Introduction

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This book examines aspects of live electronic music from the overlapping perspectives of composition, performance and study. It presents neither a history nor a theory of this music, though we believe that it can contribute to both. It also does not endeavour to cover the topic comprehensively. Given the vast array of innovative musical practices that have been and continue to be associated with this term, no book could possibly undertake a comprehensive overview. The chapters should thus be seen as snapshots of a rapidly evolving object of study. They present an array of musicological research, in which some authors report on recent achievements while others contemplate unresolved problems that have arisen over the past half century. The book reflects on current practice and how we got where we are.

Evolving definitions

The concept of live electronic music preceded the term. In 1959, Karlheinz Stockhausen (with typical clairvoyance) juxtaposed the unlimited repeatability of electronic music composed using machines with instrumental music that appeals directly to the creative, ever-variable capacities of the musician, 'enabling multifarious production and unrepeatability from performance to performance' (2004, 379). He then predicted that the combination of electronic and instrumental would move beyond the stage of simple juxtaposition in order to explore 'the higher, inherent laws of a bond' (2004, 380). John Cage, surely one of the English language's most important wordsmiths with regard to new music, has been recognised for coining the term (Supper 2016, 221). In 1962, Cage presented the two goals he pursued in composing *Cartridge Music* (1960). The first was to render performance indeterminate, and the second was 'to make electronic music live' (Cage 1970, 145).

The term 'live electronic music' began to be used regularly in groups of young composer-performers devoted to concert presentations of electronic music in the early 1960s. David H. Cope (1976, 97; see also Manning 2013, 161–66; Deliège 2011, 415–18; Collins 2007, 41–43) mentioned the Sonic Arts Group (inaugurated at Brandeis University in 1966, later the Sonic Arts Union) and Musica Elettronica Viva (Rome 1966).[1] Other groups he could

have named include the ONCE Group (Ann Arbor, active from the late 1950s), the AMM (London 1965) and Gentle Fire (York 1968). The latter explored the potential of new electronic media using a heterogeneous mix of traditional and newly invented instruments to present music that blurred the line between the avant-garde and progressive rock of the day (H. Davies 2001, 55–56). In 1967, the University of California at Davis in collaboration with the Mills College Tape Center (Oakland) organised the First Festival of Live-Electronic Music, the first time the term was used prominently in a public event. According to a reviewer, the Festival presented a radical shift in the way composer-performers approached the sound world of the concert stage (Johnson 2011, 116–24). By the 1970s, 'live electronic music' was widely used, though not consistently. The second edition of the venerable *Harvard Dictionary of Music* presents articles on electronic instruments and electronic music. The latter contains no mention of the concept or the term, even though the author was likely aware of both (Boucourechliev 1972, 285–86).

What does 'live electronic music' mean? The definition has always been troublesome, with differences cropping up depending on what is being described. In English, the term can be defined in (at least) two ways. On the one hand, it is an umbrella term under which we find a wide range of musical practices, styles, techniques and technologies that stage the dichotomy embedded in it: live (= human) vs. electronic (= sound generated by some sort of electrically powered device). In this sense, live electronic music was and continues to be used as a broad oppositional category to acousmatic music: i.e. music prepared in a studio and fixed on some medium in advance of being 'played back', normally without 'performers' in the traditional sense of the term.[2]

The origin of this binary construction can be traced back to the 1930s, when the adjective 'live' began to be used to qualify music performance in response to a crisis caused by the broadcast of recorded music on the radio. Recording technology had existed since the beginning of the century. However, by removing the sound source from the listener's perspective, radio obscured the difference between live and recorded sound, motivating the use of the term. 'The word *live* was pressed into service as part of a vocabulary designed to contain the crisis by describing it and reinstating the former distinction discursively even if it could no longer be sustained experientially' (Auslander 2002, 17). The binary constructions (human-machine, live-recorded, art-technology) embedded in the term 'live electronic music' are typical of discourse about art music in the twentieth century.[3] According to Sanden (2013, 18–43), these binaries evoke a technophobia prevalent in this discourse, which remains alive and well to this day.

On the other hand, 'live electronic music' can be used more narrowly to underscore the fact that the electronic sound production is taking place on the stage in real time. In this case, the adjective 'live' directly qualifies the electronic devices or methods used to modify or produce sound, giving rise to the term 'live electronics'. Rather than implying the binary opposition

presented above, the second meaning focuses on some kind of interactive use of the electronic devices.

