ORPHEUS INSTITUTE SERIES

Sound Work: Composition as Critical Technical Practice

Edited by Jonathan Impett

SOUND WORK

COMPOSITION AS CRITICAL TECHNICAL PRACTICE

Edited by Jonathan Impett

Leuven University Press

Editor
Jonathan Impett

Authors
Patricia Alessandrini
Alan F. Blackwell
Nicholas Brown
Marko Ciciliani
Nicolas Collins
Agostino Di Scipio
Daniela Fantechi
Ambrose Field
Karim Haddad
Jonathan Impett
Thor Magnusson
Scott McLaughlin
Lula Romero
David Rosenboom
Ann Warde
Laura Zattra
Julie Zhu

Production manager
Heike Vermeire

Managing editor
Edward Crooks

Series editor
William Brooks

Lay-out
Studio Luc Derycke

Cover design
Lucia D'Errico

Cover image
© Speculum humanae salvationis, GKS 80 folio, the Royal Danish Library, 47 verso.

Typesetting
Friedemann BV

Printing
Wilco, Amersfoort (The Netherlands)

Minderbroedersstraat 4
B-3000 Leuven (Belgium)

ISBN 978 94 6270 258 5
eISBN 978 94 6166 366 5
https://doi.org/10.11116/9789461663665

D/2021/1869/38
NUR: 664

This book is published in the Orpheus Institute Series.

Appendix

Online Materials

As further reference to chapters 2 (Rosenboom), 4 (Warde), 5 (Brown), 9 (Romero), 11 (Fantechi), and 14 (Alessandrini and Zhu) in this book, an online repository of multimedia files was created to enhance the reading of the relevant chapters. The material is hosted on the website of the Orpheus Institute, Ghent. These examples, which should be viewed in connection with a reading of the relevant articles, may all be accessed under the URL: https://orpheusinstituut.be/en/sound-work-media-repository.

Table of Contents

Designing the Threnoscope or, How I Wrote One of My Pieces

Thor Magnusson
University of Sussex, UK; Iceland University of the Arts

Introduction

To Albert Einstein is attributed the statement that if we knew what we were doing, we wouldn't call it research. No reliable sources back this up and indeed it is most likely to be an academic joke that took on a life of its own on the internet. Nevertheless, there is much truth in jest and any examination of scientific practices will demonstrate that creativity and originality in science are often the result of serendipitous events, accidents, and coincidences, but most importantly emerging from play with materials and ideas, using instruments of thinking such as pen and paper, models, prototypes, simulations, specimens, and samples. Mathematicians extend their mind's power through the prosthesis of pen and paper, engineers build prototypes or models to test their ideas, and the example of biologists Watson and Crick discovering the structure of DNA using physical models of balls and sticks is well known (Baird 2004, 32). The mental capacity to realise a "truth" emerging accidentally, during a work process seeking to achieve something else, should not be underestimated. While we might be trained in the scientific practice of having a hypothesis, expressed in a clear set of research questions with appropriate methods of answering them, all laid out and articulated, we have to acknowledge that a large portion of original thinking in the natural and social sciences, as well as in the arts and humanities, does not happen this way.

Artistic research is typically practice-based, where a wide typology of expressions and their effects on human society are studied from a range of perspectives, whether material, formal, or cultural. The material of expression can be of any sort, ranging from written words or notes, through dance, theatre, sculpture, and architecture to landscape art or microorganism research. What characterises the practice is the emergence of new knowledge from the study and manipulation of these materials, not necessarily grounded in a theoretical framework, but arriving from actual doing, making, and evaluating. But what is the nature of such epistemological practice? This is different from the well-established scientific principles mentioned above, idealised as a process that goes from hypothesis to experimentation to formal knowledge published in academic settings after peer reviews, with findings that are reproducible by

other scientists.[1] One metaphor of such practice might be the territorial map, where landmarks are clear, the field is given, but what needs to be explored are distinct routes and connections between points on that landscape. This metaphor covers what Boden calls combinatorial and explorative creativity (2011). Another metaphor might be that of a person, standing before thick fog that blankets swampy terrain rising into hills and mountains, who has a strong intuition that something interesting is to be found if the fog is entered. It is not clear what exactly that might be, but past experience and grounded knowledge of other similar journeys gives the artist-researcher confidence that something worth pursuing lies therein. Here, creativity is like a discovery, but often one that has to be hermeneutically contextualised within the language of the particular field in order for it to be accepted.

