senses. In the first case, the human being acts as a 'performer' on the sounding materials of the

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[9] In the piece *The Hidden Tune* by Sabine Breitsameter (see 1.5) the human voice is initially presented as interacting with recorded sounds of birds and insects in repeated rhythmic patterns. Later in the piece, the words 'silence'-'future' are used to relate the natural world to, or separate it from, human culture, and to describe different sections of the sounding content of the work. The 'sonic' antithesis between the dimensions of past-future indicates the destruction-alteration of the natural sonic environment by human civilisation, a message which is perceptible through the use of human speech in the context.

natural environment, while in the second, the human is the receiver of the result of the activity. Both these sides of human presence are needed to define our perception, and they usually work together in the compositional process. The human 'agent', as mentioned above, may appear in the musical context as interfering-interacting with various materials from the natural environment, while, at the same time, the human receiver can connect the sounds to human senses and feelings. It is also the human receiver-listener who interprets the connections between sounds-images-senses-feelings into values or messages.

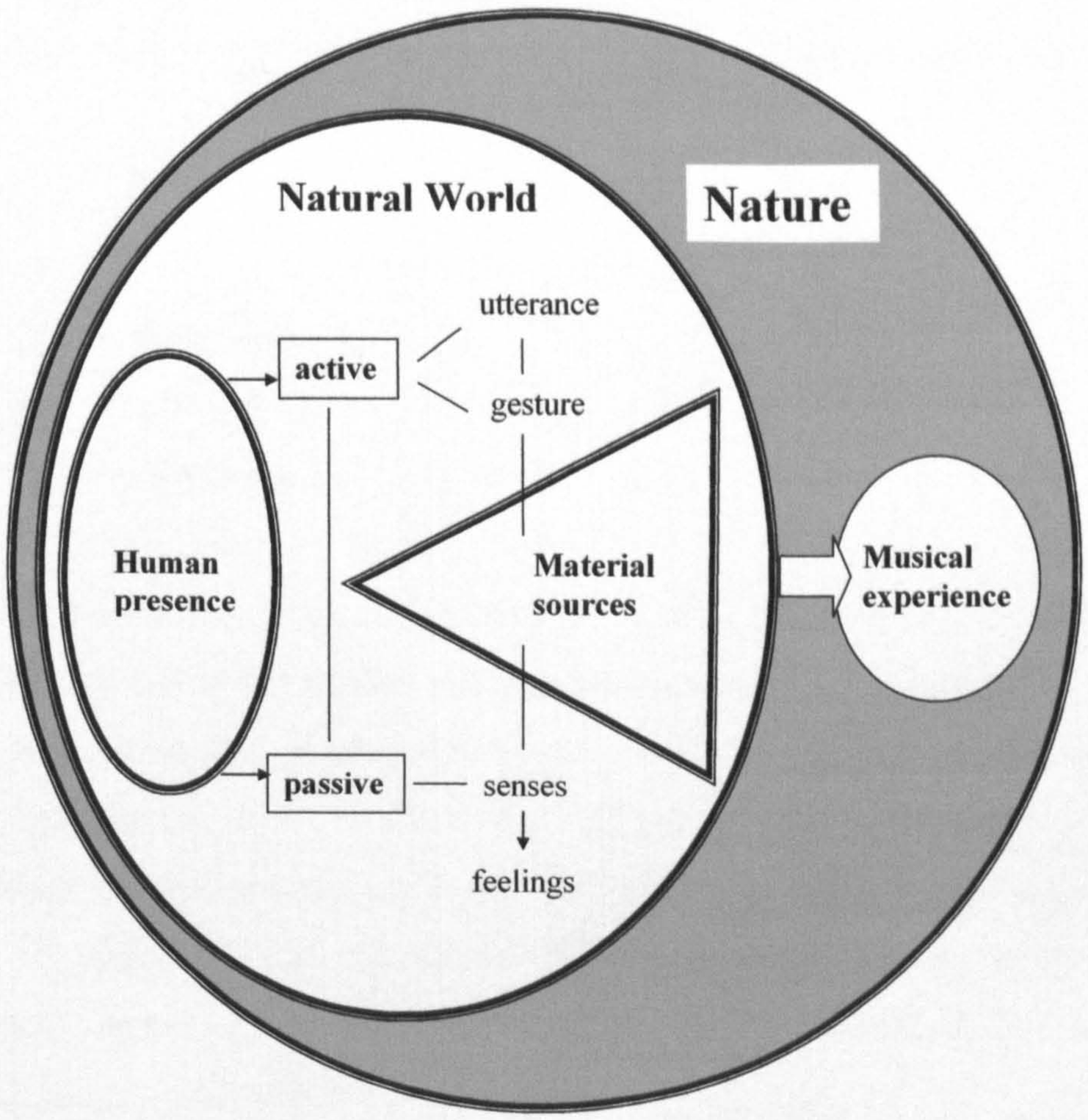

Figure 1.1: Natural world and human presence.

Considering the above, we can realise that human presence is highly involved in the musical 'functionality' of nature, and furthermore, human perception ultimately defines the meaning of nature in electroacoustic music.

In arriving at a definition of the term 'nature' from the electroacoustic music point-of-view, we could regard it as *the sum total of sounds of the material world used or referred to, as surrounding and including certain human behaviours.*

1.3 Types of nature

As mentioned in the previous paragraphs, the natural world can be perceived in electroacoustic music either by using or by indicating natural material sources in the musical context. This may be achieved through utilisation or transformation of 'captured' sonic material, but also through *mimesis*, by using sounds deriving from *non-natural*[10] sound-sources. Depending on the process we choose to follow, our perceptual approach to the natural environment can be variably defined. According to how we can use sounds from the natural world or refer to them in composition, nature can be defined according to four different but closely related types:

(a) real
(b) imagined
(c) recorded
(d) imitated

These types concern the use of material sources in composition, and define the forms through which the natural environment is related to electroacoustic music. In the compositional process the above types usually work together, as they can be closely associated and interdependent. A schematic presentation of this relationship is given in Figure 1.2. Our perceptual approach to the natural world can be dependent on the relation of the sonic context to any of the above categories. The use of these types by the composer is fundamentally *intentional* or *non-intentional*, as also shown in Figure 1.2.

[10] *Non-natural* indicates sources not existing in the natural environment, as deriving from human civilisation: these may involve the use of musical instruments or musical technological equipment to produce sounds in order to imitate nature. Furthermore, nature can be suggested by the use or transformation of any type of sound produced by human creations and controlled by human beings: these sounds can be taken from the *human environment* (usually mechanical-industrial) and may belong to human-made sources (engines, alarms, horns etc).

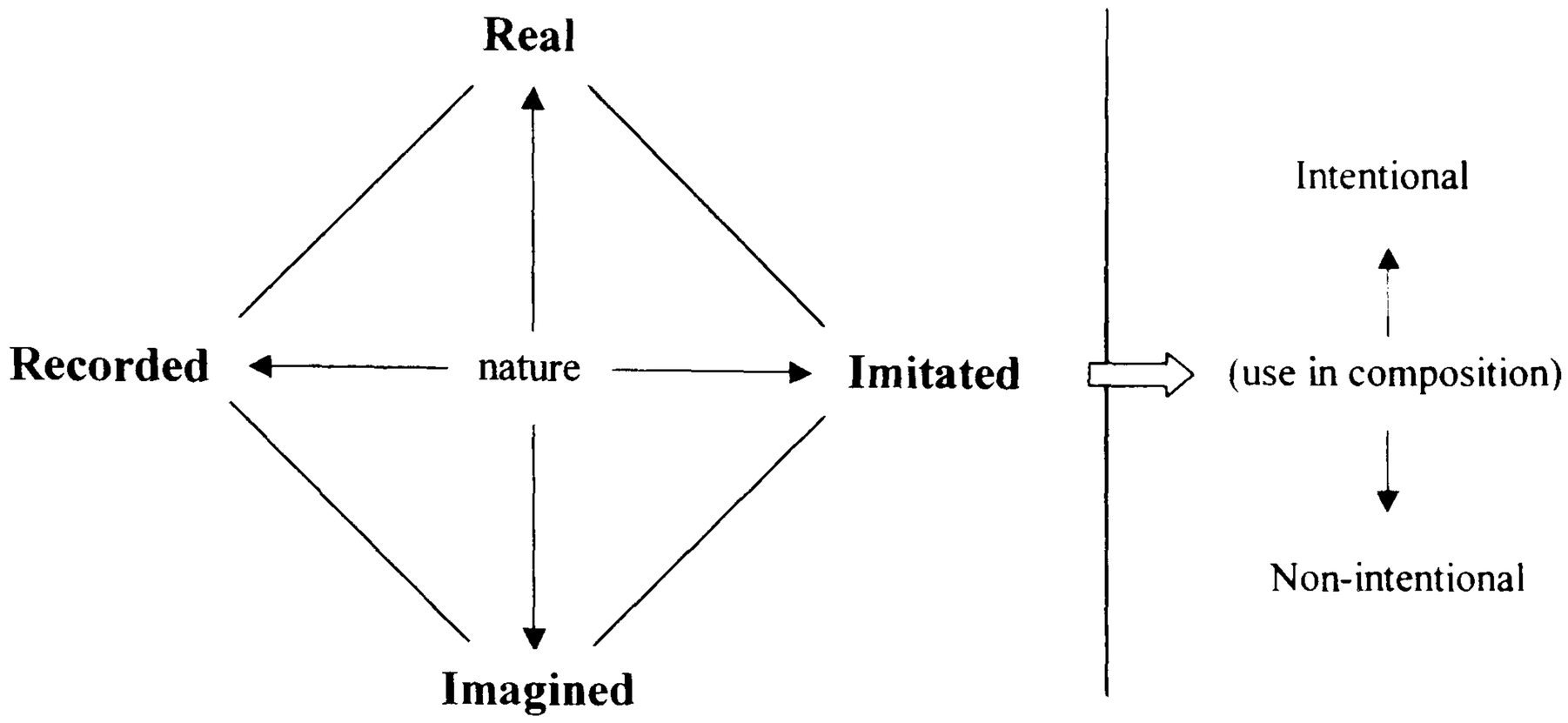

Figure 1.2: Types of nature in electroacoustic music.

A brief, definitive reference to types of nature is needed to explain how they may work in composition, and is given below:

1.3.1 Real nature

As already mentioned, a literal notion of 'real' is clearly not admissible in electroacoustic composition. For example, we may accept that natural sounds are not 'real'[11] when they are used in an electroacoustic work, if they are transformed in some way, even through the recording process. However, we may simultaneously accept that all sounds used in the musical context are 'real', as they can be heard through the listening process. The conception of *real nature* needs an understanding of the reality[12] of natural world, as opposed to the reality of electroacoustic music listening. The sounds we perceive in electroacoustic contexts may originate in or refer to the natural world, but they do not constitute

[11] Not belonging to the real-natural world, the natural environment, the reality of nature.
[12] The question of *reality* opens a wide argument which should not be discussed at this point. The reality of 'space' will be discussed in the second chapter of the thesis.

what we would call *real nature*. The natural environment works not only as a sound source, but also as a sonic reference: nature, as already explained, exists independently of human activities, but it can be 'reformed' in our minds through electroacoustic music. Environmental-natural sounds which exist in the natural world independently of any compositional activity can be referred to as 'real nature', and it is to our experience and memory of these sounds that we may direct our perception when listening to electroacoustic music. Therefore, we can define 'real nature' as *the totality of natural sounds as they are potentially perceived in the natural environment, independently of any use in composition.* We must realise that real nature works as a notional reference in electroacoustic music, and can be implied through either recorded or mimetic sound materials.

1.3.2 Imagined nature

In the wide-open perceptual field of electroacoustic music, we are free to use our imagination to connect sounds to sources and/or causes, and interpret what we hear according to our personal, intrinsic views of the natural world. Through listening to nature-related electroacoustic music contexts which do not necessarily indicate 'familiar' sound sources, we can create our own imaginary natural worlds in our mind, and mould our own aesthetic approach to the natural environment. But even when dealing with 'recognisable'[13] sounds we can create our own perceptual path and discover imaginary landscapes[14] beyond the apparently 'real' or 'natural' sound sources. In *imagined nature*, either sounds of any origin may be used to construct a nature-sounding context, or natural sounds[15] may be used to present a different, 'imagined' side of the real, natural world. However, it would not be proper to condense imagined nature in a single, definitive phrase: we could, for example, regard it as 'the totality of sounds used in electroacoustic music to imply nature', but this definition would rather constitute too much of a generality. In electroacoustic musical contexts the terms 'imagined nature' and 'nature' could be regarded as synonymous, since nature is, in general, imagined. Even when a

[13] Sounds which indicate certain sound materials existing in the natural environment.
[14] *The landscape of a sound-image we have therefore defined as the imagined source of the perceived sounds* (Emmerson. 1986: 17-39).
[15] Evolving from the natural environment, *real nature.*

'real', nature-like musical context is used, the musical events are either *recorded* or *imitated*, and the aural result is a 'representation' of the natural world configured for a compositional purpose. Our musical experience of nature involves the development of our perceptual approach through the use of our imagination, and in this sense the experience can be characterized as 'imagined'. 'Real' and 'imagined' nature can therefore be closely related perceptually.

1.3.3 Recorded-imitated nature

An electroacoustic musical context may relate to the natural world when it is constructed of sounds referring to either *recorded* or *imitated* natural sound sources. In the first case we can 'extract' sonic material from the natural environment and place it in the musical context, while in the second we can imitate the natural environment through the use of sounds which may be of any origin. In order to 'capture' the natural world sonically we have to use microphones and recording equipment; subsequently, *the sum of recorded natural sounds used in composition* can be notionally embodied in the term 'recorded nature'.

On the other hand we can imitate nature through mimesis, when using sounds from various sources in various levels of transformation. On this occasion the natural, sonic world can be regarded as *mimetic* or *imitated.* The sounds may evolve either from natural or non-natural sound sources, and the aural result may indicate landscapes other than those associated with the original sources. The term 'imitated nature' can be explained and defined as *the totality of sounds, originating or not in nature, used in composition to represent the natural environment sonically.*

However, we may confuse recorded-imitated with real-imagined nature, depending on the basis of our approach. The four mentioned types are antithetically related in a two-axis analogy, as shown in the 'tetragram' in Figure 1.2: here it is essential to understand that while 'real' or 'imagined' may refer to our sonic 'impression' of the natural world, 'recorded' or 'imitated' point towards the structuring of the sonic context.

1.3.4 Intentional - non-intentional use in composition

The recognition of sonic material as 'nature' can rely on our own speculations, or be a response directly related to the composer's intentions. Any reference to the natural world in composition can be used by composers intentionally or not. We may, for example, regard what we hear in the musical context as belonging to nature, as such an indication can be 'obvious': this means that we may be able to recognise the natural, recorded sounds and relate them to their original sources. We may simultaneously interpret the 'familiar', recorded sounds as values or messages either according to our own perceptual experience, or according to the composer's intentions. In a similar manner we might potentially identify any 'unfamiliar'[16] sonic material as real-imagined-recorded-imitated nature: again our perception depends on our own interpretation and/or on any intention-direction made 'evident'[17] by the composer.

Subsequently, the use of any of the mentioned types of nature in composition can be characterised as 'intentional' or 'non-intentional'. *In intentional use a sound or sound-image*[18] *is desired to be perceived as nature.* On the other hand, *in non-intentional use the choice of perception and connection between sound and materials is left to the listener, or is primarily a construct of the listener.*

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[16] Non identifiable as originating in sound sources of the natural environment (imitated nature).
[17] The composer's intention may be obvious in the programme notes, or may be apparent through the sonic context.
[18] The term *sound-image* is used by Trevor Wishart in 'Sound Symbols and Landscapes'. (Wishart. 1986: 53).

1.4 Material sources and sound types

1.4.1 Sound types

In electroacoustic music composition we are free to choose sonic material deriving from a wide variety of sound sources. What we perceive in the sounding content of electroacoustic works is a result of sonic transformations of the original, broad range of sonic material available to composers. The recording, generating and transformation processes of electroacoustic composition involve differing categories[19] of sounds.

'Nature-like' sonic material can be derived from a wide variety of sources, categorised below according to their origin:

(a) electronically-generated
(b) instrumental
(c) natural
(d) human culture

In (a) the sound material may be synthesised using software or hardware-based sound generators. The second category (b) involves the use of instrumental sounds. Human gesture can be used in combination with instrumental timbres to create nature-like sounds. In (c) we include those sounds we can record-borrow from the natural environment. In the fourth category (d) we find sonic material originating in human-created sources, and thus considered as belonging to human culture. The sounds in this category involve the 'human environment' and human

[19] *In one category we find sounds snatched, borrowed, captured by microphone from nature or from culture, sounds that prior to their capture had no musical purpose; in a second category are those sounds specially created for musical use: instrumental and sung sounds. In a third category are those electroacoustic sounds (whether they are synthesized or heavily transformed matters little) seemingly remote or divorced from the familiar sounds of voices, instruments, nature or the identifiable sounds of our culture*: discussed by Denis Smalley in 'The Listening Imagination: Listening in the Electroacoustic Era', (Smalley. 1996: 77).

creations, 'mechanical', 'industrial' or other. sources created to serve human civilisation purposes, potentially remote from any use in music.

In all the above sound categories the role of technology is essential for the musical 'sculpting' of nature. Through the process of transformation we can use the sound world around us for musical purposes. Any sound can be used at any level of transformation, from simple[20] to complex. to indicate real or imaginary views of the natural world. The recording process is also very important: in the categories (b), (c) and (d) recording is a principal action, a determinant compositional factor, and it is often interwoven with the sound production process.

Furthermore, the categorisation of the above-mentioned sound types has been made according to the purpose of sound production. We could, for example, include the sound material in only two source categories, as 'natural' and 'non-natural': the sounds included in (a), (b) and (d) are human-based involving human-created sound-sources, as opposed to the sounds in (c), which derive from sources of the natural environment. The introduction of four sound categories involves focusing on musical or non-musical purpose of sound materials. In the first two categories, (a) and (b), the sounds are created for musical use, while in the other two categories, (c) and (d), the sounds could exist independently of any use in musical contexts.

The sound material can be musically used and linked to our experience of nature. This connection involves the musical presentation/imitation of natural world sources, which may evoke in our perception *individual events* (like, for example, the singing of a bird), *images* (forest, valley) or *activities* (combined actions/phenomena such as rain, storm, earthquake). The connection of sound-types to musical experience of nature is presented in Figure 1.3.

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[20] Even the act of recording should be regarded as a simple (or rather the simplest) level of transformation.

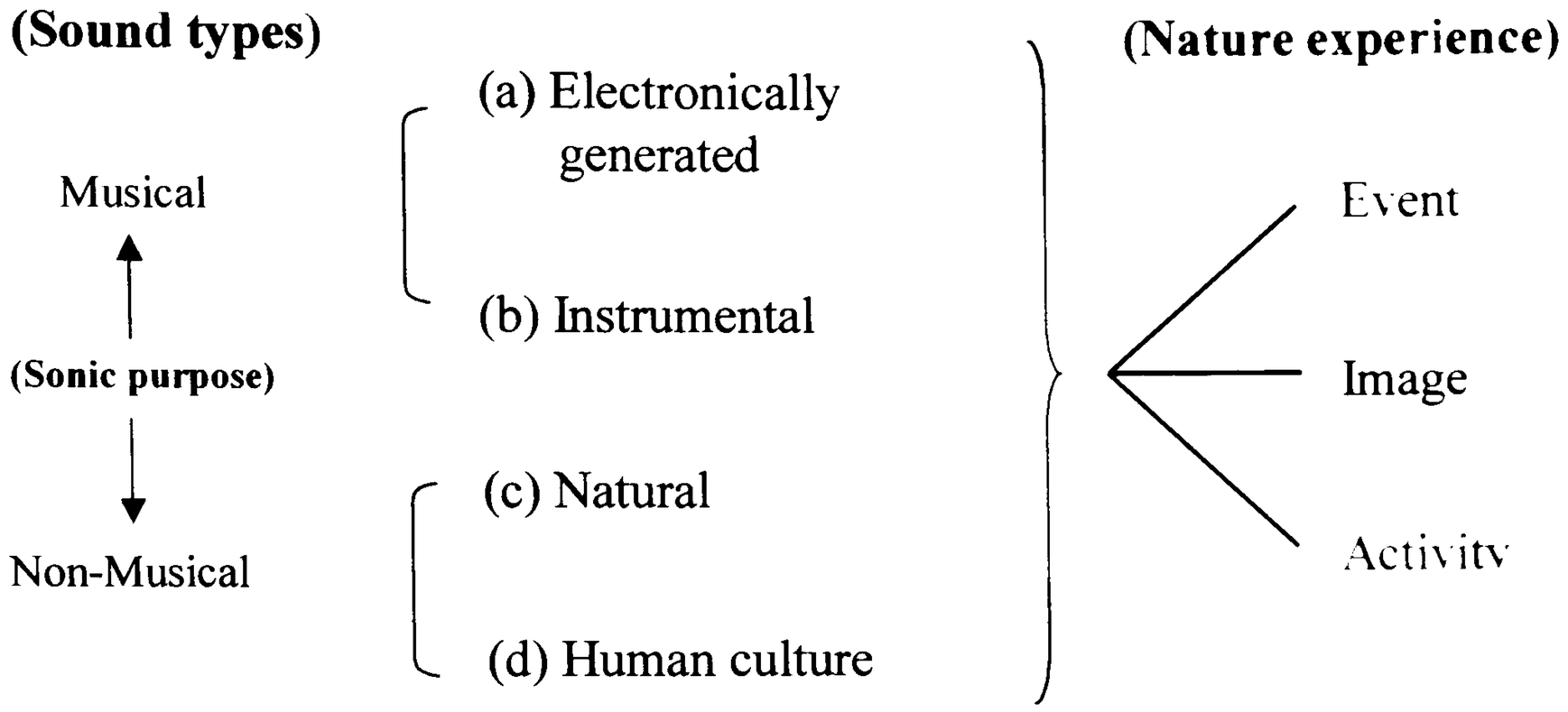

Figure 1.3: Sound types and nature experience

1.4.2 Natural sources and sound production

When we experience what we call 'nature' in electroacoustic music we link a musical work's sounding content to sounds from the natural world: the sounding sources we refer to in that case can be the natural elements, solid materials and living organisms[21] of the natural world, and they constitute what we would call 'natural sonic environment'. The natural sources can be again organised in different source-categories (displayed in Figure 1.4), in which the sounds may accordingly derive from the constituents of the 'natural world': these are the natural elements[22] (air, water, fire), other material sources (like wood, metal, or stone), plants, animals and humans.

The natural sound[23] may be produced by the source itself, or by combination of sources or actions; therefore, we can regard natural sources as 'self-sounding' or not. But how does the 'natural world' evoke our perception? How can we identify the source 'behind' what we hear in the electroacoustic musical context? The 'understanding' of sounds involves the realisation of sound sources, and therefore, in order to relate sounds to sources we must understand the actions through which the sounds are produced, in other words the sound-cause[24].

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[21] In this category we can include sources of what can be identified as 'natural' or 'organic life': animals, plants and humans.

[22] According to ancient (the ancient Greek 'ionian' or 'naturalistic') and medieval European philosophers the primordial elements-constituents of the material world are four, and they can be defined as air-water-fire-earth. In our 'sonic' approach we can understand that the aural conception of 'earth' is rather general, and (since also it is not considered a natural element today) it would not be proper to include it together with the other three elements. Instead it would be more practical to present the element of 'earth' sonically through combinations of solid material sounds. The aural experience of 'earth' or 'ground' can be general, or it can be separately linked to its ingredients (soil, dust, mould, clay, rock etc).

[23] The sound deriving from natural sources.

[24] The relationships between source and cause are extensively analysed by Christiane Ten Hoopen in 'Perceptions of Sound: source, cause and human presence in electroacoustic music', a PhD thesis in electroacoustic composition at the University of Amsterdam. (Ten Hoopen. 1996).

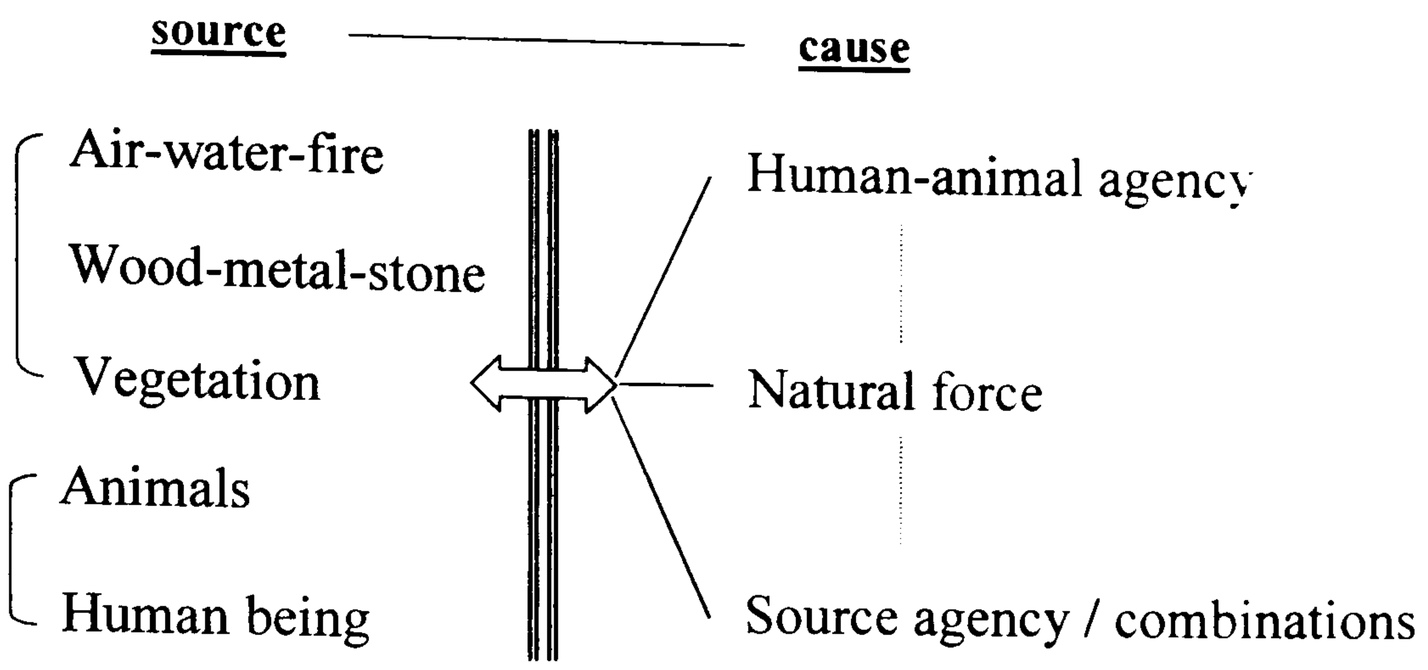

Figure 1.4: Material sources and sound production

As shown in Figure 1.4, sound production in the natural world can be a result of agency, created by humans-animals, a natural force or another material source. For example, the sound of the water can be produced through human gesture, in which case we have human agency, or it can be a result of the effect of a natural force like gravity. In the first case the energy for the action comes from the human body: in our example the human being is the 'agent' and the human action is actually the cause of the 'water' sound. In the second case, the existence-effect of a natural force (gravity) upon the source (water) may produce the aural result[25], and may therefore be the cause of the sound. In other cases, sources like wood, metal, stone and plants can produce sounds through human or animal agency, or the agent may be a natural force. For example, the 'rustle' of leaves results from the agency of another source, the element of 'air', which moves through the leaves; the air motion is the phenomenal cause of the 'rustling' sound, and itself is the result of a natural force. In this case source agency and natural force are closely related.

In Figure 1.4 'human' and 'animals' are linked together, not only as 'agents', but also as self-sounding sources, where the action takes place in their sounding body. Here the energy comes from the sounding body and the sound is

[25] For example, gravity makes the water move from one place to another: this action may sonically be experienced as 'stream' or 'waterfall', depending on the amount of energy released. In the case of water motion the sound is produced by the source (water) itself, but the cause of the sound is the effect of gravity.

produced in the body itself: the sonic result can be perceived as 'voice', 'song', 'speech', or 'paralinguistic sounds'[26].

The relationship between natural sound sources, actions and sonic experience can be presented schematically: Figure 1.5 constitutes an effort to summarise this relationship through the introduction of source-sound-experience examples. In the left column are the material sources of nature as found in the natural world, but also as they may appear and be identified in musical contexts. In the circular shape are some examples of actions used to produce different types of sounds according to effect by a natural force, agency by human-animals, or agency by other natural sources. In the same shape are included certain types of gesture closely associated in sound production with material sources like wood, metal, stone, and plants (solid materials and vegetation). On the right are different examples of sonic experience (events, activities, images) into which the actions can be translated. However it would be impossible to include all sources, actions and experience types in a complete list: we can imagine an infinite number of sound sources related to the natural environment[27], which can produce an immense variety of sounds through series of actions; furthermore, our sonic experience can be associated with numerous sources, events, phenomena, images or any other constituents-'ingredients' of the natural world.

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[26] 'Paralinguistic sounds' are produced through utterance or through combinations of utterance-gesture, and they cannot be categorised clearly as 'voice', 'song' or 'speech'.

[27] This depends on combinations of matter: the three fundamental states of matter in the physical world are defined as liquid, solid and gas, but they can be combined in different levels; therefore we can have material sources (like mud, lava, plasma etc) which do not clearly belong to a certain material state.

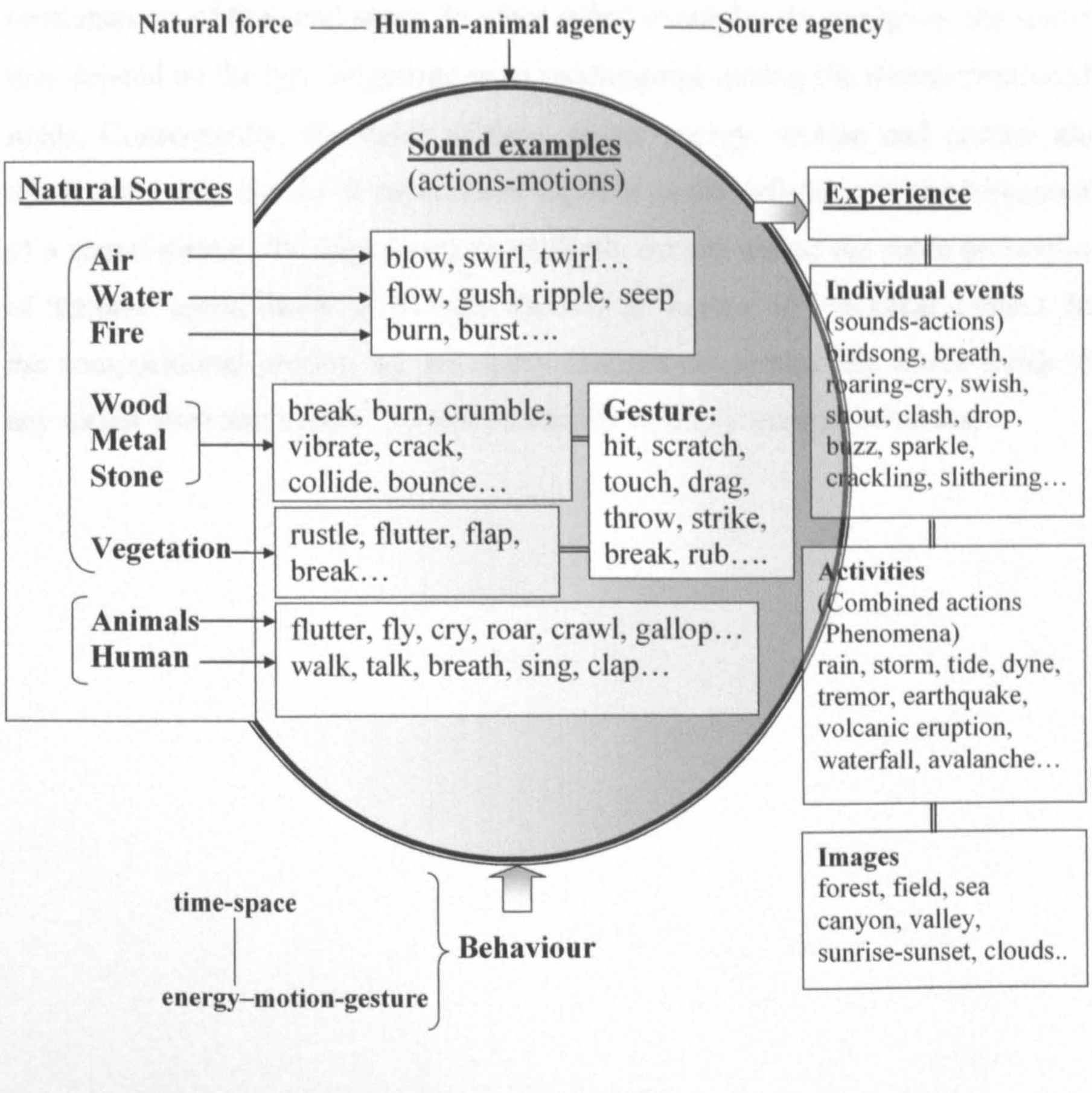

Figure 1.5: Natural sources, sound-types and sonic experience: examples.

The actions in the 'sound examples' section in Figure 1.5 indicate what would be referred to as *behaviour*, which will be broadly discussed in a following chapter: such a definition is necessary in order to understand how we can select sound materials or how we can refer to natural sources more practically in composition. However, a brief reference to behaviour can be included here, as it is needed for the appreciation of the above examples.

The behaviour of a natural sound source can be defined in the fields of *time*, *space*, *energy*, *motion* and *gesture*. Different combinations of these fields may indicate the sonic attributes of sound sources, according to the type of action resulting in sound production. For example, a sound may indicate different types of motion (as in the example of sound types of 'air' in the 'sound examples' section in Figure 1.5), which may also simultaneously indicate different

combinations of time and space. In other sound examples the energy of the sound may depend on the type of gesture or in relationships among the above-mentioned fields. Consequently, the fields of time, space, energy, motion and gesture are relative and they should be appreciated together in the definition of the behaviour of a sound-source. By considering these fields we can define the sonic properties of 'natural' sound materials or what appears as 'nature' in a musical context. In the compositional process we can apply changes concerning the above fields to any sound from any source[28] in order sonically to imply *natural behaviour*.

[28] 'Natural' or 'non-natural' as previously explained in 1.4.1.

1.5 Works

In the following paragraphs a discussion of selected electroacoustic works is provided. The works are approached from a micro- as well as a macroscopic perspective, primarily focusing on the structural role of nature, in relation to the previously-discussed topics. An examination of selected extracts (CD examples) is also included. Apart from the three submitted works appearing on CD 1, *Rous*, *Aura* and *Erevos*, the works *Sud* by Jean-Claude Risset and *The Hidden Tune* by Sabine Breitsameter are briefly discussed below with regard to their relationship to nature.

Jean-Claude Risset's *Sud* involves the presentation of 'real'-'unreal', 'far'-'close' views of the natural world. This work constitutes a good example of utilisation of both 'natural' and 'non-natural' sonic material in its sounding content[29].

> *My piece 'Sud' can be termed hybrid and naturalistic: it invokes the poetry of reality. It opens with environmental soundscapes – sound photographs of a natural scene – followed by quite different sounds obtained via synthesis. In the course of the piece, the two worlds of sound – natural and artificial – will gradually merge together through transformations and hybridations.* (Risset. 1996: 37).

In the musical context, real and imagined types of nature[30] are sonically implied and the selection of sound materials has been made accordingly. The emphasis has been put on relationships between natural and synthetic sounds: firstly, the real natural world 'revives' through the use of recorded, unchanged[31]

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[29] An extensive analysis of the use of natural sounds in *Sud* and also in other works is provided by the composer in 'Real-World Sounds and Simulacra in my Computer Music', (Risset. 1996: 29-47).

[30] See 'types of nature' as defined and related in 1.3.

[31] Not transformed to such a degree as to be unrecognisable. Furthermore, notably at the beginning of the piece, the natural sounds are used in such a way (through the lack of 'smoothing'/reverberation) as to 'suggest to the listener the actual spaces where they were captured' (Risset. 1996: 39).

sounds taken from the natural environment; secondly, the natural sounds are 'sculpted' through various transformations and they are used together with electronic/synthesised[32] sounds to suggest imagined nature: in this case the natural world usually appears as 're-synthesised' or imitated. The 'natural' sound material includes recordings of sea and country soundscapes (sea flow-ebb, water streams, birdsongs, insect buzzes, cracking seeds), while the synthetic sounds mainly derive from computer-based generators[33].

Throughout the musical structure a relationship between real and unreal natural sceneries is gradually emerging and developing. At the beginning of the first movement nature is brought to our imagination as 'real', while later on (towards the end of the first movement and throughout the context of movements 2 and 3) it is presented as imitated, 'simulated', or as turning into 'hybrid' forms. The contrasting sound materials[34] are firstly presented separately and they gradually become intervening or interacting. This development is noticeable through listening to the piece but it is also suggested in the 'formal scenario' given by the composer:

I. *The sea in the morning. Waking birds: isolated peeps rising to a stretto. Harmonic clouds. Hybrid sounds emergence from the low frequencies. Heat: real and simulated birds and insects.*

II. *Call – a bell buoy animated by the sea.*
Wind, waves, energy flows: a metaphoric tempest and wreckage.

III. *Sea sounds gradually get tuned into G sharp. The harmonic grid unfolds, animated by various pulses – from programmed gestures, from sea waves which finally subside.*

(Risset. 1996: 46)

[32] See 'electronically generated' in 1.4.1.
[33] As mentioned by the composer (Risset. 1996: 38), the MusicV program has been mainly used to create electronic sounds.
[34] 'Natural' and synthetic sounds.