Simon Emmerson has observed that the self-declared 'live electronic' ensembles of the 1960s and 1970s tended to use the descriptive label 'live electronic' freely, applying it to music that was 'produced and performed through real-time electroacoustic activity' or was the result of a combination of 'live performers and fixed electroacoustic sound' (2007a, 104). This terminological ambiguity has remained embedded in English usage to this day, resulting in a plurality of hazy definitions that are typical of electronic music in general and becoming increasingly problematic (Peters et al. 2012, 3–4). Currently, when used in the narrower sense, live electronic music usually refers to works involving the digital management or manipulation of sound, placing it firmly in the era of personal computing that emerged in the last decades of the twentieth century. Ironically, this leads to the rather odd relegation of earlier examples based on analogue technologies to the prehistory of the live electronic music, even though these earlier examples generated the term in the first place. These diverse perspectives result in strikingly different ways of explaining what live electronic music is and how it developed. For example, Peter Manning (2013, 157–67) uses the term live electronic music to discuss the period from the 1950s to the digital revolution of the 1980s. By contrast, Angela Ida De Benedictis, one of our authors, focuses resolutely on the period from the 1980s to the present. Though acknowledging an earlier period of live electronic music that produced numerous masterpieces (Stockhausen's *Microphonie I*, *II* and *Mantra*), she divides her period of study into two phases: the first is designated the 'historical phase' of live electronic music (the 1980s and early 1990s), followed by the current phase 'characterised by the hybridisation of live electronics with computer music' (De Benedictis 2015, 301–2).

Three concepts and three phases of live electronic music

Clearly numerous kinds of live electronic music have arisen over the past half century, characterised by different aesthetic goals and technologies. Elena Ungeheuer's attempt to systematically capture the development and ramification of live electronic music in three concepts provides a helpful synthesis of the problems presented above and enables us to begin to make sense of the many different threads embedded in this story. Her first concept is marked by compositions that stage the human-machine opposition described above. Like many others (Emmerson 2007a, 89; Cope 1976, 92), she cites Bruno Maderna's *Musica su due dimensioni* for flute, cymbals and tape (1952) as characteristic of this first period in which compositions for traditional instruments and music prerecorded on tape proliferated (2013, 1368–69).

Ungeheuer's second concept focuses on compositions in which technology allowed the music to transgress the traditional temporal and physical limitations of instrumental performance (2013, 1369–71). The dramaturgical

confrontation of the first concept, intended for the eye as much as for the ear, is here intentionally erased. In other words, the music of this concept moves towards a more homogeneously integrated environment dominated by listening. This shift is underscored thematically in the subtitle of the work Ungeheuer uses to illustrate her concept: Luigi Nono's *Prometeo. Tragedia dell'ascolto* [a tragedy of listening] for soloists, choir, orchestra and live electronics (1981–84, rev. 1985).

The third concept is defined by the enhancement of real-time interactivity between the performing agents (be they humans or machines) that provided live electronic music with its 'lettres de noblesses' (2013, 1372–73).[4] Ungeheuer cites *Répons* for chamber ensemble and live electronics (1981–84) by Pierre Boulez as an early example of music that enabled a new more intensive interaction between the human performer and the machine. Rather than having to mechanically follow a prerecorded tape (concept one) or to be subjected to a preprogrammed sound production scheme (concept two), the performer was now able to interact directly with the sound-generating devices, as though playing a traditional acoustic instrument. In the late 1980s, Philippe Manoury composed a series of four compositions entitled *Sonus ex machina* (1987–91) based on the possibilities offered by a new programming language called Max (now Max/MSP), developed at IRCAM by Miller Puckette in the mid-1980s.

Ungeheuer's concepts imply a rough chronological frame: concept one precedes concepts two and three, while two and three tend to overlap in her presentation. In an effort to flesh out the history of live electronic music, Emmerson has identified a series of small but significant technological revolutions, which he calls the three paradigms of development.