This chapter describes the artistic research and development of a live coding system, called *Threnoscope*, as an example of an artistic research process. The Threnoscope (Magnusson 2014a) is a graphic score system notated by code, which affords long durational drones of a microtonal nature, expressed in a multichannel speaker system. It has been released online[2] and other musicians have started using it in their work. But the final outcome of this completed system (or *nearly* completed, I should say, as software is never finished) was never one that I drew up, conceived, planned. It emerged from traversing swamps, with wet feet roaming the hills, and finally reaching the top of a mountain, where a sunny view was gained when the fog cleared, and I asked myself "what did I find here?"

The Threnoscope

The Threnoscope is a system for live coding spatial microtonal music. Or, at least, that is what it affords most people composing and performing with it. What typically happens when you release software out in the wild is that someone somewhere rejects the script of the technology, as is well theorised by actor–network theory (Akrich 1992), and makes something completely different with it. Ignoring such antics, for example where the system has been used to create a sixteen-step drum machine, the Threnoscope is a system that splits the screen into two views: a graphic visual representation of the microtonal sounds and their spatial locations, and a live coding interface that enables the live coder to compose microtonal music, spreading the sounds across a multichannel space.

There are two visual representations of the Threnoscope: a harmonic view and a scale view. Figure 10.1 shows the harmonic view, where the innermost circle represents a fundamental frequency, for example 55 Hz, the standardised A, and the concentric circles outwards are the harmonics of that frequency,

1 It should be noted that both the natural and the social sciences are currently undergoing what is called the "reproduction crisis" where a considerable bulk of peer-reviewed and published research cannot reproduce the same findings when experiments are rerun. This calls for a different methodology for research and the publication of findings, with solutions ranging from funding experiments rather than researchers to the pre-registration and peer review of experiments before they are conducted.

2 http://thormagnusson.github.io/threnoscope.

110Hz, 165Hz, 220Hz, and so on. The fundamental can be set to any desired frequency, which is important when performing with instruments of a specific key, like the clarinet or the horn, or simply to rest the ears from listening to specific frequencies for longer durations. Thin lines cross the circles, and these represent the speakers, whether they are stereo (left and right), quadraphonic (left, front, right, back or left-front, right-front, right-back, left-back), quintaphonic (5.1), septaphonic (7.1), or octophonic surround. The wedges represent the sound forms as they move through the space; the thickness of the wedge corresponds to the cut-off frequency of the low pass filter applied to the wave. All the parameters of the drone—waveform, frequency, amplitude, cut-off filter frequency, resonance frequency, speed, and length—can be set on initiation and controlled in real time.

