Introduction

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Electronic music is the mainstream. From musique concrète to audio-visual sampling, from elektronische Musik to minimal techno, from the Telharmonium to the laptop, electrical technology[1] has facilitated more than a century of original music, spawning a multitude of new styles, instruments and methods. Fruitful crossovers with other media and arts have allowed it to reach new audiences and to become an accomplice in many forms of expression. It appears ubiquitous, from mobile phones, television and podcasts to the art gallery and other unorthodox performance spaces. In many ways, electronic music is now so well accepted and integrated into contemporary practice that it is transparent to the observer. Yet on the periphery of musical exploration it remains highly visible – from sonic art, to live electronics, to new advances in computational music.

Whilst electronic music would not restrict itself to computer-mediated art, much current work in this area is related to computational applications and the boom in accessibility of personal computing. The last seventy years have seen a move from rare electronic music studios to commonplace bedroom studios. As if the thought experiment about Shakespearian monkeys has come true, millions of composers are at large exploring a multiplicity of software and devices in the pursuit of their own musical worlds. The entry cost of an electronic music hobby is no longer the hard graft of acoustic instrument practice, but a simple willingness to explore musical outputs within predominantly visual software paradigms. The influence of computers in compositional techniques, sound analysis and processing, performance interfaces and concert practice is astounding.

Yet the mass of software and hardware recording and performing tools are resting on a wonderful heritage. The most indispensable musical devices of the twentieth century have often been proclaimed to be microphones and loudspeakers.[2] In this era, the mass availability of electronic music-making tools is such that to create musical items is a daily occurrence: from composing ring tones on a mobile phone, to selecting and adding sound media to visual presentations and video, through to creating sophisticated works of expressive value that incorporate original sound processes.[3] Whilst not all musicians care to delve into the background and latest developments in this field, living with the common manifestations of

the technology without critical complaint or luxury, for the curious reader, this companion should deliver access to a powerful territory of inspiration and excitement.

A rich history underlies electronic music, full of radical inventors, pioneering composers and daring innovators. Modern-day musicians indiscriminately employing the technology might only know Karlheinz Stockhausen as a face on the cover of *Sgt. Pepper's Lonely Hearts Club Band*, Raymond Scott from incidental music in Warner Bros cartoons, Delia Derbyshire from her electronic orchestration of the *Doctor Who* theme, and be unaware of the contribution of Lee Scratch Perry to the history of remixing. However, the worldwide success of electronic dance music and other electronica has raised the profile of the pioneers of electronic music and increased our curiosity about the foundations of this subject area. And as new experimental music inevitably proves itself in time (or dissolves from view) the cutting-edge research of today will inform new musical movements of the future.

Given such a vibrant tableau, this book can only attempt to survey and analyse a proportion of the developments. We have gathered here what we hope is an exciting collection of perspectives on electronic music. We have tried to encourage novel approaches to the more well-trodden topics, taking in the distant history and origins of electronic music, the relation of computers to music, and highlighting fascinating figures such as Halim el-Dabh, Laurie Spiegel and Gottfried Michael Koenig. We have also commissioned chapters on some less widely represented themes from the research front. Topics vary from DIY and live electronic music making, through audiovisual and crossmedia practice, to aspects of interactivity, musical analysis and network music. Whilst there may be some overlap with familiar notions and history of electronic music, we have tried to avoid duplicating the content that can be found in already well-known books (a representative sample of which are included at the end of this introduction).

Indeed, in this manically communicating world the target is moving quickly. For instance, the proliferation of dialects and idioms is nowhere more publicised than in electronic dance music, where new genres are promoted each week in a desperate bid to put space between producers and their rivals for economic advantage. This rapidity of advance may eventually make writing any book impinging on contemporary topics an exponentially difficult task.

Rapidity is also fun however; there is no need to be bored or uninspired, look at all the activity! Far more recordings are released each year than you could ever listen to in multiple lifetimes. And look at the fads and fashions of devices: vocoded vocals, Roland x0x's, Euroracks, Max/MSP with nato,

Max/MSP with Jitter, Max for Live, Minimoogs, mainframes, a Kim-1 or Amiga.[4] We could profitably hold a moratorium on the technological head charge and just experiment with what we have; you could spend another lifetime exploring all the freeware and shareware music programs available from the World Wide Web.