- Paradigm 1 (ca. 1950–80): the steady miniaturisation of circuits following the adoption of the transistor and the subsequent development of voltage controlled synthesis and processing in the mid-1960s, resulting in (a) the signal processing of a live instrument or voice and (b) the combination of this processed sound with prerecorded material;
- Paradigm 2 (the 1980s): the revolution of the personal computer and the invention of the Musical Instrument Digital Interface (MIDI) protocol, which enabled event processing in so-called real time;
- Paradigm 3 (the 1990s going forward): the quantum leap in processing power of personal computers and the emergence of the laptop allowed real-time signal processing, as well as the absorption of most aspects of studio and performance systems.

(Emmerson 2007a, 115–16)

Emmerson's paradigms map on to Ungeheuer's concepts very well, effectively sharpening the chronological articulation of her categories. Thus, an initial period of development in which analogue technology dominated (ca. 1950–80) was followed by a period in which new digital tools and personal computing replaced earlier equipment (ca. 1990 to the present).

Between these two periods, we have a transition phase (ca. the late 1970s to the early 1990s) in which new digital technology was combined with older analogue equipment.[5] Of course, the progressive nature of the story is destabilised, because older concepts and paradigms do not conveniently disappear when new ones arise. 'At each juncture the previous archaeological layer has not peacefully given way to the next, but has carried on, adapting and upgrading its technology' (Emmerson 2007a, 116). For example, after completing his monumental *Prometeo* featuring the innovative use of newly developed digital technology, Nono wrote *La lontananza nostalgica utopica futura* madrigal for several 'travellers' with Gidon Kremer, for solo violin, eight magnetic tapes and eight to ten music stands (1988–89). Even though it employs older technology, it would be wrong to understand this impressive work, written in the last years of the composer's life, as somehow going back to an earlier aesthetic. On the contrary, Nono's use of magnetic tape was informed by his recent achievements. Thus, today we are confronted with a complex assortment of live electronic practices that have arisen over the past half century and continue to cohabit and intersect.

Musique mixte – mixed music

If the terms and concepts currently associated with live electronic music have resulted in ambiguous and contradictory discourse, the situation with regard to 'mixed music', the English translation of musique mixte, is even worse.[6] Vincent Tiffon, one of the authors in this book, has defined musique mixte as concert music that associates acoustic instrumental music and sounds generated electronically; the latter being produced either in real time during the concert event or prerecorded and projected via loudspeaker during the concert.[7] This distinction between the real-time manipulation of electronically generated sounds in concert (temps reél) and sounds fixed on some medium in advance (temps différé) has been consistently present in discourse about musique mixte since the term emerged in the 1960s (Emmerson 2007a, 104).

In 1972, Fernand Vandenborgaerde published a short text that elaborated on this distinction and announced that Karlheinz Stockhausen's *Mixtur* for five orchestral groups, four sine-wave generators and four ring modulators (1964) was the first significant example of live electroacoustic manipulation of sound. He explained that Stockhausen's achievement constituted a response to a problem that had plagued musique mixte from the beginning, i.e. the stark, unrelenting contrast between the acoustic and electronic sound sources that characterised the early works of the 1950s (Vandenborgaerde 1972, 44–45).[8] In identifying the problem, he cited a text published three years earlier by his former teacher, Jean-Étienne Marie, who had attended the first performance of Edgar Varèse's *Déserts* for wind instruments, piano, percussion and tape (1949–54) at the Théâtre des Champs-Elysées in 1954. In Marie's view, the two distinct sound worlds of *Déserts* were merely

juxtaposed, resulting in nothing more than the 'confused, timid stammering of children', though he hastened to add that the work nevertheless identified 'the path to the future' (Marie 1969, 130–31).

During the 1970s, the meaning of musique mixte evolved and began to be used to differentiate new forms of interaction between human performers and electronically powered devices (enabled by digital tools then being developed at IRCAM and other centres) from the older works for performer and tape of the previous generation.[9] Mario Stroppa's *Traiettoria* for piano and electronics (1982–88) and numerous works by Jean-Claude Risset are often cited as new, innovative examples of musique mixte. According to Tiffon (2005b, 27), during this period musique mixte moved away from the aesthetics of collage (confrontation and juxtaposition) that characterised the early works to one of dialogue. The older distinction between temps reél and temps différé continued to be used discursively. However, by the turn of the twenty-first century, the explosive development of new digital tools rendered it obsolete (Tiffon 2013, 1300).

