Processing Nature: Recordings, Random Number Generators and Real-Intrinsic-Extrinsic Perceptual Threads

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Abstract. In this paper, I propose the concept of the *real-intrinsic-extrinsic perceptual thread* in acousmatic composition, which has become deeply intertwined with my wildlife sound recording practice and non-realtime use of Csound as a processing tool in the studio. The concept draws heavily from Denis Smalley's spectromorphological discourse regarding intrinsic-extrinsic threads and source-bonding (referenced throughout). Following a brief introduction (and in an attempt to articulate my thoughts from a practical perspective), I discuss processing approaches for two, recently-completed acousmatic works, in which Csound's random number generating opcodes were employed to break apart natural source recordings and create complex, secondary source materials. I then proceed to break down and describe the real, intrinsic, and extrinsic thread components separately. The paper concludes with a brief summary of the proposed concept and the role of Csound in its development, followed by a consideration of its apparent linear aspect and recent influence on my technical recording methodologies.

Keywords: wildlife sound recording, nature, random number generator, non-realtime processing, acousmatic composition, methodology, spectromorphology.

1 Introduction

My ongoing PhD research fuses two practices: wildlife sound recording and acousmatic composition.

Drawing exclusively from an ever-growing, personal sound library of species, soundscapes and abiotic phenomena, I use Csound (in conjunction with a range of other studio plug-ins and effects units) to extract hidden sonic detail out of my own wildlife recordings, generating complex, secondary source materials for fixed media electroacoustic works. These new sources are often combined and juxtaposed with original, unaltered (primary) source recordings to create unique sound worlds of my own imagining.

A fundamental component of this compositional workflow involves the non-realtime use of Csound instruments constructed around random number generating, control-rate modulation blocks. These instruments, which often feature opcodes such as *randomi* and *jitter*, are repeatedly applied to wildlife recordings to generate new sonic content.

As my research has progressed, I have been particularly struck by the inherent power of such randomly-driven instruments to 'grow' or give birth to species and natural phenomena; to slowly tease sounds with 'imagined, extrinsic connections'[1] out of processed material (which was itself derived from unaltered, real-world recordings). I call this compositional workflow, which traces a perceptual path from real to abstract to suggestive, the *real-intrinsic-extrinsic perceptual thread:* a concept I attempt to formalise in this paper, and which draws heavily from Denis Smalley's spectromorphological discourse regarding intrinsic-extrinsic threads and source-bonding.

In order to articulate the concept, I first outline some random-number-based processing approaches for two, recently-completed acousmatic works. I then discuss the real, intrinsic and extrinsic thread components individually. The paper concludes with a brief summary of the concept and the role of Csound in its development, followed by a consideration of its apparent linear aspect and recent influence on my technical recording methodologies.

2 A Practical Overview

In the following sections, I provide brief, code-based overviews of my use of random number generating opcodes in Csound. The examples are taken from instruments used during the recent composition of two acousmatic works: *Deadwood* and *Shorelines*.

My intention at this stage is to outline the real-intrinsic-extrinsic perceptual thread concept from a practice-based perspective.

2.1 Deadwood

The first acousmatic composition as part of my doctoral research,[1] my main objectives with *Deadwood* were twofold: to lay an aesthetic foundation for future work, and establish the effectiveness of using wildlife source materials exclusively as compositional building blocks in the studio.

A seven-minute, octophonic piece, *Deadwood* takes the listener on an imaginary journey through the internal and surface sound worlds of a rotten branch. Whilst a lengthy source recording of internal branch vibrations serves as a consistent structural/sonic foundation, the main 'subjects' are actually tiny, invertebrate creatures, whose detailed sounds were crafted from highly-processed, layered recordings of wind, water and birdsong.

Pivotal in the generation of this so-called invertebrate material was the use of a relatively simple, eight-channel random panning instrument in Csound, whose unpredictable fluctuations were built around the following, *jitter* and *randomi* control block:

```
krndcps   jitter   kamp, kcpsMin, kcpsMax
krndcps1 =  krndcps+kamp
```

1 Generously supported by the Midlands4Cities Doctoral Training Partnership and AHRC.

```
krnd1     randomi  0, 1, krndcps1*iscale
krnd2     randomi  0, 1, krndcps1*iscale
krnd3     randomi  0, 1, krndcps1*iscale
krnd4     randomi  0, 1, krndcps1*iscale
```

The four, k-rate *randomi* outputs control the input panning argument values of four corresponding *pan2* opcodes, which output the original source sound as follows:[2]

```
asig      diskin2  ifile, ipitch*krndpitch
amix      = asig*iamp

a1, a2    pan2     amix, krnd1
a3, a4    pan2     amix, krnd1
a5, a6    pan2     amix, krnd1
a7, a8    pan2     amix, krnd1

; French 8 pair routing.
outo      a1, a3, a2, a4, a5, a7, a6, a8
```

This amounts to random, eight-channel control of four loudspeaker pairs, which can be configured to 'French' eight, 'American' double-diamond and other octophonic routing standards via *outo*.