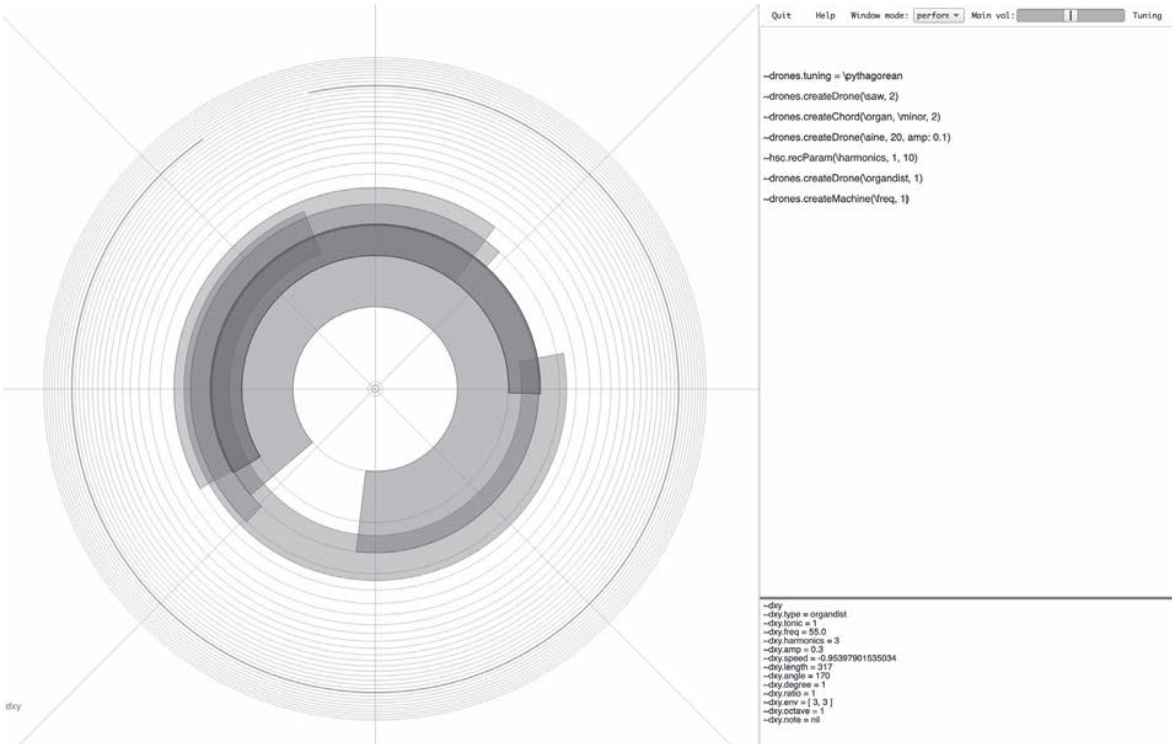

Figure 10.1.

The scale view can be seen in figure 10.2. Here the innermost circle is the fundamental frequency, but what follows are the degrees of the particular scale, set to a particular tuning. Octaves are represented with a red circle. The circles are rearranged when a new scale is chosen or when a new tuning is selected (the scale could be minor, but the circle ratios are adjusted when moving from, say, a twelve-tone equal-tempered tuning to a just intonation. Likewise, the circles change location when changing from, for example, a minor to a

Figure 10.1. The Threnoscope harmonics view. The concentric circles represent the harmonics of a set fundamental frequency. The crosshairs represent the speakers. The wedges are the "drones" (long-duration notes) and when they overlap a speaker line, they come out of that speaker. The interface is interactive, but most of the performance happens in the coding window.

mixolydian scale). The drones can be initialised on any of the degrees of the scale and they can be moved between degrees. This can also happen in the harmonic view; the only difference is that we don't see which degrees the drones are on. Additionally, chords can be initialised, new chords created, and drones grouped into clusters that can be controlled with central commands. These can be saved for later use.