This brief examination of musique mixte suggests that the term is in fact the French expression of what in English has been and continues to be known as live electronic music. The terms are different, but the story is the same. Ungeheuer's concepts and Emmerson's phases of live electronic music easily coincide with the different categories of musique mixte and their historical development.[10] Indeed, even the scholarly examination of the respective terms, which took place independently, shows a remarkable parallelism. Vincent Tiffon submitted his PhD dissertation, entitled 'Recherches sur la musique mixte' in 1994, the same year in which Simon Emmerson published '"Live" versus "Real-Time"'. Since then, both have gone on to establish themselves as authorities with regard to the meaning and development of musique mixte (Tiffon 2013; 2005b; 2004 among others) and live electronic music (Emmerson 2012; 2009; 2007a among others). The subtle differences one finds in the respective discussions have more to do with the cultural backgrounds and contexts of the authors than with the music and technology the terms are intended to describe.[11]

If live electronic music and musique mixte do indeed designate the same music, then the English translation of musique mixte is unnecessary and ought to be abandoned, because it has generated and continues to generate confusion. The term mixed music appears to have emerged in the last decades of the twentieth century, thanks in part to the international success of IRCAM. However, its reception has been 'mixed', to say the least. While some have ignored it (Manning 2013; Collins 2007, 38–54), others have embraced the term and attempted to explain the difference between it and live electronic music (Landy 2007, 154–55; Emmerson 2007, 104–8). Recently Nicolas Collins et al. have addressed both terms in two separate sections of *Electronic Music* implicitly suggesting that the terms denote different categories (2013, 133–34 and 180–91, respectively). Concerning mixed music,

the authors note that though works for instrument and tape constitute the classical model, today the term is also used to designate:

1 the live processing of instrumental sound;
2 music produced by meta-instruments;
3 music using software to provide more flexible playback of prerecorded material;
4 live performance of electroacoustic instruments;
5 machine listening or interactivity;
6 computer-assisted instrumental composition.

(Collins et al. 2013, 133–34)

Thus, with the exception of compositions for tape, mixed music can now include any music involving some kind of electronically generated sound, creating a yawning catch-all category that approaches the universal fallacy, i.e. a term, a category, a concept or a theory that purports to explain everything explains nothing. Consequently, the editors have advised the authors of this book to use the original term 'musique mixte' and not the English translation.

Why do we choose to use a foreign term when plain English is readily available? English authors have been borrowing terms from Italy, France and Germany to discuss music for centuries. The problem with the English equivalents of 'bel canto' and 'Sturm und Drang' is that they erase the cultural and historical connotations of the terms, which are far more important than the definitions of specific words. An example of problems that arise when literal translations are applied too liberally is the unfortunate decision by Christine North and John Dack to translate musique concrète as concrete music (Schaeffer 2012). No English reader can possibly know what concrete music means, *unless* he or she is already familiar with Schaeffer's definition of musique concrète, in which case the English translation is utterly useless. In this case as well, we have advised our authors to stick with the original French term.

Live electronic music as performance

For the purposes of this book, we will define live electronic music as performance in which the electronic part has an impact on or is influenced by the performers in some interactive way (Bertolani and Sallis 2016). Donin and Traube (2016, 283) have recently observed that the scholarly examination of musical performance has become one of the most rapidly growing subfields of the study of music and particularly of the creative process. Our book contributes to this literature. Rather than attempting to understand live electronic music as a compositional category, as has often been done in the past, we believe it is best to approach it as a performance practice. Why insist on this distinction? After all composers usually consider the constraints of an eventual performance when they create their work. By focusing on performance rather than compositional techniques or strategies, we obtain

a more comprehensive and coherent understanding of live electronic music. A performance of *Symphonie pour un homme seul* for tape (1950) by Pierre Schaeffer and Pierre Henry at the Salle de l'Empire in Paris on 6 July 1951 provides a good example.