To guide us in our coverage of the subject, the contributors to this book range widely across a number of generations of academics, writers and composers, from many locations in the world. An international flavour befits the current age of mass participation and mass communication, and we hope to see a truly global accessibility and a globally intensive exploration of electronic music in the future. In alliance with such an aspiration, we have gathered a series of artists' statements, showcasing diversity across many styles of electronic music. Whilst it remains true that many accounts and explorations of electronic music have involved European and American artists, the wider world has not been idle, even if the media coverage and technological apparatus have not always been of the same order.

We have also deliberately engaged with media beyond sound alone. Though the acousmatic is covered on its own terms, we have also reserved two chapters for audiovisual art. This is not just because such practice is an exciting area of contemporary activity, but because its history is interleaved with that of electronic music; indeed, early experiments with optical soundtracks predate magnetic tape. We have also pursued an active approach to live electronic music, as opposed to fixed recordings; the latter medium remains an area where traditional Western classical music might (however misguidedly) claim superiority over electronic experimentation. We wish to show how much interesting work has been undertaken to confront the possibilities of electronic music for concert use, and to honestly appraise the issues involved in the union of machines and musicians.

It seems pertinent at this point to confront one division in contemporary musical life which is the subject of much discussion, and stress to some: the polarity of *electroacoustic*, caricatured as serious academic art music, and *electronica*, as popular electronic music,[5] also including many forms of experimental electronic music. In reality, various continua stretch between these forms. Perhaps there is a certain amount of posturing going on for economic and artistic reasons; this can lead to a certain sociological resistance to new states of play in musical affairs. Electronic music is joyfully accessible to anyone with a computer of even limited power – an instrument today as intuitive to some as the electric guitar was to previous generations. For others, it can be threatening that those lacking formal training still produce fascinating electronic music; many successful practitioners learn as they go.

What does this mean in practical terms? Well, perhaps we should relax a bit, but what you'll find in this book is some mingling of electronica and electroacoustic in a bid to defuse some of the dangerous divisionism. That's also why Kevin Blechdom's statement is next to Karlheinz Stockhausen's.[6]

In truth, we hope to reconcile the electroacoustic and electronica worlds. We may show that electroacoustic composition is nothing but 'academic' if it doesn't acknowledge what is happening in the popular ambitus, and that electronica is inconsequential and disposable if it doesn't learn from the history of electronic creativity.[7]

This book is structured in three parts broken up by artists' statements, though these divisions are not meant to be overly prescriptive, for chapter authors discussing practices or foundational themes will also delve into the history, and vice versa. Whilst we hope that these chapters will be accessible to a reader previously unfamiliar with electronic music, the authors have not shied from making original assertions and bringing in subjects of controversy and contemporary research.

We've provided a chronology which draws together many events mentioned in this book.[8] It is particular to this book; like any history, it is just one view amongst many. And in a field that actively develops at the pace of electronic music, that engages with a great plurality of techniques and approaches, and indeed, isn't adverse to the odd algorithmic game, readers are encouraged to find their own personal tapestries of works and experiments. Part of the charm of this area is that it is very much alive and continually transforming, and the most fascinating works may be yet to come; indeed, from readers of this book!

Postscript: Second Edition

Ten years on, we wouldn't add much to the Introduction to the first edition. No overthrow of electronic music has taken place to remove it from the centre ground of musical development. The last decade has seen an explosion of interest in DIY music making, the further consolidation of computers at the heart of studios and much live performance, including with applications for mobile phones and web browsers, and much work in sound art (as fine art practice in the medium of sound) and music information retrieval (the machine understanding of music across large databases of examples), amongst other subfields. There has also been healthy academic activity in investigating the history and analysis of electronic music, often promoting less widely known and overlooked paths, for example, with a recent conference championing Alternative Histories of Electronic Music (AHEM, held April 2016, The Science Museum Dana Research Centre in London),

or in the acknowledgement of the importance of female artists within that history (Rodgers 2010).