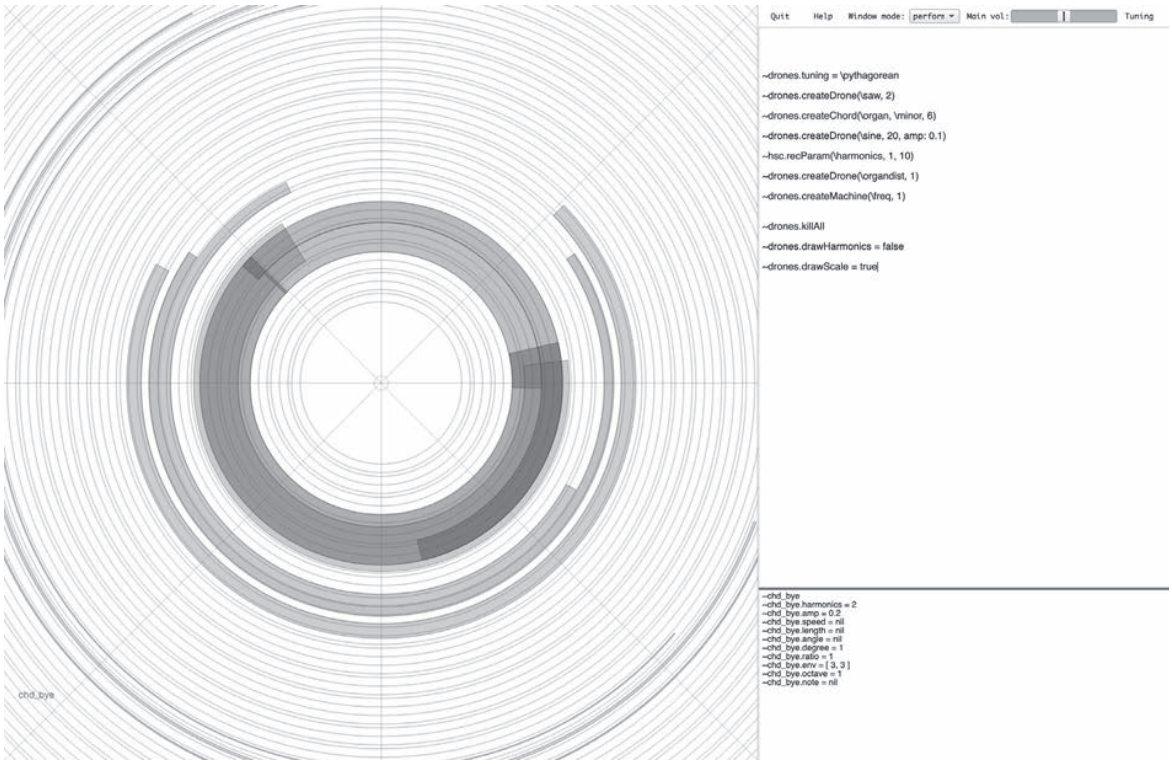

Figure 10.2.

The Threnoscope has a plethora of other functionalities, such as creating satellites, where a multitude of smaller drones appear on the stage according to the parameters set at initiation. There are various types of machines that can be made to appear at the middle of the interface to manipulate the drones (shifting their frequencies, timbre, amplitude, etc.). A score system was implemented in order to compose more set pieces, and this code score can be both deterministic and generative, depending on the code it contains. The score system can also be used to compose short "riffs" that can be initiated at any point in time in a performance. Finally, the state of the Threnoscope can be stored and recalled at any point and it is possible to move from one state to another over a specified timeframe.

Figure 10.2. The Threnoscope scale view. Here we see another representation of the pitch space. The red circles are octaves from the fundamental frequency. The other circles are the notes in the selected scale. A scale could be in various tunings, for example a Lydian scale in just intonation tuning.

The system is in many ways complete, although there are some features that would be good to work on further. My hope is that by releasing it as open source software, other users will contribute to the system or fork its development in other directions. I wrote the Threnoscope over a number of years, during free time from work. Unlike ixi lang (Magnusson 2011), I did not want to release the system nor the code as open source early, as I didn't want interruptions to my way of thinking and experimenting. In my experience, user requests can drastically change the way one thinks about the development of software, and in this case I wanted to take time with my own pace of development, and explore the system through performance and audience feedback. In the next section, I will explain how I developed this system, from initial experimentation to its completion.