Pushed to the extremes, *jitter* control was used to impose rapidly fluctuating panning values on loudspeaker pairs. After a certain threshold, source materials began to fragment and take on the textural character of pointillistic sounds generated through granular synthesis; at this point, rapid loudspeaker panning (which can be regarded as a form of spatial amplitude modulation) entered the domain of microsound.[3]

With repeated processing in Csound, these ripped, torn, intrinsically-detailed textures took on imagined, extrinsic characteristics: to my ears, strongly source-bonded to a microscopic sound world inhabited by invertebrates such as beetles, centipedes and millipedes.[4] These features were subsequently isolated and shaped to envelop the audience in the intimate, internal spaces of a piece of dead wood.

2.2 Shorelines

Building on the successful UK premiere of *Deadwood*, my processing approach with *Shorelines* focused on relatively simple bandpass filter designs. My intention once again was to generate abstract base textures from real-world source recordings, then repeatedly apply specific Csound instruments to draw out additional sounds with imagined, extrinsic connections.

2 After some experimentation, *pan2* was favoured sonically over the higher-level *pan*.
3 A fascinating approach to processing, and one I hope to explore further in the future.
4 Source-bonding and other spectromorphological terms are addressed in subsequent sections.

A series of reflections and re-imaginings from Talisker Bay Beach on the Isle of Skye, this ten-minute, octophonic work is also concerned with microscopic sonic detail, exploring seaweed textures, the imagined feeding processes of limpets, crabs and snapping shrimp, and jellyfish propulsion mechanisms. Themes of ancient volcanic activity, subterranean tectonic shifts and my own ancestral connections between Scotland and Northern Ireland are also explored.

In the early stages of composition, a random bandpass filter instrument was created in Csound to begin intensively processing and re-processing selected source recordings. The vast majority of materials used in the finished work were generated from soundscape and subterranean beach recordings, with excerpted river, stream and invertebrate sounds used for additional layering.

Three *randomi* opcodes were used in a control block for random modulation of filter frequency and bandwidth as follows:

```
kbwmod    randomi  imodmin, imodmax, imodcps
krandfr   randomi  irfrqmin, irfrqmax, irfrqcps
krandbw   randomi  ibwmin, ibwmax, kbwmod
```

Notable here is the use of an extra *randomi* opcode to modulate input arguments within the control block itself: in this case, the rate of random bandwidth values written to the variable *krandbw*.

Various *butterbp* filters were subsequently added in combination with *diskin2*, which could be programmed to skip as needed to interesting portions of the relevant source recording. Using the simple control architecture outlined previously, the frequency and bandwith input arguments of each *butterbp* filter were modulated directly, with a base filter frequency added to focus processing on relevant portions of the audible spectrum:

```
asig      diskin2  ifile, ipitch, iskip
abpfilt   butterbp asig, ibasefr+krandfr, krandbw
```

Given the tendency for random bandpass filtering to 'blow-up' and produce uncontrollable amplitude values, *clip* and *limit* opcodes were used at the output stage.

After employing this relatively simple, random bandpass filter design to generate base textures rich in intrinsic detail, repeated processing led to the emergence of highly complex gestures and textures, many of which were suggestive of marine species and their various behaviours.

3 Perceptual Thread Components

I now attempt to break down and explain the real, intrinsic and extrinsic components of the perceptual thread concept.

3.1 Real

Perception/exploration of the real as a wildlife sound recordist is the first stage in all of my compositional work. This essentially boils down to specialised field recording, using parabolic reflectors, tripods, highly-sensitive microphones and a range of other, custom-built, application-specific solutions.

Recording subjects range from birds, mammals and amphibians to plants, insects and atmospheres. These are what I call primary compositional sources: real-world recordings, entirely unprocessed (save for basic level adjustments and the removal of the very lowest frequencies, where applicable).

All of these primary sources are meticulously documented and catalogued as part of a growing, personal sound library.