During the early 1950s Schaeffer and Henry experimented with a gestural controller that allowed a performer to modify the amplitude of individual loudspeakers in real time from a central position on stage and in so doing articulate the performance from a spatial perspective. According to Schaeffer, the goal was to associate musical form with a three-dimensional spatial form, whether static or cinematic.[12] He called the apparatus that enabled this a 'pupitre potentiomètrique de relief': roughly, a potentiometric desk that enables an acoustic articulation of space (Schaeffer, cited in Gayou 2007, 413). Designed and built by Jacques Poullin in 1951, the apparatus consisted of circular electromagnets placed perpendicularly between which a performer (in this case Pierre Henry) would move an activating device in and out of the circles. The gestures allowed him to control the sound intensity of the speakers placed around the audience (Teruggi 2007, 218). In 1953, an astonished correspondent for *The New York Times* reported sitting in a small studio equipped with four loudspeakers (two in front, one behind and one suspended above the audience) and listening to a performer articulate space.

> In the front center were four large loops and an 'executant' moving a small magnetic unit through the air. The four loops controlled the four speakers, and while all four were giving off sounds all the time, the distance of the unit from the loops determined the volume sent out from each. The music thus came to one at varying intensity from various points in the room, and this 'spatial projection' gave new sense to the rather abstract sequence of sound originally recorded.
>
> (Cited in Ungeheuer 1992, 152)

The example is pertinent here for two reasons. First, compositional strategies and techniques are not an inherent feature of live electronic music. *Symphonie pour un homme seul*, a classic piece of musique concrète, was not composed with the *pupitre potentiomètrique de relief* in mind and was initially performed without it. This work is not usually listed as an example of live electronic music, and yet when performed under the circumstances described above, that is precisely what it became for the duration of the performance. Second, live electronic music should not be associated with specific types of technology. According to Johannes Goebel, new digital tools developed in the last two decades of the twentieth century opened up a demarcation between a 'pre-interactive' period of live electronic music (corresponding with Ungeheuer's first concept) and the digital era, which enabled true interaction between performing agents (Goebel 1994, 3–4). Goebel's notion of true interaction and its implicit value judgement constitute of form of 'flat-earth' thinking. As our example clearly shows, musicians did not

wait for the emergence of digital technology to engage interactively with sound in real time. To be sure, the horizon of expectation with regard to live interactivity has changed considerably over the past half century. A reconstruction of the 1951 performance of *Symphonie pour un homme seul* would no doubt appear quaint to audiences familiar with the complex and polished capability of current digital technology, but to judge an event fifty years ago by today's standards misreads the past and ultimately hinders our ability to understand the present. Since the nineteenth century, composers and their acolytes have regularly misread and reinterpreted the past consciously, semi-consciously and unconsciously. Richard Wagner's reinterpretation of Beethoven's achievement, through his introduction of the term 'absolute Musik', is only one of a long series of such endeavours. The frequency and regularity with which this takes place does not justify the practice.

Thus, live electronic music is not a subgenre of electronic music, nor does it rely on specific technology. The term does not define a compositional type or category; rather, it designates the performance of music using some kind of electronic technology and covers a continuum of practice, 'from the single press a button to initiate playback, to in-the-moment fine control of all aspects of the music' (Collins et al. 2013, 180). Consequently, to examine live electronic music is to look 'over the whole history of electronic music, since the drive to take such music live has been ever present' (188). In his seminal article, entitled 'Live-Electronic Music' (published almost forty years earlier), Gordon Mumma came to the same conclusion, stating that the 'history of electronic music begins with live-electronic music', which for him meant the end of the nineteenth century (Mumma 1975, 287). As the reader will have noted, this timeframe differs sharply from the accounts of most authors, who normally place the beginning of electronic music in the years following World War II. This stark discrepancy reflects the fact that the history of Western music is usually written from the perspective of the composer and rarely from that of the performer. Compositional outcomes have been the backbone of music historiography since it began in the nineteenth century. Consequently, most authors in search of a terminus post quem for live electronic music have inevitably chosen the mid-twentieth century, when the radio stations in Paris and Cologne began using magnetic tape as a reliable storage medium. Composers quickly realised that the medium could be edited, allowing them to intervene creatively with recorded sound. This perspective conveniently ignores the fact that music using electronic devices had been made and performed for a half century already: see, for example, Thaddeus Cahill's Telharmonium, as well as the Thermin, the Hammond organ and the Ondes Martenot, to name but a few (Mumma 1975, 287–91).