Developing the Threnoscope

I began working on the Threnoscope sitting in the middle of an eight-channel surround sound studio in Brighton. With the audio programming language SuperCollider in front of me—my favourite way of thinking out loud about sound—I experimented with sending waves of different frequencies to the speakers around me, moving them from one speaker to another while changing them in pitch, amplitude, and texture. The code might have looked something like this:

```
{PanAz.ar(8, SinOsc.ar(110, 0, XLine.kr(1, 0.4, 10, doneAction:2), Line.kr(0, 1, 10))}.
play

// [here a sine wave is panned across eight speakers in ten seconds. The wave
is 110Hz, and its amplitude goes from 1 to 0.4 in ten seconds, then the synth
disappears].

Or

{PanAz.ar(8, LPF.ar(Saw.ar(XLine.kr(55, 110, 10, doneAction:2)), XLine.kr(880, 440,
10, doneAction:2), Line.kr(1, pi, 10)) }.play

// [here a saw wave is panned across eight speakers. The frequency goes from 55Hz
to 110Hz, and the cut-off frequency of the low-pass filter (LPF) moves from 880Hz to
440Hz, all in ten seconds].
```

In addition, series of variations containing different waveforms and filters were applied, morphing the sound in time, moving it in space.

Previously, I had developed the ixi lang live coding system, which affords a simple interface for creating beat-based music, supporting polyrhythm, polymetre, and a large range of tunings and scales, but primarily aimed at working with patterns of samples in a live coding setting (Magnusson and McLean 2018). Playing in this eight-channel surround sound studio, I didn't really have any strong intention other than to explore the movement of sound waves in frequency and space, and I was more interested in long durational notes, exploring further the drone music that I'd been listening to since I was a teenager, for example Indian music, the Velvet Underground, Terry Riley, La Monte

Young, and Phill Niblock. Much of this music, of course, is in complex microtonal tunings, and I was interested in studying their effect on the human listener. Although I had read much about the world's diverse tuning systems and musical scales, I had never properly explored their effect systematically and comparatively in my own musical experience and practice. Moreover, I had the intuitive idea that it might be interesting to explore the relationship between tuning and spatiality.

Thus, I began working on a musical piece that I could perform in different tunings, with waveforms ranging from the purest sine wave, through synthesised waveforms rich with partials, to more complex organ sounds, xylophones, or reed instruments. I implemented a system for circular looping of sampled sounds so I could use the output of real instruments as waveforms, leaving out the attack and the decay of the sound, but looping its sustaining part. I then wrote a SuperCollider class that would read the thousands of scales of the Scala library[3] and feed them as frequency data into my waveforms. This was exciting! Swapping the tuning of a cluster of drones in real time would completely change the feeling of the sound heard, and the sounds travelling through the surround system created an effect of movement, shape morphing, and liveliness.

Visual representation of sound and interaction design in music software has been a long-term interest of mine, so it was natural to think about how to visualise and control these drones through a graphical user interface. I wanted to "see" the sound as well as hear it. The context of sitting in the middle of eight speakers made it natural to start by drawing a double cross (a mix of an "x" and a "+") on the screen and somehow represent the drones on those speaker lines. Since I was studying alternative tuning systems, I subsequently drew circles of harmonics where the lowest harmonic was the innermost circle, and the next ones circling that one outward. I decided to represent this on a linear scale pattern (as opposed to an exponential one) as I wanted the octaves to appear at regular intervals, but also because the visual screen space would not easily (from a usability perspective) give room for the exponential drawing of harmonics.

With this visual system I had the physical speaker space and the sonic frequency space represented. The drones themselves would get a representation on their set frequency and a thickness depending on their frequency range before the low-pass filter cut-off and could be placed on any of the speakers depending on their length (in degrees, around the circle). The next step was to implement time, where the drones could move around the circular space (or increase in length, crossing more and more speakers). I experimented with using vector-based amplitude panning (VBAP) and Ambisonics for fading in and out of the speakers, but eventually I became more interested in conceiving of the eight speaker lines as static timelines through which the musical "notes" would pass. Here, I had suddenly arrived at a very peculiar system of representing circular musical time, and one that was certainly not decided on a drawing board before beginning to program the piece. This is an example of a satisfying artistic and technical solution emerging from iterative

3 http://www.huygens-fokker.org/scala.

experimentations and testing, with many failed ideas abandoned on the roadside, with others implemented and developed further.