Sabine Breitsameter's *The Hidden Tune*[35] refers to changes brought by human activity to the natural sonic environment, using the 'changing' soundscape of Vancouver[36] as an example. In the four parts of the piece the natural world is presented as sonically changing through the existence and intervention of human civilisation. In the first two parts the concepts of 'past' and 'future' are presented as contrasting. As indicated in the first part (1: Prelude) 'past' is a state of *real nature*[37] brought into our minds through imagination: this 'pure' dimension of nature is described by recorded[38] natural sounds: water (sea waves) and insects (cicadas). In the second part (2: After the Silence) human gesture and utterance are used to introduce human presence as an element relative to, but also opposing the natural environment: firstly, gesture points towards the existence of a human being amongst the other material sources of the natural environment, while utterance is combined with sounds of insects and birds; secondly, utterance is used as 'speech' to indicate human culture but also to describe the sounding content. The use of speech (as English language) evokes imaginary worlds, sound-images of the future ('...and he listened into the future...' in 4'50). This 'human-controlled' future dimension is sonically presented in the musical context by the dominance of sound material deriving from human-created sound-sources. The following two parts (3: Interference and 4: The song of this Place) are constructed by combinations of sonic elements deriving from both parts 1 and 2, and they refer to the 'present' time dimension. The 'present' soundscape appears in the context through human or non-human based sounds[39]: the sounds of nature (water, air, birds, crickets, frogs, cicadas) are presented as intervening with the sounds of human civilisation (trains, cars, aeroplanes, sirens, horns and other sounds of the 'city' and 'harbour' environment).

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[35] Composed as part of the Vancouver Soundscape Project which occurred during May/June of 1996 and consisted of a four-week composition workshop with symposium and concluding concert (May 6 – June 8, 1996). The works were composed at the Sonic Research Studio of Simon Fraser University, Vancouver.

[36] The first recordings were published in 1973 in the Vancouver Soundscape, by the World Soundscape Project at Simon Fraser University in its study of the acoustic environment in Vancouver. The new recordings made in 1996 present the changes in Vancouver's soundscape in the intervening years. An analytic explanation of the Soundscape Project and a study on soundscape compositions is given in 'Soundscape, Acoustic Communication and Environmental Sound Production' by Barry Truax (Truax. 1996: 49-65).

[37] See definition and discussion in 1.3.1.

[38] See *recorded nature* as described and defined in 1.3.3.

[39] See the relationship of 'natural' and 'non-natural' sound-sources as discussed in 1.4.1.

1.5.1 *Rous*

Rous was completed in June 2001. The general idea in this work is cosmological[40] and it refers to the 'flux'[41] among the materials of the natural world. In *Rous* the 'eternal recreation of nature' is a fundamental concept appearing as 'continual flux' from one material state to another.

The sound material used to construct this piece does not include recorded natural sounds: all the sounds derive from non-natural, human-made sound sources (mostly electronic sound generators and musical instruments) and they are used in scales of transformation to represent the natural environment through mimesis[42]. A variety of human-produced sounds, other than vocal and instrumental, are also employed in the sounding content of this piece. The source-sounds and the 'natural' sounds they represent are shown in Figure 1.6.

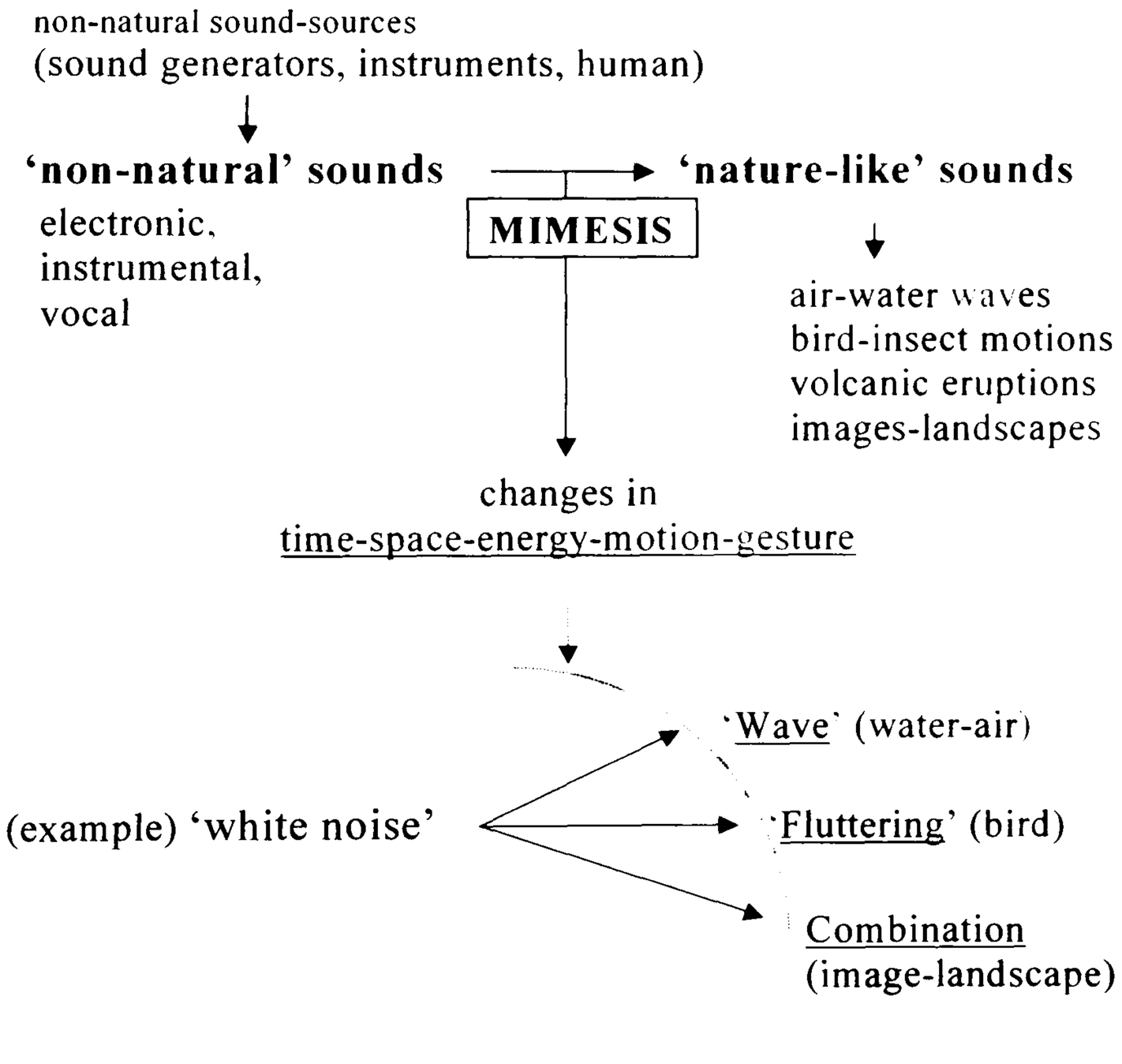

Figure 1.6: Sound sources and 'natural' sounds in *Rous*.

[40] It was conceived through a study of the 'naturalistic' cosmological views of the ancient Greek philosopher Heracletus, developed in his theory 'peri physeos' (=on nature), upon the origin of the natural world. See Kirk (1954) for a broad discussion.
[41] *Rous* means 'flux' in Greek.
[42] The compositional process of this work is totally based on mimesis and thus it involves the use of what has been regarded as *mimetic* or *imitated nature*, as defined previously in 1.3.2.

During the compositional process, non-natural sounds (white noise-sine waves produced by sound generators, instrumental sounds borrowed from piano-guitar-percussion, vocal sounds, and also sounds produced by human-made everyday objects like keys, pencils etc) have been transformed to varying degrees in order to indicate events, activities and images of the natural world (like bird-insect motions, air-water waves, 'forest' or 'volcanic' landscapes). For example, as shown in Figure 1.6, the white noise from a sound generator can be transformed to be perceived as 'wave', where the sound output can be linked to a natural element (air-water), or 'fluttering', indicating the motion of birds (natural life), and it may well be combined with other sounds, contributing to the emergence of a natural landscape image. This virtual sonic recreation of nature has been achieved through applying changes in the fields of time, space, energy, motion, and gesture. Computer-based compositional techniques (primarily pitch-shifting, time-stretching, reverberation and granular synthesis) were employed in order to achieve the changes in the fields mentioned above, and consequently transform the sounds.

In the musical context the changing and circulating natural environment is sonically presented through a continual transformation of its sonic materials; in this mimetic representation the imagined/imitated sound sources evolve and often return to their original state in a circular process (as shown in Figure 1.7): birds and insects evolve in waves of water, metals become stones, landscapes unfold – they gradually turn into vortexes and explode.

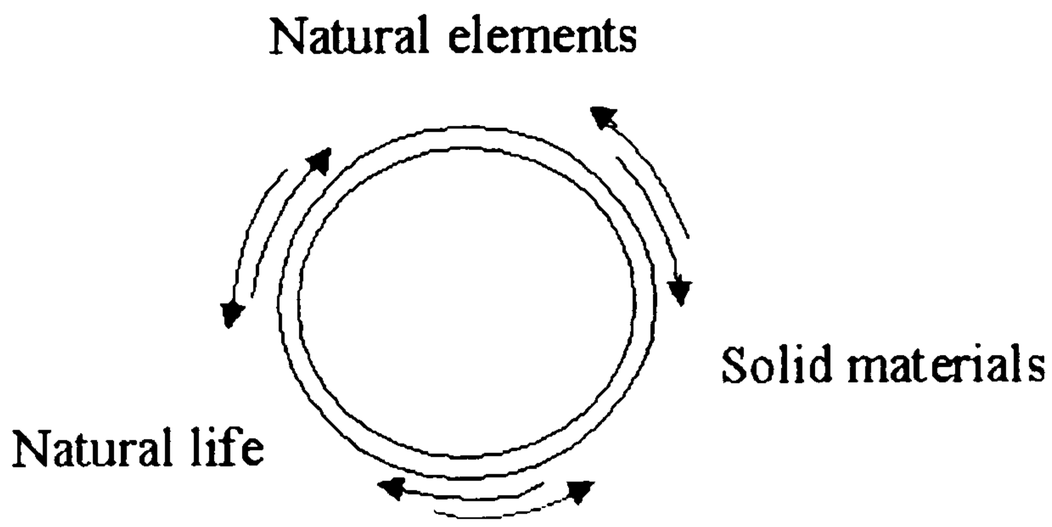

Figure 1.7: 'Circulation' of nature in *Rous*.

Reference to the natural world and the interference between natural elements and sources can be illustrated in two chosen examples:

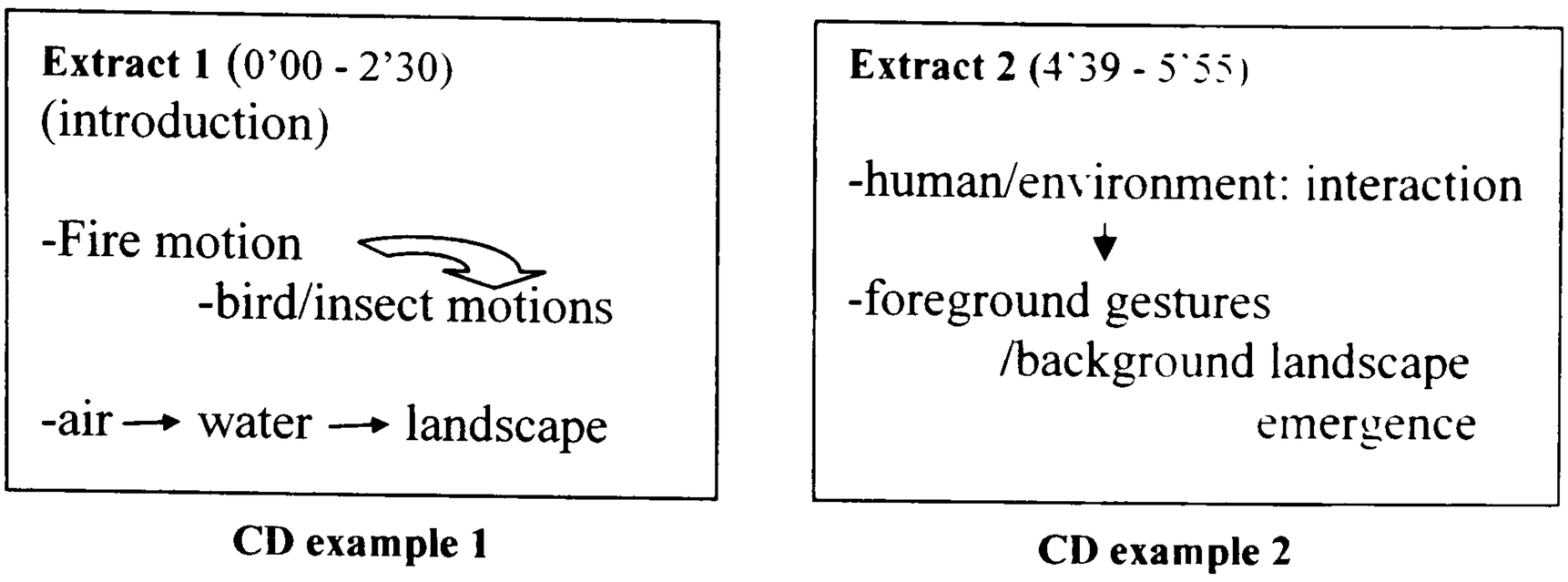

Figure 1.8: *Rous*, extracts referring the natural world.

In the first example, (CD example 1) fire motion – the principal, primordial element of becoming[43] – is described by electronic sounds (white noise) placed in a rhythmic texture. At around 0'30 the electronic sounds are used more 'accidentally', suggesting the motions of birds and insects, while in a background layer the same sounds evolve in natural elements suggesting waves of air and water. The intervening motions finally lead (at around 2'30) to a natural sound-image, a forest-like landscape, which continues evolving behind the musical events of the following segment. In the second example (CD example 2) human gesture reveals human presence in the natural environment: a human being is implied as interacting with various natural materials (wood, metal, stone or ambiguous materials) by rubbing, hitting and scratching them. Here the human element is regarded as an 'ingredient' of nature and therefore as being amenable to eternal flux. The human-triggered events are framed by a gradual development of an unfamiliar, imaginary landscape in the background. The foreground and background sonic events merge together towards the end of the extract and result in a climax in the sixth minute of the piece.

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[43] According to Heracletus becoming is itself the first principle of reality, the essence of things. The process of becoming finds its origin in 'fire', an animated and archetypal element, not to be confused with what we usually experience as 'fire'. Because of its unstable nature fire most closely corresponds to becoming, and thus the motion of fire may be (metaphorically) regarded as the first principle of 'life'; it may also be considered as the symbol of continuity and it may be paralleled to the human soul (concluded from Kirk, 1954).

The idea of eternal flux, regarded as 'war'/'strife'/'struggle' between materials, is dominant throughout the longer part of the sounding content and it is musically presented through the use of rhythmic and kinetic elements. Therefore rhythm and kinesis are the main characteristics of the piece. However, there is an opposing 'dimension' of nature, an imaginary state remote from the circulation of reality, described by Heracletus as 'peace'/'harmony' of nature, where the ideas of unity and stability are present. This second, ideal state is musically presented through harmonic structures and tonal elements in the last section of the piece, which works as a resolution in the development of the form. The diagram in Figure 1.9 constitutes a 'macrostructural' view of the piece, where the antithetic relationship of opposite states-dimensions is presented according to the structural development of the context:

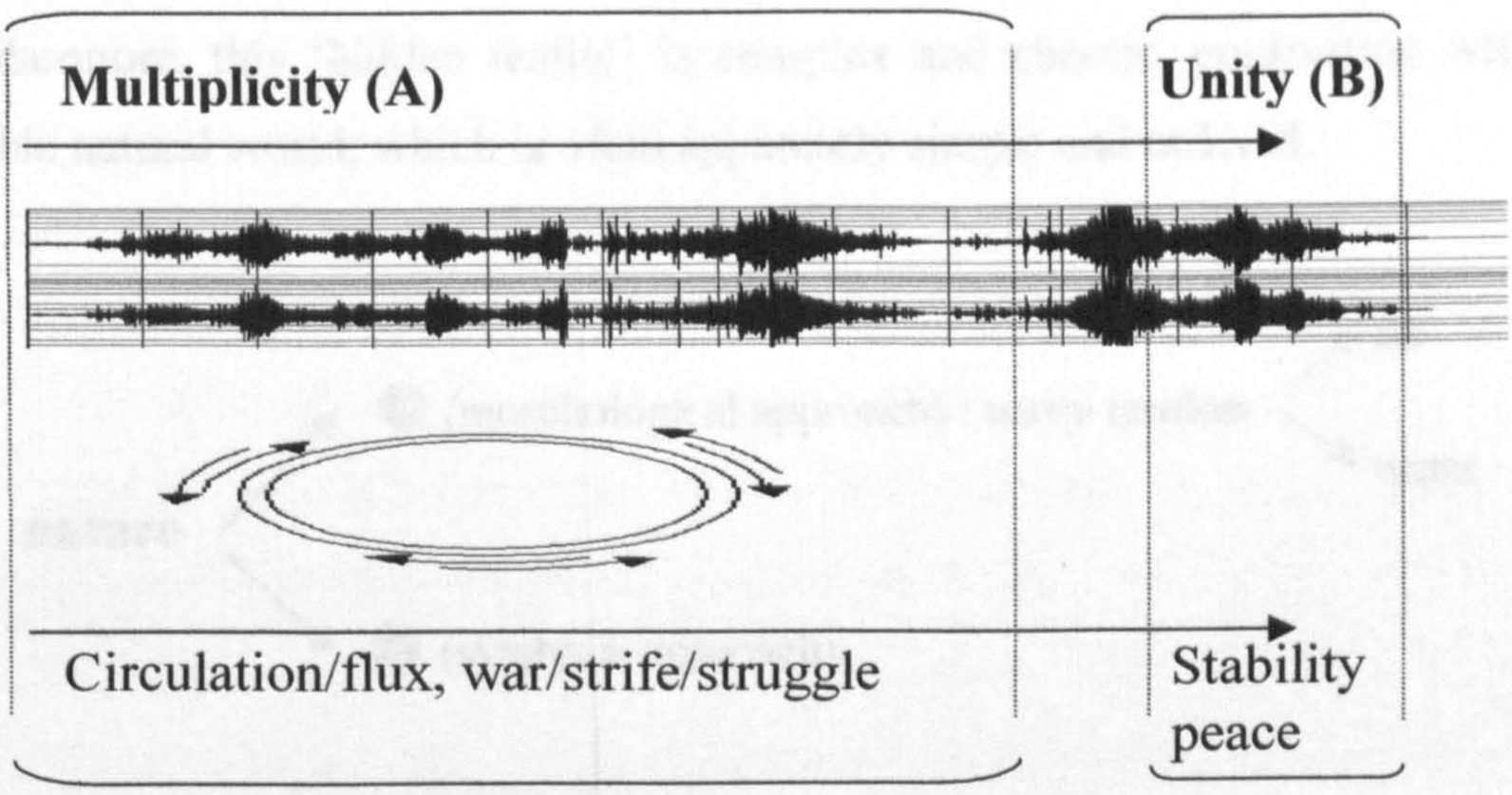

Figure 1.9: *Rous,* macrostructure.

The opposite ideas are presented in two categories. The first category (A) covers most of the context, where kinetic and rhythmic elements present the idea of 'eternal flux'. The second category (B) refers to the 'ideal' state of nature mentioned above, which is revealed at around 10'00 after the final climax. Here the sounds develop into sustained notes which are placed in harmonic structures, emphasising the existence of 'pitch'.

1.5.2 *Aura*

Aura was completed in March 2002. In this work the role of nature can be approached from two different but interrelated perspectives[44], as indicated in Figure 1.10. The first approach is morphological: throughout the context *nature* is implied morphologically, since the character of the sound material indicates, at a macrostructural level, a 'wavy' kind of motion, which may be linked to the elements of air and water. The second approach is symbolic: in *Aura* references to natural sources are used to represent the contrast between the 'visible' natural world and 'invisible' microcosmic reality, which is hidden behind. The antithesis between the 'microcosm' and the 'visible' natural world is the central idea in *Aura*, a concept functioning as the basis of structural development. The 'microcosm' consists of a universe of evolutionary processes, which evolve behind the scenery of nature, in the core of even the simplest form of natural life. Furthermore, this 'hidden reality' is complex and chaotic, contrasting with the visible natural world, which is often apparently simple and ordered.

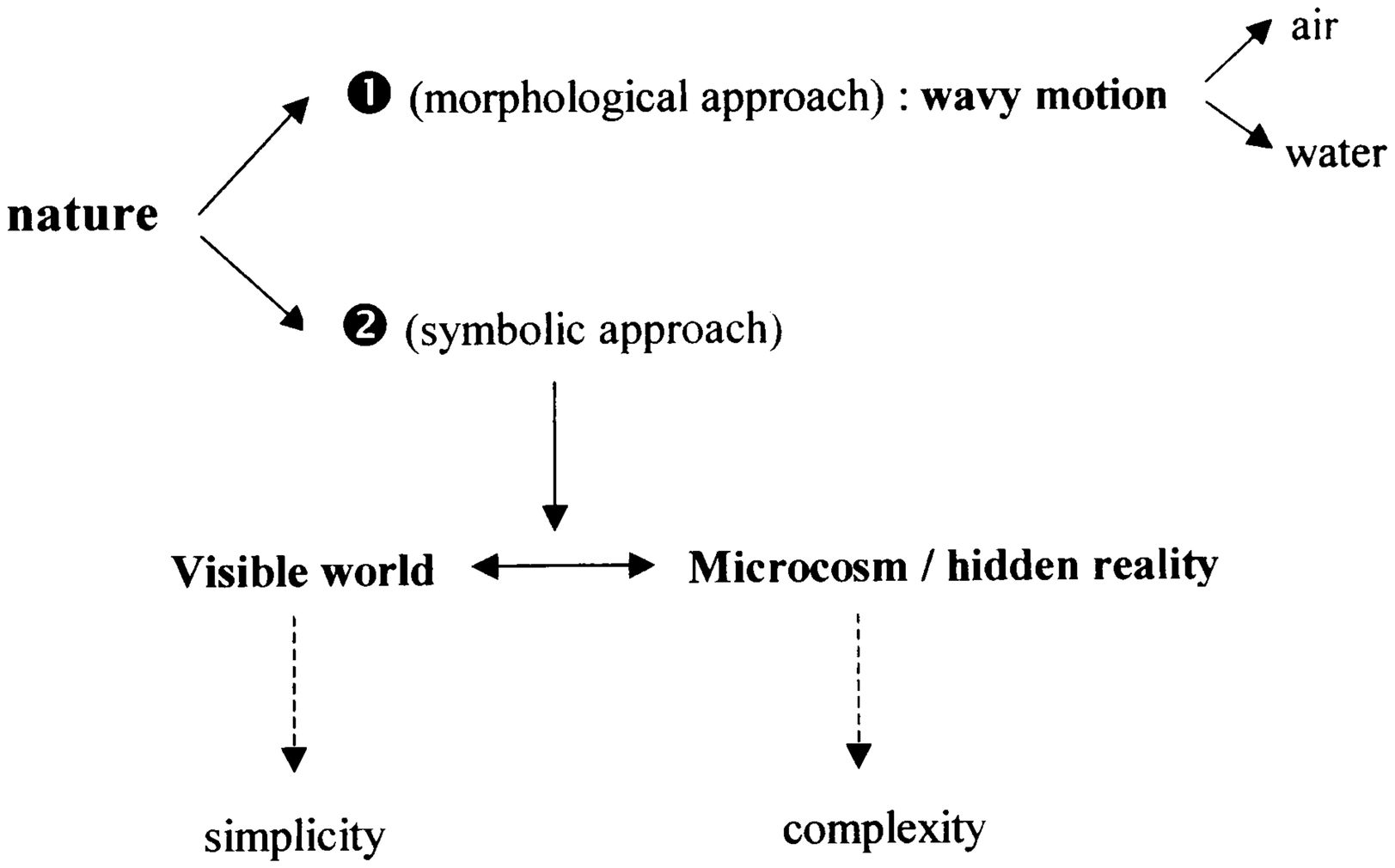

Figure 1.10: The natural world in *Aura*: Outline.

[44] This may also be suggested by the title of the work. The word 'aura' has two meanings: firstly it represents a 'gentle breeze', and secondly it represents a 'surrounding glow' invisible to the naked eye.

For the construction of this piece, electronically-generated sound material was primarily used, but a few recordings from nature and human culture[45] have been employed as well. The electronic material consists of sounds of 'metallic' character produced by computer-based sound generators. The 'natural' sounds derived from recordings of crickets and cicadas, but also from recordings of water. Recorded human gestures and utterances have also been employed in transformations to create short foreground events, which appear successively and give the impression of 'aliveness'.

In *Aura* the sounding content can be divided and appreciated in three hypothetical layers of depth, the 'foreground', the 'background' and the 'middle-ground', which 'flow' simultaneously throughout the context (Figure 1.11). These do not represent the audio channels used in the mixing process[46], but they indicate three different areas of focus concerning the position of the sound in the listener's aural field. The 'background' layer primarily consists of sustained electronic sounds, which are combined to create a 'harmonic' electronic space. The 'foreground' layer consists of granular sounds produced through gesture and metallic/high-pitched sounds, transformed to create a restless 'microscopic' sound-world. The space between the foreground-background layers is what constitutes the 'middle-ground', a layer which links the other two. In the 'middle-ground' area materials from the 'background' and the 'foreground' are often placed in variations of pitch, duration and amplitude[47].

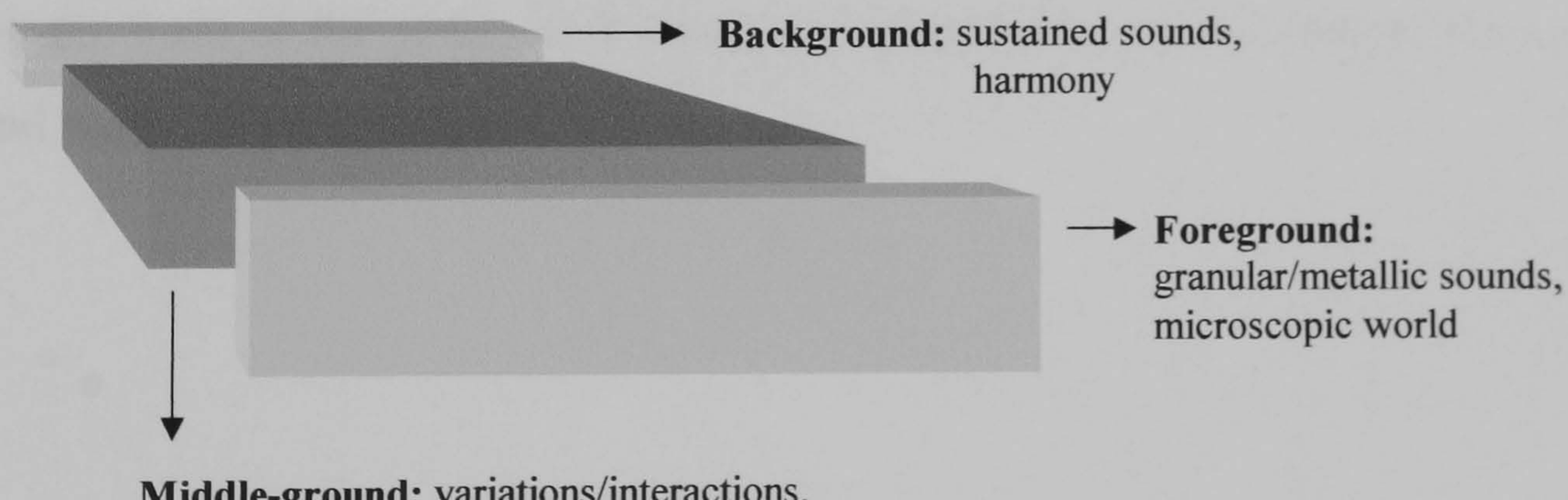

Figure 1.11: *Aura*, layers of depth.

[45] The 'human environment', as described previously in 1.4.1.
[46] The sounds used in the construction of *Aura* were mixed in 64 audio channels. However they can be grouped according to their characteristics and appreciated in three major areas.
[47] In the 'middle-ground' layer, the sound material is placed in different areas of the spectrum to avoid masking and overlapping between frequencies.

Real nature hardly appears throughout the context of *Aura*. However its role is significant for the idea and structure of the piece. In fact, there are only two sections where natural sources are revealed and might be recognized in the context. The first section (CD example 3) begins at 7'00, where after a climax we arrive at an imaginary, 'electronic' landscape. Here, filtered cicada noises[48] appear in the 'middle-ground' and foreground events turn into animal-like motions and water streams, while the whole section is 'framed' by harmonic-metallic threads in the background layer. The landscape gradually reveals human-like 'breaths' and gestures and is finally interrupted and linked to the next section by another climax, which arrives at 8'53. The placement of this landscape-section in the context is very important as it alters the overall character of the sound material, which up to the point where the section begins can be rather appreciated as 'abstract'[49]. Furthermore, being placed between the two main climaxes of the piece, this section may also be regarded as the 'turning point' which allows the structure to continue.

The second section where nature appears is the final section of the piece and arrives slowly through a passage between 11'00 and 11'20 (CD example 4). In this section, after a series of glissandi, harmonic waves and interventions between materials (9'10 - 11'00), the previously-mentioned layers converge and the structure dissolves into a 'cricket' environment. The cricket sound dominating this section derived from a recording of nature and is placed in the context almost unchanged[50] in order to be recognisable. This final section works as a resolution for the form of the piece, as it introduces a repetitive texture, which fades slowly and works as an ending.

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[48] In this section the cicada recording is transformed and it might not be clearly recognized in the context, however its 'noisy' character contributes to the creation of the 'landscape' impression.
[49] The term 'abstract' is here used to describe a context which does not include references to familiar sources.
[50] Noise reduction and filtering techniques were used to make the cricket sound slightly brighter and clear, but its pitch and duration remained the same.

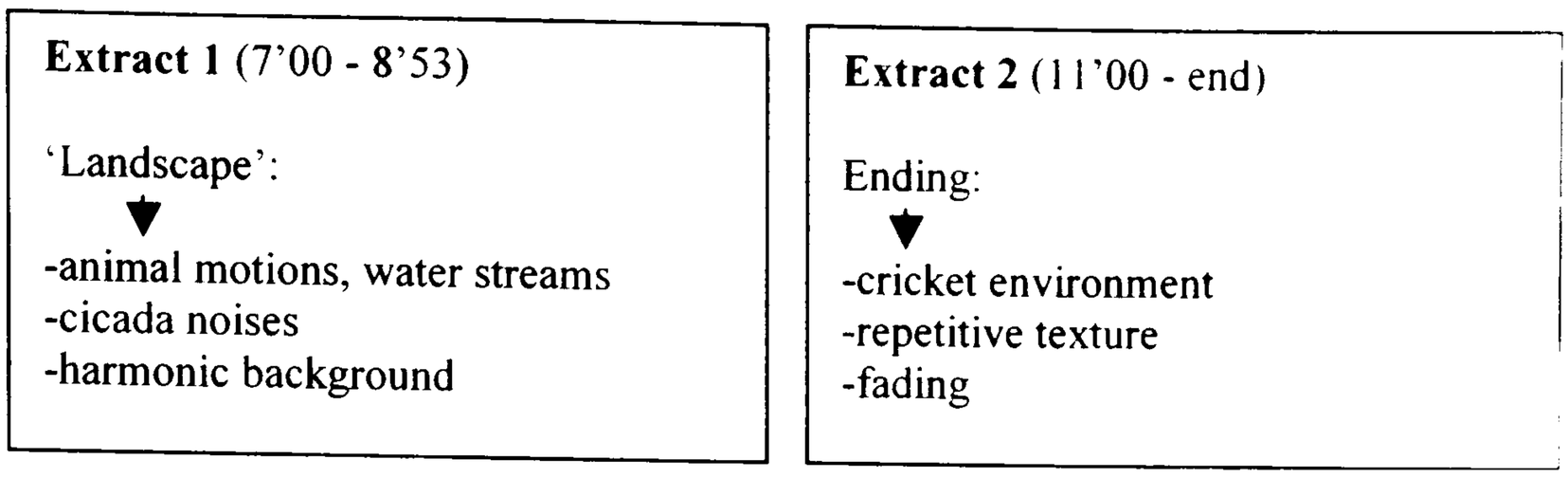

Figure 1.12: *Aura*, selected extracts.

In *Aura* the structural development of materials at a macro-level is strongly related to the central idea, as described in the beginning of this analysis. The form can be divided in two parts. In the first part (part **A**) the sound-world can be generally regarded as 'abstract'. This abstractness represents the 'microcosm', a world of invisible processes, a world unfamiliar and unusual to our experience. Its complexity is presented through continuously evolving and intervening sonic events, creating the impression of a constantly expanding and contracting space. This complex world leads to the 'peaceful' cricket environment towards the end of the piece (part **B**), where the cricket reference represents 'simplicity'[51]. The landscape appearing between the climaxes (7'00 - 8'53) prepares the ground for this structural development and works as a 'prologue' to part **B**[52]. The antithetic relationship between microcosm (complexity) and the perceptible natural world (simplicity) can therefore be observed macrostructurally, as indicated in Figure 1.13.

[51] The 'cricket' appearing in the last section can be metaphorically regarded as a source which actually 'contains' the preceding microcosmic world represented in part **A**. Of course, this metaphorical connection cannot be expected to be perceived as such by listeners, since perceptional approaches may vary, however it has functioned as the conceptual basis for completing this work.

[52] This section introduces a combination of 'nature-like' sonic events, which prologue the appearance and dominance of nature in the final section of the piece.

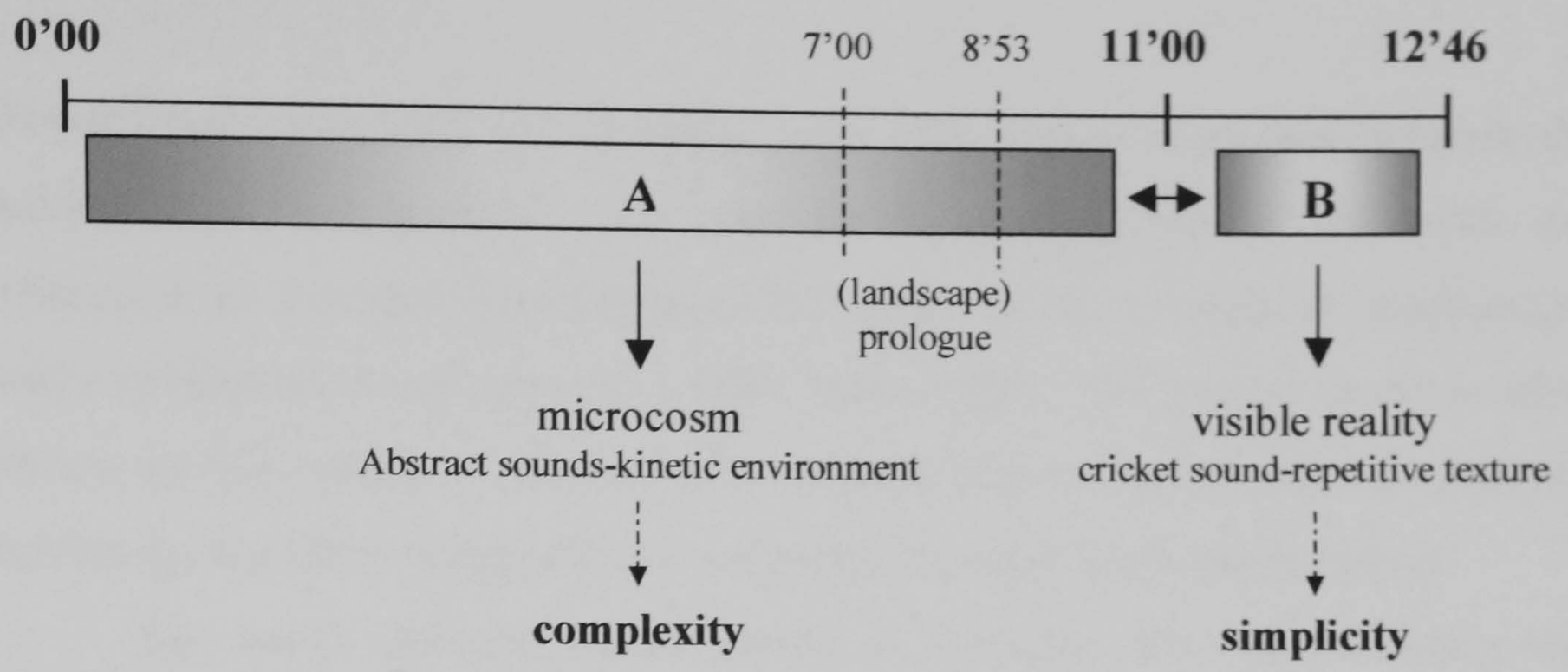

Figure 1.13: *Aura*: idea and form.

The development indicated in Figure 1.13 reveals a similarity with the development described previously in the analysis of *Rous*[53]. Indeed, in both works the structural development is based on the antithetic relationship between two opposing dimensions (multiplicity-unity in *Rous*, complexity-simplicity in *Aura*). The difference is that in each work the course of development concerning the materials of the natural world is followed in a different direction: in *Rous* the natural world dominates the context and gradually disappears, while in *Aura* it is revealed towards the end and contrasts with the larger part of the sounding content.