New chapters added to this edition reflect this continued development, and new artists' statements have been added to further convey the rich tapestry of electronic music. We have generally tidied up the first edition, and quietly dropped two chapters, but made room for four more. We hope you'll enjoy this book, in whatever order you care to browse it, and whatever electronic music you personally create.

Notes

1 There is a certain pressure to define and delimit electronic music, which we will sidestep. Electronic music has sometimes been technically differentiated from any music that might utilise electricity (in one sense, the brains of acoustic violinists use electricity!); for instance, the Wikipedia entry on electronic music founds its definition on the restriction of the IEEE standards body definition of 'electronic' (as referring to low-power components like transistors and integrated circuits). Whilst the main focus of our investigations in this book will refer to electronic circuits, and especially those modern-day hyper-miniaturised computer chips, we shall not refrain from discussing any electromagnetic and electromechanical technologies, especially where related to the history of electronic music, but also in contemporary work.

2 In one inspiring example of custom electrification and amplification, the ensemble Konono no.1 feature hand-built microphones salvaged from old car parts, and distorting sound systems incorporated into the essential fabric of their music (Congatronics, Crammed Discs).

3 In this book we will often emphasise such real-world examples, on one hand to support the ideas discussed, and on the other to serve as searchable topics for the Google/Wiki/YouTube/Facebookfriendly generation.

4 A large number of artists proudly declare that they bought the first or second Synclavier or Fairlight in the country…

5 This is especially true of the categorisation of electronica in the United States; elsewhere, it can connote a wider spirit of experimentation more readily.

6 At the time of writing, they both lived in Germany, after all!

7 In another angle to such debate, fine artists who work with sound have entered into, well, not exactly competition, but correspondence and engagement with many of the same areas that musicians have explored. As we have discussed already, the music conservatoire education is not a necessary prerequisite for work in electronic music. It is often around the arena of electronic music where much of the sound art crossover takes place. Our own approach to this is pragmatic – everyone should learn about everyone else's work and background. It is now entirely normal practice that sound installations are cited as examples of work as well as tape pieces and live performances.

8 Further chronologies are provided in Cox and Warner (2004) and Shapiro (2000), or online.

Further reading

Chadabe, J. (1997) *Electric Sound: The Past and Promise of Electronic Music*. New Jersey: Prentice-Hall

Cox, C., and Warner, D. (eds.) (2004) *Audio Culture: Readings in Modern Music*. New York: Continuum

Collins, N., Schedel, M., and Wilson, S. (2013) *Electronic Music*. Introductions to Music series. Cambridge: Cambridge University Press
Collins, N. (2010) *Introduction to Computer Music*. Chichester: Wiley
Dodge, C., and Jerse, T. A. (1997) *Computer Music Synthesis, Composition, and Performance* (2nd edition). New York: Schirmer Books
Emmerson, S. (2007) *Living Electronic Music*. Aldershot: Ashgate
Holmes, T. (2015) *Electronic and Experimental Music* (5th edition). New York: Routledge
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Roads, C. (1996) *The Computer Music Tutorial*. Cambridge, MA: MIT Press
(2015) *Composing Electronic Music: A New Aesthetic*. New York: Oxford University Press
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1 The Origins of Electronic Music

ANDREW HUGILL

Classical Visions

> We have also sound-houses, where we practise and demonstrate all sounds and their generation. We have harmony which you have not, of quarter-sounds and lesser slides of sounds. Divers instruments of music likewise to you unknown, some sweeter than any you have; with bells and rings that are dainty and sweet. We represent small sounds as great and deep, likewise great sounds extenuate and sharp; we make divers tremblings and warblings of sounds, which in their original are entire. We represent and imitate all articulate sounds and letters, and the voices and notes of beasts and birds. We have certain helps which, set to the ear, do further the hearing greatly; we have also divers strange and artificial echoes, reflecting the voice many times, and, as it were, tossing it; and some that give back the voice louder than it came, some shriller and some deeper; yea, some rendering the voice, differing in the letters or articulate sound from that they receive. We have all means to convey sounds in trunks and pipes, in strange lines and distances.
>
> Francis Bacon, *The New Atlantis* (1626)[1]