Code can be good for many things, and for some it is a much better control interface than any graphical user interface. For example, in a few lines of code I can create one hundred drones, placed on every third degree of a particular scale, with a reducing number of harmonics and a random amplitude in each drone. Later, I might write another line and make these drones move around the space, following each other by 20 degrees.[4] It simply does not make sense to create a user interface for such a one-off random idea; but with code, practically anything can be expressed that fits within the parameters of the piece. However, looking beyond the power of code, since there was already a graphic representation of the sounds, this representation could easily become a control interface too. I thus implemented the capability of moving drones around with the mouse, and created a control mechanism to adjust the parameters of the sound, such as pitch, texture, or amplitude. I also implemented the functionality of recording the movements of those parameters in time, as it is often easier to demonstrate a trajectory in time and space intuitively with the hand than to write it as an algorithm in code. This direct interfacing with the drones after they have been created, both through code and the graphical interface, was important for the live performance of the piece and I subsequently supported both MIDI and OSC control to interface with the system.

An audiovisual collaboration with a colleague, Jüri Kermik, on an animated film prompted me to come up with a score system for precise timing (Magnusson 2014b). This was easy to design: simply a two-dimensional array with the first element being the time, and the code to be triggered at that point, all run by a dedicated clock. Of course, such functionality becomes interesting when one begins to explore the stretching or compressing of time, or to run multiple timelines or multiple scores at once—and here the spirit of experimentation has resulted in some design decisions that are uncommon in conventional software, probably for a good reason.

A piece or a system?

I have described the development process of the Threnoscope: how one idea led to another, following research interests, and working with the affordances of the sound equipment as well as the screen, physical interfaces, and the SuperCollider audio programming language. This was a bottom-up process, working with the materials at hand as they emerge or appear on the ideological horizon, as opposed to the top-down process of designing first, then implementing, for example using UML diagrams for a fully developed systems design. Shelly Turkle and Seymour Papert have described the distinction between these two types of programmers, terming one a bricoleur, the other a planner (Turkle and Papert 1990).

4 Note that the degrees of a scale are not the same as degrees (°) in the mathematics of a circle, measuring an angle.

The Threnoscope was given a name, as a system, very late in the process, for the simple reason that I only intended to write some music in my preferred notational format: code. The initial idea was to compose a piece that I would perform live through the method of live coding—only later did I realise that I had invented a compositional system. Now, the boundaries here are not clear and I have elsewhere described how contemporary music is moving from a definition of *composing a work* towards the idea of *inventing a system*. In a recent book, *Sonic Writing* (Magnusson 2019b), I analyse the tendency to invent systems to be navigated by performers (often themselves) rather than composing musical works in the manner we are accustomed to, like those that emerged with Romanticism and are so well analysed by Goehr (1992). Although musical works are still being composed—and common musical notation is not going anywhere—contemporary music is now eagerly exploring new instruments (Holland et al. 2013), new notations (Vear 2019), and new types of musical expression in new media formats (Magnusson 2019b).

This "new systematicity," or the shift from composing a work to inventing a system, is characteristic of twenty-first century music. In an article from 2000, Jonathan Impett investigates the concept of *invention* in his practice of interactive music: "In my work, I needed a name for a particular software construct: a unit of musical behaviour which encapsulates materials and behaviours from multiple sources which is formed by the interaction of several dynamical systems. . . . The *invention* in this context is the locus of materials, behaviour and relationships" (Impett 2000, 29). Impett applies the concept to describe a construct that is perhaps a musical piece, but not really. While he applies it to his own practice in a narrow sense, I wish to view it in the context of classical rhetoric, where invention was one of the key tropes, alongside arrangement, style, memory, and delivery. Invention was the *discovery* (and note that we make a distinction between these two words in modern English that did not exist in Latin) of a new version from a template or a set of rules. See Bach's *Inventions*, described by Dreyfus as "more than a static, well-crafted object, but instead like a mechanism that triggers further elaborative thought from which a whole piece of music is shaped" (1996, 2). In my book, I define the invention of a system as