Examining music that escapes conventional notation

Our definition of live electronic music puts performance at the centre of this book (both physically and metaphorically), which is not to say that we

ignore composers or their perspective. On the contrary, the book begins with chapters by Agostino Di Scipio and Chris Chafe, two very different composers, whose music shares (at least) one important characteristic. Both compose music conceived as performance events rather than as ideal aesthetic objects consigned to paper or some other fixed medium. Indeed, Di Scipio (2011a, 106) has categorically denied that he composes idealised sound objects at all. He presents *Two Pieces of Listening and Surveillance* (2009–10) by giving a detailed account of a performance, an unusual approach for a composer, but so appropriate for this book. Chafe presents Animal, an algorithm he created to react unpredictably in two pieces of computer music: an interactive installation entitled *Tomato Quintet* (2007) and *Phasor* for contrabass and computer (2011). Whereas the algorithm is activated in the former by ripening tomatoes and the presence of visitors, in the latter Animal has to be coaxed into unexpected sound outcomes by the contrabassist.

Our book also examines the circumstances under which live electronic music is composed: who is involved and how the creative process is organised. In Chapter 3, Laura Zattra discusses the collective nature of the creative process at the Institut de Recherche et Coordination Acoustique/Musique (IRCAM) in Paris, the Centre for Computer Research in Music and Acoustics (CCRMA) at Stanford University and the Centro di Sonologia Computazionale (CSC) in Università di Padova. She compares the roles of musical assistants at each of the institutions and explains how the professional computer music designer emerged at turn of the century.

The central section of the book containing five chapters focused on the performance of live electronic music. Chapter 4 is largely based on a series of interviews of Alvise Vidolin undertaken by Zattra over the past seventeen years. Vidolin, one of Italy's leading computer music designers, speaks of his close collaboration with Luigi Nono and Salvatore Sciarrino. The interviews contain detailed information about Vidolin's role in the first performances of major works, such as Nono's *Prometeo. Tragedia dell'ascolto* (1981–85) and Sciarrino's *Perseo e Andromeda* (1991). François-Xavier Féron and Guillaume Boutard present information obtained through a survey of twelve performers from France and Quebec in Chapter 5. All are classically trained on traditional instruments, and all have performed live electronic music. Using semi-structured interviews, Féron and Boutard interrogate the achievements and frustrations of the performers, examining first-hand accounts of what works and what does not with this type of repertoire. Chapter 6 takes this perspective one step further. Xenia Pestova writes about her extensive experience performing live electronic music as a pianist. Her chapter examines the innovative notational approaches that composers have devised in order to communicate their instructions and the challenges that these approaches entail for the performer.

Chapters 7 and 8 address robotic performance, an area that is likely to develop considerably in the coming years. Initially, John Granzow was

supposed to write the second part of a co-authored chapter with Chris Chafe. In the end, the authors submitted independent chapters, which can be read as one extended text. Whereas Chafe explores the internal mechanisms of his algorithm, Granzow examines Animal from the perspective of organology and performance. He compares it to the daxophone, a bowed electronic instrument designed, like Animal, to produce surprising and unexpected sounds. Following a brief overview of the field, George Tzanetakis examines the technical challenges of robotic performance. His research, carried out with a team of specialists, aims to produce automated instruments that can function as partners in improvisation with human musicians. His chapter reports on progress, as well as on the challenges that remain. In order to test techniques and methods embedded in his research project, members of the research team composed pieces, two of which are presented at the end of the chapter: *Red* + *Blue* = *Purple* for tenor saxophone and robotic piano (2012) by Tzanetakis and *Prepared Dimensions* for performer and robotic piano (2012) by Gabrielle Odowichuck and David Parfit. In both works, the creators (who function as researchers, composers and performers) experimented with automated improvisation.

This book was first proposed under the working title: 'Seizing the Ephemeral: The Composition, Performance and Study of Music that Escapes Conventional Notation'. The title was rejected because, given current search-engine technology, potential readers would probably not be able to find the book. It is worth citing here because it constitutes an important thread, linking the last six chapters of the book in which the authors examine authorship, reception, notation, transcription and the study of performance. All of these topics are related to the problematic fact that live electronic music, like much of the world's music, cannot be set in Western staff notation.