[53] See 1.5.1, page 38.

1.5.3 *Erevos*

Erevos[54] was completed in September 2002. The idea of a journey between the 'natural' and 'supernatural' state inspired the composition of this work and influenced its structural development. The piece reveals a world of imagination, where relationships and analogies differ from reality. The natural world is often present in this context. However, it is apparently transformed and continuously interacting and intervening with an 'unnatural'/'unreal' sonic environment.

The sound material which served as the basis for transformation was derived from both 'natural' and 'non-natural' sound-sources, and can be divided in three categories of sounds, classified according to their origin. The first category includes sounds borrowed from the natural environment: recordings of water (water-streams and water-drops), insects (bees, flies, cicadas) and birds have been either transformed or placed 'as is' in the context. The second category includes human-produced sounds (gestures and utterances), which are used at various levels of transformation to simulate animal motions. The third category includes electronically-produced[55] sounds (sine waves, white noise, brown noise, DTMF signals[56]), which have been altered and combined in order to create abstract sonic environments, but also in order to imitate sonic events and behaviours related to natural sources.

In *Erevos* the continuous passage from the 'natural' to the 'supernatural' dimension is presented through a mixture of sound-worlds, a continual juxtaposition-convergence between 'natural'/familiar and electronic/unfamiliar sounds. Throughout the piece the sounding content successively adopts three different characters (shown in Figure 1.14.). The first is a 'natural' character, and refers to those parts of the context carrying references to the natural world. The second is a 'supernatural' character, and refers to the parts dominated by non-referential[57], mostly electronic and heavily transformed sounds. The third

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[54] *Erevos* (L. 'Erebus') is mentioned in Greek and Roman mythology as an imaginary place beneath the Earth, a mythical passage which connected the Earth to the underworld.
[55] Generated by using software-based audio generators and virtual synthesizers like Absynth (Macintosh platform) and SimSynth (PC platform).
[56] Dual Tone Multi-Frequency (DTMF) signals (touch tones) are used in telephones as dialling tones.
[57] Which do not indicate any known source.

character can be regarded as 'hybrid', and refers to the combination of natural/recognisable and electronic/unrecognisable sounds in the same context. Moreover, it refers to those nature-like events[58], which may reveal a behaviour simultaneously relating to different natural sources[59].

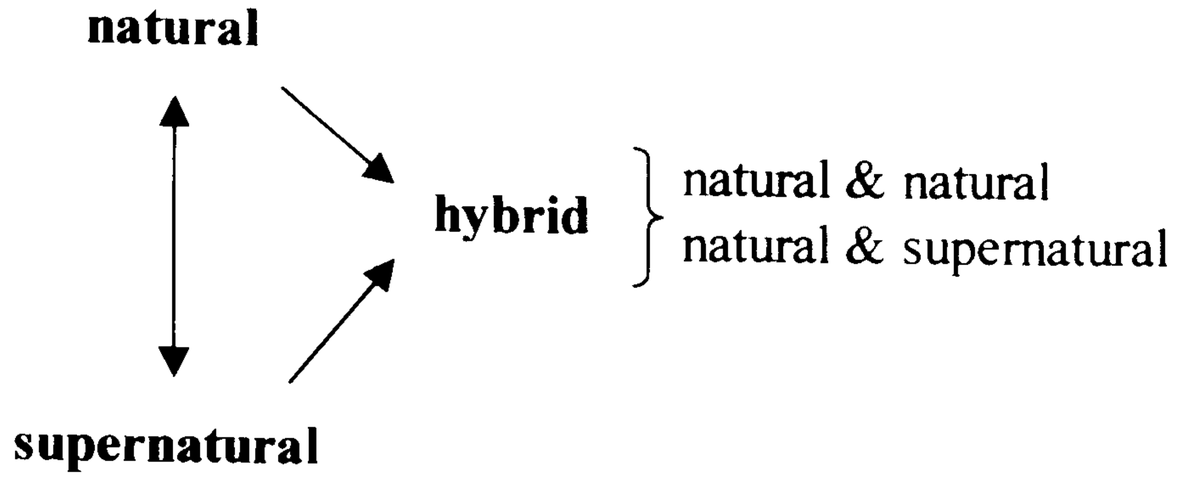

Figure 1.14: *Erevos*, sonic characters.

This 'hybrid' relationship amongst materials is prevalent, metaphorically suggesting 'amalgamative' forms of matter and life. Natural sources are often apparently transformed into others: insects become rocks, animal motions and bird songs become water-streams. Furthermore, the natural materials are often linked to the supernatural/electronic world in a similar manner: water-drops and ground noises gradually disappear into harmonic landscapes, which later vanish into explosions of metallic waves.

The above-mentioned relationships can be observed in different parts of the context. At 2'40 (CD example 5) a series of electronic pulses and waves is suddenly interrupted by human/animal-like gestures, introducing a new section. The gestures suggest human-animal presence and interaction between materials of uncertain texture[60]. The gestures momentarily disappear, and reappear seconds later accompanied by a water-stream (3'00 - 3'10). In a different section (at

[58] Represented by natural/recorded sounds, or imitated by transforming the non-natural sounds described in the previous page (electronically-generated, human produced).
[59] For example, a combination of certain granular sounds in the piece may give the impression of something between a 'water-stream', a 'water-fall' and a 'landslide', without relating to any source exclusively (water or solid materials in this case).
[60] In this section the use of gestures reveals natural behaviour. However it does not reveal certain sources because the textures created adopt a 'liquid' and 'solid' character simultaneously.

around 5'00) a sequence of 'natural' events (insect buzzes, ground noises, bird chirps and water drops) is revealed amongst a combination of electronic/harmonic waves and granular, abstract sounds (CD example 6). The 'natural' events gradually come to prominence and create a foreground 'earth-like' environment (lasting between 5'30 and 6'33), which is placed in a 'harmonic atmosphere' created by sustained background frequencies. Finally, at around 7'50 (CD example 7), natural references appear again in front of a harmonic, descending[61] space: metallic and 'stone-like' sounds arise from the harmonic background and lead to an accumulation of transformed insect buzzes and 'watery' textures, constantly being 'granulated'[62] and finally bursting (at 8'33) into gliding frequencies[63].

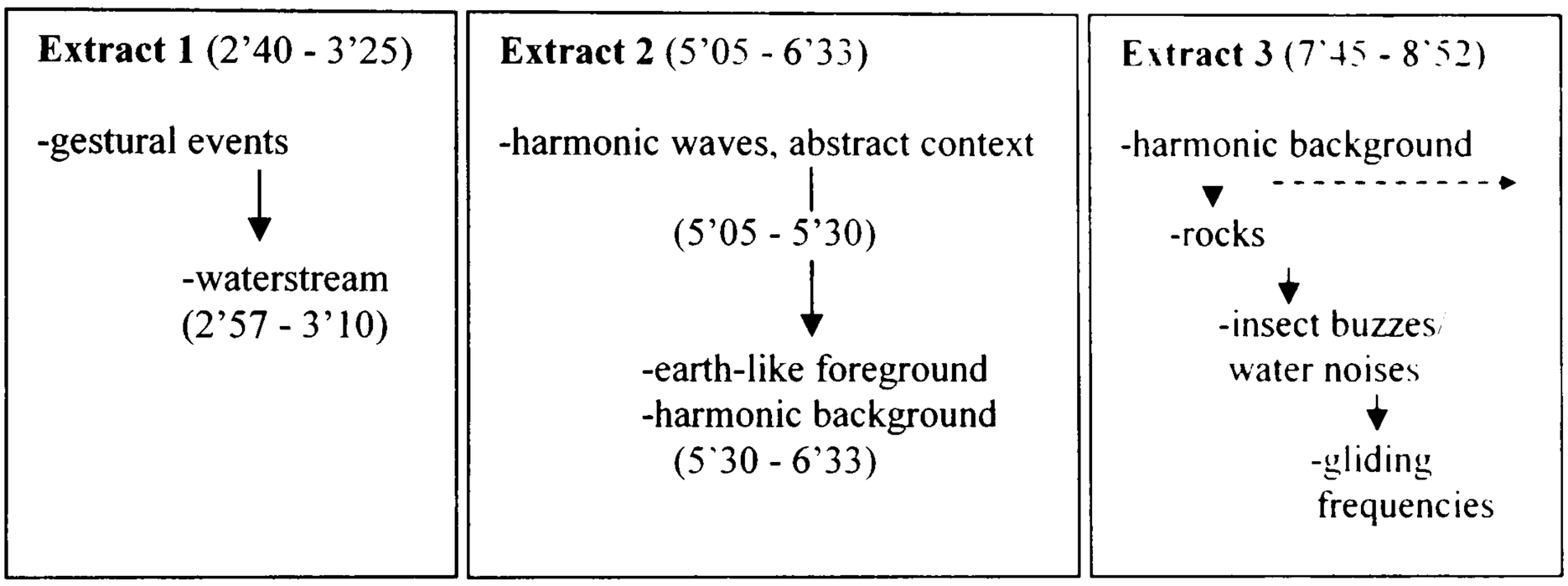

Figure 1.15: *Erevos*, selected extracts.

From a macrostructural point-of-view the piece can be divided into three major parts (shown in Figure 1.16.): the 'introduction' (part **A**), the 'main body' (part **B**) and the 'conclusion' (part **C**). The first part (introduction) begins in a series of intense, 'metallic' attacks. This aggressive sound-world is dissolved in a quiet, 'alien' landscape, characterised by sustained high frequencies. This 'static' landscape works as a passage to the second part (main body), which begins at

[61] Between 7'35 and 8'15 sustained metallic frequencies are descending in semitones, creating a harmonic impression in the background. This section is a slow passage, which later leads to a sequence of climaxes.
[62] Divided-multiplied into small fragments (grains).
[63] Which can be perceived as 'radio waves'.

1'00, when short granular events appear in the foreground, introducing an unsteady, kinetic environment. The second part covers most of the piece, and is divided into multiple smaller sections. The main characteristic of this part is the mixture of materials, as described in the previous examples. Another primal characteristic is 'harmony': in each section the sonic events are layered in front of harmonic backgrounds, constructed primarily by sustained electronic sounds. 'Harmony' often separates the sections from each other as well, since harmonic changes in the background often signify the beginning of a new section. Finally, in sections-passages the harmonic background is 'ascending' or 'descending'[64], indicating a constant change of space. The third and final part (conclusion) constitutes the 'ending', the closing section of the piece. This section reveals an 'outdoors' environment, a 'natural' landscape, which arrives at 10'20 after a long harmonic passage[65]. The natural world is here imitated: separate recordings of *nature* (water-streams, bird songs) and animal-like sounds[66] have been placed in the same context in order to artificially construct a 'real-like' natural image.

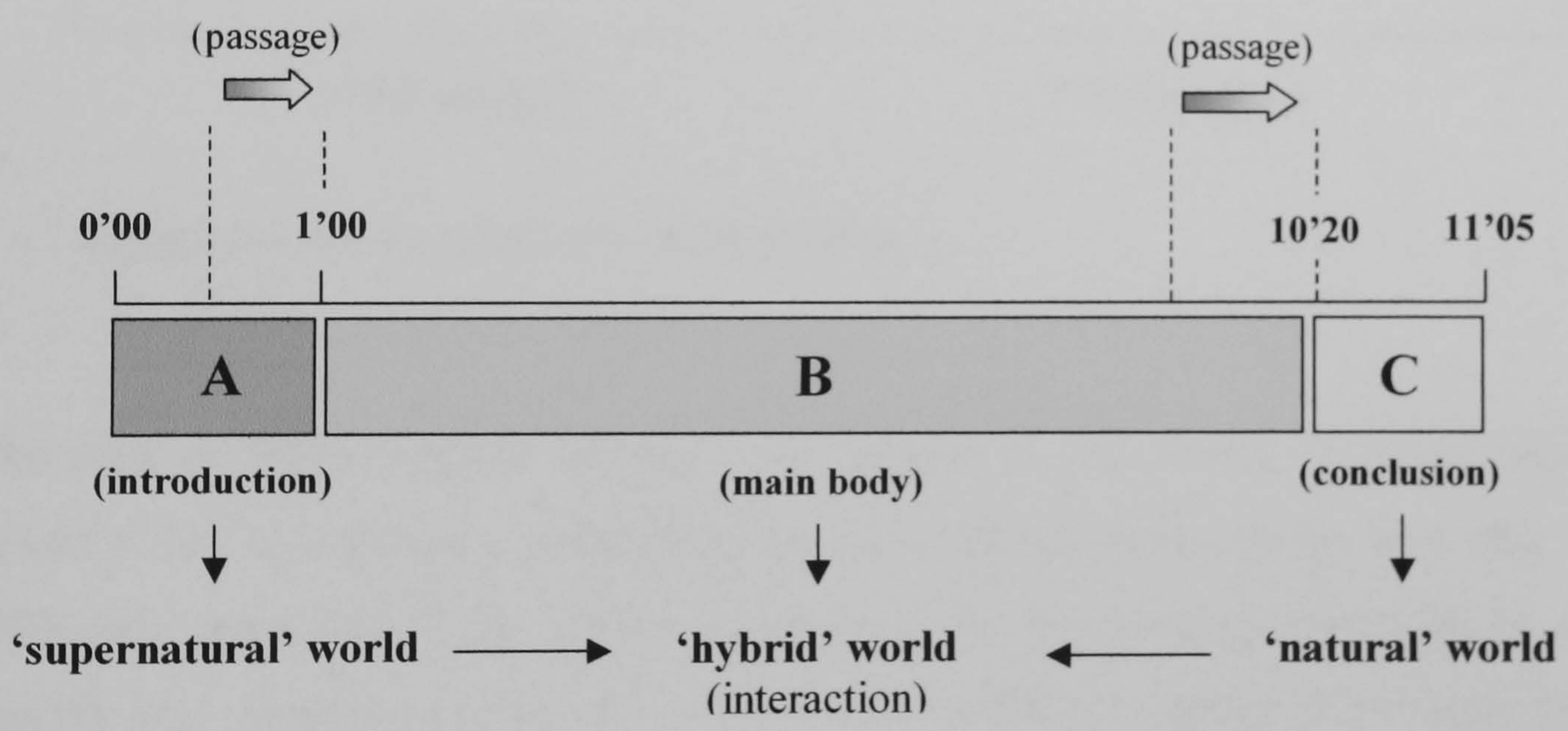

Figure 1.16: *Erevos*, macrostructure.

[64] It is gliding upwards or downwards, as shown in CD example 6.
[65] In this passage (lasting between 9'20 and 10'20) the sustained background is slowly gliding downwards until it almost disappears, while in the foreground the natural world gradually emerges: sporadic water-drops are followed by randomly appearing motions, finally being mixed with water-waves and bird songs.
[66] Derived mainly from non-natural (electronic and human-produced) sounds, transformed to imitate ground motions.

Figure 1.13. presents a symmetry in the macrostructure of the piece. The first and the last section (parts **A** and **C**) are both short in length (each one lasts less than one minute), and they are both connected to the main body (part **B**) by passages. Moreover, regarding the use of materials, the beginning and the ending of the piece are antithetically related. In part **A** the abstract character of the sound material represents the 'supernatural', an unknown world opposed to the 'real' natural world presented in part **C**. The area where the two contrasting worlds collide and interact is part **B**, in which a 'hybrid' sonic environment is formed.

The difference between parts **A** and **C** can be appreciated through a comparison between CD example 8 and CD example 9.

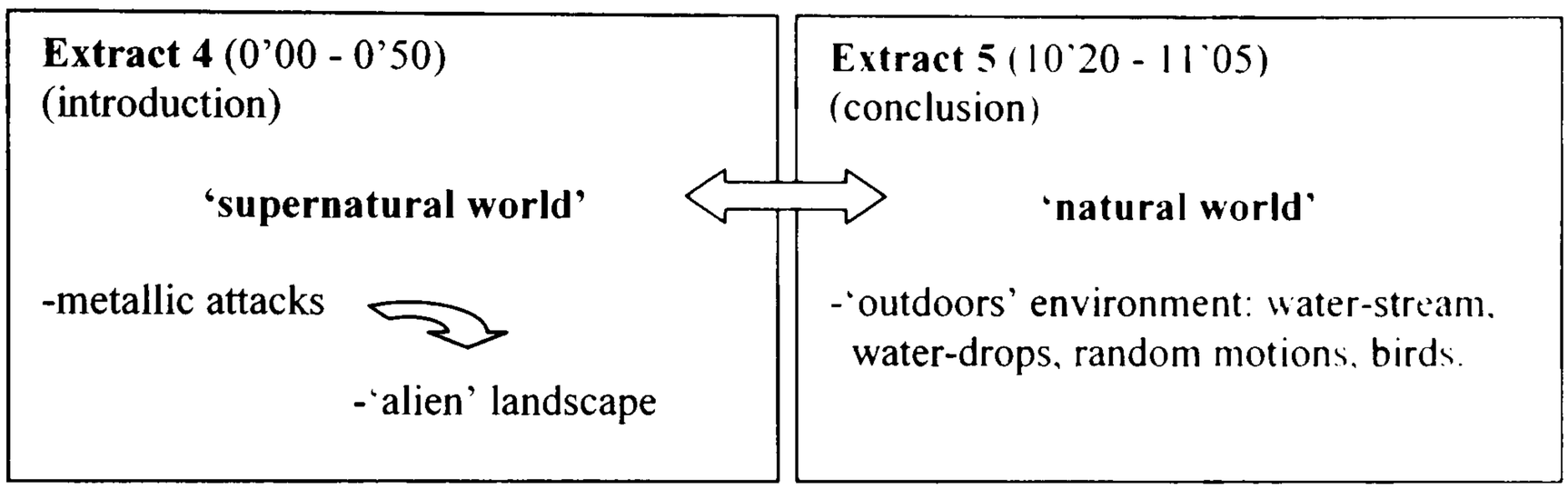

Figure 1.17: *Erevos*, introduction and conclusion

The idea of 'hybridisation' between two worlds is also found in Jean-Claude Risset's *Sud* (as discussed previously in 1.5.). However in *Erevos* this idea is differently approached and utilised concerning the development of the form. In *Sud* the two opposing sound-worlds (natural and artificial) gradually converge and finally unite, while in *Erevos* they interact throughout a large part of the context, but they finally separate and contrast[67].

[67] The appearance of the nature-like landscape at the end emphasises this contrast, as it introduces a new sonic territory, totally different than the one presented in the beginning. Furthermore, the appearance of the 'outdoors' environment at the end (in which the previously ubiquitous 'harmonic background' is nearly absent), constitutes a dramatic change of space, which also differentiates it from the preceding part **B**. The last section comes as a resolution for the development of the form as it completes the symmetry indicated in Figure 1.16.

Chapter 2: The Naturalness of Sound

2.1 Introduction

In the previous chapter nature was introduced as an important inspirational and structural factor in the composition of electroacoustic music. Four types have so far been defined (real-recorded-imagined-imitated), and nature has been analysed and explained through a categorisation of its sources, which both aids its definition and makes the term musically understandable, by presenting the natural materials as structural elements of the musical context.

The next step is to focus on the sonic construction of nature and how this can be achieved in the process of composition. When an electroacoustic work is nature-related, its sounding content may indicate natural sources, either because it may contain sounds recorded from the natural environment, or because it may be constructed in such way as to 'simulate' images, events and activities of the natural world. In both cases nature functions structurally, since not only does it provide the basic materials but it also defines the criteria for sound creation and sound transformation. The role of technology here is very important as it often determines the 'path' which composers follow in order to alter the properties of sounds and also in order to imitate the behaviour of sources found in the natural world.

In the following paragraphs the ideas of *naturalness* and *natural behaviour* will be defined and explored. Moreover, the idea of *mimesis*, already introduced in the previous chapter, will be further discussed as it is linked to the sonic structuring of nature. Finally, the process of transforming the sound materials to achieve 'naturalness' will be explained.

2.2 Naturalness and musical context

2.2.1 'Natural-sounding' contexts

When an electroacoustic work is regarded as being related to nature, its sounding content will reveal events, 'landscapes' and activities, which affect and direct our perception. We tend to relate the sounding content to the natural world because we recognise certain natural sources, or because it simply 'sounds natural'. For example, we may recognise a recorded 'water' sound in the musical context if this sound is obvious enough, or we may well perceive a 'stream-like' sound as familiar in its behaviours, and relate it to a 'water stream'. In the first case the sound is taken from nature, while in the second case the sound is constructed in such way as to seem to imitate nature. In both cases, we link our perception to the water element whether the sound is actually 'natural' or whether it imitates certain properties of the natural source. A context which reveals the natural environment in either of these ways can be characterised as 'natural-sounding', and, intentionally[1] or not, it reveals a condition of *naturalness.* We can also regard such a context as *referential*[2], as the sounds it may contain can either reveal the source to which they belong, or may indicate recognisable natural sources, even if they were not actually derived from nature.

Figure 2.1 presents ways of utilising the sound material available to us in order to create natural-sounding contexts. We might place recorded natural sounds 'as is' in the context, or we might transform natural and non-natural sounds into 'nature-like'. The manner in which the sounds can be combined in context may

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[1] As mentioned in 1.3.4, the use of materials can be intentional or non-intentional. Whether a sound is desired to be perceived as natural or not, the choice of perception is left to the listener. Depending on our perceptual experience, we may recognise natural properties in the sounding content and relate this content to nature, even if this is not the composer's intention.

[2] a) The term *referential* has been used in the first chapter to describe a listening process-reference to a sound-source.

b) *By referential sounds I should like to designate only those which point towards a more macroscopic setting, referring to natural scenes and phenomena, human or mechanical activity. It is not their real origin that matters, but their power of evoking extrinsic settings. A referential sound can even be of synthetic origin: e.g.: a filter sweep in a band of white noise could refer to wind.* (Rodolfo Caesar, 'The Composition of Electroacoustic Music'. PhD Thesis, University of East Anglia, 1992).

determine whether we might be able to perceive events, images or activities of nature, as well as defining the degree of naturalness.

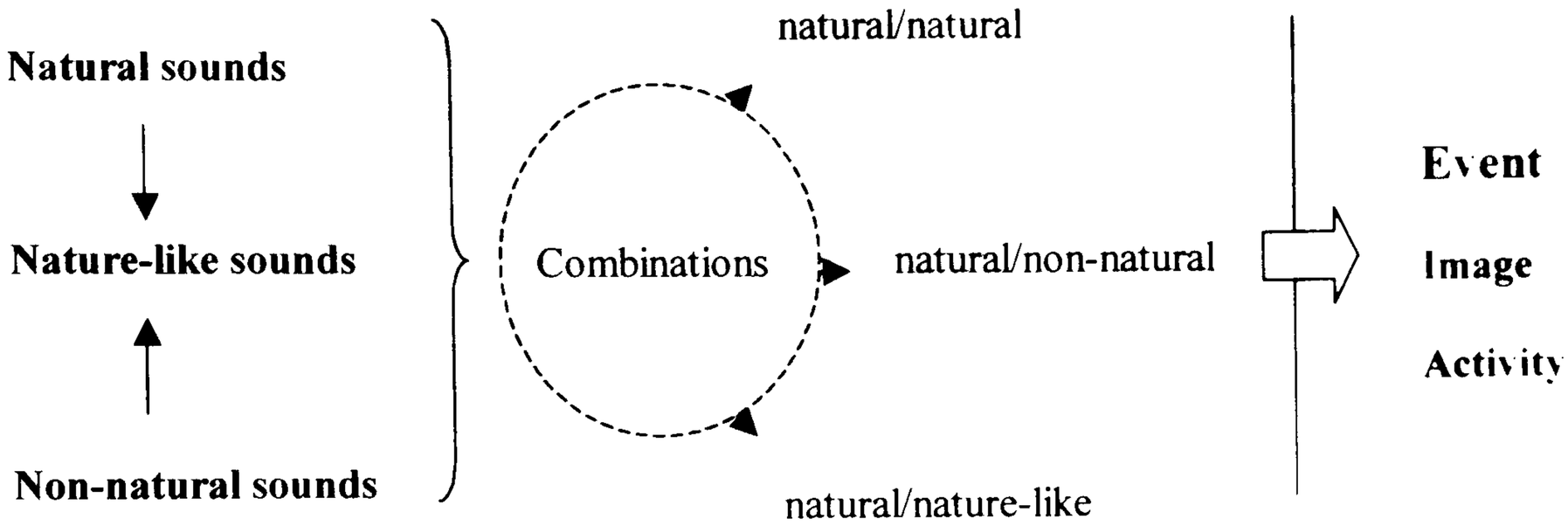

Figure 2.1: Use of sounds in natural-sounding contexts.

2.2.2 Mimesis and natural-sounding contexts

Mimesis is generally regarded as the process of imitating certain attributes. Simon Emmerson defines the term in electroacoustic music as '*...the imitation not only of nature but also of aspects of human culture not usually associated directly with musical material*' (Emmerson, 1986: 17). In the composition of electroacoustic music mimesis can play a very important role, as it is often associated with the process of transformation. Through mimesis we are able to create a 'real-like' sonic environment, which carries references to certain sounding materials found in nature or culture. Therefore, mimesis is a 'pathway' to appreciating the real world musically, and often directs our compositional methods. Consequently, from the electroacoustic music point-of-view, mimesis is a compositional strategy, and more specifically, where nature is concerned, mimesis is a method for achieving naturalness.

A nature-related *mimetic process* may involve the use of non-natural sounds. For example, as explained in the discussion on *Rous* in the previous chapter[3], 'white noise' can be transformed into 'air' or 'water'. Here, the first step of simulating these two elements was to choose a sound with certain characteristics (white noise), and the second step was to 'shape' this sound accordingly (through pitch-bending, reverberation and other sound-processing techniques), in order to achieve an air-like or water-like sounding result. Both of the above steps were part of the mimetic process.

Mimesis may often involve the use of 'natural' sounds as well. Even when we place natural sounds with strong referential attributes 'as is' in the musical context, we may simulate reality, depending on the way we utilise these sounds compositionally. The terms *recorded* and *imitated* have so far been introduced to describe antithetically related types of nature. However, in the compositional process, even recorded nature can be used mimetically. For example, we can 'compose' a 'forest' environment by using individual recorded sounds from nature (water stream, air waves, bird songs, insect motions etc). The result can be described as a forest image, in which we are able to recognise its constituents, but

[3] See 1.5.1.

this forest image is not a recording of nature itself. It may consist of recorded sounds but it is artificially created, and therefore can be regarded as imitated. In this example, the utilisation of natural materials as co-existent in the same context is part of the mimetic process. Finally, even the action of recording can be regarded as part of a mimetic process, since it involves the choice of sounding materials to be used mimetically.

The mimetic process takes place in two stages, as indicated in Figure 2.2:

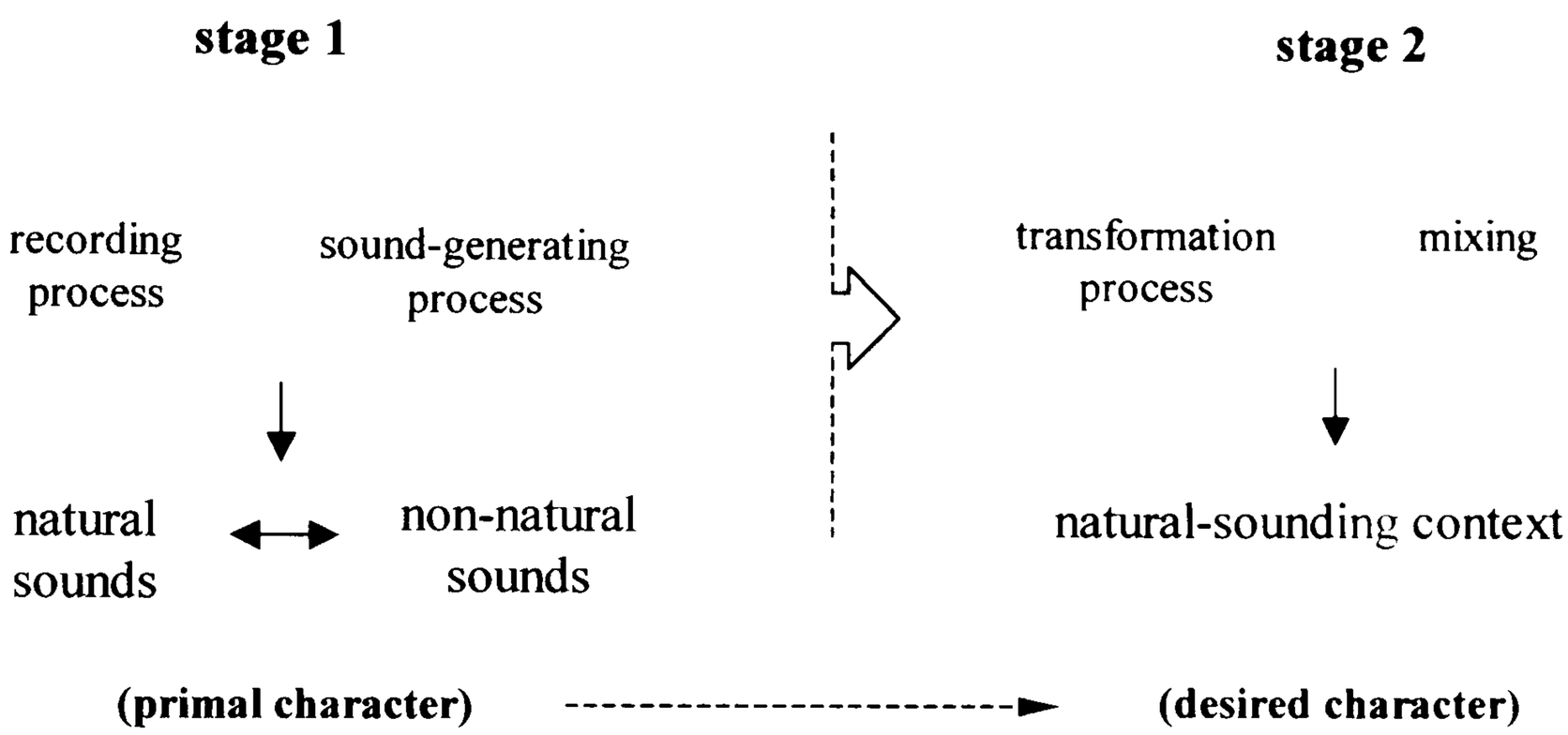

Figure 2.2: Nature and mimetic process: outline.

These stages are usually interdependent and we may regard them as referring to a series of compositional processes. **Stage 1** involves the use of technology to capture sounds from the real world (recording process), but also involves the process of creating new sounds (sound generating process). In **Stage 2** the sounding materials are elaborated (transformation process) and placed in the musical context (combinations/mixing).

The terms *primal* and *desired* can be used to describe the character of sounding materials. Primal character refers to the original characteristics of the sound, before the sound is transformed in any way. Desired character is the character we wish to achieve, and refers to the result of mimesis. In the example of *Rous* 'white noise' was chosen because of its high-frequency/grainy character.

Due to its attributes, 'white noise' was considered the best choice of material to serve as a basis for transformation, and therefore it was selected for its primal character. During the transformation process 'white noise' was transformed into 'water' and 'air' waves. The attributes of 'water' and 'air' constituted the desired character, the target of transformation. The primal character / desired character fields may be related in either a convergent or an antithetic way and mimesis is the joining/separating link.

We may regard mimesis as always being involved if and when nature is utilised musically. Whether we wish to keep the character of the original sounding materials unchanged, or whether we transform the materials to create new 'natural' characteristics, the approach to mimesis defines and directs our compositional methods, and therefore, mimesis can be regarded as a 'bridge' between the musical context and the natural world.

2.3 Natural behaviour and sonic properties

2.3.1 Behaviour and naturalness

The term *behaviour*[4] can be used to define the sonic properties of a sound or a sound-source, and it can be regarded as referring to relationships amongst 'characters', and 'identities' of sounds within a musical context. Moreover, behaviour often reveals relationships between the musical context and the 'real world' as well: a natural-sounding context includes sounds which are linked to the natural world, in a way that they have the power to evoke events, landscapes and activities of nature in our imagination. In this case, the character of these sounds indicates the behaviour of sound-sources found in the natural environment, even if these sources never actually served as the basis of transformation.

At this point, the term *natural behaviour* is introduced to represent not only the behaviour of natural sources, but also the behaviour of sounds which simulate these sources in a musical context. In the works discussed so far non-natural sounds have been extensively employed to imitate a variety of natural behaviours. In *Rous,* apart from simulating the characteristics of air and water[5], white noise was shaped to create fluttering textures, which can be clearly heard in the introduction (CD example 10). In this process, two major components were primarily considered: firstly, white noise was chosen for its granularity and was 'shaped' to create a certain bird-like type of motion, characterised by rapid and random fluctuations[6]. In *Erevos* white noise was utilised differently. It was transformed in order to create a repetitive cicada-like sound, which in the context of the piece has often been mixed with real (however, usually transformed) cicada recordings, and has been mostly employed in passages between sections (CD

[4] Behaviour is widely discussed by Denis Smalley in 'Spectromorphology: explaining sound-shapes' (Smalley. 1997: 107-126), and also in 'The Listening Imagination: Listening in the Electroacoustic Era', (Smalley. 1996: 77).
[5] As discussed previously in 2.2.2.
[6] This was achieved via the application of phase-shifting, time-stretching and panning.

example 11[7]). Moreover, in *Aura* (CD example 12), as well as in *Erevos* (CD examples 11, 13 and 14), the randomness of motion implied by short, granular, foreground events (deriving from non-natural sounds) in many sections throughout each work, may direct our perception to animal gestures. Furthermore, the combination of a variety of such events and their placement in front of nature-sounding backgrounds might give the impression of 'natural landscapes'[8].

In all the above examples there are certain components (such as granularity, wavy-linear motion, randomness, repetitiveness, rapid fluctuation) which characterise the sound material and reveal naturalness in its behaviour. The existence of such components in the sound world of nature, in association with our individual experience and memory of this world, but also the manner in which these components are approached and utilised compositionally, may create a link between nature and musical context.

[7] In this particular example white noise was 'filtered' by an actual recording of cicadas (via cross synthesis) in order to obtain a similar morphology, and then was mixed with variations of the cicada sound (pitch-shifted upwards and downwards) in order to create the 'noisy' cicada like entries, which successively appear until the end of the climax.

[8] As discussed previously in 1.5.2, *Aura* (CD example 3) and 1.5.3, *Erevos* (CD examples 6 and 9).

2.3.2 Behaviour fields

The attributes revealing *natural behaviour* can be explained and defined in five fields – *time*, *space*, *energy*, *motion* and *gesture*[9] – (shown in Figure 2.3.), which can also be regarded as defining the behaviour of sounds in general, not only in association with nature. The appreciation of these fields is important in the mimetic process, as it may prove helpful in defining the properties of the desired 'natural' sound we wish to achieve.

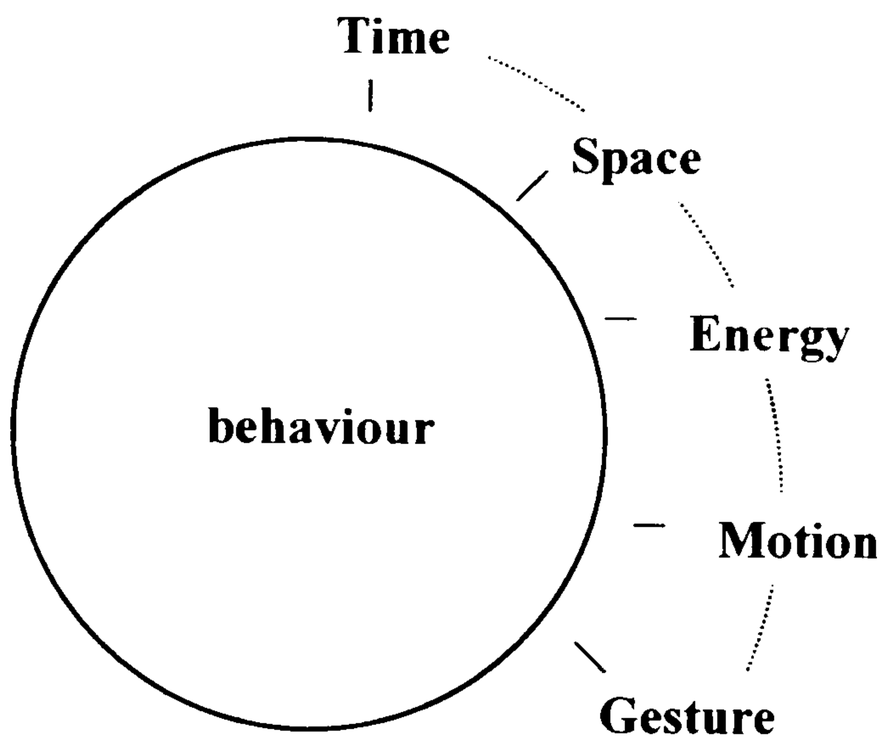

Figure 2.3: Behaviour fields.