> something that has been put together, not discovered, but actively created through combinatorics or out of nothing (as in *poiesis*). Examples include generative compositions, new musical instruments, audio games, live coding systems, animated notation pieces, unit generators in audio programming languages, verbal scores, virtual worlds, and so on. These are theoretical systems that "contain" the music through their affordances and constraints—objects, in other words, that generate actions through their ergodynamic potential. The contemporary act of composition and performance in these new media is therefore a search, a *ricercare*, where we explore the ergodynamics of the instrument, its playability, sound, and musical structures. Thus, the questions often asked, in twentieth-century language, whether the work is the instrument or the musical piece, or whether the live coding language is a system or a composition, become irrelevant. By applying the concept of *invention*, we transcend the work-concept and the conceptual problems that have lingered as

> linguistic remains of a musical culture we have now surpassed. (Magnusson 2019b, 183)[5]

The Threnoscope has been released, and other people are using it. They are making *their* music with it. Yet, this is music based on a very strong personal vision that has been inscribed into this instrument, this system, this composition. And here is the problem: the language we have traditionally used to describe our musical practices—such as composer, performer, audience, score, work, composition, instrument, interpretation, space, sound system, producer, engineer—is not descriptive of how current work patterns and roles are evolving in contemporary music. Equally grounded in new philosophical theories of creativity and originality, as well as new computational media, new artistic practices transcend the interrelated twentieth-century discourses of research and creativity.

Conclusion

The Threnoscope has served as a testbed for experimentation. Through the research process, I have explored ideas of microtonal composition through applying and creating new tunings and scales. I have studied the psychoacoustics of microtonal sound in space, and relationships between waves as they are placed in speakers surrounding us. The interface has become the score, the instrument, the system, and I have learned a lot from audience feedback telling me what they learned from observing the system in operation. But most importantly, I feel I have been able to study ideas of authorship, creativity, authenticity, originality, and co-operation in music, as the system has become a connective device, a focus for discussion about the above-mentioned notions that are necessarily changing in today's music. I also feel that I have not only studied these changed notions through the work, but also actively contributed to their redefinitions, no matter how small that contribution might be.

The Orpheus Institute has organised exemplary symposia and published important work on practice-based research. This is a wide and complex field: what is practice-based research? How is it different from other research? There are innumerable points of view and distinct ideologies and methodologies, as can be seen in the institute's previous publications. Personally, I can say that without being able to make things, compose, program, perform, listen, talk, and present, I would not have been able to gather and formulate new knowledge of the role of the score, of microtonal tunings, of designing scales, of the spatiality of sound and related psychoacoustics, or partake in innumerable cases of collaboration with other musicians that have taught me so much. I have sought to present that knowledge in the form of the system itself, as an object resulting from the research: an epistemic tool pregnant with music theory of all kinds, including tuning and instrument design. The Threnoscope can be

5 For a further discussion on the notion of *ergodynamics*, *ergomimesis*, and *ergophor*, see Magnusson (2019a).

studied through use, through exploring its affordances and constraints (or better *ergodynamics*, see Magnusson 2019a), as a way of understanding the new knowledge imbued in it. It can be studied in performance by the audience whose interpretations bring new insights. The Threnoscope's source code can also be studied, reading the design decisions, line by line, analysing the actual theoretical constructs it encapsulates. Finally, I have presented the system at music festivals and academic conferences. I have written about the system and sought to communicate its qualities as an objective proposal for music-making, an intervention into the state of musical instruments, improvisation, live coding, notational practices, and musical collaboration.