The origins of electronic music lie in the creative imagination. The technologies that are used to make electronic music are a realisation of the human urge to originate, record and manipulate sound. Although the term *electronic music* refers specifically to music made using electronic devices and, by extension, to certain mechanical devices powered by electricity, the musical possibilities that these technologies have opened up are a recurring theme in literature, art, engineering and philosophy. But it was not until the turn of the twentieth century, when electronic and electromechanical instruments started to become a physical reality, that certain forward-looking musicians began to turn to the new possibilities already imagined by others.

Francis Bacon's celebrated description of a modern sound studio is one of many examples of such a creative imagination. *The New Atlantis*, written in 1624 and published in 1626, was a utopian tale of mariners in the south-eastern seas who were shipwrecked upon an island containing a model civilisation, in which science and spirituality found union. The 'sound-houses'

passage is one of a series of descriptions, given by the island's governor, of its various knowledge resources and houses of learning.

Bacon was familiar with some of the most experimental technologies of his time, including those devised by Salomon de Caus (1576–1626), a Frenchman who moved to England in 1612 to work as a garden designer and engineer specialising in hydraulics. De Caus created steam engines, fountains and many water-driven musical instruments including a player-piano, mechanical songbirds and various organs.

Bacon himself wrote an essay 'On Gardens', but the description of imaginary technologies of music in the 'sound-houses' text goes much further than merely reproducing the contemporary mechanical devices used in garden displays. It seems to express a desire to expand musical language beyond the familiar pitch-based system of Western instrumental music, to incorporate sound processing, novel timbres, microtonal tunings, amplification, recording, spatialisation – in short, every technique known to electronic music.

Bacon's frame of reference was as much classical as contemporary. The majority of his work and thought arose from a rejection of the received wisdom of the period, founded upon Plato and Aristotle, and an enthusiastic reappraisal of the pre-Socratic philosophers, such as Epicurus (341–270 BC), Democritus (460–370 BC) and Thales (*c.* 635–543 BC). These philosophers developed a theory of matter. Thales argued for an underlying unity based on the idea that the world was made from water. Democritus developed this idea to suggest that all matter is made from imperishable indivisible elements called atoms, which are surrounded by a void, and have various characteristics (size, shape, mass, etc.) whose complex interactions give rise to physical reality. Epicurus in turn refined Democritus by theorising that the atoms are in continuous state of parallel motion from an absolute high to an absolute low. Every so often, one atom inexplicably makes a slight swerve (the *clinamen*) in its path, creating a chain reaction of collisions, which give rise to matter. The theories of these 'atomist' philosophers seem largely to have come from their imaginations, but there was at least *some* experimental basis for their ideas. Thales, for example, wrote that amber rubbed with animal fur could lift straw and feathers, and Democritus observed fire to conclude that motion is inherent to atomic particles.

Bacon was not the only sixteenth/seventeenth-century scientist interested in these ideas. In 1600, William Gilbert published *De Magnete, Magneticisque Corporibus, et de Magno Magnete Tellure* (On the Magnet and Magnetic Bodies, and on That Great Magnet the Earth) which contains the first discussion of an 'electric force'. This was static electricity, and Gilbert made explicit reference to the pre-Socratic philosophers' discovery

of the attractiveness of rubbed amber. The word 'elektron' is Greek for 'amber', and the Latin word 'electricus' means 'produced from amber by friction'. Some of the elements required for 'electronic' music already existed at this time.

Music theory in the sixteenth century was in the grip of a debate about tuning systems. Writers such as Nicola Vicentino (1511–*c*. 1576) were defending just intonation against the steady rise of compromised tuning systems such as meantone and equal temperament. The adoption of these latter systems enabled both musical instruments and, ultimately, published music notation, to be disseminated across Europe. The central importance given to pitch and hence harmony in music theory led to a musical practice which ignored most of the sound-based concepts described in Bacon's text.