The fields are closely associated and interdependent. For example, a certain gestural event always has a specific duration (*time*), and carries a certain amount of *energy*; moreover, this event may imply a certain type of *motion* (depending on the amount of energy), and also may indicate a certain type of *space*. If we apply changes in any one field, then these changes affect the other fields. For instance, if we shorten the duration (using time-contraction/pitch-shifting techniques), this change will potentially result in faster *motion*, a greater amount of *energy*, and

[9] The fields, including behaviour as well, are derived from the 'indicative fields' discussed by Denis Smalley in 'The Listening Imagination: Listening in the Electroacoustic Era' (Smalley, 1996). For the definition of behaviour the fields of energy, motion and space are strongly involved (also see Smalley. 1997: 117-118). The time field is also included here, since it is always involved in the appreciation of sounds. Gesture is also examined as it refers to specific actions regarding the use of sound materials of nature. Finally, utterance may also be related to behaviour. However, this field is not included here, since the use of human voice in electroacoustic music, when related to 'speech', needs to be examined separately (see Smalley. 1996: 86-87, 98-99 for a further discussion on utterance).

furthermore, it will potentially reveal different types of *space* and *gesture*, depending on the degree at which the sound is transformed. A brief, general description of the behaviour fields is provided below[10].

2.3.2.1 *Gesture*

Gesture is a physical movement or action provoked by the body. When used as a musical term, gesture reveals human existence, and more specifically, it reveals the involvement of human agency in sound production. In traditional[11] music *gesture* is mostly associated with instrumental performance, while in electroacoustic music its utilisation is wider, as it can be associated with a vast amount of sounding materials of nature or culture[12]. However, whether it is examined from a 'traditional' or an electroacoustic music point of view, *gesture* involves a series of actions applied to material sources (whether these are instruments intended for musical use or not) in order to produce a variety of sounds, and it is therefore related to expressiveness.

Gesture can be related to the natural world if and when natural sources are involved in the sound production. In this process we should include animals as well as humans acting as 'agents' on the materials of nature. A gestural action takes place in two areas: the first area is the agent 'body', where the energy of the action comes from, and the second area is the natural environment, where the energy is 'transmitted' in order to produce sounds. In the previous chapter[13] a few examples of gesture relating to natural materials were introduced. Actions like 'hit', 'scratch', 'touch', 'drag', 'throw', 'strike', 'break', 'rub', etc can be associated with materials like wood, metal, stone and plants (solid materials and vegetation). Other actions can be associated with natural elements, like for example 'stir' or 'splash' in relation to water. In 'fluttering' textures gesture is mostly related to air and water, but can also be associated with combinations between natural elements-vegetation-solid materials.

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[10] It is not the purpose of this thesis to explain fully and explore these fields in depth. The focus on this research is on nature-related behaviours, potentially evoked by certain combinations of these fields.

[11] The term 'traditional' as used here refers to instrumental music.

[12] In this case also including traditional instruments.

[13] See Figure 1.5.

Gesture can be implied, even if the sound is not the result of human-animal agency. For example, we can artificially create imaginary gestures by transforming sounds not originally produced by animals or humans. In this case the agent may not be present in the sound production, but the result of transformation may reveal a certain type of *imaginary gesture* and may potentially direct our perception towards the action-intervention of a 'mythical' being.

2.3.2.2 *Energy-Motion*

Energy and *motion* are associated and should be appreciated as one field when they are related to behaviour. However, a brief, general definition for each term can be offered[14]:

a) Energy is related to force or power, which produces a type of action, and energy is needed to set matter in motion.
b) Motion is related to the displacement of matter in space. It can also be described by the term *kinesis*. More specifically, motion can be regarded as the disposition of a body in a specific direction, in a specific period of time, and it always involves the release of a certain amount of energy[15].

When concerned with sound, the fields of energy and motion can be approached from different, but closely associated, perspectives. Firstly they are related to material sources and sound production: energy is released when a material source is set in motion, or in other words when it 'vibrates' and produces sound waves, which reach our ears and make our eardrum vibrate accordingly[16]. Therefore, the fields can be appreciated as defining the way in which sound is produced and also the way in which sound is transmitted and detected by our reception mechanism. Secondly, and most importantly, energy and motion can be analysed in order to define the identity of a sound, even if the sound-source and the sound production

[14] According to these two definitions, energy and motion can be related to many physical processes other than sound production and reception, such as light, electricity, gravity, radioactivity, etc.
[15] Concluded from Roederer (1979: 63), where energy and motion are discussed in relation to physics and acoustics.
[16] Concluded from Benade's explanation of sound transmission and vibrations (Benade. 1990: 26-71).

method are not known. Each sound carries an amount of energy, and is characterised by a certain type of motion, no matter how it is produced, and therefore every sound can be appreciated in these fields, whether it indicates a sound-source or not. This second approach involves a *spectromorphological*[17] way of thinking and it is with this approach that we are mostly concerned in the current discussion. In this perspective the fields can be appreciated in relation to *spectral space*[18], where the amount of energy and the type of motion characterising a sound can be defined according to the manner in which this sound occupies the spectrum of audible frequencies.

The energy field is concerned with *density/occupancy*[19] in the spectral domain, and may be distributed from the lowest to the highest frequencies of the spectrum, creating various types of 'spectral texture' depending on the manner of distribution[20]. However, energy cannot be appreciated alone here: there is always a certain type of motion involved, which determines the way in which energy is distributed over time. Denis Smalley has introduced and developed an extensive vocabulary explaining types of motion[21]. There are, for example, internal motions of texture (like 'continuous-discontinuous', 'iterative-sustained', 'periodic-aperiodic', 'streaming', 'flocking' etc.), as opposed to external motion-shapes ('drag', 'push', 'throw' etc.) directly associated with gesture. When referring to nature, all types or combinations of types should be considered possible, as long as they evoke actions related to materials found in the natural world.

Apart from the dynamic shaping of sounds over time in the 'pitch field', motion is also related to the displacement of sounds in a 'spatial field', that is, the virtual space created between the loudspeakers (stereo image – foreground/background perspective). The above implies that motion should be

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[17] The spectromorphological approach concentrates on the spectrum of available pitches and their shaping in time. It has been introduced and developed by Denis Smalley, and it is broadly discussed in 'Spectro-morphology and structuring processes' (Smalley. 1986) and in 'Spectromorphology: explaining sound shapes' (Smalley. 1997).

[18] Denis Smalley refers to the term *spectral space* as representing '...the wide variety of sound qualities, timbres and pitches perceived over the spectrum of audible frequencies'. (Smalley. 1997: 118).

[19] See 'spectral space and density' in 'Spectromorphology: explaining sound-shapes' (Smalley. 1997: 121).

[20] For example, a texture can be 'diffused' or 'concentrated' depending on whether the frequencies involved are 'dispersed' or closely placed in areas of the spectrum.

[21] 'Spectromorphology: explaining sound-shapes' (Smalley. 1997: 115-118).

appreciated together with space, as this is needed in order to define the dimensions in which motion takes place.

2.3.2.3 *Space*

Space can be explained from two different perspectives in the context of the current discussion[22], according to the way in which sound is approached perceptually.

(i) *Realistic space*:

Realistic refers to the 'illusion' of real-world spaces ('natural' or 'non-natural') potentially implied by certain combinations of sound textures and events in a musical context.

(ii) The *timbral* or *spectral* approach:

According to this perspective space refers to the implication of width and depth through relationships between frequency components[23].

Although apparently different, the two perspectives can be related in a convergent manner and are both needed in defining behaviour in a musical context. A 'realistic' space always involves – and therefore might be analysed in – certain spectral relationships, while at the same time certain changes in the spectral domain may reveal references-connections to spaces found in the 'real world', or may well reveal 'abstract' sonic environments.

Realistic spaces can be created through the application of signal-processing effects (reverberation - resonant filtering), or through the recording of sounds in places other than 'acoustically dead' recording studios (reverberant rooms, outdoors spaces), where the sonic environment existing around the sound-source being recorded is also captured by the microphones[24].

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[22] Sound projection issues (diffusion-acoustics) are not discussed in this thesis.

[23] For example, a sound containing very high and also very low frequencies can be regarded as occupying a wide frequency space.

[24] Recordings of 'real-spaces' may also be 'non-focused', where the target is to capture a sonic environment (combination of multiple sounds) without focusing on a specific source. The realistic spaces created to simulate such an environment can be also called 'non-focused'.

In natural-sounding contexts the target of transformation is to create realistic spaces giving the impression of natural landscapes. In the case of 'imaginary' landscapes the context might be 'less realistic', in that it may include non-recognisable sounds, or in that the sound relationships might seem impossible from a 'real-world' perspective[25]. However, we might still retain the landscape impression due to the spectral identity of the sounding content.

2.3.2.4. *Time*

Time is often regarded as the most basic element of sound. It involves duration, or else the period in which sound occurs, and can be appreciated as *real* or *psychological*. *Real time* – also regarded as 'clock-time' – is accurate and objective, and can be measured in units such as hours, minutes, seconds and milliseconds[26]. *Psychological time* is subjective and cannot be measured with precision, as it involves an appreciation through memory and imagination[27].

Musical time can be examined at a micro- and macro- level of structure in a variety of scales ranging from the distance between particles (grains) within a sound-texture to the distance between whole sections.

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[25] See Wishart (1986) for further discussion on natural landscapes.
[26] The mentioned units are mostly used in association with musical contexts.
[27] A detailed discussion on the involvement of time in electroacoustic music is provided by Barry Truax in his 'Musical Creativity and Complexity at the Threshold of the 21st Century' (Truax. 1992) and in 'Discovering Inner Complexity: Time-Shifting and Transposition with a Real-time Granulation Technique' (Truax. 1994).

2.3.3 Natural behaviour: selected examples

Some examples of natural behaviour have been presented in the diagram of paragraph 1.4.2 in the previous chapter[28]. The actions-motions presented in the circular shape reveal natural behaviour and are related to the sounds potentially produced by natural materials, either through the involvement of human-animal agency, or through the effect of a natural force[29].

A few representative examples of contexts involving natural behaviour are discussed in the following paragraphs.

2.3.3.1 'Waves'

'Wave' contexts indicate a periodic, undulating type of motion, where energy gradually increases and decreases over time. Each period of increase/decrease can be identified as a single 'wave', as indicated in Figure 2.4.

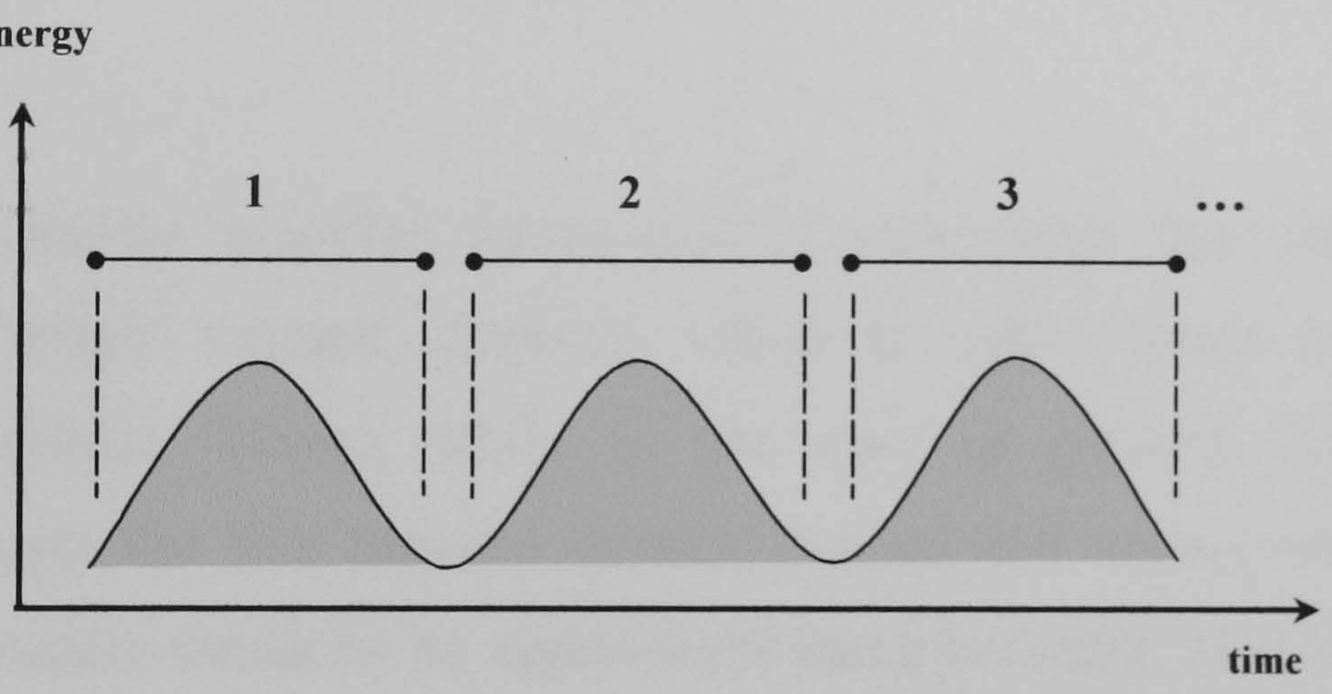

Figure 2.4: Waves.

Different types of waves can be defined as appearing in the context of the submitted works. *Granular* waves can be created by transforming materials of 'grainy' character (such as generated or recorded noise), where the indication of pitch is totally absent. On the other hand, *pitched* waves may derive from sustained – electronic, instrumental or vocal – sounds, carrying pitch information. Pitched waves can be regarded as *harmonic* if they involve certain pitch relationships between layers, or in other words if the impression of 'harmony', in

[28] See Figure 1.5.
[29] Also see Figure 1.4: material sources and sound production.

a traditional musical sense[30], is revealed in the context. Finally, *inharmonic* waves are those which may carry pitch information, but in which a definite pitch is not discernible. Inharmonic waves can be created by transforming material of metallic, resonant character, and they can be situated at an ambiguous point between the ideas of 'noise' and 'pitch'. Figure 2.5, derived from Smalley's writing on 'harmonicity and inharmonicity'[31], presents the relationship between the above types:

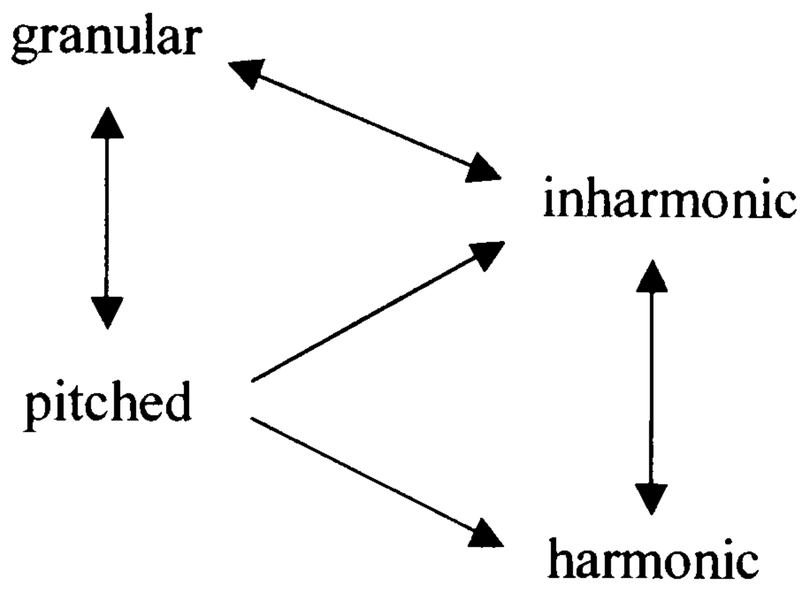

Figure 2.5: Types of waves.

We tend to associate 'granular' waves directly with nature, since they indicate a non-pitched, 'rough' textural character, which is widely found in the natural environment (water waves), while in the case of pitched, harmonic and inharmonic waves the link between musical context and natural world is rather indirect and usually needs to be appreciated metaphorically. However, whether found in nature or whether they are part of the musical discourse, granular waves may reveal – or may seem to contain – pitch information, if they become resonant, or if they are influenced by the context in which they are placed.

In *Rous* granular waves have been primarily used in backgrounds and as connective links between sections. This can be observed at the first minute of the piece (between 0'55 and 1'28), where granular waves appear and evolve into a noisy, 'wavy' background space, embracing the continuous entry of repetitive textures which gradually reveal the idea of pitch. (CD example 15). A similar

[30] Harmonic waves may involve a combination of two or more sustained pitches, in order to create a texture where certain intervallic relationships can be detected.
[31] See Smalley (1997 :120-121) for further discussion.

environment appears again later, in the landscape section between 2'20 and 3'22 (CD example 16). In *Erevos* harmonic and inharmonic waves (created by transforming primarily vocal and metallic/resonant sounds) have been extensively employed in background layers in order to 'frame' nature-like events. This is clearly noticeable between 5'05 and 6'30 (CD example 6). In *Aura*, harmonic and inharmonic waves have been placed throughout the larger part of the sounding content, creating a 'wavy' impression regarding the overall morphological character of the piece.

2.3.3.2 'Streams'

In the case of 'streams' a linear/continuous type of motion is generally implied, while the texture might be fragmented and highly detailed if examined at a micro-structural level. A 'stream'-like texture involves the placement of sound material in multiple layers (as indicated in Figure 2.6) which 'flow' simultaneously, and which may differ from each other morphologically. In each layer the sound might be organised into 'waves' or 'clusters' (groups/concentrations of sound-fragments, where the increase/decrease in the energy field is not gradual) often separated/interrupted by gaps (sudden 'silences', areas of annihilated activity). The impression of 'flux' created by the difference between layers in such a texture may link our perception to the water element (water stream).

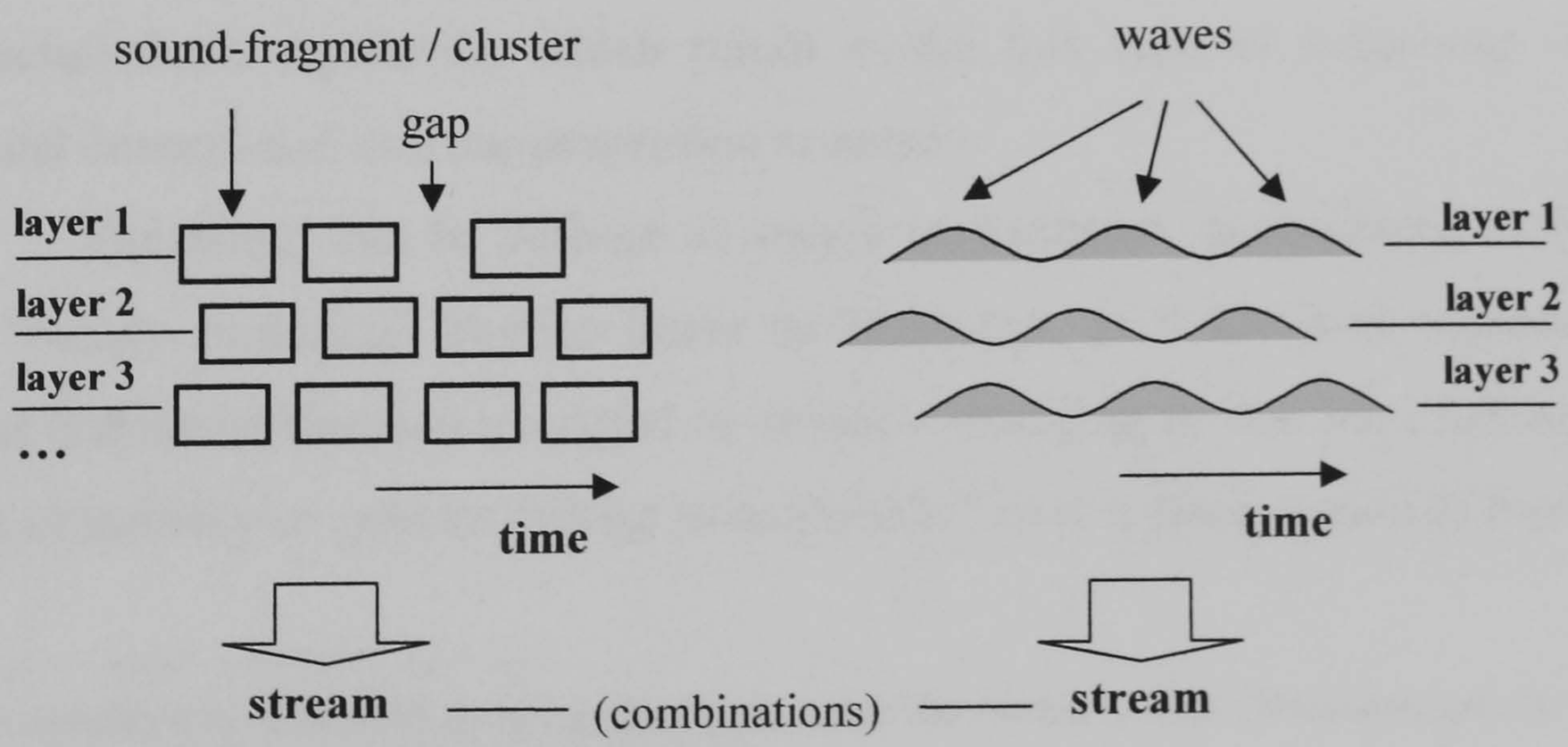

Figure 2.6: 'Streams'.

Streams may convey pitch information or they may often be considered to be closer to the idea of 'noise'. This depends on the internal arrangement of sound material. If we imagine that a stream-like sound internally consists of layers of micro-sounds, the amount of pitchness or noisiness characterising each of these sounds defines the external appreciation of a stream. Moreover, streams consisting of granular/noisy content may well create the impression of pitch, if the internal layers of materials are arranged in such a way as to create resonance.

The stream-like sounds appearing in the submitted works mainly derive from actual recordings of water streams, which were used untransformed or were slightly transformed (filtered, reverberated). A stream recording can be heard in the last section of *Erevos* (CD example 9). However, streams were also created manually. In *Erevos*, the stream-like entry appearing momentarily in 2'57 was created by the exaggerated application of reverberation to a recording of water drops. In *Rous*, the stream-like background textures in CD examples 1 and 16[32] were created by transforming electronically-generated granular noise[33].

2.3.3.3 'Fluttering'

'Fluttering' textures can be related to the natural world, since they imply a bird/insect-related type of gesture, which from a 'real world' perspective can be associated with the effort to 'fly'. Moreover, 'fluttering' can be connected to vegetation in association with the 'air' element[34]. Granularity, rapid fluctuation, repetition and often randomness at the micro- and macro- level are the main sonic characteristics/components, which might evoke this type of behaviour in the musical context and link our perception to nature.

'Fluttering' can be defined as *steady* or *irregular*, as indicated in Figure 2.7. 'Steady fluttering' implies linear development, as it involves repetition of sound fragments/fluctuations equal or steadily changing in duration, following a route of stability or gradual change in amplitude[35] over a given period of time[36]. In

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[32] The appearance of streams is ambiguous here, since the context might simultaneously be linked to other natural behaviours (waves, fluttering).

[33] Further discussion on how white noise was treated in *Rous* is provided in 2.4.2.

[34] Air may pass through vibrating bodies such as leaves or branches and may result in the production of 'flaps'.

[35] Amplitude can be used together with the parameters of frequency and time to provide an objective frame for the appreciation of spectral energy distribution. The representation of sounds

the case of 'irregular fluttering' the character of the material is 'unstable', as each fragment may be different in length and/or the change in the amplitude domain may not be constant. A variety of combinations between the two types is possible.

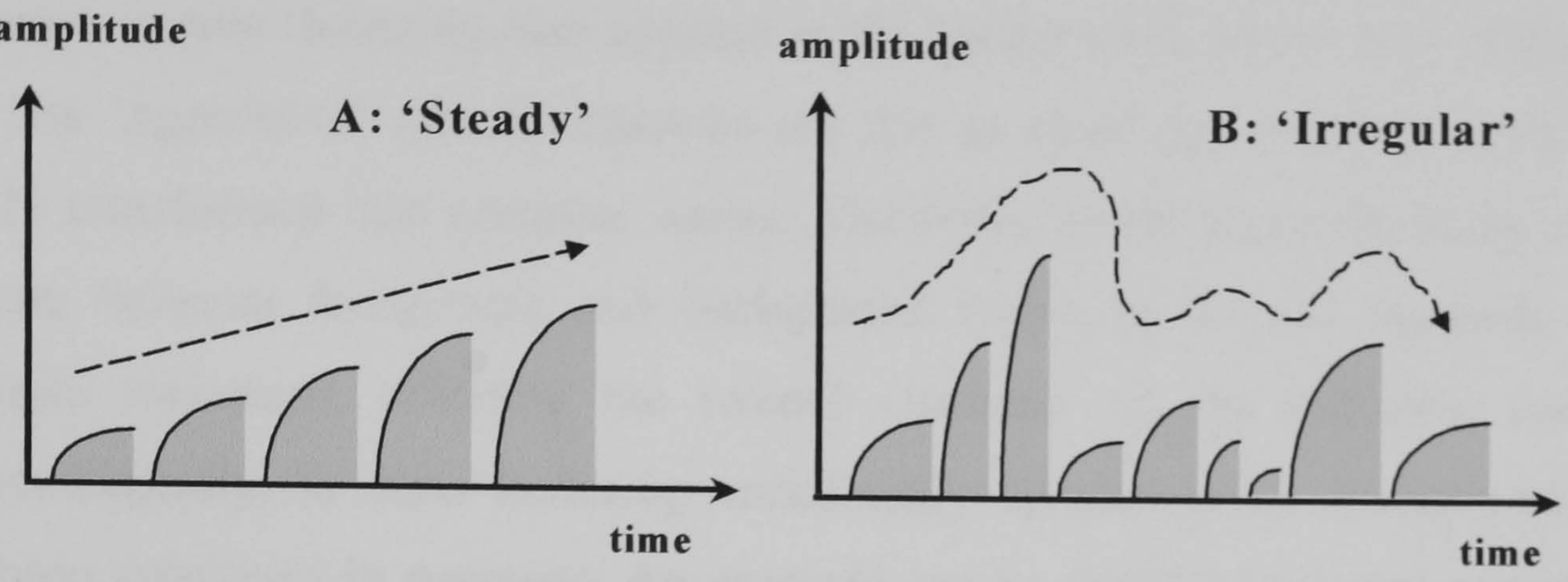

Figure 2.7: 'Fluttering' types.

Differences among 'fluttering' sounds can be defined in the spectral domain. More specifically, the fluctuations can be translated to sudden and rapid changes in spectral density/occupancy over time. These changes can often be more or less sudden and rapid or they may involve a larger or a smaller number of frequencies. Moreover, the frequencies involved may be situated higher or lower in the spectrum, and they may occupy a wider or narrower area. The above may delineate different types of sounds in terms of textural quality, rapidity/intensity/randomness of motion and magnitude of gesture, and may direct our perception to different fluttering-related sound-sources. For example, a sound characterised by high-frequency content and extremely rapid fluctuations may be related to small insects and birds. If the sound is slowed down, or in other words, if changes in spectral density/occupancy become less sudden and rapid, but also if they become more intense (involving a larger number of frequencies) and/or involving low frequencies as well, the sound may potentially be linked to larger vibrating bodies, referring to different types of birds/insects or ambiguous combinations. Finally, if the sound becomes 'stretched' to a degree where the

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in these parameters might be useful, though it does not define the energy field spectromorphologically.

[36] The amplitude of the sound is rapidly fluctuating. However, the level of fluctuation is the same every time or changes gradually.

changes are not any more considered to be 'rapid' and 'sudden', it will totally lose its 'fluttering' identity.

Fluttering (mostly 'irregular') has been extensively used as a structural element in the context of *Rous*. The noise-fluctuations appearing in the foreground between 0'30 and 1'30 (CD example 10) constitute a characteristic example. In the same section fluttering also appears in the background, where it is 'diffused' and less 'aggressive' (the fluctuations are not so clear and intense), until it is finally transformed into granular waves. Elsewhere in the piece fluttering often appears between foreground and background layers in several rhythmic and dynamic variations, affecting the overall character of the sounding content morphologically. In *Aura* fluttering occasionally appears in the foreground and has been employed in passages. An example can be found in the first minute of the piece, where, between 0'55 and 1'20, fluttering is revealed amongst a variety of short, 'microscopic' granular events, and introduces a new section (CD example 17). Later (at around 1'42) fluttering appears again and it is accompanied by harmonic changes in the background, signifying the ending of the section and the transference to a new sonic environment (CD example 12).

2.3.3.4 'Rustling'

'Rustling' is mostly related to vegetation in association with 'air', since it involves an irregular succession of soft, non-pitched sounds, as of leaves being moved by a 'breeze'. Rustling might also be related to 'ground' components[37] in association with human/animal gesture, indicating actions like 'shuffling', 'dragging', 'drifting', 'crawling', 'slithering' etc ('rustling' might be regarded as the sound produced as a result of these actions), and thus it may also be regarded as pertaining to 'ground noises'[38].

Rustling is often texturally similar to fluttering, as it is characterised by granularity and randomness of motion. The difference lies in that in rustling we are not aware of discernible fluctuations and intense fragmentation. If we attempted to represent a rustling sound in the axes of amplitude and time, the representation would be different from that of a 'fluttering' sound, since the

[37] Materials found on the ground (such as soil, grit, ground leaves, twigs etc).
[38] 'Ground noises' can be regarded a group of relatively short-grainy textures indicating various actions, not clearly distinguishable from each other in the context.

change in amplitude would be different in the same period of time (as shown in Figure 2.8.).

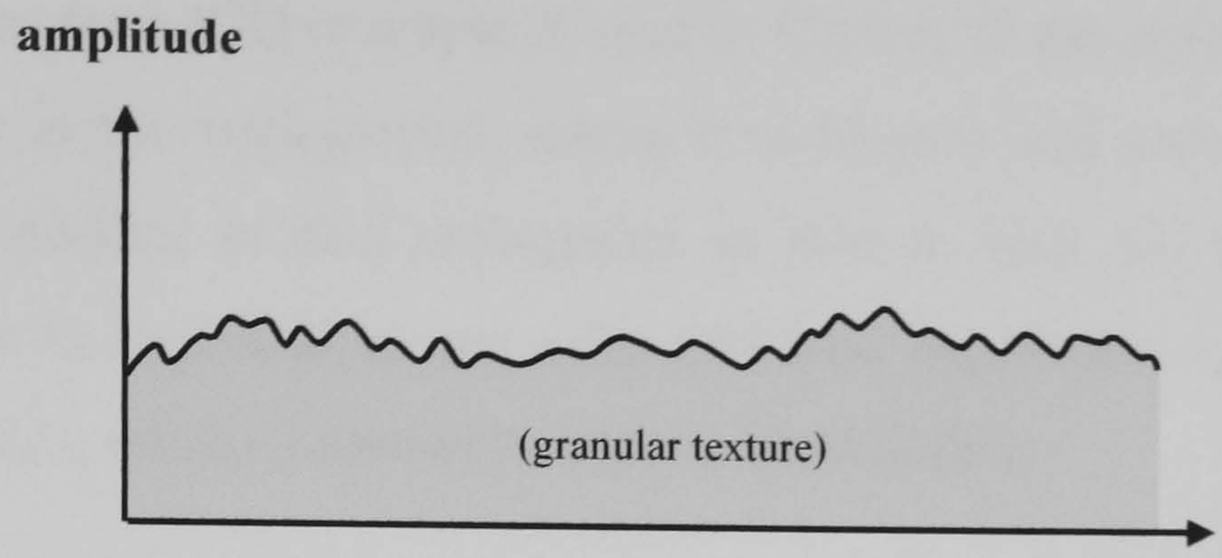

Figure 2.8. 'Rustling': amplitude change as opposed to 'fluttering' (see also Figure 2.7.).

In the musical context 'rustling' can be defined in two major categories according to the distribution of energy in the spectral domain. In the first category rustling might be indicating a blurry-indistinct textural character[39], where the sound is spread in the spectrum of audible frequencies. In this case it may resemble the sound produced by leaves/air, a sound often-found in a 'forest' environment, and its appreciation focuses directly on its texture. In the second category rustling might be less spread and may tend to be fused in certain areas of the spectrum, potentially indicating human/animal motions such as the ones described above. The two categories may be combined and create what can be described as 'mixed rustling', where the appreciation of the sound as 'texture' or 'gesture' is ambiguous. In this case a strong implication of space can also be involved, depending on the spectral arrangement of the sounding content. For example, if a rustling-like sound consists of high-density frequency-groups and simultaneously reveals a diffused, low-density texture, it may resemble a forest-like space, where granular, rustling-related events might seem as taking place in front of a noisy-indistinct background[40].

In the works discussed so far different types of rustling appear usually in landscape sections. In *Erevos* (CD example 6) rustling has been placed in close

[39] This is potentially obtainable via the application of reverberation.
[40] A more specific example of the relationship between rustling and forest-like spaces is provided in the discussion on *Woods*, in 2.5.1.

proximity to the listener, interwoven with a variety of events appearing in front of harmonic waves. Here rustling reveals gesture, although we may not be able to clearly detect the human- or animal- aspect in it, and is associated with ground components[41]. In *Aura* (CD example 3) and in *Rous* (CD example 16) the idea of rustling appears in the background, where it is blurred and does not reveal any gestures. Here rustling is also ambiguous in that it does not reveal a certain source, but also in that it is mixed with different behaviours (granular waves, streams, fluttering), where it cannot be clearly identifiable.

2.3.3.5 'Buzzing'

'Buzzing' is the most characteristic insect-related sound in the natural environment[42]. In the real-world 'buzzing' is produced as a result of the action of 'flying'[43] and can be related to insects like bees, wasps, flies, mosquitoes etc.

Within a natural context a 'buzz'[44] is a sound covering a narrow area of frequencies in the spectral domain, potentially being rapidly and randomly displaced in different directions within the virtual space created between the loudspeakers. A 'buzz' may also be characterised by sudden changes in pitch and amplitude. The motion-related attributes the sound adopts in this case (multi-directionality/randomness/nervousness/inconstancy) together with the pitch reference and also the spectral narrowness/concentration of texture might create a link to the character of the insect-related real-world 'buzzing' in our perception. Moreover, one 'buzz' might be different from another in that it may be situated 'lower'/'higher' in the spectral domain, its occupancy of the spectrum may be 'narrower'/'broader', or it may demonstrate a different level of intensity regarding changes in the energy-motion fields. This differentiation might reveal different types of insects each time, as in the real-world 'buzzing' may vary from one insect to another. Finally, 'buzzing' not only might reveal a single – real or imaginary –

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[41] In this particular example, human-produced 'shuffling' (moving the feet in a circular manner over dry leaves on the ground) was recorded in an outdoors environment. The sound was slightly filtered and mixed with different nature-like sounds in the foreground layer.

[42] Of course, 'buzzing' may also refer to human-made sources (airplanes-electronic devices), but here it is examined only in association with the natural environment.

[43] More specifically, buzzing is actually a result of fluttering, since it involves an extremely rapid displacement of small vibrating bodies (insect wings) at a level where they create the impression of pitch.

[44] The term 'buzz' is here used as insect-related.

'insect', but also might refer to a group of interwoven 'buzzes', potentially indicating a 'swarm' of insects.

'Buzzing' appears clearly in *Erevos*. In a section between 5' and 6' (CD example 6) an insect 'buzz' is revealed among other nature-like sounds in the foreground. In a later section (CD example 7) a group of 'buzzes' progressively emerges and constantly expands. Here, the number of buzzes constantly increases and the sound becomes more 'aggressive'[45] (changes in the energy-motion trajectory become more intense) until it finally disappears into a climax.

2.3.3.6 'Forests'

A 'forest' sonic environment can be regarded as a combination of behaviours rather than a behaviour in itself and involves a strong implication of space. Within a musical context 'forests' can be regarded as those aspects which reveal a reverberant 'noisy' space, potentially perceived as the acoustic space of a real-world forest, often including multiple nature-like sounds: rustling, water streams, ground noises, fluttering, bird-song etc. The sense of 'reverberation' in such a context together with the noisy, blurry character of the material constitute the aural basis, the 'background' space in which the sonic events take place. Moreover, the way in which the events are related is also determinant: the overall randomness of appearance as well as the simultaneous positioning of events in different areas of the aural image contribute dramatically to the 'forest' impression. A 'forest' may also include non-natural (non-recognisable) sonic events, or even abstract sounds, which nevertheless give the impression of a real-world environment, but also it may reveal the idea of 'pitch' in a traditional, intervallic sense. In this case it can be regarded as 'imaginary' or 'surrealist'[46].

'Forests' are often revealed in the works composed as part of the present research. The landscape-sections already discussed in *Rous* and in *Aura* can be considered as pertaining to the 'forest' category. In *Rous,* the landscape in which

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[45] The effect of 'aggressiveness' was achieved here through combinations of granular synthesis, time-stretching and pitch-shifting.

[46] Trevor Wishart (1986: 47-48) uses the 'forest' example to indicate different landscape-types. Two types of 'imaginary' forests are mentioned, indicating different relationships: 'unreal objects / real space' and 'real objects / unreal space'. A 'surrealist' landscape indicates the relationship 'real sounds / real space'. It is called 'surrealist' because the sound-sources it reveals cannot exist together in the real-world environment.

the structure is resolved after the first climax (CD example 16) can be regarded as an 'imaginary' forest, revealing behaviours of natural sources (water-air-birds), which are interwoven creating a restless and noisy sonic environment, but also containing a layer of sustained, gliding frequencies. The strong 'pitch' reference which these frequencies convey, and also their organisation into intervallic relationships[47], contribute to the 'imaginary' impression. In *Aura*, between 7'00 and 8'15 (CD example 3), the appearance of cicada-like sounds, together with the overall sense of noisiness, reverberation and blurriness in the background lends a forest-like character to the sounding content. However, in this example the implication of space is different from that in the *Rous* landscape, as there is a clear distinction between the foreground-background layers, also involving a greater sense of 'depth'. Here the sound is 'focused' on the foreground, where a series of animal-like gestures appear successively as if they have been magnified, or else as if the listener is observing them from extreme closeness. The 'forest' image seems to be simultaneously evolving at a relative distance in the background and gradually transforming (between 7'50 and 8'15) into a metallic, resonant space.