3.2 Intrinsic

As Smalley notes, intrinsic features essentially refer to the raw, sonic characteristics of an electroacoustic work: 'sound events and their relationships as they exist within a piece of music'.[2] In other words, the intrinsic focuses on raw, internal spectromorphological detail, and is strongly bound up with Pierre Schaeffer's concept of reduced listening.[5]

In my own work, through the application of random processing methodologies using Csound in conjunction with other software, abstract, highly-complex textures and gestures are generated from original source recordings. It is at this stage that I begin to engage in the process of reduced listening and focus on perceiving intrinsic detail.

3.3 Extrinsic

As processing intensifies, external, extrinsic connections are often made: for example, throaty gestures may suggest complex, internal species vocalisations, or a rough, uneven texture may imply dragged motion across a pebble-strewn surface.

Smalley notes how the 'wide-open sonic world of electroacoustic music encourages imaginative and imagined extrinsic connections because of the variety and ambiguity of its materials'.[4] This ultimately equates to *source-bonding:* a concept also created by Smalley to represent the intrinsic-extrinsic link, and defined by him as 'the natural tendency to relate sounds to supposed sources and causes, and to relate sounds to each other because they appear to have shared or associated origins'.[5] He also notes how, for the listener, source bondings can be actual or imagined, and may never have been envisaged by the composer in the first place.[6]

These perceived extrinsic connections often have a powerful influence on how a work progresses. In *Shorelines*, vivid extrinsic connections were made to perceived, aquatic species snaps, pops and propulsion mechanisms when working with highly-processed sand and water material. These details were subsequently extracted and worked into the final version of the piece.

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5 Described by Smalley as, 'an abstract, relatively objective process, a microscopic, intrinsic listening'.[3]

4 Conclusion: Threading Everything Together

In proposing the concept of the real-intrinsic-extrinsic perceptual thread, what I have ultimately attempted to do is formalise various aspects of my own compositional process, as opposed to articulate a fully-fledged theory or body of terms. At this early stage of my doctoral research, I find the concept particularly useful as an aid to creative thinking, and to instil an awareness of workflow: of how to trace a path from initial recording to intensive processing and, finally, the imaginative construction of sound worlds through perceived extrinsic connections.

The fact that Csound has played a key role in the development and refinement of my compositional process and the notion of perceptual threads is no accident. I find the use of random number generating opcodes complementary to many of the unpredictable and exciting behaviours encountered whilst recording wildlife. I also see workflow parallels between the use of Csound and the practice of wildlife recording. Planning for the best recording opportunities essentially boils down to planning against the highly unpredictable elements of nature, narrowing-down and quickly adapting once a particular target species emerges; similarly, the unexpected sonic material thrown out by randomly-driven Csound instruments must be adapted to through further input argument refinements within the control block, in order to continually focus processing and chase sonically engaging material.[6]

Although I have highlighted the linear aspect of the perceptual thread concept, this has largely been for the benefit of clear presentation and outlining of compositional process. In my own experience, sonic perception does not function so linearly, and each component (real, intrinsic, extrinsic) is deeply intertwined; it is not a simple matter of proceeding in a single direction. For example, whilst recording the real has certainly informed my intrinsically-focused studio work and subsequent connections with the extrinsic, the extrinsic (what I have imagined and constructed compositionally) has also re-informed my perception of and approach to the real.[7]

Perhaps the most striking influence in this regard has been the modification of technical recording methodologies. In my recent search for bumblebee sounds, my approach has centred largely on using a small, handheld microphone to follow the bees and capture their flight buzz. This has now broadened to include highly-proximate mandible and body sounds as the bees gather nectar and pollen inside flowers, using miniature microphones placed directly on petals and other plant structures. I believe the search for these hidden sounds has been directly influenced by extrinsic connections to invertebrate activity made during intensive processing for *Deadwood*.

It will be interesting to see where all of this leads over the course of my doctoral research, as I explore various Csound instrument designs in my continued exploration of real-intrinsic-extrinsic perceptual threads.

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6 In addition, I find my continued, preferred non-realtime use of Csound complementary to a wildlife recording approach centred on patience, and the requirement to listen back intently to many hours of recorded material.

7 The possibility for perceptual thread truncation should also be noted: in the future, I may sever the link between intrinsic and extrinsic components, instead developing a non-source-bonded, abstract sonic palette from wildlife source recordings.

5 References

1. Smalley, D.: Spectromorphology: Explaining Sound Shapes. Organised Sound (2)2, 110 (1997).

2-6. Ibid.