Vicentino's *L'antica musica ridotta alla moderna prattica* (Ancient Music Adapted to Modern Practice), published in Rome in 1555, outlined his interpretation of the music theories of Pythagoras (569–475 BC), Aristoxenus (fourth century BC), Ptolemy (*c*. 90–168 AD) and Boethius (*c*. 480–525 AD). Vicentino himself built a number of instruments, such as the *archicembalo*, a keyboard with thirty-six keys to the octave, designed to play the Greek *genera* (diatonic, chromatic, enharmonic) derived from Pythagoras' discovery of a *harmonic series* made up of whole-number ratios subdividing a vibrating string or other body.

Other theorists, however, were less interested in the refinements of such 'just' intonations than in the development of a musical language that was reproducible and standardised, with an accompanying notation system that similarly privileged pitch. The meantone tuning system[2] deliberately detuned certain intervals (particularly fifths) in order to achieve the maximum number of 'pure' thirds. Equal temperament systematically detuned all the fifths in order to achieve a 'cycle' that is both effective and practical. This solution is still the dominant Western musical tuning system today.

The source of all these theories of tuning, Pythagoras, was also the leader of an elitist cult, which was divided into an inner circle called the *mathematikoi* and an outer circle called the *akousmatikoi*, or 'listeners'.[3] The latter were obliged to listen to the master from behind a curtain, a practice which has given its name to present-day *acousmatic* music in which the original source of the sound is not visually apparent, the immediate source being the loudspeakers which are apparent. Where acousmatic music explores a 'sound-houses' model, by manipulating and processing sound, the instrumental tradition, on the other hand, uses a pitch-centred model, and ultimately abandons Pythagoras in favour of the pragmatic distortion of nature that is equal temperament. It is only as electronic technologies have become available that the music envisaged by Bacon (and perhaps

Pythagoras too) has become a reality. However, the absence of these technologies in the intervening years did not eliminate the urge to create this kind of music.[4]

Automata

The eighteenth century saw a surge of interest in mechanical musical devices such as carillons, music-boxes and mechanical organs of various types. The most celebrated engineer was Jacques Vaucanson (1709–82), whose machines took on a life of their own by mimicking natural and biological functions. His life-size flute-player (1738) blew, breathed and played twelve different melodies so convincingly like a human being that it surpassed previous mechanical devices. This *automaton*, or self-operating machine, started to resemble a robot in its simulation of human action. Vaucanson's most celebrated automaton was a duck, which moved its wings, legs and body, quacked and, most amazingly, both ate food and dabbled in the water. Vaucanson was keen to reveal the inner workings of the duck, showing the 'digestive' tubing through which the food passed, the throat, and so on.

Vaucanson had numerous imitators, and the general spirit of mechanical and scientific experiment at that time was contagious. New musical instruments were also created with varying amounts of automation, and there was even an electronic instrument: the *claveçin électrique*, built in Paris in 1761 by Jean-Baptiste Delaborde, which used statically charged clappers to ring bells, controlled by a harpsichord keyboard. The fascination with automata was also pursued in contemporary philosophy, most notably in the writings of Julien de La Mettrie (1709–51). In *L'homme machine* (Man a Machine) (1748), La Mettrie developed his ultra-materialist, atheistic vision of man as a machine made from a single universal substance. In doing so, he set himself against the prevailing Cartesian idea that mind and body are separate and occasioned the wrath of many of his contemporaries. Not that this bothered him: he cheerfully asserted the idea that we only have one life and it is our duty to enjoy ourselves as much as possible while we are alive. He duly lived fast and died young.

As the interest in automata grew, so did the concept of an artificial intelligence (although that phrase was not itself used at the time). The most celebrated example of this was a hoax, but the fact that people were fooled gave rise to a large amount of imaginative fiction that predicted, amongst other things, electronic music. Once again, the creative imagination (in this case the literary imagination) anticipated developments which musicians themselves ignored.