[47] The frequencies are successively gliding upwards and downwards in semitones, creating the idea of 'melody'. Moreover they are placed at different intervals and evolve simultaneously in order to create the idea of 'harmony'.

2.3.4 Comparison - conclusions

As implied in the discussion of the examples above, there are qualities which are not only important in distinguishing 'natural' from 'non-natural' behaviours but also in defining relationships among natural sounds. Some of these relationships are approached from different perspectives in the following discussion.

a) A motion perspective

In most cases motion is a basic determining factor in defining the perception of behaviour. 'Natural' motion, as well as motion in general, can be *internal* or *external*, depending on whether we examine the sound at a low (micro-) or a high (macro-) structural level. Moreover it can be appreciated in relation to different types of *gesture* and *texture* implied within a musical context. The gesture aspect is related to the indication of actions by humans and animals and is usually approached externally. However, a natural sound might occasionally consist of multiple internal gestures, no matter whether we regard these as separate gestures or not. The texture aspect is related to the interior of sounds, since 'texture' in itself implies internal activity, and can be approached at a variety of time-scales, regardless of whether gesture is implied. Textures, if examined from a relatively macro- perspective, can be 'shaped' externally without necessarily indicating gestural action (waves-streams). On the other hand, gestures as well as non-gestural sound-shapes can be multiplied and combined in a context to a degree where they cannot be individually perceived. In this case we can only focus on the texture aspect of the context.

Figure 2.9: Approaches to 'natural motion'.

Gesture-motion can be detected and defined at different levels regarding the temporal evolution of sounds. For example, it may appear as an individual gestural event, such as a human/animal produced 'scratch', or a 'crack', whereas it may involve a succession of events organised into a continuous gestural action (scratching, cracking, crawling etc). We can therefore consider gesture-motion as potentially dividing into smaller- or larger-scale events/actions, depending on the level of our approach with regard to the shaping of sounds in the time domain. Moreover, within a musical context gestures may co-exist and/or develop simultaneously. In this case gesture-motion has to be appreciated in different layers of activity, and its detection may become complex, or impossible, depending on the amount of interference. The continua presented in Figure 2.10 are closely associated and define the structural level at which gesture-motion can be approached.

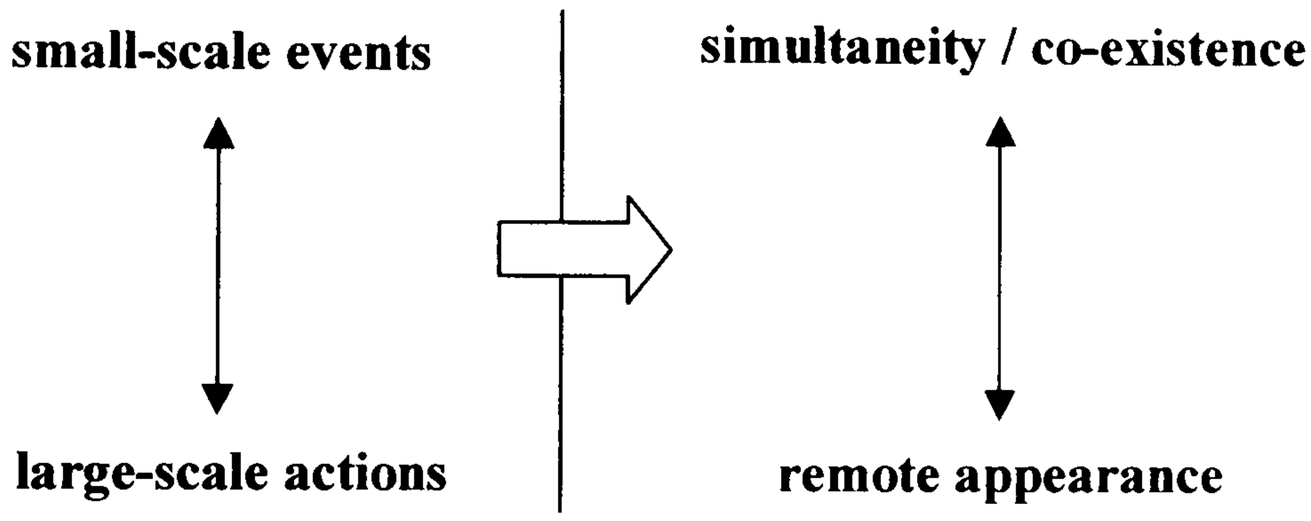

Figure 2.10: Approaches to gesture-motion.

Large-scale gestural actions always consist of lower-scale events. However, we do not necessarily recognise these 'micro-' events as gestures. Moreover, even if the gesture aspect is recognised we do not necessarily associate the micro-events with the same type of behaviour. For example, a fluttering sound is characterised by a rapid succession of fluctuations, each one of which is produced by gesture. If we manage to isolate one of the fluctuations and examine it separately we will not gain a fluttering impression, independently of whether we may be able to detect gesture behind it. In order to perceive the fluttering behaviour we need a succession of fluctuations, and here repetition is an important factor. Therefore, the manner in which micro-events are grouped and shaped over time determines the appreciation of large-scale gestural actions. In a similar way, individual

gestures, such as those appearing only once and also those existing as part of a large-scale gestural action, can be also be divided into smaller particles. However, it would be impossible to search for the lowest gestural 'unit', since even the shortest sound can be divided in multiple fragments. Independently of whether they are approached at a micro- or macro- perspective, gesture-related events reveal a sense of physicality with regard to the intervention of humans and animals upon sounding materials. Moreover, whether a short attack or a continuity of events is perceived as gestural action depends on our experiences and our perceptual expectations, but also on the manner in which sounds are associated and contextualised: a gestural event may appear once, it may be repeated creating a larger-scale action, it may be simultaneously evolving with others etc. Consequently, depending on their placement in a musical context, gesture-related events may create a variety of structural expectations, and therefore their musical utilisation determines our perceptual approach.

In relation to texture, gesture may be described as its external shaping. However, as already mentioned, textures may form external shapes without necessarily relating to gestural motion (e.g. waves). These shapes may be considered just as important, since they may function in a variety of ways as structural elements. The difference between these shapes and the gesture- shapes is that the latter reveal the actions of humans and animals, or in other words, their textural content is arranged in such a way as to reveal human/animal intervention. In some cases, such as in ground noises or rustling or in 'heavily populated' contexts, the ideas of gesture and texture are not clearly separable. These can be described as gesture-texture mixtures and their appreciation depends on the degree to which the gesture or texture aspect is revealed.

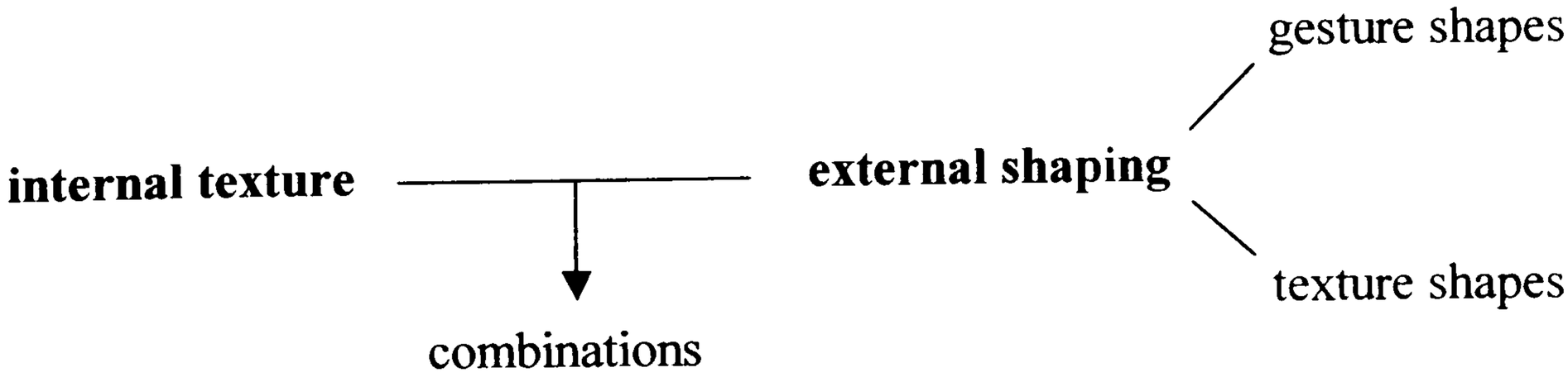

Figure 2.11: Internal texture and external shaping.

Texture motion, when examined in the time domain, is primarily concerned with the level of consistency, and it may well be appreciated on different time-scales, depending on the perspective of our perceptual approach (micro- / macro- level). A natural sound might be texturally characterised along the continuum between fragmentation and sustainment, depending on whether we perceive individual sound-fragments/particles or not[48]. Granularity is placed somewhere between the two extremes (sustainment-fragmentation), since its appreciation depends on the closeness of the fragments in the time domain.

Sustained textures might prove highly fragmented if examined at a low structural level. For example a 'stream' might externally seem relatively sustained but internally it may consist of multiple fragments or fragment-groups, which we cannot perceive individually since they are multiplied in different layers. Moreover, a 'rustling' texture, when associated with leaves/trees, also consists of multiple fragments and it is rich in low-level detail. However, its overall external character can rather be regarded as granular/sustained. On the other hand, 'rustling' in association with ground components consists internally of groups of close particles, which externally might be perceived as individual gestures.

We may therefore regard the textural interior of sounds as being temporally different compared with their outward appearance. Natural sounds are usually highly fragmented internally and the level of fragmentation may define basic external differences between them.

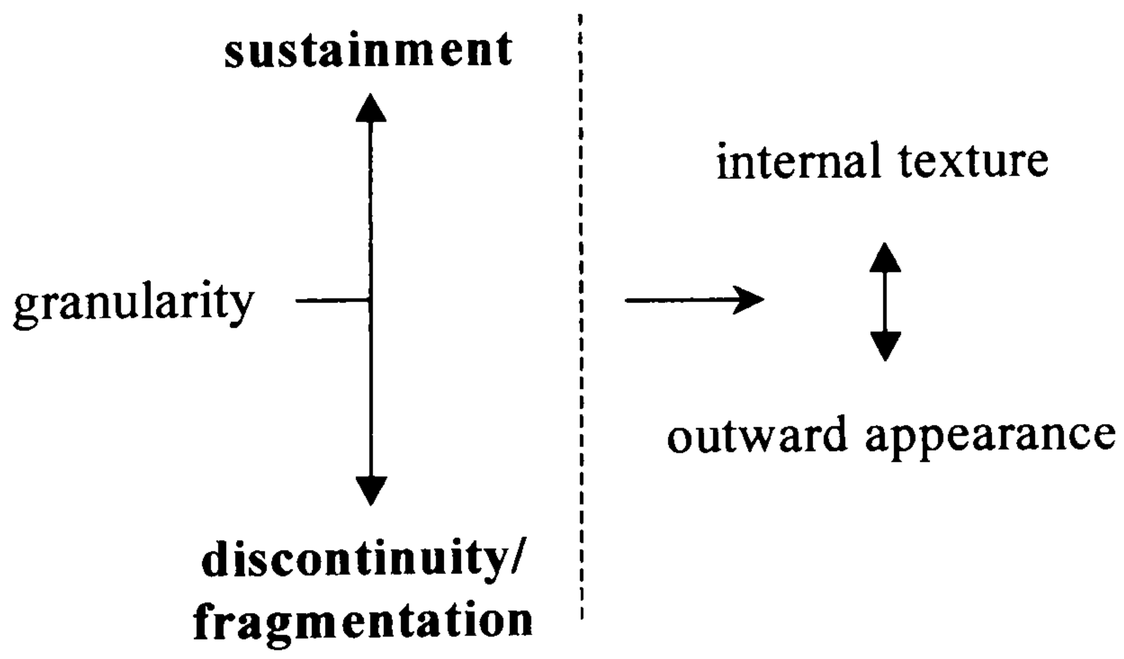

Figure 2.12: Texture motion: level of consistency in the time domain[49].

[48] All sounds are actually divided into smaller fragments. However in this discussion we are concerned with the level at which these fragments are perceptible.
[49] Figure 2.12 derived from Smalley's writing on 'texture motion' (Smalley. 1997: 116-117).

Motion-related attributes and differences between natural sounds also need to be examined in the spectral domain. In this case *spectral occupancy* and *spectral density*[50] are important qualifiers. These qualifiers need to be considered together as they are closely associated. Firstly, a sound always occupies spectral space in a certain way, and the manner of occupancy[51] may identify its textural character. For example, a basic difference between a buzzing and a rustling sound is that the buzzing sound occupies a narrow area of frequencies, while the rustling sound occupies a broader spectral space. Secondly, a sound is always characterised by a degree of spectral density, depending on the number of frequencies involved, the area in which they are located and their compactness or distribution across the spectrum. Differences in spectral density, therefore, imply a different manner of occupancy, and it is the manner in which the two qualifiers change over time that creates the idea of motion and characterises gesture- or texture-related motions.

The temporal change in spectral density can be regarded as defining different types of motion between the two previously-discussed rustling sounds[52] (trees/leaves-ground components). A hypothetical representation of how the two sounds might behave in the frequency domain over time is given schematically in Figure 2.13[53].

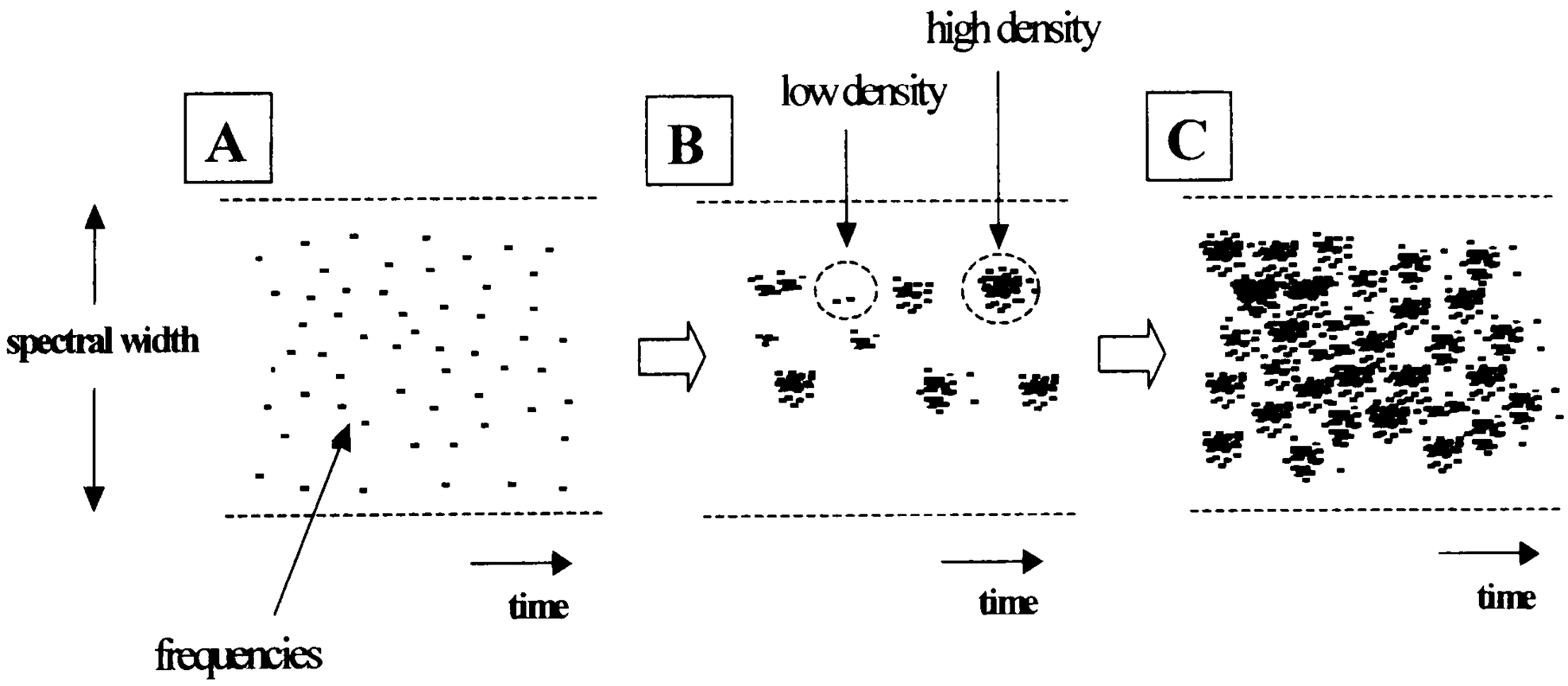

Figure 2.13: Rustling: density change.

[50] See Smalley (1997: 121).
[51] Denis Smalley defines four qualifiers (1. emptiness-plenitude, 2. diffuseness-concentration, 3. streams-interstices, 4. overlap-crossover), which help in describing the occupancy of spectral space (Smalley. 1997: 121).
[52] See 2.3.3.4.
[53] This representation does not exactly reflect what we may perceive. It is provided to indicate basic spectral differences among sounds regarding the arrangement of frequencies across the spectrum in a given period of time.

In (A) any change of density over time is indiscernible, since frequencies are spread in the spectrum, indicating a rather blurry character externally. Motion is here *texture-carried*[54], as we potentially do not perceive any individual gestures due to the rapidity of change. In (B) the frequencies are concentrated in certain regions of the spectrum creating groups. The groups are areas of high density and may be externally recognised as individual gestures or they might well form larger-scale gestural events. In this case the sound can be regarded as *gesture-carried*. If the groups are multiplied as shown in (C) we might lose the gesture connection, since we might not be able to perceive individual events, and therefore we might only be able to appreciate the sound from a texture-related perspective. Finally if we compare (A) and (C) we will discover that in (C) the overall density is higher, firstly because a larger number of frequencies is involved, and secondly because the overall level of compactness/concentration in the frequency domain is higher as well.

In a similar manner the change in density over time may define certain types of motion regarding other natural behaviours. For example, if the density is gradually increasing/decreasing the sound can be characterised as 'wavy', and the change might be accompanied by an increase/decrease in spectral width, as indicated in Figure 2.14.

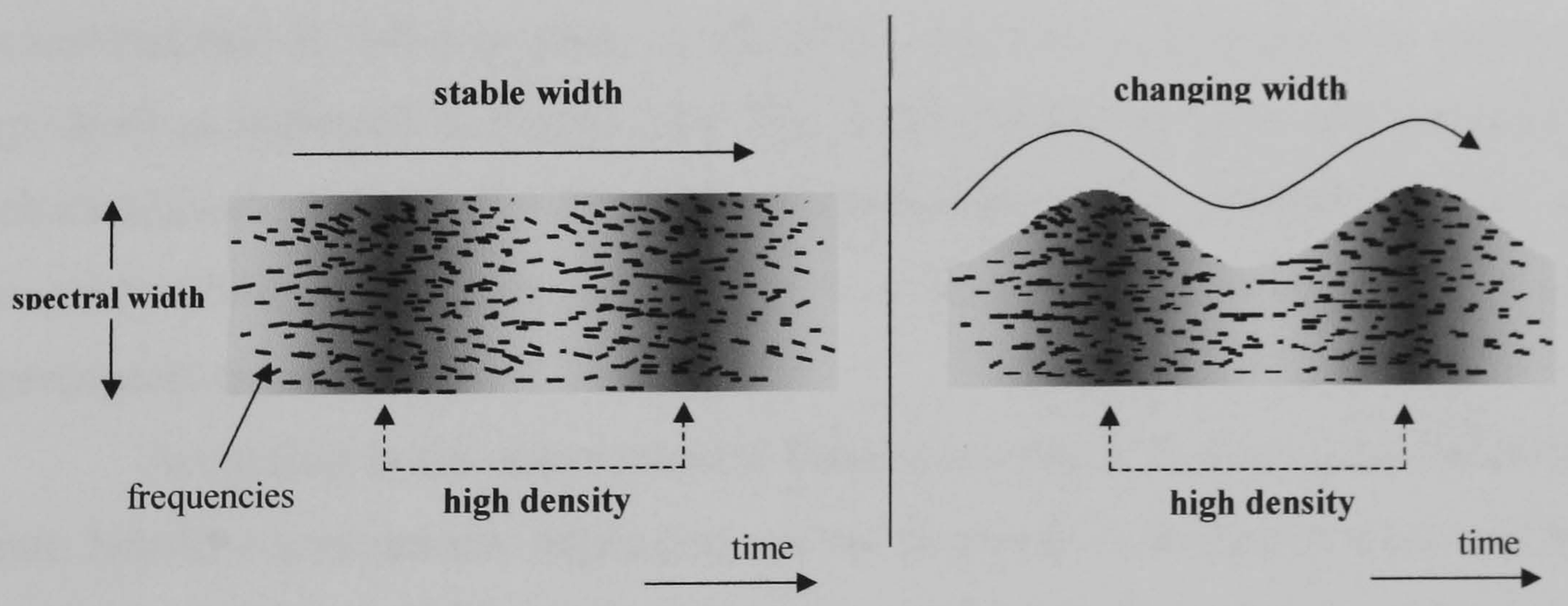

Figure 2.14: Waves and density change.

[54] The terms *texture-carried* and *gesture-carried* are introduced and defined by Denis Smalley in his discussion on 'gesture and texture as forming principles' (Smalley. 1997: 114).

In fluttering, as already mentioned[55], the energy fluctuations can be described as sudden and rapid changes in spectral density, and they might appear in a random (irregular fluttering) or a predictable manner (steady fluttering). In buzzing a similar type of change is implied (sudden/rapid/random) together with a change in pitch. The pitch variation here might not imply change in the spectral width, but can be described as the temporal displacement of a relatively fixed-narrow width over the frequency domain, as indicated in Figure 2.15.

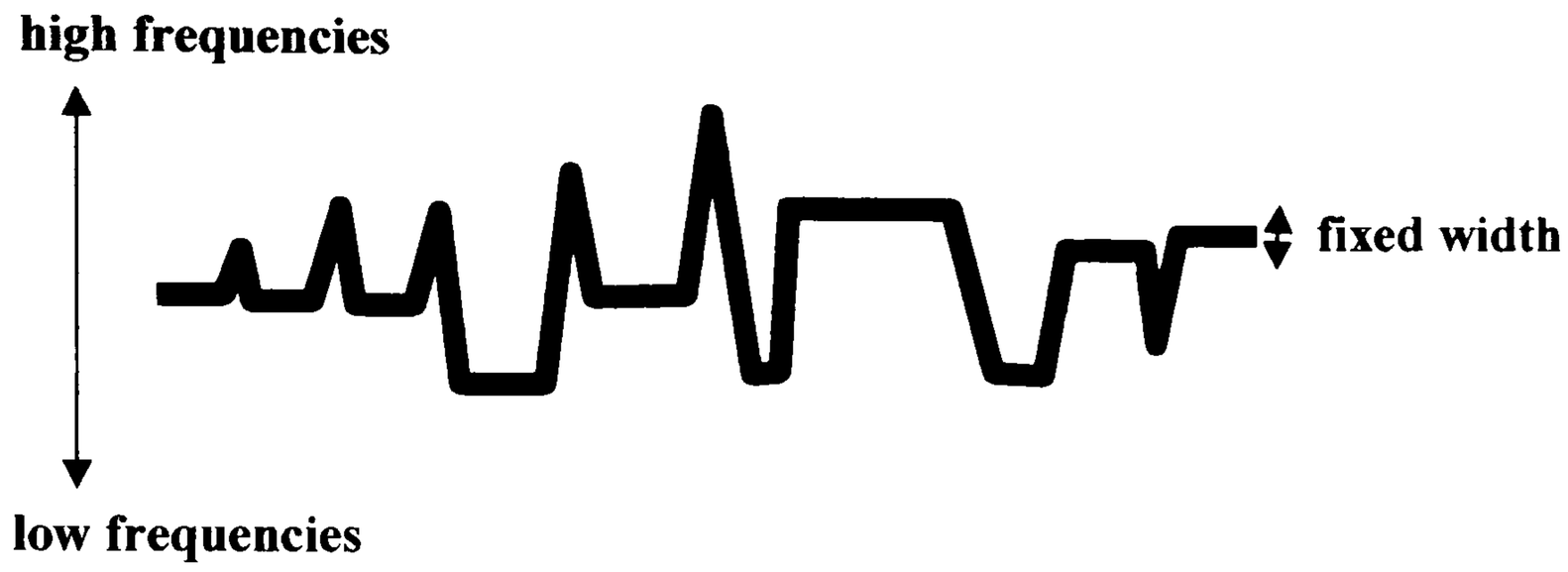

Figure 2.15: 'Buzzing' and spectral occupancy.

Consequently, certain changes of spectral occupancy/density in the time domain delineate certain types of motion amongst natural sounds. Regarding the natural behaviours discussed so far the changes can be primarily identified in combinations of different pairs of extremes (rapid-slow, intense-loose, sudden-gradual) as indicated in Figure 2.16. The result created by these changes can be characterised as predictable or unpredictable (or predictable in its unpredictability), depending on whether it is surprising or not according to our perceptual expectations.

According to the above, natural behaviours might transform into others or into hybrid combinations, depending on the temporal evolution of their spectral content. Fluttering, for example, might eventually transform into buzzing if the fluctuations characterising it become extremely rapid, at a level where they might resonate and reveal the idea of pitch. In a similar sense fluttering might transform into rustling, or stream, or something in-between these behaviours, if the frequencies become spread across the spectrum and/or the fluctuations become

[55] See 2.3.3.3.

less intense. However, there cannot be a clear border which the sound needs to surpass with regard to the above changes in order to lose its 'natural' identity and turn into an 'abstract' sound, or in order to indicate a different known behaviour. An immense variety of sounds can be considered as 'ambiguous' in that their attributes do not clearly reveal natural-world behaviours, or in that they may reveal a number of different behaviours simultaneously. Moreover, the point where we might lose the outward gesture connection and be able to concentrate on the texture of sounds is also not clearly definable. There are sounds which clearly indicate gestural activity (fluttering), but there are also others (ground noises, rustling) in which neither the gesture- nor the texture- aspect is clearly dominant.

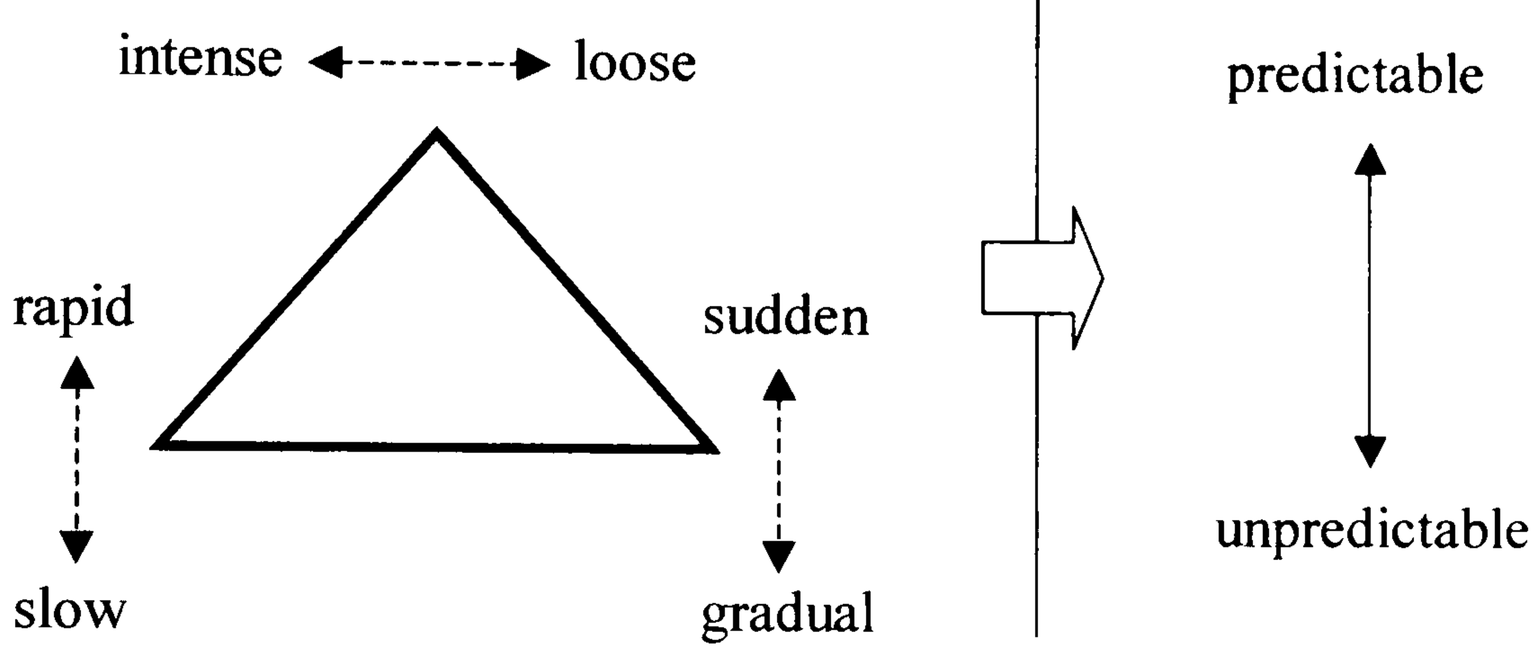

Figure 2.16. Types of temporal change in spectral density/occupancy.

Finally, the *spatial evolution* of sounds should be considered as an important motion-defining factor. This is related to the displacement of sounds across the stereo image[56] and in the foreground-background perspective, and it should be appreciated in association with the idea of space in general. We may consider the boundaries of stereo displacement as being dramatically affected by the placement of loudspeakers. For example, if a buzzing sound is rapidly being displaced in a right/left direction, the distance it covers – and therefore the width/magnitude of the implied gesture – is affected by the closeness in which the speakers are placed[57]. Foreground-background displacement refers to how 'distant' or 'close' a

[56] Multi-speaker (or diffused) sound distribution is not examined here.
[57] Although we might be able to imagine a vast virtual space through and out of the stereo image (also depending on the implication of spatial depth), the placement of speakers is fundamental as it establishes the real-world listening-frame where the sound is reproduced, and therefore affects the manner in which the aural image can be interpreted.

sound might become in the course of its temporal evolution. In this case the borders of displacement are not altered in a similar sense, but they can still be affected by speaker-positioning. The altitude of sounds in the pitch field should also be considered here, as the way in which frequencies are displaced between the high and low registers may create analogies with real-world spatial displacement.

The three fields identified above can be analogically compared with the three real-space dimensions of width, depth and height, as indicated in Figure 2.17, and they can be thought of as delineating the virtual space in which motion may take place. The manner in which a sound evolves regarding these fields may vary. For example, a sound (such as the buzzing sound mentioned above) may seem to be gradually or rapidly displaced from left to right and/or from closeness to distance, while at the same time it might be ascending or descending in pitch. Moreover, a sound can be contracting and/or expanding (such as in the case of wavy textures), indicating a simultaneous, three-dimensional type of spatial activity. Vortex-related sounds, such as those mostly referring to water or air but also to certain animal/human-related gestures, can be imagined as rotating around a central point in the aural image.

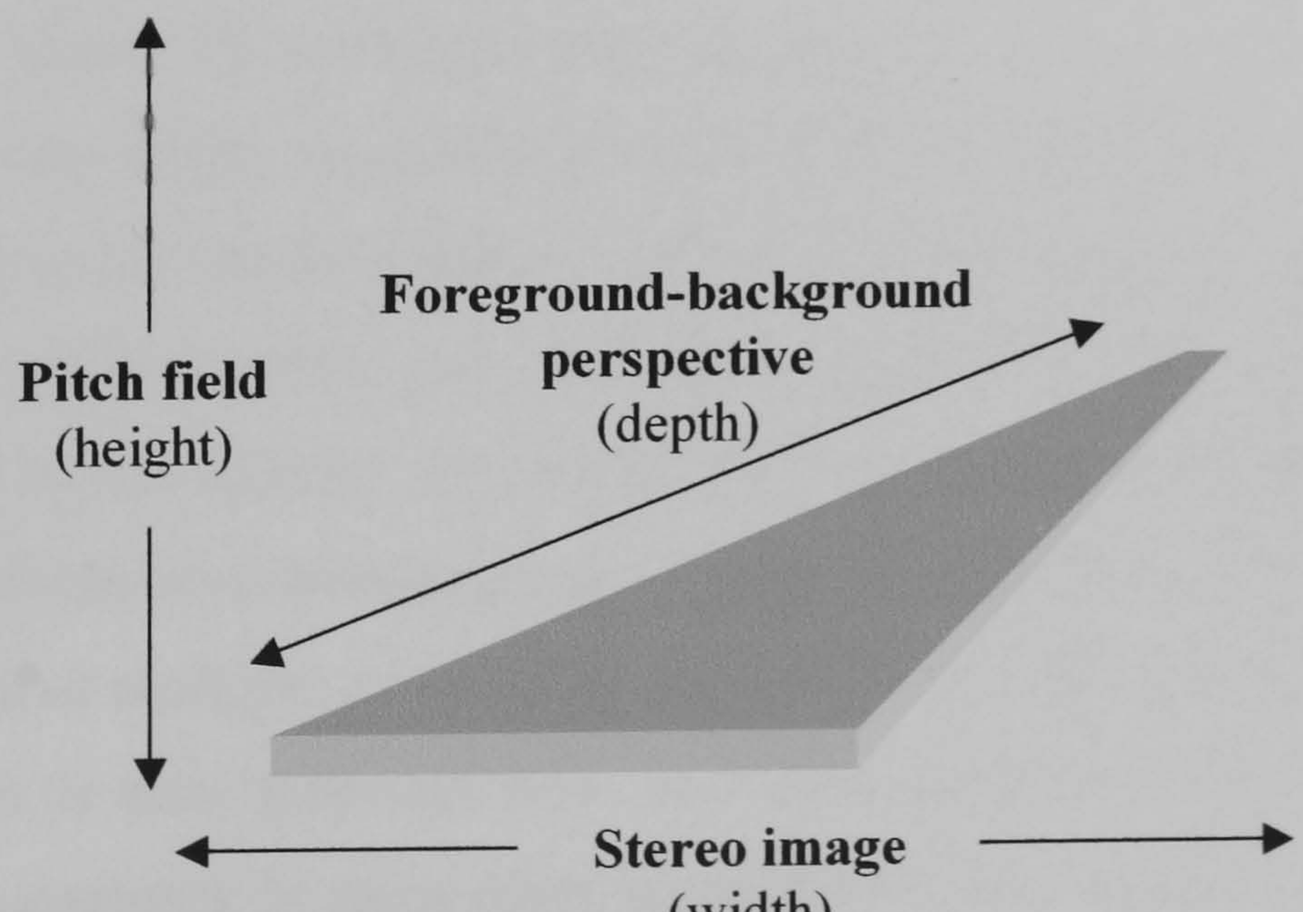

Figure 2.17: Fields of spatial motion distribution.

We may easily detect the spatial evolution of a single gestural event, given that it appears alone or is clearly distinguishable in the context, since it may potentially be recognised as an individual sound-shape moving in a virtual space. In this case the event can be rather considered as 'creating' space, since the spatial impression we might get depends on the distance it apparently covers during its evolution, with regard to the three above-mentioned virtual dimensions. In the case of certain sound-textures (rustling) or gesture-texture mixtures spatial distribution can be more complex as it may involve a simultaneous displacement of multiple micro-morphologies (or micro-gestures) in different spatial directions. Additionally, if multiple gestural events are combined in a context, the overall spatial distribution might become complex as well, depending on the number of the events and the manner of their individual temporal and spatial evolution. On the other hand, textures might form external shapes (such as waves or vortexes) which are less difficult to detect and 'follow' in relation to their spatial behaviour. Therefore the spatial appreciation of sounds may vary, depending on their gesture-texture indication, but also depending on whether they are approached from a micro- or macro- perspective (individual behaviours - overall behaviour).

In the case of natural landscapes a variety of combinations between gestures and textures with different spatial characteristics can be involved. For example, a gestural event might seem to be rapidly moving across the stereo image, in front of a seemingly static background texture, while at the same time another event might be gradually moving along different layers of spatial depth and/or across the stereo image as well. In the same context, a granular texture with complex spatial content may well exist in front of the other sounds, in close proximity to the listener. Moreover, the sounds may individually delineate – or might be considered as belonging to – their own spatial environments, creating the impression of multiple, co-existing spaces. The degree of focus on separate spatial behaviours is also important here, and often defines the spatial interpretation of landscape-contexts. In some cases we might be able to detect an individual spatial behaviour among others, as this behaviour may seem superimposed (focused context), while in other cases the concentration on the spatial evolution of separate sound-shapes may be difficult or impossible (non-focused context).

Spatial and spectral behaviour are closely related and interdependent. In fact, the impression of spatial displacement, as well as the illusion[58] of motion in general, is a result of certain changes in the spectral domain. For example, the temporal change in the spectral density/occupancy of a sound might be rapid (fluttering, energy fluctuations) but gradually losing its intensity, where the number of frequencies involved in each fluctuation may decrease over time, and/or the frequency-concentrations may gradually become more and more diffused over the spectrum. In this case the sound might seem to be gradually moving towards the background, and its course may also be characterised by a left-to-right or right-to-left displacement. We may therefore consider spectral density and spectral occupancy as the fundamental qualifiers needed for the definition of spatial behaviour, since the manner in which they change over time may convey spatial implications. Where landscapes are concerned the context reveals multiple sounds with variable levels of density and different types of occupancy. The manner in which the sounds individually evolve in the spectral domain over time, and also their relationship and their utilisation in the musical context may create impressions of spatial localisation and spatial displacement, and moreover, may create connections to spaces found in the natural world. A closer approach to natural landscapes with regard to the relationship between spectral and realistic space is provided in the following pages.