In this chapter I have described my working methods in developing the Threnoscope. I explained how it moved from a musical piece to a compositional system, and I pointed out the problems in such dichotomies, as our new musical practices transcend our past language. But I should admit that I rarely work this way nowadays, and that I consider working in this way, as a bottom-up bricoleur, a privilege when operating in the academic context. The fact is that the structure of artistic practice-based research in university grant-proposal, evaluation, and quality-control systems, and for arts and humanities research funding bodies, is moulded to fit that of hypothesis-based scientific research. Here, the general assumption is that artistic work can be well defined as an idea before entering the studio or the workshop. That the work can be expressed as a set of research questions that will be answered through a well-defined research methodology. And that the final piece is simply the result of this process, an outcome. Most creative artists know this is not how it works: the materials we work with are not neutral: they speak, resist, protest, and at times go with the flow of our ideas as they emerge in a conversation with the materials. It is easy to mass-produce new work when a method has been reached, but this is *the result* of a research process, not research on its own. This is the character of artistic research (and indeed much research outside the arts): we serendipitously arrive at new visions or knowledge through forking paths that bend or recurse back; in a dialogue with the materials we work with, whether it is clay, canvas and brush, instruments, or code. And it is here that "Einstein's joke" begins to ring true, in that if we knew what we were doing, we wouldn't call it research.

References

Akrich, Madeleine. 1992. "The De-scription of Technical Objects." In *Shaping Technology/Building Society: Studies in Sociotechnical Change*, edited by Wiebe E. Bijker and John Law, 205–24. Cambridge, MA: MIT Press.

Baird, Davis. 2004. *Thing Knowledge: A Philosophy of Scientific Instruments*. Berkeley: University of California Press.

Boden, Margaret A. 2011. *Creativity and Art: Three Roads to Surprise*. Oxford: Oxford University Press.

Dreyfus, Laurence. 1996. *Bach and the Patterns of Invention*. Cambridge, MA: Harvard University Press.

Goehr, Lydia. 1992. *The Imaginary Museum of Musical Works: An Essay in the Philosophy of Music*. Oxford: Oxford University Press.

Holland, Simon, Katie Wilkie, Paul Mulholland, and Allan Seago, eds. 2013. *Music and Human-Computer Interaction*. London: Springer.

Impett, Jonathan. 2000. "Situating the *Invention* in Interactive Music." In

Organised Sound 5 (1): 27–34.
Magnusson, Thor. 2011. "The ixi lang: A SuperCollider Parasite for Live Coding." In *Proceedings of the International Computer Music Conference 2011*, University of Huddersfield, 503–6. Accessed 9 April 2021. https://quod.lib.umich.edu/cgi/p/pod/dod-idx/ixi-lang-a-supercollider-parasite-for-live-coding.pdf?c=icmc;idno=bbp2372.2011.101;format=pdf.
———. 2014a. "Improvising with the Threnoscope: Integrating Code, Hardware, GUI, Network, and Graphic Scores." In *Proceedings of the International Conference on New Interfaces for Musical Expression 2014*, Goldsmiths, University of London, 19–22. http://doi.org/10.5281/zenodo.1178857.
———. 2014b. "Scoring with Code: Composing with Algorithmic Notation." In *Organised Sound* 19 (3): 268–75.
———. 2019a. "Ergodynamics and a Semiotics of Instrumental Composition." *Tempo* 73 (287): 41–51.
———. 2019b. *Sonic Writing: Technologies of Material, Symbolic, and Signal Inscriptions*. New York: Bloomsbury Academic.
Magnusson, Thor, and Alex McLean. 2018. "Performing with Patterns of Time." In *The Oxford Handbook of Algorithmic Music*, edited by Alex McLean and Roger T. Dean, 245–66. New York: Oxford University Press.
Turkle, Sherry, and Seymour Papert. 1990. "Epistemological Pluralism: Styles and Voices within the Computer Culture." *Signs* 16 (1): 128–57.
Vear, Craig. 2019. *The Digital Score: Musicianship, Creativity and Innovation*. New York: Routledge.