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[58] The idea of motion in electroacoustic music can be considered 'illusory', since the sound-shapes we perceive, whether related to the real world or whether they are 'abstract' shapes, do not represent – or else they are not the result of – an actual disposition of material bodies within the aural image.

b) Natural spaces and spectral density

The space-related differences among the landscapes described previously can be primarily translated into differences concerning spectral density, and can be defined along two interrelated continua. The *closeness-distance* continuum defines the placement of sounds in the foreground-background perspective, while the *level of transparency* defines whether a sound might let other sounds pass through its texture or not. The level of transparency is related to spectral occupancy and might alone seem to define whether spectral density is high or low. However, since two or more sounds need to co-exist in the same space in order to be compared, spectral density is inevitably related to the idea of distance. For example, if 'opaque' sounds are placed in the foreground they may block the aural image and we might be unable to hear what is placed behind them, and therefore be unable to perceive the idea of a realistic 'space'. If those sounds are placed at some distance in the closeness-distance perspective they might constitute a solid background in front of which additional activity might take place.

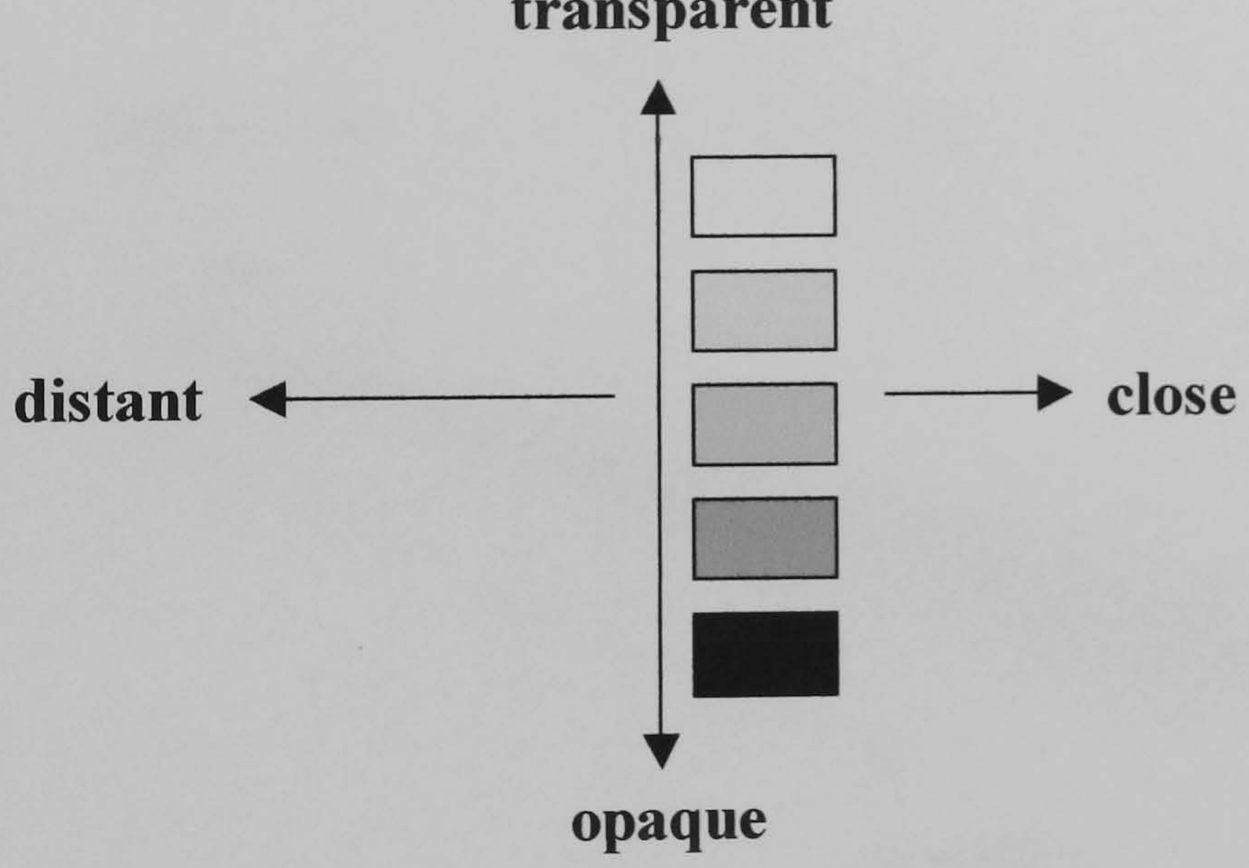

Figure 2.18: Continua of spectral density.

Landscapes consisting of transparent textures spread in different layers along the closeness-distance continuum might indicate a high level of depth, since a background 'border' is not definite, and they can be highly detailed as they might allow many spectromorphologies to reach our ears simultaneously. The last section in *Erevos* (CD example 9) is such a landscape, where the impression of an

unreachable – or a non-existent – horizon is given. In 'forests', however, there is a definite background-border, which does not permit any listening further back. Differences between landscapes can also be defined in the arrangement of sounds in the mid-ground, the space between the closest and the most distant sounds. In *Rous* (CD example 16) this space is interspersed with events of variable level of transparency, while in *Aura* (CD example 12) it has been left relatively empty.

A typical simultaneous placement of sounds of different densities in a forest-like landscape is presented in Figure 2.19. As shown in the diagram, leaf-related 'rustling', the least transparent[59] among the sounds included, is placed in the background layer, establishing a 'blurred' listening frame which is difficult to pan through. Bird-songs and water-streams may occupy the mid-ground space, while ground noises and insect buzzes are usually placed closer to the listener.

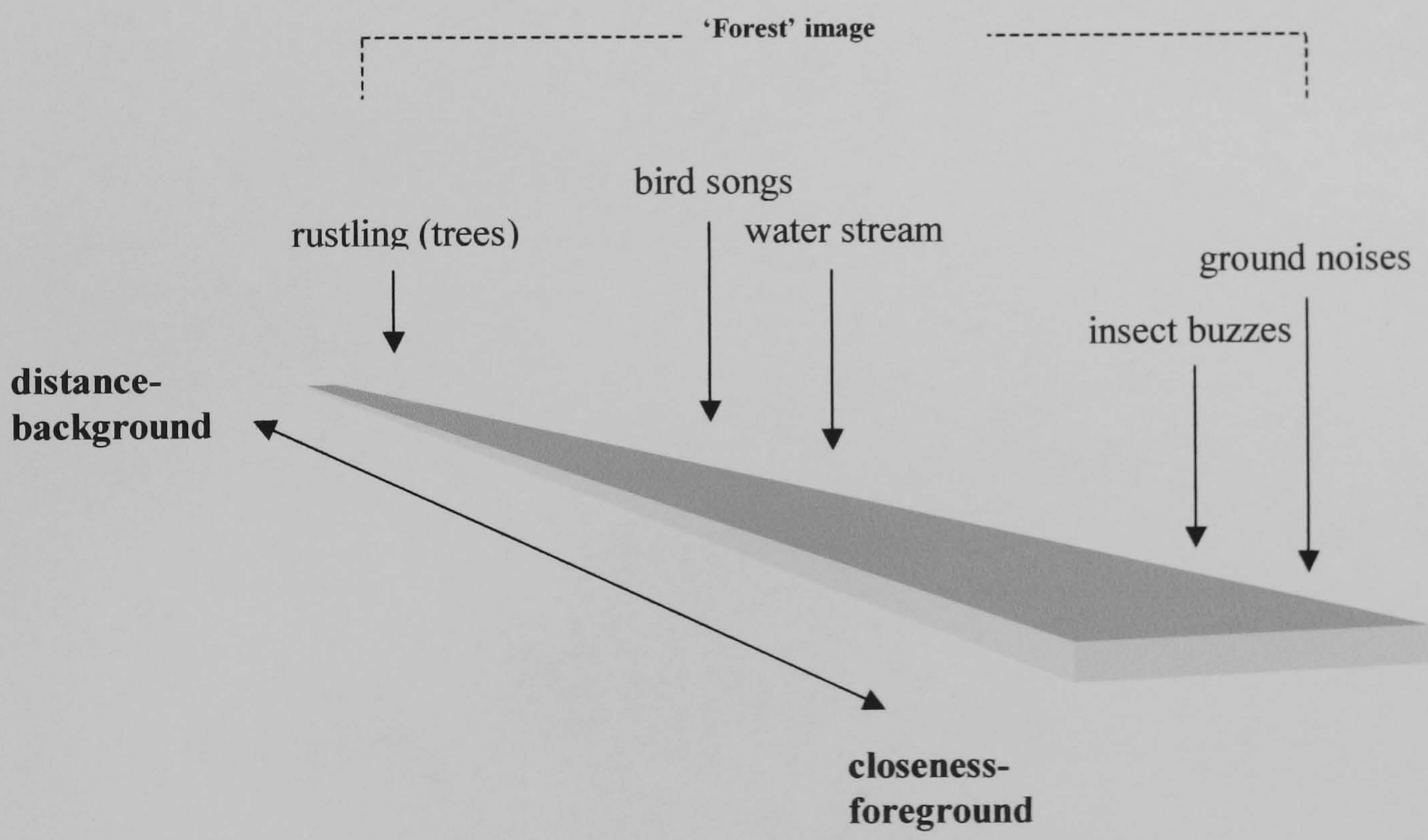

Figure 2.19: Placement of sounds in a 'forest' image.

[59] Rustling can also be transparent, depending on the number of frequencies involved. In this example it is regarded as 'the least transparent', since, in comparison with the other sounds, it might be hard for sounds set further back to penetrate.

If the foreground and mid-ground sounds in the above image become less transparent we might not be able to perceive a high degree of detail, and if they become opaque we might totally lose the sense of depth.

There are factors determining the level of transparency, which need to be considered together. A basic factor is the *level of occupancy*, or in other words the overall number of frequencies in the spectrum of a sound. Sounds involving a large number of frequencies might be characterised as 'packed' and be likely to block other sounds. The *level of concentration* (how closely the frequencies are packed[60]) is also important, but it should be considered together with the *location* of the frequencies in the pitch field. For example, if a sound's frequency concentration is in a high-frequency area, this sound will probably let a sound with a low-frequency located concentration through (see Figure 2.20.). The *narrowness of occupancy* in the spectral domain is another basic factor. For example, a 'buzzing' sound placed in the foreground as above, although it may be a sound of high spectral density (the frequencies are usually closely packed), will probably let background frequencies through, since it only occupies a narrow area in the frequency domain (see Figure 2.21.).

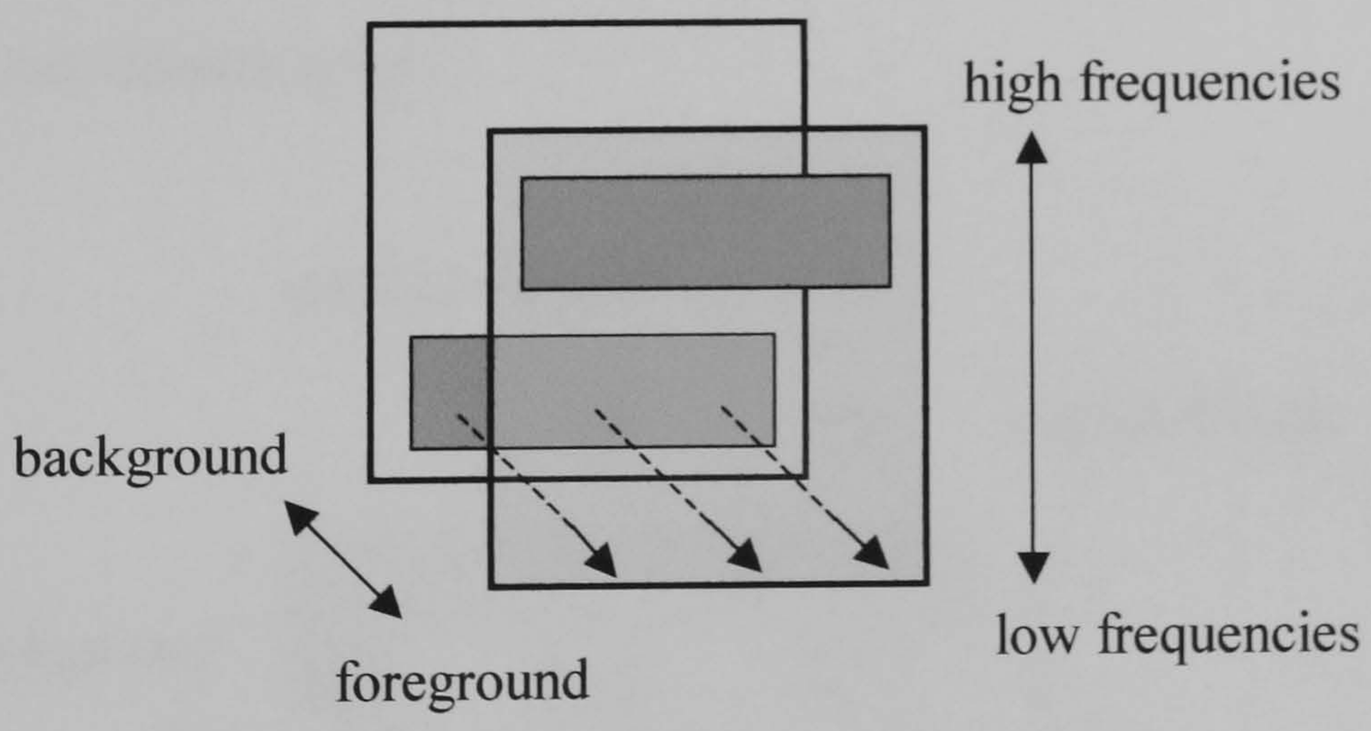

Figure 2.20.

[60] Closeness not only refers to time-distance here, but also to pitch-distance.

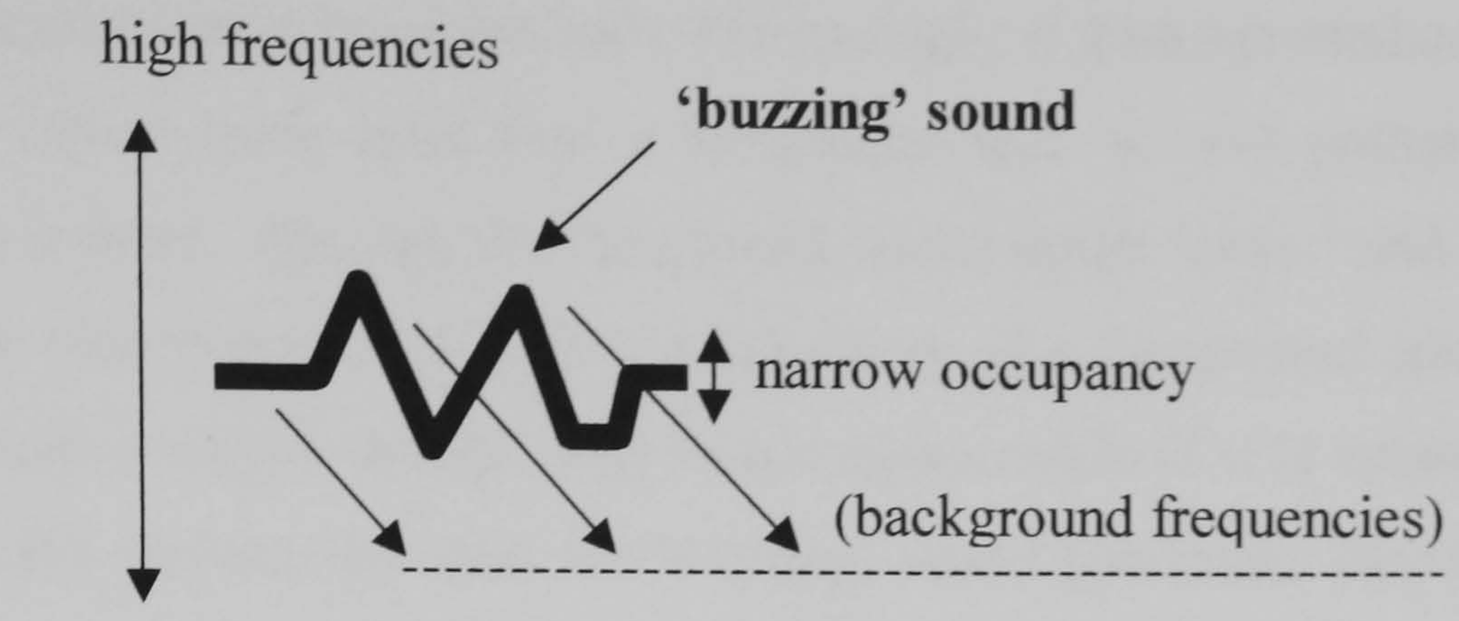

Figure 2.21.

Moreover, the level of transparency needs to be appreciated in association with the time field, since the *temporal distancing* between events is important for defining transparency in landscape contexts. For example, if a high-density foreground event is repeated occasionally in front of a sustained background, it might allow us to listen behind it, since it is characterised by spectral gaps, which allow background frequencies to get through. The same applies if a high-density event is followed by a different event set at a degree of temporal distance (see Figure 2.22.). The manner in which *density* changes over time is also important: a sound indicating a constant change in density (like a 'fluttering' texture) might let frequencies through even if it is not interrupted by gaps, since it may include penetrable low-density areas.

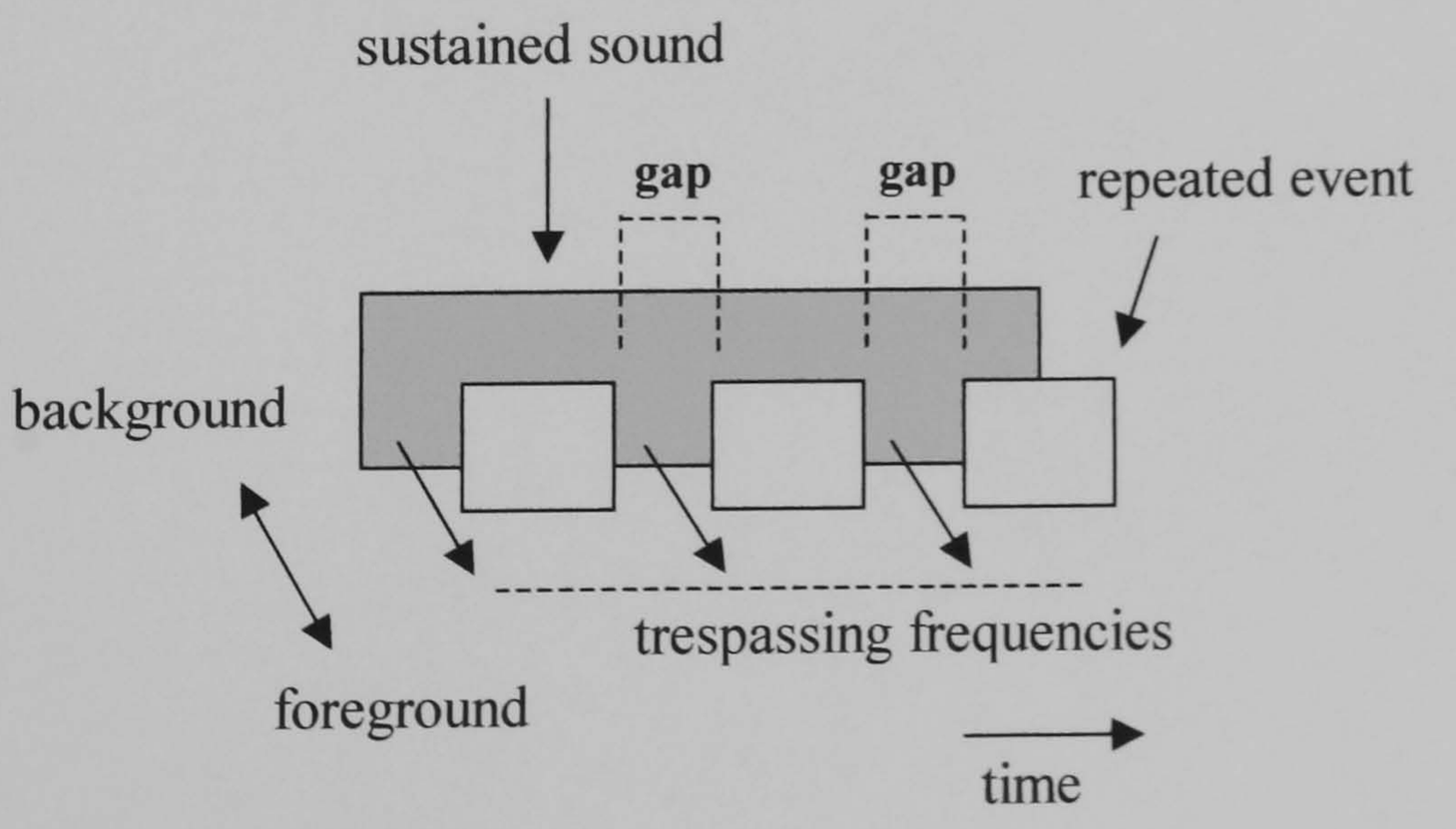

Figure 2.22.

Finally, the placement or displacement and spreading of sounds over the stereo space needs to be considered. For example, if a background sound is spread over the stereo space more than a foreground one, we will probably be able to realise it is there, although the foreground sound might 'cover' and 'hide' a large part of it (see Figure 2.23.). In a similar way, if a foreground sound is left- or right- based it might free up some stereo space, while if it is apparently moving between the speakers (as with the 'buzzing' sound previously-discussed) it might again successively create left- or right-based gaps through which background frequencies may penetrate.

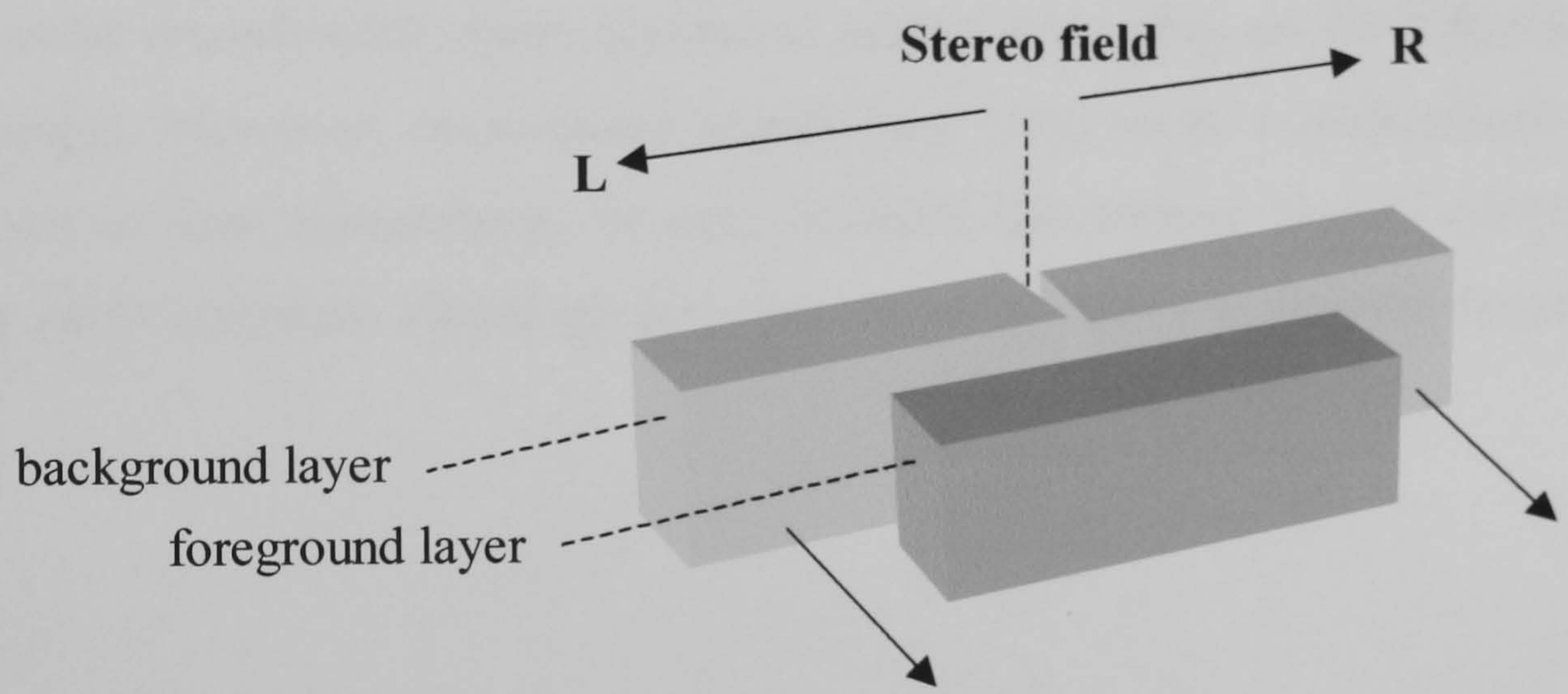

Figure 2.23.

c) Noise and pitch

The continuum between 'noise'[61] and 'pitch' is another important behaviour-defining factor among natural sounds. Many sounds found in the natural world - including 'water/air waves', 'water streams', 'fluttering' and 'rustling' - are closer to the idea of noise since indications of definite or stable pitch are nearly or totally absent. Many other natural sounds – including buzzing, bird songs, crickets, animal cries etc – might carry strong pitch indications and therefore could be generally regarded as 'pitched', depending on how they are contextualised. Therefore, combinations between pitch and noise are possible: a natural sound (such as the sound of cicada insects) might be located at an ambiguous point between the two, where it cannot be clearly regarded as pitched or non-pitched, or else can be considered as more pitched or noisier depending on the influence of the context. Moreover, noise-based sounds may often adopt a pitch identity, as they can, at least momentarily, become resonant (air waves); sounds carrying a strong pitch reference (buzzing) may just as easily carry a variable degree of noise.

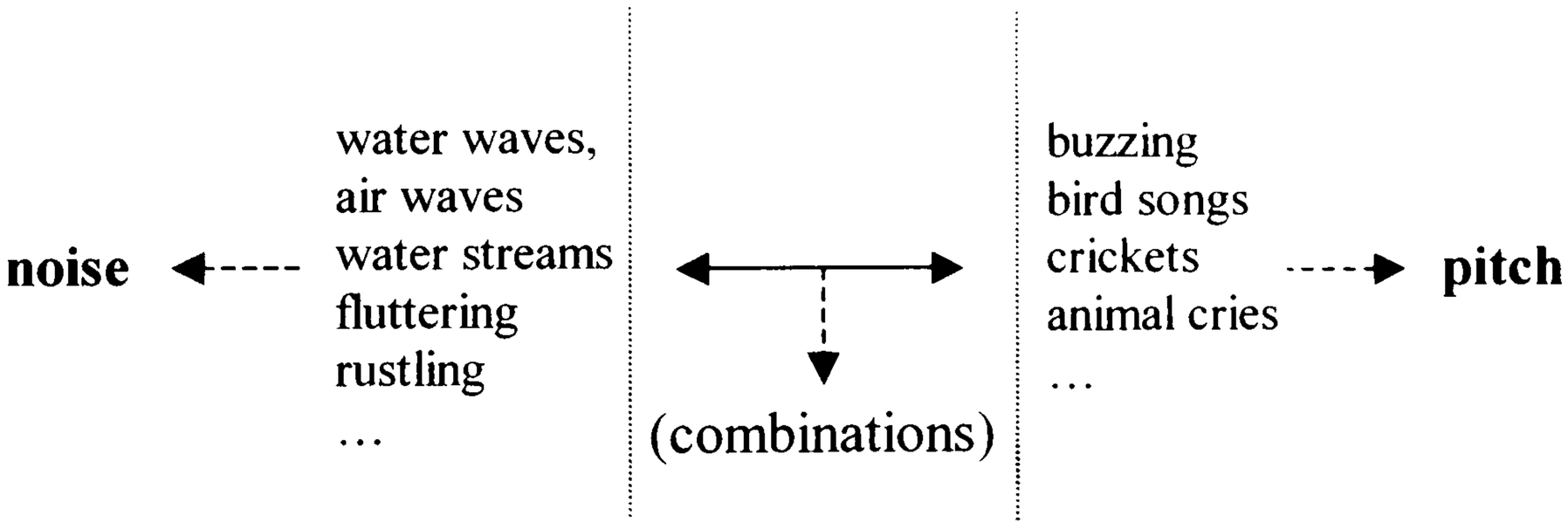

Figure 2.24: The noise-to-pitch continuum.

[61] Noise is not here concerned with density, but refers to the non-pitched, 'rough' character of sounds. Denis Smalley defines this type of noise as 'granular noise' (Smalley. 1997: 120)

d) Summary

To summarise the above, we may conclude that the fields of motion and space are fundamental in identifying natural behaviours and defining differences and relationships between them. From an electroacoustic music perspective, there cannot be space without motion and vice versa. Therefore, the two fields are integrally associated and interdependent. Spectral occupancy and spectral density constitute the link between those fields, and reflect the distribution of energy in the spectral domain. The manner in which energy is distributed defines different types of sounds and determines their relationship within a musical context. The continuum between pitch and noise is also important and should be considered independently of whether motion or space is discussed.

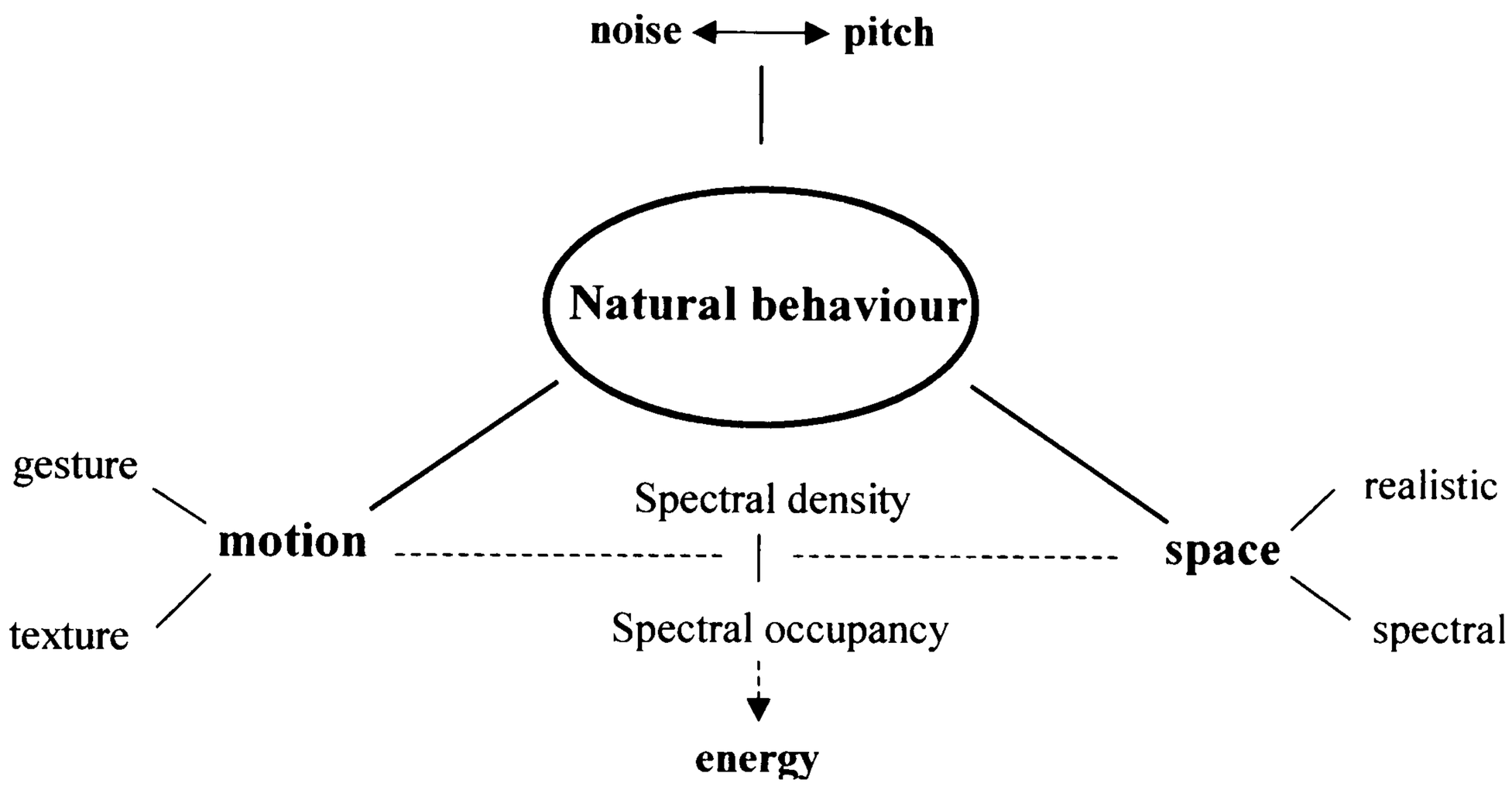

Figure 2.25: Natural behaviour, summary.

We may also conclude that a high degree of ambiguity can be involved among nature-like sounds within a musical context as far as their relationship with real-world natural behaviours and their indication of material sources are concerned. Many sounds might convey a degree of naturalness but not necessarily reveal certain natural behaviours. Moreover, even if certain behaviours are recognisable, a sound might not be clearly attached to a natural source, or it might reveal combinations between different sources.

Finally, we should understand that the way in which we may choose to utilise different sounds in a musical context is very important. Despite their individual attributes, natural behaviours can be interpreted in an immense variety of ways. The manner in which these behaviours exist in a context may create certain relationships between them, and may reveal connections to the natural world accordingly. Therefore, it is the manner in which natural behaviours are utilised compositionally that determines their appreciation and defines the aspect of naturalness.

2.4 The mimetic process: a closer approach

2.4.1 The basic materials: thoughts concerning the use of recorded and electronically-generated sounds

The sound material available to composers is a determining factor in the compositional process, as it constitutes the base, the point from which the journey of transformation departs. The output of transformation is always dependent on the input and therefore the choice of sound-base is always of primary importance.

We often wonder whether it is better to use sounds recorded from nature and culture or to start by setting the parameters ourselves and creating sounds electronically. There cannot be an objective answer to this question, as it may depend not only on the functionality of the chosen material, but also on each individual composer's aesthetic approach.

Recorded sounds, whether obtained from nature or culture, always carry a degree of unpredictable sound information not perceptible to our ears in the form in which the sound is initially captured. New sound information can be discovered during the transformation process if, through applying certain processes, we manage to reveal the sound's micro-structure. The existence of hidden qualities often makes recorded sounds entertaining to work with, and the process of discovering these qualities is often highly creative.

However, due to their intrinsic complexity recorded sounds are often difficult to 'carve'. The more we search inside a recorded sound's texture, the more hidden information we may discover, but sometimes this information might prove disorientating and uncontrollable. Moreover, some recordings[62] may inevitably carry spatial information (natural reverberation, background noise), which, if not desired, might be difficult to eliminate or use effectively. Finally, the strong implication, often carried by recorded sounds, of certain types of motion-gesture may be an obstacle to detaching the sound from its original source.

[62] Those obtained in acoustically 'alive' – outdoors or indoors – spaces.

On the other hand, electronically-generated – or *synthetic* – sounds are often argued to be more 'sharp', 'clear' and 'precise'. Indeed, this argument might be true, since they include only the information we want them to include. When we create electronic sounds (nowadays mostly through computer-based audio generators) we set the criteria of sound-synthesis and in such a way as to predict and control the sound output.

However, electronically-generated sounds are often believed to lack richness of internal texture, and therefore to have less potential for creative exploration. Even if we manage to create complex electronic sounds (for example by setting 'randomness' as a synthesis parameter), their interior will not be similar to that of recorded sounds. For example there might be a significant difference between the digitally produced 'white noise' and the 'white noise'-like sound produced in the natural environment (e.g. by a waterfall), however similar the two sounds may appear externally. If we allow ourselves to listen to their spectral evolution at a micro-level (by stretching the sounds at an extreme level in the time axis) we will discover that electronic white noise consists of digitised, 'cloned' noise-grains, while recorded white noise might reveal several different 'micro-morphologies', not perceptible to the 'naked ear'.

In the works discussed in this thesis so far, and also in those remaining to be discussed, nature, real or imaginary, has been created through transforming both recorded and electronically-generated material. Non-pitched material (recorded and electronically generated noise, human gestures) has been employed to create natural-sounding gestures and textures. Pitched material (instrumental/vocal tones, electronic/sustained frequencies) has been selected and shaped to create animal cries, insect buzzes and harmonic backgrounds. Consequently, despite any differences in character and potentiality, both recorded and electronically generated sounds can be utilised successfully and creatively in order to produce nature-sounding results.

2.4.2 Naturalness and sound manipulation

The mimetic approach to achieving naturalness can be practically defined in a series of compositional processes employed in the creation of the sounding content of a work. Some processes are highlighted here (recording, sound-generation[63], reverberation, filtering, granular synthesis, cross-synthesis, pitch-shifting, time-scaling, spatialisation, amplification change, mixing) as they have been extensively applied to deliver natural-sounding results in the six submitted works. In the following pages the manner in which these processes can be combined to create natural behaviours is discussed.

Fluttering textures can be created by applying changes in amplification, and also by applying time-stretching/time compression and panning. Granular, non-pitched material is needed as a basis for transformation. In *Rous* the foreground fluttering appearing at 00'30 (CD examples 1 and 10) has been created in stages, as shown in Figure 2.26. Firstly (a) white noise was generated and stored (CD example 18). Secondly (b) it was shaped dynamically to create fluctuations. In this particular example the fluctuations were created manually, by using real-time interactive interfaces, in order to imply physical gesture (CD example 19)[64]. In the third stage (c) the sound was transformed again by applying pitch-shifting/time-scaling in order to create a more realistic result[65] (CD example 20). Finally (d), the sound was spatialised in the stereo field using envelope-controlled panning and phase shifting, in order to create a two-dimensional space[66] (CD example 21).

The result in this example is ambiguous: one can easily detect a sense of physicality, as in fact physical gesture has been employed in the transformation process. However, the sound does not reveal any certain sound-source. Moreover the space in which the above sound is placed in this section is also ambiguous: in

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[63] Here meaning the electronic creation of sounds.
[64] More specifically, this stage involved a combination of digital delays, ring modulators and high-pass filters, all controlled manually. A number of 'clicks' was produced as a result of the process, which was not the initial intention. However the clicks were kept, as they proved useful at later stages.
[65] Very quick fluctuations were impossible to create manually. Time compression in association with pitch-shifting were applied to achieve this effect.
[66] When the piece is diffused in a performance, however, this space becomes three-dimensional as the sound might be reproduced through multiple stereo speaker-pairs.

the background multiple fluttering textures, produced by transforming white noise using a similar process, have been mixed in rhythmic variations and dynamic variations to create a kinetic, noisy world, which can be described as a 'fluttering stream' (CD examples 22 and 23). The connection to nature comes later (at 2'30) through the appearance of a forest-like landscape. Until that point the fluttering behaviour is probably stored in our memory as ambiguous, and its connection to nature is confirmed through the appearance of the landscape, which, including more obviously recognisable sounds pertaining to nature (such as 'bird songs'), potentially makes this connection stronger.

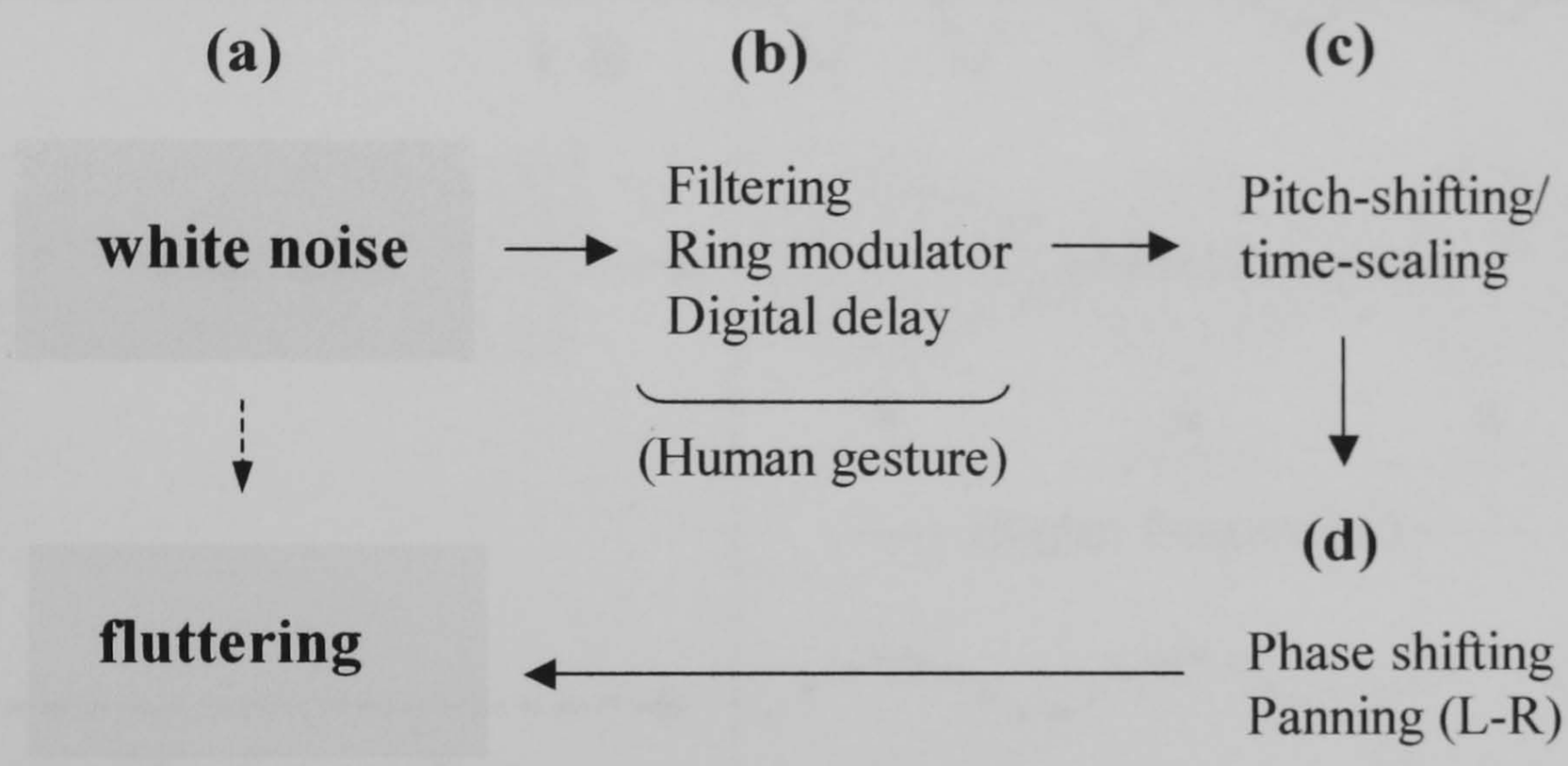

Figure 2.26. Fluttering creation process in *Rous*.

White noise was manipulated differently elsewhere in *Rous*. It was transformed to create granular waves, which are used extensively in backgrounds and in passages between sections. In this process the amplitude was shaped through an amplification envelope to create undulations (CD example 24), which were later spatialised randomly through a pan envelope (CD example 25) and were reverberated in order to become 'smoother' and gain a sense of 'depth' (CD example 26). The undulations were occasionally 'highlighted' with high frequencies, obtained by transposing the white noise upwards, or by filtering non-pitched material through high pass filters in order to achieve a gradual change in spectral breadth (Figure 2.27). In the landscape between 2' and 3', different noisy/wavy sounds, produced using a similar process, were shifted upwards and

downwards (which also resulted in changes in duration) and were mixed in layers (CD example 27). In this example we may detect pitch content, as some particular waves became resonant due to the application of reverberation in combination with time-stretching. Apart from water- and air-waves, this sound may also be linked to cicadas or ambiguous combinations between cicadas and rustling, and, being placed in such a context in combination with other nature-related sounds, it contributes to the 'landscape' impression.

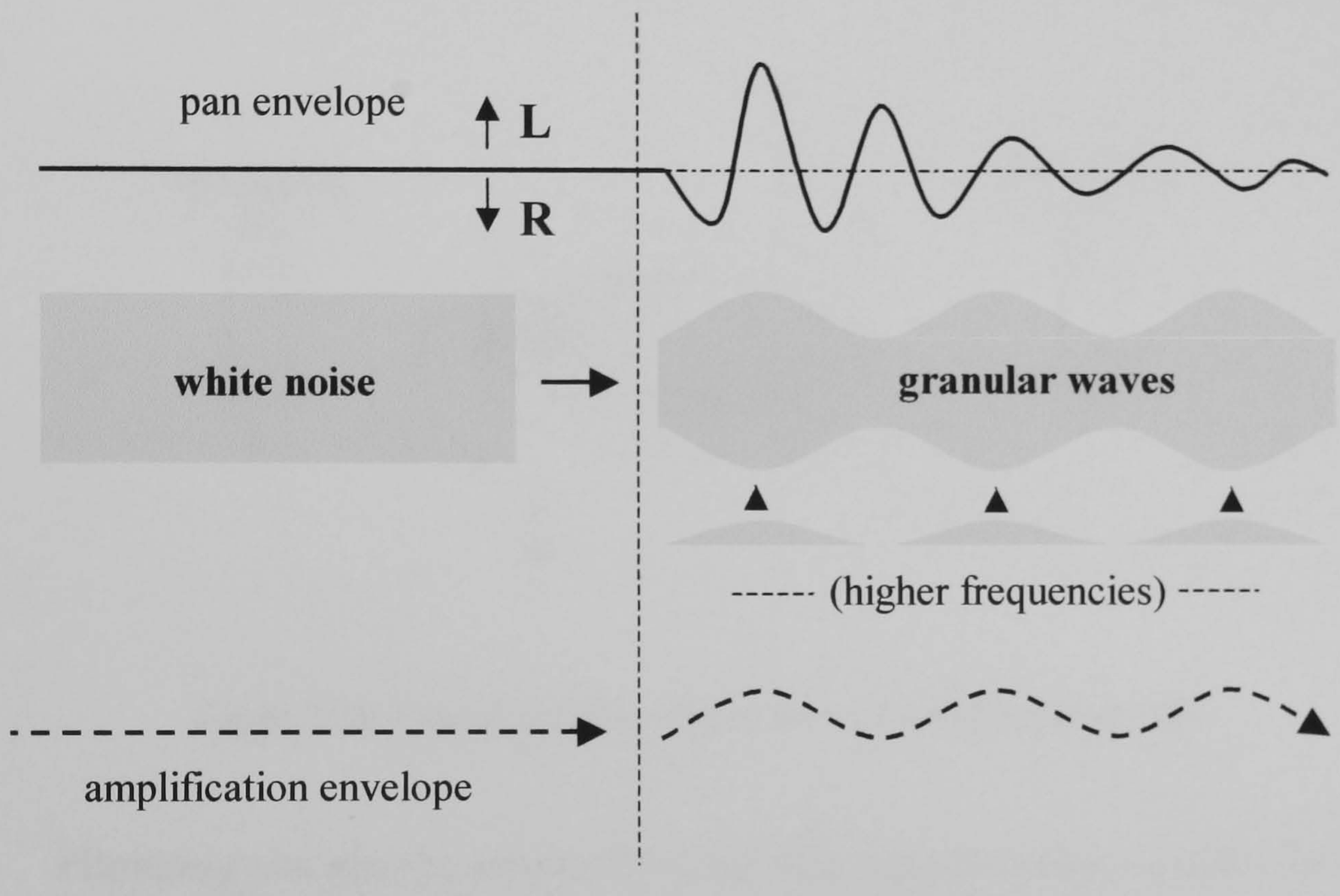

Figure 2.27: White noise and granular waves: basic creation process.

Alternatively, granular waves can be created using recorded material. CD example 28 demonstrates the use of human gesture in order to produce a wave-like sound. A wide-diameter tambourine containing a large number of microscopic metallic balls is held horizontally between the microphones, and is slowly moved in a circular manner but also upwards and downwards, so that the balls travel along the circular frame and on the leather membrane, as indicated in Figure 2.28. The result of this action can be described as a 'wave' effect, potentially linked to water textures (sea-waves)[67].

[67] Different versions of the instrument, with regard to frame diameter and construction materials (e.g. wooden balls – plastic membrane), can be used to produce a variety of 'wavy' sounds. The current recording was provided by the percussionist Nikos Touliatos, using the home-made instrument as described above.

The placement of microphones was the determining factor. The source was placed close to, and between the microphones (see Figure 2.28), firstly in order to allow the capturing of internal detail, and secondly in order to create physical spatialisation[68]. This sound has been used in *Rous* without being transformed, and can be heard between 3'10 and 3'30 where it is mixed with different material (also noticeable towards the end of CD example 16).

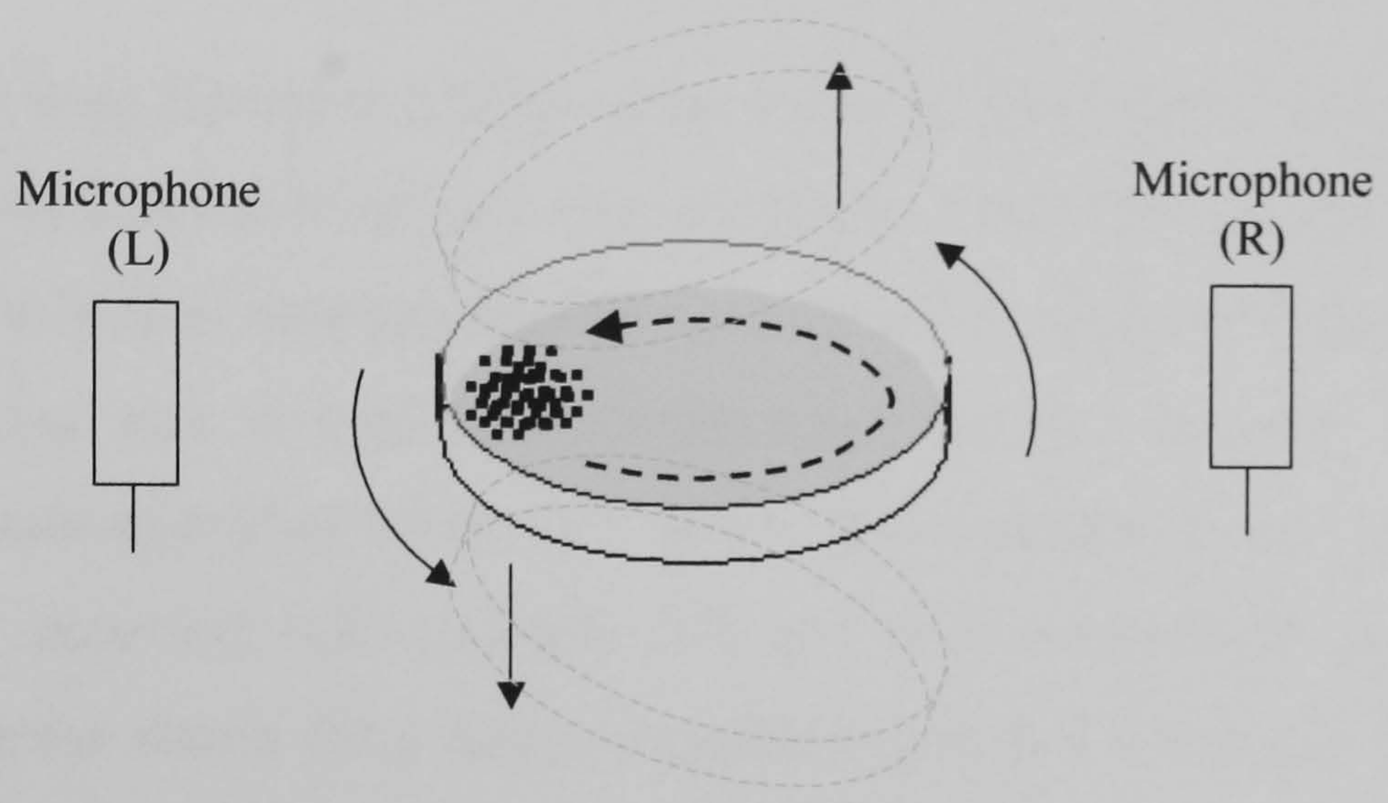

Figure 2.28: Manual creation of granular waves (CD example 28).

Fluttering can also be created by recording human-related sounds. In *Aura* the fluttering behaviours appearing in CD examples 12 and 17[69] were created through the use of human utterance. A succession of rapid human breaths was recorded and transposed upwards in order to obtain a high-frequency content and faster motion (CD example 29). Pitch variations of the new sound, also obtained via pitch-shifting, were mixed to produce a different output (CD example 30).

Stereo displacement was achieved physically, as in the previously-mentioned example, though this time by moving the microphone[70] around the source. Moreover, the sound to be recorded was deliberately chosen as it provided the basic morphology (intense fluctuations), and textural quality (granular/noisy

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[68] The balls move successively either towards the left or right microphone, creating spatial displacement. Additionally, the recording includes reverberation since it was realised in a reverberant space.

[69] Also see 2.3.3.3.

[70] A single stereo microphone was gradually moved around the mouth.

character), which have been determining factors in creating a fluttering-like behaviour.

The above implies that the way in which sound can be physically produced (choice of source/action), and the way in which it can be captured (placement of microphones) often determine the impression of naturalness. Sound recording can therefore be regarded as part of the mimetic process, since it may deliver natural-sounding results without necessarily being associated with natural sources and thus it should be considered as important as any of the other compositional stages[71].

Apart from fluttering and granular waves, a variety of different nature-like behaviours was derived from non-natural sounds. Moreover, actual recordings of nature often served as base-materials for sound exploration and transformation. In *Erevos* buzzing was utilised in different ways. Firstly, in order to create the imaginary insect appearing between 5' and 6' (CD example 6) a single insect buzz was initially recorded (CD example 31) and was dynamically processed and spatialised in the stereo field using manually-controlled envelopes (CD example 32) to obtain a more dramatic sense of spatial displacement. At a later stage the sound was further transformed through a combination between pitch-shifting/time-scaling and ring modulation in order to adopt a rather non-realistic character (CD example 33). In this example, having been passed through a ring modulator, the sound was separately shifted upwards and downwards, each time by 12 semitones, creating two different outputs which were finally mixed together[72] and combined with ground noises, as shown in CD example 6. Later in the piece the new sound was again transformed to create an imaginary 'swarm' of insects, appearing between 8'15 and 8'27. Here buzzing was multiplied, where the sound was divided into fragments differing in duration and pitch (CD example 34).

Elsewhere in *Erevos*, water recordings were transformed to create behaviours different from those originally recorded, thereby indicating different sources. Firstly a recording of a water-stream (CD example 35) was filtered[73] and

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[71] See 2.2.2, Figure 2.2: Nature and mimetic process: outline.
[72] A longer duration was also achieved during the mixing process by cross-fading a succession of short fragments taken from different parts of each sound.
[73] A signal-following method of filtering, normally used for noise-reduction, was applied.

was transposed downwards, creating a number of granular sounds varying in pitch content which were mixed in different layers to give the impression of 'rocks', or an ambiguous combination of solid and liquid materials (CD example 36)[74]. Secondly, the gesture-like events appearing between 2'40 and 3'25 (CD example 5)[75] were derived from a recording of water drops. Here, a combination of delays was applied, resulting in an indication of human/animal gestural activity[76], while the water- texture aspect is still recognisable in the sound output. (CD example 37). Finally, the two recordings above were both used in the final section of the piece (CD example 9) nearly unchanged, with filtering (high-pass filters), pitch-shifting, panning and reverberation being applied to a degree that the original behaviours remained recognisable.

The examples mentioned so far, taken from *Rous*, *Aura* and *Erevos* demonstrate ways in which natural behaviours can be created for a mimetic compositional process. Further reference to sound manipulation with regard to natural behaviours is provided in the following discussion on *Woods*, *Shore* and *Night Pulses*.

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[74] Part of this sound can be heard in the piece between 1'38 and 1'52.
[75] Also see 1.5.3.
[76] In this case the gestures resulted accidentally. The purpose of applying delay was not to create gestures, but was to experiment with the material and explore its potential for transformation.

2.5 Works

2.5.1 *Woods*

Woods was completed in April 2001. The title was inspired by the idea of a 'forest' landscape image, which is frequently sonically revealed and explored throughout the work. In the course of its evolution, the piece often reveals natural behaviours, which sometimes get organised into forest-like images, sometimes interact with abstract sonic environments.

For the creation of the sounding content mostly recorded, instrumental sounds were employed. More specifically, the flute (soprano and piccolo) provided the basic material. Apart from sustained notes, a variety of sounds produced by modern flute techniques were recorded and transformed in order to create natural behaviours: key-clicks, wind-tones, whisper-tones, jet whistles, multiphonics etc[77]. The human voice was also combined with the flute in order to produce sound (flute-singing technique), and therefore it can well be here included as a base-source. Finally, a few non-instrumental gestures were employed as well, involving human-made sources.

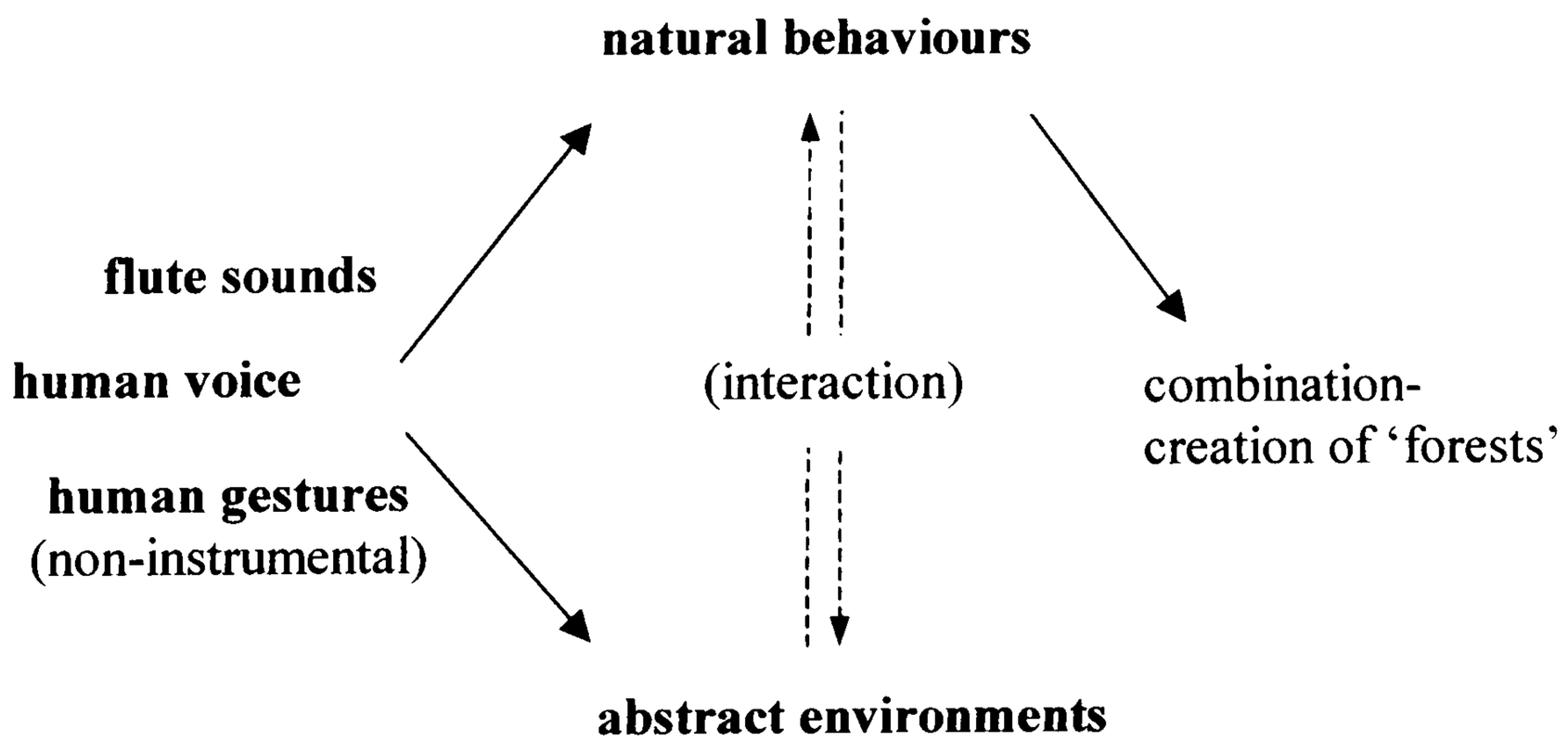

Figure 2.29: Use of materials in *Woods*.

[77] An explanation of modern flute techniques is given by Robert Dick in 'The Other Flute'. (Dick. 1989).

The recording process was a determining factor for the outcome of transformations. Several methods of capturing the flute sound were explored, such as placing the microphones at extreme closeness to the source or moving them far away from it, changing the distance between them, changing the altitude at which they were placed etc. The purpose was to produce a series of recordings with differences regarding the focus of capturing the source in relation to the surrounding space[78]. Close-focused recordings provided material rich in micro-level detail, not usually noticeable in flute playing, which conveyed strong potential for transformation. The close-to-the-source placement of microphones also provided a high degree of 'granular noise'[79] in the sound, which was often isolated (through high-pass filters) and treated similarly to the way in which 'white noise' was treated in the previously-discussed works[80]. Distant recordings mainly involved the capturing of sustained notes and carried an amount of natural reverberation which often proved useful for the creation of blurry, background textures. Moreover, some recordings involved a displacement of the microphones around the flute player and vice-versa (moving the flute or walking around the microphones while playing), in order to achieve the effect of spatial displacement across the stereo space.

Having been recorded, the sounds went through a series of processes, mainly granular synthesis, reverberation, pitch shifting, resonant filtering and mixing. Within the journey of sound exploration the material often adopted a 'nature-like' identity. The natural behaviours in which the transformation process resulted include animal cries, rustling, water streams, bird chirps, flies, rainfall, crickets and also 'sound-amalgams' where source-indication is ambiguous. The result of transformations also included a variety of abstract sounds which did not reveal any reference to nature but were extensively used for the creation of the sounding content.

The utilisation of nature-like sounds can be clearly observed in a section lasting between 3'15 and 4'40 (CD example 38), where nature is purely imitated.

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[78] The recordings were made in an acoustically 'live', reverberant room, where reflections could also be captured by the microphones.
[79] It was possible to capture the noise produced by blowing into the flute, which is not usually present in the sound when flute playing is heard from distance.
[80] See 1.5.1, 2.2.2 and 2.3.1.

Here, after a short silence, the structure reveals a realistic, nature-like landscape. which can be interpreted as a 'forest'. The natural behaviours constituting this section appear separately in different parts of the work, but here they co-exist and they are placed in various levels of depth between the foreground-background borders in order to create the 'forest' impression[81]. The dominance of a reverberant, noisy environment in the background is determinant for the appreciation of the context as a 'forest'. For the creation of this environment the use of human gesture and utterance provided the sound-base. An example of sound manipulation can be included here. Firstly, human gesture was applied to a wooden surface (by scratching and rubbing it[82]) in order to produce a rough, non-pitched sound (CD example 39), which was later mixed with whisper-tones[83]. The new sound (CD example 40) was reverberated in order to gain the sense of 'depth', and then was shifted upwards and looped in order to become longer (CD example 41). The result can be heard as an entry of granular noise in the background (particularly noticeable between 3'55 and 4'25), potentially indicating an ambiguous combination between leaf-rustling, ground gestures, bird chirps and water-streams. The section also reveals other, artificially created, nature-like sounds, such as insect buzzes and bird-song[84] and, additionally, these are interspersed with percussive, repetitive sounds deriving from the flute (key clicks), which do not reveal definite source-origins, but can be regarded as pertaining to the natural environment due to strong the influence of context[85].

At 4'48 the forest image is interrupted by a series of attacks and explosions which lead, at around 5'05, to an obscure, unstable environment, characterised by interwoven sustained textures gliding upwards and downwards (CD example 42). The idea of 'pitch' is dominant here. This section can be

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[81] See 2.3.4: 'natural spaces and spectral density'.

[82] The microphones were placed between the two hands scratching and rubbing the surface, in order to achieve a wide spread of the sound in the stereo image.

[83] This technique involves the use of whispering into the flute mouthpiece, instead of blowing air. See Dick (1989) for further explanation.

[84] The buzzing-like sound appearing in the beginning of the section was created by filtering flute tones through band-pass filters, in order to achieve a narrow occupancy in the frequency domain, and also by slightly 'detuning' the material (pitch-bending). The bird-song-like sounds (apart from those indicated in CD example 41) were created physically, by using a recorder-like wooden instrument, which (depending on how it is used) may simulate it with precision.

[85] The overall implication of a natural space is so strong that it may allow the forest image to be retained in our perception, even if sounds which cannot be clearly recognised are included in the context.

regarded as 'abstract' as it does not reveal any connection to nature, and it totally contrasts with the preceding sound-world.

Nature appears again later, in another 'landscape' section arriving at the beginning of the seventh minute (CD example 43). Here a 'forest' environment similar to the one previously discussed gradually builds up, introduced by a stream-like texture, potentially referring to water-stream or rainfall which lasts throughout the section. This texture was created by transforming key-clicks, which were shifted upwards and multiplied through the application of granular synthesis in order to lose their individuality. The result of transformation in this case can be described as stream-like, indicating continuous/linear motion in its overall character, and consisting of innumerable sound-fragments, impossible to be perceived individually by the listener (CD example 44). The second 'forest' landscape is different from the first one regarding its character and sound-development. It is gradually filled-up with 'alien' cries[86], as if nature is being invaded by unfamiliar existences. Moreover, the motions implied become more and more sudden and rapid until they burst (at around 8'20) into a state of confusion, characterised by aggressive attacks. The climax finally leads to a sonic environment similar to the one presented in extract 2.

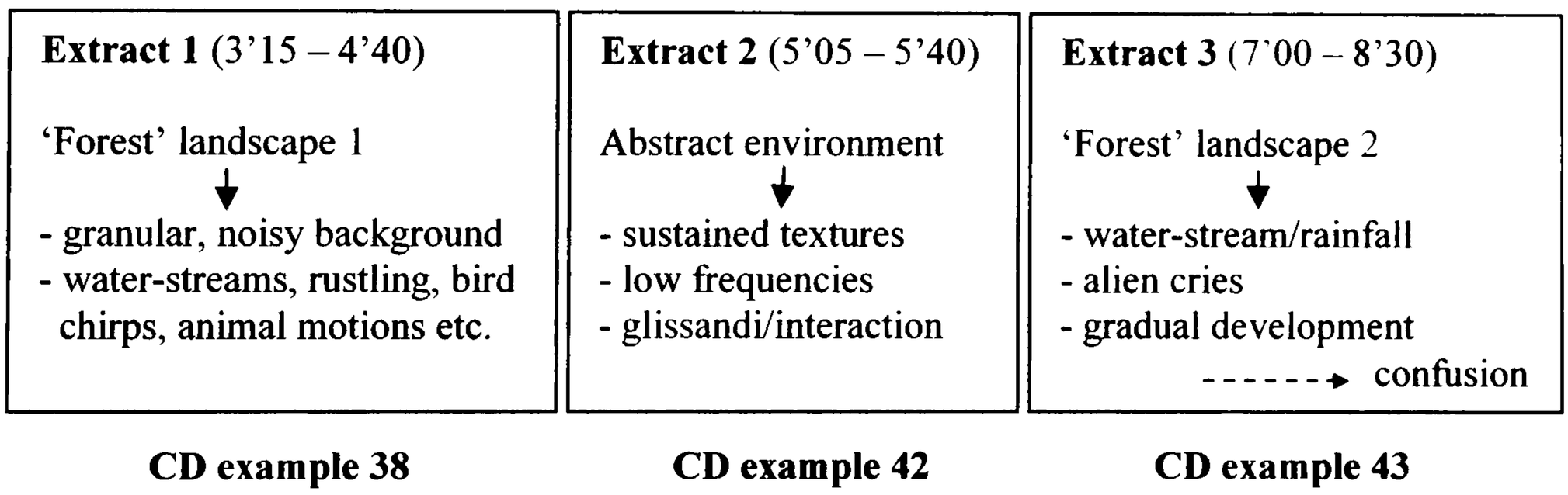

Figure 2.30: Selected extracts from *Woods*.

Through comparing the above extracts, but also through listening to the work in its entirety, we may conclude that three sound-worlds appear in *Woods*, indicating

[86] Due to their attributes ('pitched' character, relatively short duration, descent in pitch, repetition) these sounds may seem to imitate animal cries. However they do not indicate a specific animal source and therefore can be characterised as 'alien'.

an analogy with the three sound-characters identified in *Erevos*[87]. The 'natural' sound-world, characterised by motions and spaces, creating references to nature, interacts with a contrasting, 'abstract' environment where such references are absent. The result of the interaction can be regarded as 'alien' and reveals a world where naturalness and abstraction co-exist: non-recognisable cries and gestures are often placed in front of nature-sounding backgrounds, but natural sources also often emerge from dark, unfamiliar territories. A separate sonic approach to each of the three worlds (natural-alien-abstract) is clearly observable in the central part of the piece (between 3'15 and 8'20), from where the above extracts were taken, and is significant for the development of the form. The first 'forest' landscape introduces 'pure nature' for the first time and is finally resolved into an antithetic state (extract 2). The second landscape comes as a variation of the first one, revealing a different approach to nature. There is also a similarity between the two landscapes regarding their development and their placement in the context. Both emerge gradually, leading to violent climaxes, and both dissolve in abstraction.

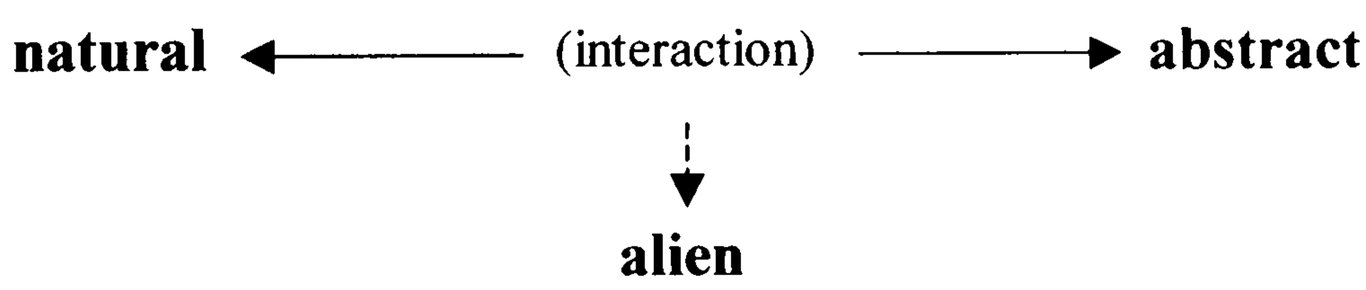

Figure 2.31: Three sound-worlds in *Woods*.

A few remarks concerning the overall development of materials can be included here from a macrostructural perspective. Firstly, the sounding content generally reveals a wide scale of dynamic alternation, ranging from quiet, almost silent sections to intense climaxes. Moreover, significant differences in behaviour can be observed between neighbouring sections. Transparent textures, such as the one introducing the second 'forest' landscape (extract 3, CD example 43), gradually become dense and impenetrable. Additionally, as it can be concluded through a comparison between CD examples 38 and 42, sections dominated by

[87] See 1.5.3.

high frequencies and richness in micro-level activity are usually followed by sustained, low-frequency sonic environments. Also, rapid and random motions are followed by slow, ascending and descending textures until they reappear and develop in different parts of the context. Finally, the juxtaposition between 'pitch' and 'noise' is apparent throughout the work and is very important structurally. Pitch-carrying cries linked to animal sources emerge from grainy/noisy backgrounds (as in extract 3), while they might often become 'stretched' and create pitched backgrounds themselves. In sections like the one presented in extract 2 the dominance of pitch often works as a 'solution', allowing for further structural development.

2.5.2 *Shore*

Shore, which was completed in January 2001, constitutes a journey through a succession of virtual spaces, and is metaphorically related to the idea of convergence between 'water' and 'land' environments[88]. These aspects are approached morphologically, creating an imaginary sound-world where water- and land- related behaviours co-exist.

Mainly recorded sounds were used, deriving from the human environment and from the natural world. The human-related material included recordings of instruments (cymbals, tom toms, flute, piano) and the city environment (crowd, traffic). The nature-related sounds included recordings of water (water drops), wind (rustling - trees/ground leaves) and birds (fluttering). Recordings of water associated with human gesture were also employed.

Most of the sounds were heavily transformed to a degree where the original source is not perceptible. In some cases, sounds deriving either from nature or culture were reverberated to an extreme level in order to undermine their outward shaping significantly, thereby create blurry backgrounds. Additionally, instrumental sounds were pitch-bent to create a number of glissandi and portamenti, varying in duration and spectral shaping, which were extensively employed throughout the work and served particularly as transition passages between sonic environments. Pitch-bending was used to create a number of cries, which were arranged into repetitive patterns and often placed in layers of different depth. Moreover, filtering was applied to create short granular events[89] which were treated in a similar manner. Finally, a few recordings of natural materials were used untransformed or slightly transformed and still recognisable.

From a macroscopic morphological perspective, *Shore* is characterised by the idea of 'moving space', mainly due to the sense of a continuous gliding in pitch created by the extended use of glissandi and also due to a continuous change in the impression of depth. This might metaphorically suggest the motion of

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[88] 'Land' is here used to suggest solid materials, vegetation and organisms living at ground level, while 'water' suggests the 'water-world', including water-life.

[89] Noise reduction (using a signal-following / frequency rejecting algorithm) was applied to an extreme level, resulting in the creation of multiple short/granular sounds. Some of those were selected and organised into rhythmic patterns (looping).

water. Moreover, the water aspect is often revealed through the use of granular noise (waves) combined with glissandi, and this is also apparent in the textural quality of a variety of events, since much of the material was derived from actual water recordings. The repetitive cries and short, granular events appearing in different parts of the work can often be linked to animals and insects, depending on how the sounds are contextualised. Finally, the placement of untransformed natural sounds in the context is often important to create an impression of naturalness.

At this point selected extracts from different parts of the work can be examined. At 2'40 a quiet, outdoors-like environment gradually emerges from silence (CD example 45). From the beginning of this section there are certain behaviours which suggest the appearance of nature and potentially create a link to an imaginary outdoors space. Firstly, a short/repeated high-frequency sound, which might be connected to the sound of an insect or a bird, arises in front of a smooth, blurry and rather distant background, which gradually becomes resonant and reveals the idea of 'pitch'. The repeated sound is accompanied by a number of short, quiet, randomly appearing high frequencies which can be interpreted as animal gestures. Secondly, the sound of water is recognisable, becoming more obvious at around 3'10 and lasting throughout the larger part of the section. The combination of these aspects (water - insect/bird - quiet gestures) in association with the relative impression of depth in the background create the idea of a landscape setting. At 3'35 a succession of more dramatic events is introduced in the foreground, potentially indicating imaginary gestures and utterances, lasting until the end of the section.

The environment described above is finally interrupted at 4'24 by a 'metallic' attack, followed by a slow descent in pitch, which gradually leads to a totally different territory, represented in extract 2 (CD example 46). Here a 'dark'/'opaque' space is revealed, which can be interpreted as an 'underwater' environment. This section is dominated by low frequencies and slowly evolving textures, which contrast with the rather rapid, high-frequency gestures appearing in the preceding section. Moreover, the sense of reverberation is strong here, suggesting (in association with the overall low-frequency content) an enclosed, wide space. As far as motion is concerned, the slow development of interleaved

textures with regard to pitch-shaping, but also the smooth, virtual passage of sounds between different spatial locations within the aural field, might create the impression of 'in-water' motion. The impression of a water environment is enhanced by the appearance of water-drops and water textures in the background, which were transformed (via reverberation and pitch-shifting downwards) so as to remain recognisable[90].

At 6'12, the quiet, dark section is suddenly interrupted and followed by a noisy, kinetic world (CD example 47). The transition between the two sections (noticeable at the beginning of CD example 47) constitutes a dramatic change of space, since the low frequencies suddenly disappear, taken over by high frequencies and reverberated granular noise. This creates an unexpected change in the impression of spatial depth, and might also suggest a change in altitude[91]. Additionally, this change might be metaphorically interpreted as if the listener 'reaches' the surface of water, being suddenly transferred from an underwater to an outdoors environment. The change is followed by the gradual emergence of a reverberant/noisy background while the foreground and mid-ground events become increasingly aggressive, leading to a forest-like environment, particularly noticeable after 6'35. Here, apart from the sense of reverberation in the background, the context reveals a number of gestures, repetitive cries, bird-like 'caws' and cricket-like sounds interwoven with glissandi and continuously moving between the foreground and mid-ground areas. The 'forest' world finally dissolves into a harmonic space between 7'00 and 7'10, where the sound-world is similar to that of extract 2 but slightly more 'pitched' and energetic.

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[90] However, each listener's impression of this section, with regard to space and source indications, might be different. The above describes the composer's intention and interpretation.

[91] As mentioned in 2.3.1a), the way in which frequencies are displaced between the high and low registers may create analogies with real-world spatial displacement (also see Smalley. 1997: 122 for further discussion). Here the sudden change of frequency content might create the impression of upwards motion, and in relation to the sudden appearance of events in the foreground, motion is directed upwards-forwards.

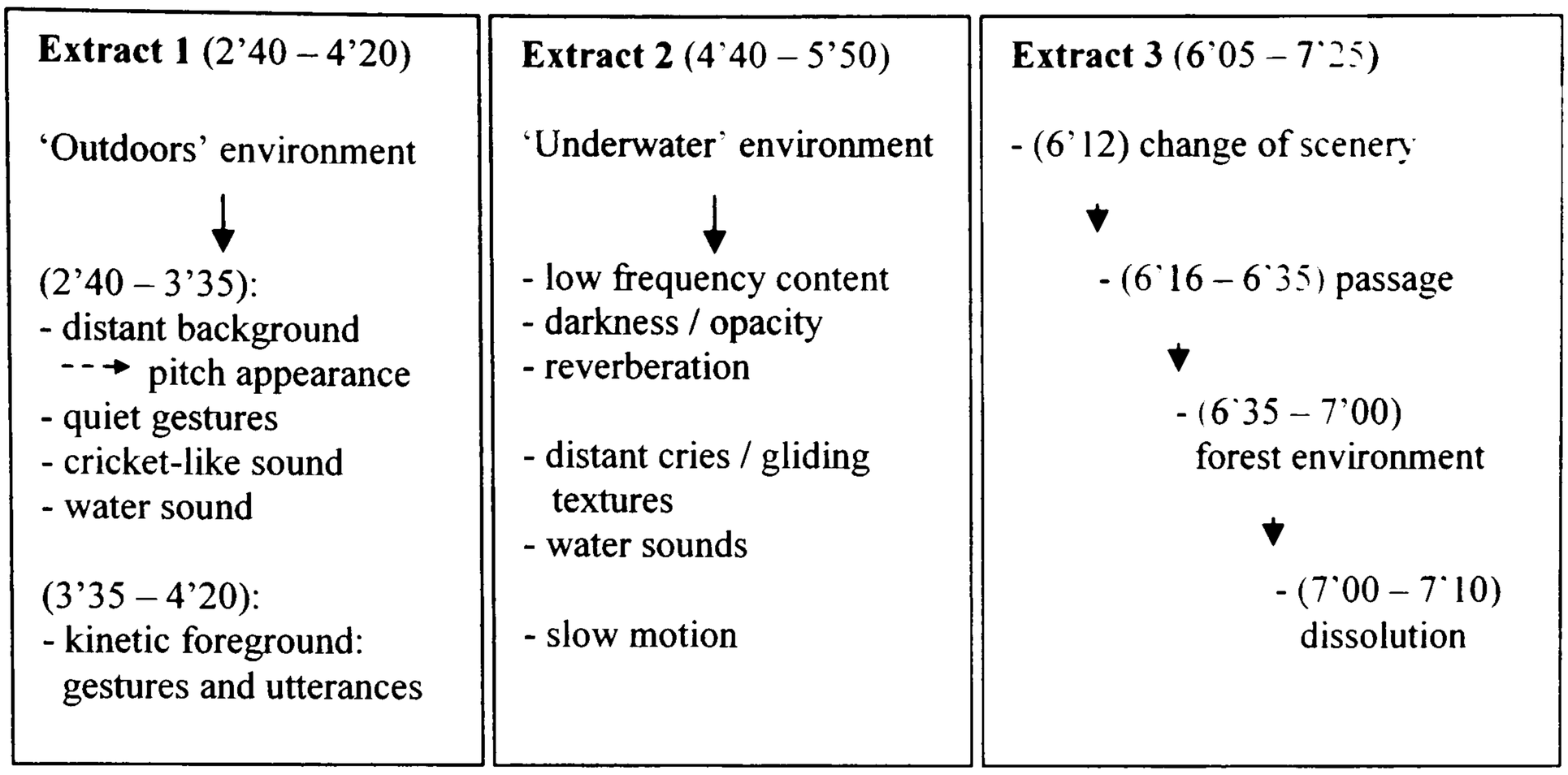

Figure 2.32 : *Shore,* selected extracts.

The above extracts, covering a large, central part of the work, reveal basic information about the overall structural development. Through a comparison between them, but also through listening to the whole work, we might detect a similarity with *Woods* regarding differences between neighbouring sections. High-frequency, 'bright' environments are usually followed by low-frequency, 'dark' and 'opaque' territories. Moreover, vivid gestures are followed by sustained, slowly evolving – and sometimes repetitive – textures. As far as the idea of 'pitch' is concerned, it is revealed throughout the context, either in the form of harmonic backgrounds or through the appearance of pitched, repetitive cries and larger-scale glissandi. 'Pitch' is here often combined with 'noise', since the entry and shaping of pitch-carrying sounds (mainly glissandi) is often highlighted by granular/noisy content and vice versa[92].

Finally we may here conclude that the development of musical material in *Shore* rather focuses on the creation and indication of spaces as opposed to the development of individual behaviours. Although the appearance of gestural events is often strong, the way in which these events are contextualised leaves the impression that the work seeks to explore a number of different spatial settings.

[92] Entries of noise (mostly noise waves) are often accompanied by the appearance of glissandi, which follow a similar dynamic shaping.

Several events reappear 'unchanged' in different parts of the work, though each time in front of different backgrounds, their appreciation varying on each occasion since the surrounding space becomes different. Moreover, sounds are often constantly repeated, so that our attention might eventually turn to what is happening behind them.

2.5.3 *Night Pulses*

Night Pulses was completed in March 2003. The larger part of this work can be described as an 'electronic landscape', gradually unfolding and often revealing natural sources and behaviours.

The sound material used to construct the piece was derived from a variety of sources, mainly including human gestures (everyday human-made objects) and electronically-generated granular noise. A few sounds recorded from nature were also used (water drops, rain, crickets and cicadas). The sounds were processed in a variety of ways, sometimes to create natural behaviours and sometimes to create sound-shapes which do not indicate any recognisable behaviour and/or source.

In examining the work we might easily discover that `pulsations` are the main morphological characteristic. The sonic events are often interwoven with a number of pulses with which they appear to be in a continuous interaction. These pulses often become organised into multiple, simultaneously-evolving repetitive patterns, with different levels of spatial depth, varied in pitch and duration. The extended use of pulsations reveals a sense of 'rhythm', and together with a variety of randomly appearing granular events creates a kinetic sound-world which evolves in front of a seemingly 'static' harmonic background.

In *Night Pulses* natural behaviours are introduced from the beginning of the piece, as demonstrated in CD example 48 (part 1 - introduction). Here the scene opens with fluttering-like entries, followed by water-like textures and a number of gesture-related 'cracks' (noticeable between 0'30 and 0'55), potentially linked to 'ground noises'. These events are accompanied by pitched/pulsed sounds which become increasingly present. At around 0'50 cicada-like sounds enter and turn into waves, while at the same time low frequencies emerge, leading to an attack (at 1'11) which introduces a variety of new, more dramatic events in the foreground. Fluttering may again be distinguished here, this time being characterised by more intense fluctuations.

Later in the piece, after a climactic succession of explosions, pulsations and noise waves, the structure is resolved in a quiet, 'night' landscape (CD

example 49), similar to the one described in the last section of *Aura*[93]. This section is characterised by the appearance of crickets in the background while unidentified gestures gradually become noticeable in the foreground layer. The gestures become more intense at around 4'10, also adopting a rhythmic behaviour[94] while in the background the cricket environment becomes 'stretched' and reveals intervallic changes, drawing attention to the pitch content. The context later reveals a succession of nature-like events such as those appearing in the introduction of the piece (fluttering, noise-waves, water drops, ground noises). finally leading to a succession of large, sea-like 'waves', characterised by granular but also harmonic content (CD example 50), which lead us to the next section. The new environment is more energetic than the 'night' world described previously, and is dominated by the sound of cicadas (CD example 51). Here, the cicadas often appear to transform into gestural events and they are accompanied by ground noises in the foreground and by a gradual emergence of a harmonic background. At around 6'45 pulsations and noise-waves appear, leading to a gradual climax which seemingly 'erases' the cicada environment.

Extract 1 (0'00 – 1'33) Introduction: - fluttering - granular gestures - water drops - pitch emergence (1'11): - attack → dramatic events	**Extract 2** (3'15 – 4'40) 'Night' landscape: - crickets → pitched background - unknown gestures → rhythm	**Extract 3** (5'10 – 5'35) Passage: - large waves - 'sea' indication - harmony	**Extract 4** (5'45 - 7'30) - cicadas → gestures - ground noises - harmony emergence (6'45): - pulsations - noise waves → (climax)
CD example 48	**CD example 49**	**CD example 50**	**CD example 51**

Figure 2.33: Selected extracts from *Night Pulses*.

[93] See 1.5.2, extract 2 (CD example 4).

[94] The idea of rhythm is already introduced from the beginning of this section, through the repetitive character of the cricket sounds, but also through the appearance of a constantly repeated bird/insect-like sound. At around 4'10 rhythm becomes more obvious, since it is 'transferred' to the foreground layer, where gestural action takes place and on which our attention is most likely focused at this point.

In the above extracts the material was manipulated in a variety of ways, as far as natural behaviours are concerned. Fluttering sounds and noise waves were primarily created artificially, by shaping white noise in a way similar to the treatment in *Rous*. For the creation of the sea-like waves in CD example 50 though, a sound deriving from a 'waves' instrument (such as the one described previously in 2.4.2) was used, reverberated and filtered through a ring modulator and finally mixed with different sounds.

The crickets introducing the second extract (CD example 49) were derived from a recording of nature, used untransformed. However, later in the same section the cricket recording was transposed downwards (in octaves and sixths), and was reverberated to create a pitched-harmonic background. The cicada sounds were also derived from a recording of nature. At the beginning of extract 4 (CD example 51) the recording is slightly transformed but recognisable (CD examples 52 and 53[95]), while later in the section it was shifted upwards, filtered (high-pass filter), dynamically shaped (amplification envelope) and spatialised (stereo panning) to create kinetic foreground entries (CD examples 54 and 55). Cicada-derived sounds, transformed in a similar way, were used in different parts of the piece, and can also be noticed in CD examples 48 and 50.

Finally, the 'crispy' granular sounds appearing throughout the work in the foreground, often indicating 'ground noises', were created by transforming recordings of human gestures – a variety of human-made materials such as plastic bags, matches, paper etc – which were manipulated through combinations of pitch-shifting and filtering (high-pass / signal following filters, ring modulation[96]). Many of these sounds were also derived from computer-generated 'clicks' which were transformed in a similar manner. The 'ground noises' in extract 4 were created by transforming a combination of human gestures and water-drops (CD example 56). In this example, a recording of water drops and a recording of crumpling a piece of paper were mixed together and the new sound was transposed upwards and heavily filtered using noise-reduction and ring modulation. In the same section 'ground noises' were also derived from a

[95] In CD examples 52 and 53 the cicada recording was transposed upwards and downwards to create two different sounds, which appear together.

[96] Ring modulation has been used extensively in this work. In fact, many sounds were derived accidentally, as a result of experimenting with and exploring the ring modulator's functions.

recording of rain (CD example 57)[97], which was initially ring modulated to create a 'harsh', high-frequency texture (CD example 58), and was then dynamically and spatially shaped using amplification/pan envelopes (CD example 59).

From the above discussion we can conclude that nature has served as a significant structuring element. However, the overall development of the sound material can also be approached metaphorically where nature often adopts a symbolic role. The repetitive appearance of pulsations and the overall impression of 'rhythm' and repetition (especially towards the end of the piece) might suggest metaphorically the passage of time (continuity/eternity). Together with the appearance of natural behaviours the above aspects might be regarded as referring to the continuous and eternal cycle of natural life. This idea has influenced the composition of the work and has been the determining factor in its macro-structural development. More specifically, the context can be divided into three major parts (shown in Figure 2.34). The first part (A), lasting until the emergence of the cricket landscape (0'00 ≈ 3'10), represents an imaginary stage of creation: quiet behaviours arise (awakening), followed by dramatic events and explosions (release of energy) and finally leading to confusion (climax). The second part (B) is associated with 'earth', since it reveals a number of familiar natural behaviours evolving within landscape settings. The transition from cricket- to cicada-dominated sections might here create a link to the cycle of night and day where crickets symbolise the night world and cicadas symbolise the day environment[98]. This relationship (night/day) is enhanced by the overall dynamic and spectral development in each section. The 'night' section is relatively quiet and empty in the background, while the cicada environment is more 'bright' and energetic, involving a greater engagement with high frequencies, a greater sense of urgency in the succession of events and a relatively close and present background. Apart from the appearance of crickets and cicadas, the 'earth' environment is referred to through the appearance of ground noises, sea-waves and air-waves (noticeable in

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[97] In this example, a heavy summer rain is pouring on the metal and glass surfaces of a car. The recording was made from inside the car.

[98] The sound of crickets only appears at night and that of cicadas in daytime. In the Mediterranean, and generally in rather hot climates this is particularly noticeable, in some cases even within city environments. Of course, it cannot be expected that listeners actually recognise this relationship, since it is not universally realised. The above reflects the composer's interpretation and personal experiences.

the beginning of CD example 51). Finally, the third part (C), beginning at around 8'40, is characterised by repetition, where the events are organised into rhythmic patterns accompanied by harmonic changes and glissandi in the background. Here, any reference to natural behaviours is absent, and therefore, if we were to listen to this part separately it would be impossible to relate it perceptually to nature. However, in listening to the entire work this part becomes influenced by the previous two, and a metaphorical connection to nature might be established due to the preceding appearance of natural behaviours. In this last part the idea of 'rhythm' gradually develops, becoming more noticeable (in particular between 9'45 and 10'25), while between 10'30 and 11'10 the structure dissolves, as the repetitive events and the harmonic textures slowly disappear, leading to a smooth ending. What finally remains in the foreground is a single, steadily repeated 'pulse' which, together with the overall impression of rhythm/continuity in this part, but also in association with the other two parts, might be regarded as symbolically representing the eternal cycle of life[99].

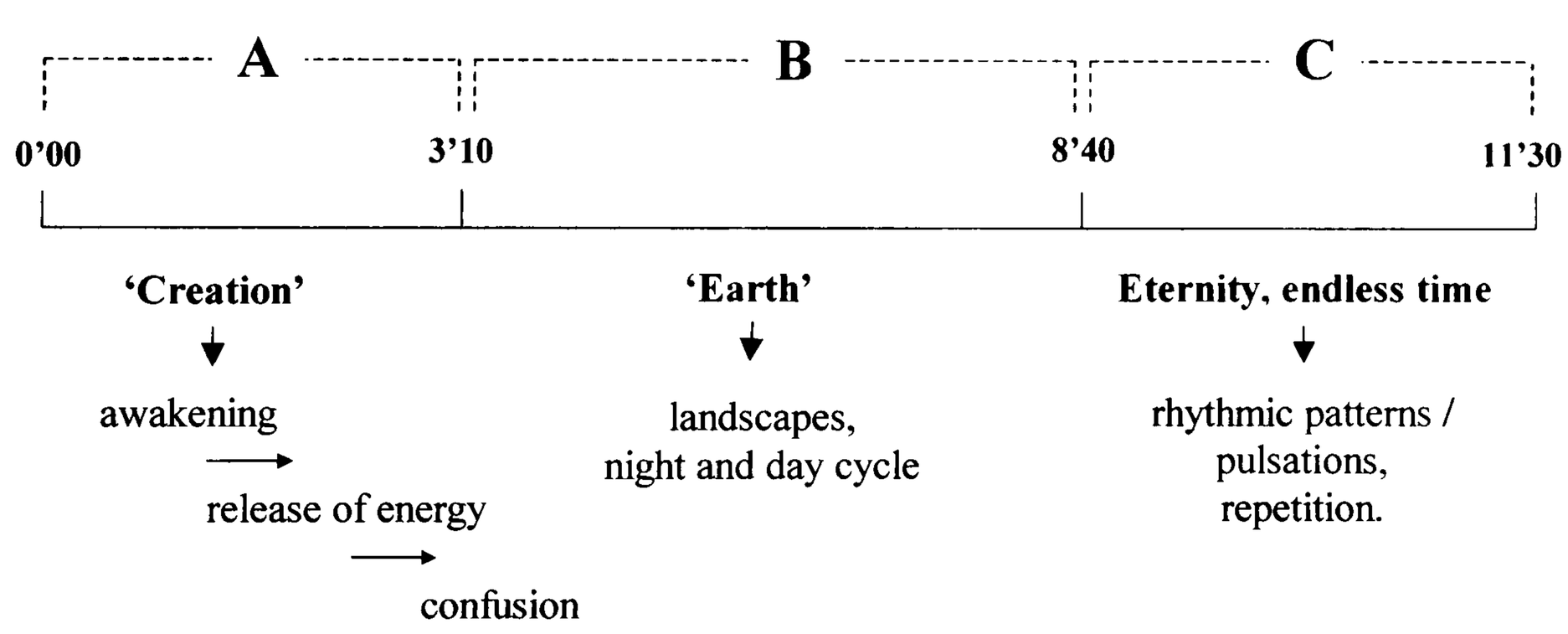

Figure 2.34: *Night Pulses*, macrostructure.

[99] The idea of 'eternity' might be suggested metaphorically, since the repeated pulse remains alone and continues for a while, although the piece seems to have reached an ending at around 11'15. Also, a metaphorical reference to eternity/endlessness might be suggested through the overall repetitive character of this part. The connection to the idea of 'life' might be created if the repetitive context of part C is appreciated in association with the preceding natural behaviours, which up to this point might be stored in our memory.

In comparison with the previous works, *Night Pulses* introduces a rather different approach to the idea of rhythm. Although strong rhythmic elements were also found in *Rous*, the manner in which events are repeated here is rather steadier and slower (particularly in part C) and often more persistent. Pulsations can also be found in *Aura* and *Erevos* but their utilisation in *Night Pulses* has been more extensive, as they appear throughout the piece and in a large number of variations, creating the idea of a continuously 'pulsating' sound-world. As far as the overall dynamic development is concerned, the work is characterised by gradual and relatively smooth climaxes, as opposed to the aggressive climaxes often-found in the previous works, and also by smooth transition passages, where the starting/ending points of each section are often not clear. Sudden interruptions and massive attacks (apart from the attack at 1'37), such as those found particularly in *Rous* and *Erevos*, are also absent. Finally, as in *Rous*, the idea of 'pitch' exists throughout, but becomes particularly noticeable towards the end of the piece where it is developed into certain intervallic relationships[100], creating the impression of 'harmony' in a traditional musical sense.

[100] At around 9'53 the already existing sustained pitches become organised into a minor chord, which also suggests a change of tonality. A series of harmonic changes follows, accompanied by a number of glissandi, which always end in a definite pitch. The appearance of 'harmony' is accompanied here by a sense of 'rhythm' (repetitive patterns), lasting throughout the section.

Summary - conclusions

This thesis has addressed some issues concerning the appreciation of nature within electroacoustic musical contexts and its functionality as a compositional element. In the preceding chapters, the discussion focused on different areas:

In Chapter 1 general definitions of the term were given, from both 'real world' and electroacoustic music perspectives, and different ways in which nature can be approached perceptually were delineated. A categorisation of sound-sources and causes related to the natural world was considered essential, since it provided the solid basis for an understanding of how the sound-world of nature functions in reality[1] and in what form it can be referred to in electroacoustic music.

In Chapter 2 the discussion focused on the closely related ideas of naturalness and natural behaviour. Certain types of nature-related contexts were examined and compared in order to explore and define their special characteristics and also to explain their connectivity to the natural world. Certain ways in which natural behaviours can be created, and also ways in which natural recordings can be elaborated creatively, were demonstrated through reference to sound manipulation processes.

The purpose of discussing the works separately was to give a global view as to how nature was utilised during the compositional process, and also to describe each work in greater detail. The work discussions were focused on the micro- and macro-structural role of nature in relation to the topics developed in each chapter. In fact, the interpretation of each work was the starting point for the development of a theoretical framework related to nature.

Human presence is an essential factor for the musical utilisation of nature, since nature-related contexts are often created through human intervention. A human agent often interacts with natural or non-natural materials to produce sounding results which can be linked to the natural environment. Moreover, the human being acts as an interpreter of the musical context. When we listen to an electroacoustic work nature can be moulded in our imagination depending on our

[1] See 1.3.1, *Real nature*.

perceptual experiences, regardless of whether the sounds we perceive are actually derived from the natural environment. Hence, it is we who ultimately make the connections and determine the impact of nature on our perception.

Nature not only provides a rich sound-palette for composers but often functions as a 'guide' to musical creation. This is strongly suggested in the discussions of the separate works and it is also generally implied throughout the thesis. Firstly, nature can be often associated with ideas (cosmological views, mythological references, general concepts) which may determine the formal development of a composition. Secondly, during the compositional process we may often attempt to imitate nature sonically, where natural sounds serve as 'models', directing our methods for sound creation and sound transformation. An understanding of the behaviour of nature-related sounds – whether these are part of the musical discourse or not – aids in defining the criteria according to which the feasibility of the mimetic compositional process can be accessed.

The comparison between various natural behaviours has shown that certain relationships and differences can be detected between nature-like sounds within a musical context and also between the musical context and the natural world. In nature-related contexts, the aspects of naturalness can be appreciated in the fields of time, space, energy, motion and gesture, which constitute different but closely related and interdependent areas of approach. The manner in which a context evolves with regard to the above fields may delineate different types of spectral and spatial behaviour, which can be examined at a low- or high- structural level, and which can be perceptually connected to a variety of sounds, sound-sources and spaces pertaining to nature. The fields of motion and space can be highly involved in describing fundamental behavioural characteristics where spectral density and spectral occupancy are important qualifiers. The continuum between 'noise' and 'pitch' should also be considered important here: many 'natural' sounds are clearly noise- or pitch-based, while in some cases the dominance of any of the above two aspects is not clearly discernible. Finally, regardless of their individual attributes and their power to evoke nature in our imagination, the manner in which natural behaviours are contextualised within a musical composition affects significantly the influence of the sounding content on our perception. Firstly, the temporal and dynamic arrangement of nature-related

sound-events in the musical context might create a number of structural expectations and might potentially provoke a kind of appreciation different from that originally associated with each individual event, depending on the types of behaviour involved and the manner in which the events appear and combine. Secondly, the simultaneous appearance of different natural behaviours might often create links to real or imaginary landscapes, depending on the spectral and spatial identity of each individual behaviour, but also depending on the number of sounds involved and on the way in which these sounds are arranged within the borders of a virtual spatial environment (stereo spread, foreground/background perspective).

As far as sound manipulation is concerned, we may conclude that the mimetic process to achieve naturalness often starts from the moment we choose to record sounds or generate sounds electronically. An appropriate choice of materials is always essential, since the character of the basic materials may affect the output of sound-processing to a high degree. Sometimes the recording process may deliver nature-related sonic results, without necessarily being associated with natural sources[2]. In this case, the choice of source/action and the placement of microphones are vital. Apart from the choice of materials, the way in which the materials are utilised during the stages of transformation is fundamental. The discussion in 2.4.2 has shown that rather simple and commonly used techniques can be combined to create natural behaviours. The mimetic approach to nature - as well as the compositional process in general - does not solely depend on complex sound-processing methods and/or on highly sophisticated and advanced technological equipment[3], but needs an inventive and imaginative way of using the compositional tools. Finally, the mixing process to produce a final output[4] should be considered very important and determinant for the impression of naturalness. During the mixing process we decide which sounds to combine and how these sounds will finally appear in the context, and thus we considerably affect the way in which the nature-related sound material is potentially perceived.

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[2] See 2.4.2, Figure 2.28, CD example 27.
[3] Though the development of technology is helpful, since it often makes the compositional process easier as it may provide more choices for sound transformation.
[4] Mixing can also be involved in earlier stages of the compositional process, as part of individual transformations.

We may therefore regard the function of the world of nature not only as an inspirational source, providing the stimuli for musical creation, but also as offering the criteria and the potential for a creative and innovative sound exploration. Working with nature, either when planning a composition or through applying transformations, can be a unique and fascinating compositional experience, as it has been during the creation of the six submitted works.

Appendix 1

Programme Notes (as appearing on **CD 1**)

Rous (2001)
Duration: 12'35

Rous is an electroacoustic work completed in June 2001. The title indicates 'flux' (*rous* means flux in Greek), and refers to the flux amongst the materials of nature. The idea for composing this piece was conceived through the study of the 'naturalistic' cosmological views of the ancient Greek philosopher Heracletus upon the origination of the sensible, natural world.

In *Rous* the 'eternal recreation of nature' is a fundamental concept presented through the continual flux from one material state to another. The materials-elements of nature apparently follow a course of continual transformation throughout the sonic context. 'Eternal flux' is paralleled to the motion of 'Fire', an archetypal principle, a symbol of continuity, which is musically presented through rhythmic and kinetic elements in the piece. The continuous process of passage from one state to another suggests a struggle, a 'war' between materials, which actually constitutes the first principle of reality, the essence of the existing natural world. The opposite, imaginary state can be described as 'peace', 'unity' or 'harmony' of nature, and it is presented through pitched-harmonic textures. This antithetic relationship (war/strife/struggle-peace/unity/harmony) is perceptible in the structural process, but also in the form of the piece: rhythmic and kinetic elements are intensely sensible in the beginning and broadly developed throughout the sonic context, but everything gradually flows towards pitch and harmony in the end.

Rous was composed at the composer's private studio and at City University Electroacoustic Music Studios in London. It was awarded the audience prize at the *Noroit 2002 International Competition for Acousmatic Musical Composition*, Arras-France.

Aura (2002)
Duration: 12'44

Aura was completed in March 2002. The title can be interpreted in two different ways: firstly the word 'aura' suggests a 'gentle breeze', indicating a certain type of motion, which characterises the sounding content morphologically. Secondly, the context is related to the 'hidden world', which exists behind the materials of nature: what we experience in the natural environment is a result, a 'framing' of a

whole universe of evolutionary processes, which exist as invisible, and which constitute a 'hidden' microcosmic reality.

In *Aura* the 'concrete' sonic events are layered in front of a sustained. synthesised harmonic background, with which they interact and create different types of space. The 'cricket' sound in the final section is used as a symbol of nature, presenting the simplicity of the perceptible natural world, which contrasts with the complexity of the invisible world behind.

Aura was composed at the composer's private studio and at City University Electroacoustic Music Studios in London. It was selected for the '*Metamorphoses' Acousmatic Music Composition Competition*, Brussels-Belgium.

Erevos (2002)
Duration: 11'05

Erevos was completed in September 2002. The title means darkness. dusk in Greek. In ancient Greek and Roman (Erebus) mythology *Erevos* is mentioned as a place between the earth and the underworld, a place where day and night went in turns.

The work reveals a world of imagination, in which relationships and analogies differ from reality. The idea of the piece refers to a journey between 'natural' and 'supernatural', which is presented in the musical context through the combination of recognisable and non-recognisable sounds. Throughout the work, nature adopts different colours and characters: its materials are sonically placed in unfamiliar territories, while they are successively combined, revealing hybrid forms of matter and life.

Erevos was composed at the composer's private studio and at City University Electroacoustic Music Studios in London. It was awarded a mention at the *Bourges 2003 / 30th International Electroacoustic Music and Sonic Art Competition*, Bourges-France.

Woods (2001)
Duration: 11'40

Woods was completed in April 2001. The title can be related to the natural landscape of a 'forest', but also to the sound sources (woodwind) primarily used in the construction of the piece. The sound materials employed in the context are basically instrumental, deriving from soprano and piccolo flute recordings, and have been used in various transformations in order to present 'real' or 'unreal' landscapes. Throughout the work the sounding content may often be linked to natural sources-images-events associated with the natural environment and specifically with the 'forest' landscape: bird singing, water streams, rain, leaf-rustle, ground noises etc. However, this 'nature-like' sonic world is often interrupted by or mixed with electronic sounds, which indicate unknown-'alien' sources and landscapes. The two sonic worlds (natural-electronic) either intervene or are presented and develop separately in the sections of the piece.

Woods was composed at the composer's private studio and at City University Electroacoustic Music Studios in London. Many thanks to Myrto Korkokiou for providing the flute sounds, the sonic basis for transformation.

Shore (2001)
Duration: 11'44

Shore was completed in January 2001. The idea involves the construction of 'virtual', water-related sonic images and events. The title is used to indicate an image of nature, in which water and earth are indissolubly attached: such an image has been the inspirational source for the composition of this work.

In *Shore* the appearing sources and events are clearly imaginary: the listener is 'placed' in a 'virtual' sonic world as an observer of imaginary sceneries-landscapes, which emerge and unfold successively.

'Linear motion' and 'moving space' are the main characteristics of the piece, relating to the behaviour of water. The idea of 'linearity' is presented through the combination of repeated motifs and sustained low-frequency sounds, while 'moving'/changing space functions as a passage between sections and events, and is indicated through the use of glissandi and portamenti.

Shore was composed at the composer's private studio and at City University Electroacoustic Music Studios in London.

Night Pulses (2003)
Duration: 11'30

Night Pulses was completed in March 2003. In this work the idea of 'night' is used to represent an abstract sound-world, an 'electronic landscape', which gradually unfolds, often revealing sources and behaviours of nature.

'Pulsations' are the main morphological characteristic: the sonic events are often interwoven with variable pulses, which interact and develop an unsteady, kinetic environment, set in a static harmonic field. 'Pulsations' can also be appreciated symbolically: they symbolise the continuous cycle of life in relation to time.

The context is divided in three major parts, which are connected by bridge-sections, and in which the sound material has different structural and symbolic role:

Part 1: creation: awakening, release of energy, confusion.
Part 2: earth: crickets and cicadas, ground noises, air and water.
Part 3: eternity, endless time: harmonic backgrounds, rhythmic patterns, repetition.

Night Pulses was realised at the composer's private studio and at City University electroacoustic music studios in London. It was awarded the jury prize and the audience prize at the *SCRIME 2003 International Competition*, Bordeaux-France.

Appendix 2

The Computer Tools Used in Composition*

Operating System	Software	Functions used
Windows (ME-XP)	CoolEdit Pro	sound recording, sound synthesis (noise, sine-square waves, DTMF signals), filtering (resonant, band-pass/reject) delay effects, phase shifting, amplification, panning, noise reduction, pitch-shifting, pitch-bending, DirectX plugins (see below), mixing (64-128 stereo tracks).
	WaveLab	VST plugins (GRM Tools, spectralizater, wunderverb, stereo delay), DirectX plugins (see below) .
	Cubase (SX-VST)	VST plugins (live improvisation), mixing (8-24 tracks).
	Sound Forge	pitch-shifting, pitch-bending, time-stretching
	VirtualSampler	sampling, frequency modulation, midi reproduction (live improvisation).
	DirectX plugins:	DSP-FX / TC (reverberation), SonicFoundry (pitch shifting, time stretching), Hyperprism-DX (ring modulation, phase-shifting, phase vocoding), Waves / Q-Tools (equalizing).
MacOS 9.2	AudioSculpt	sound analysis, spectral filtering, cross-synthesis
	Peak	sound recording, noise reduction (ionizer), amplification, pitch shifting, phase shifting.
	MetaSynth	(image editor): granular synthesis-sampling, spectral filtering, sound synthesis (sine waves)
	AbSynth	sound synthesis, frequency modulation.

* *Shore*, *Woods* and *Rous* were composed on the PC platform. For the composition of *Aura*, *Erevos* and *Night Pulses* both PC and Macintosh platforms were used.

Appendix 3

CD Examples (CD 2)

Example # (Track)	Description	Original Playing Time:
1:	*Rous*, extract 1 (Figure 1.8).	00'00 - 02'30
2:	*Rous*, extract 2 (Figure 1.8).	04'39 - 05'55
3:	*Aura*, extract 1 (Figure 1.12).	07'00 - 08'53
4:	*Aura*, extract 2 (Figure 1.12).	11'00 - 12'46
5:	*Erevos*, extract 1 (Figure 1.15).	02'40 - 03'25
6:	*Erevos*, extract 2 (Figure 1.15).	05'05 - 06'33
7:	*Erevos*, extract 3 (Figure 1.15).	07'45 - 08'52
8:	*Erevos*, extract 4 (Figure 1.17).	00'00 - 00'50
9:	*Erevos*, extract 5 (Figure 1.17).	10'20 - 11'05
10:	*Rous*, white noise / fluttering.	00'30 - 01'06
11:	*Erevos*, passage.	01'30 - 02'30
12:	*Aura*, random events / fluttering.	01'17 - 01'46
13:	*Erevos*, short, granular gestures.	00'50 - 01'15
14:	*Erevos*, quiet gestures / water drops.	09'42 - 10'25
15:	*Rous*, granular waves / repetitive textures.	00'55 - 01'28
16:	*Rous*, 'noisy' environment.	02'20 - 03'22
17:	'Fluttering' in *Aura.*	00'55 - 01'20
18:	White noise.	-
19:	'Fluttering' creation, stage (b).	-
20:	'Fluttering' creation, stage (c).	-
21:	'Fluttering' creation, stage (d).	-
22:	'Fluttering stream' 1.	-
23:	'Fluttering stream' 2.	-
24:	Granular waves / amplitude shaping.	-
25:	Granular waves / panning.	-
26:	Granular waves / reverberation.	-
27:	Granular waves / pitch-shifting, mixing.	-
28:	Manual creation of granular waves.	-
29:	Human breaths / pitch-shifting.	-
30:	Human breaths / pitch-shifting, mixing.	-
31:	'Buzzing': insect recording.	-
32:	'Buzzing': dynamic shaping, spatialisation.	-
33:	'Buzzing': pitch-shifting / time-scaling, mixing.	-
34:	'Buzzing' / 'swarm' of insects.	-
35:	Water-stream recording.	-
36:	Water-stream transformation (rocks).	-
37:	Gestural events / 'water' texture.	-
38:	*Woods*, extract 1 (Figure 2.30).	03'15 - 04'40
39:	Human gestures on wooden surface.	-

40:	Human gestures / whisper-tones.	-
41:	Forest-like noisy texture.	-
42:	*Woods*, extract 2 (Figure 2.30).	05'05 - 05'40
43:	*Woods*, extract 3 (Figure 2.30).	07'00 - 08'30
44:	Key-clicks (flute) transformed into 'stream'.	-
45:	*Shore*, extract 1 (Figure 2.32).	02'40 - 04'20
46:	*Shore*, extract 2 (Figure 2.32).	04'40 - 05'50
47:	*Shore*, extract 3 (Figure 2.32).	06'05 - 07'25
48:	*Night Pulses*, extract 1 (Figure 2.33).	00'00 - 01'33
49:	*Night Pulses*, extract 2 (Figure 2.33).	03'15 - 04'40
50:	*Night Pulses*, extract 3 (Figure 2.33).	05'10 - 05'35
51:	*Night Pulses*, extract 4 (Figure 2.33).	05'45 - 07'30
52:	Cicada sound 1.	-
53:	Cicada sound 2.	-
54:	Cicada sound transformation (filtering / dynamic shaping / spatialisation).	-
55:	Cicada sound transformation 2.	-
56:	'Ground noises': human gestures / water drops, transformation.	-
57:	Rain recording (in-car).	-
58:	Rain transformation 1 (ring modulation).	-
59:	Rain transformation 2 (amplification / pan envelopes).	-

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