Chapters 9 and 10 by Angela Ida De Benedictis and Nicola Scaldaferri, respectively, were initially intended to make up one co-authored text, like those by Chafe and Granzow cited above. In her chapter, De Benedictis looks at how the performance practice of music by Luciano Berio, Stockhausen and Nono has generated problems of authorship and work identity. In the following chapter, Nicola Scaldaferri examines similar questions, but from the perspective of contemporary ethnomusicology. He is particularly sensitive to the impact of recording technology that objectifies performances of traditional music. By fixing this music on stable platforms, the technology provides opportunities to better understand the practice. However, it also raises questions about authorship and work identity that are foreign to the source culture.

In chapter 11, Dániel Biró and George Tzanetakis apply computational tools to recordings of Hungarian laments, Jewish Torah cantillation and Qur'an recitation to identify the pitch content of this music, which cannot be accurately set in conventional staff notation. As such this chapter can be understood as a bridge. On the one hand, it continues the examination of traditional music that we encountered in chapter 10. On the other, it presents

automated methods developed to identify pitch content similar to those in chapter 12.

In the next two chapters, Jan Burle and Friedemann Sallis focus on the same object of study: a recorded performance of Luigi Nono's *A Pierre. Dell'azzurro silenzio, inquietum* for contrabass flute in G, contrabass clarinet in B flat and live electronics (1985). Burle reports on the transcription of the recorded audio data captured on a spectrogram in Chapter 12. Using a combination of automated pitch analysis and close human listening, Burle and student assistants were able to identify the salient musical events of the performance, articulated by both real (the two performers) and virtual (the delay, the harmonisers and band pass filters) voices. The data collection and transcription methods developed for this project present examples of how the study of music is adapting to the new technological environment. Building on the outcome of the previous chapter, Sallis presents an interpretation of the performance of *A Pierre* in Chapter 13. As De Benedictis pointed out in Chapter 9, Nono's late work is elusive because large portions of it cannot be set in conventional notation, and performances will change from site to site depending on room acoustics. Consequently, one of the only means we have to study this music in its entirety is through an examination of recordings of specific performances.

In the final chapter of this book Vincent Tiffon examines the performance experience of two very different pieces of live electronic music: … *Of Silence*… for alto saxophone and chamber electronics (2007) by Marco Stroppa and the digital installation entitled the XY Project (2007…) created by Tiffon and a team of researchers. Tiffon compares the traditional concert presentation of Stroppa's piece, with the experience of visitors engaging with the XY Project. The latter is made up of a graduated series of game-like events that force visitors to actively listen and act on what they hear. In this process and regardless of their previous training, engaged visitors are transformed into 'musicants' (i.e. musical participants).

The companion website: live-electronic-music.com

Discussing music without hearing it is like looking at paintings with closed eyes. A book, as a printed medium, can contain only text and static images. The number of images, their size and resolution are limited, and they can be printed only in shades of grey, lest the book become too expensive to print. CDs or DVDs were included with books that needed multimedia – audio to be played in a CD player, colour images and videos to be watched on a computer screen. But CD and DVD players are disappearing, both as portable devices and as parts in personal computers, replaced by media streamed over the Internet. Personal computers are being replaced by tablets and smartphones with Internet connection, anywhere and anytime.

Therefore, we did not produce a CD or DVD as a multimedia companion to the book, but rather created a companion website. The web address

of the website complements the title of this book and thus is easy to remember: live-electronic-music.com. On the website, the interested reader will find, for selected chapters, playable audio tracks of musical works discussed in the text, higher-resolution full-colour versions of printed images and additional material, such as images that for space reasons could not be included in the printed book. The companion website also contains an errata and corrigenda page where mistakes will be rectified as we become aware of them and gives the reader an option to send an electronic message to the editors.

Notes

1 The Group's name was clearly an effort to translate 'live electronic music' in Italian.
2 See, for example, Richard Toop's discussion of electroacoustic music, which he subdivides into two categories: tape music and live electronics (2004, 464–66).
3 The same terminological anxiety does not appear in discourse about popular music. From the crooners of the 1930s who used microphones to transform vocal technique, through the electric guitar and the emergence of turn-tabling, electronic technology has been part and parcel of the worldwide development of commercial popular music.
4 In Chapter 4, Laura Zattra addresses these interactions and presents the different types of agents, notably the computer music designer, that intervene in the composition and performance of live electronic music (see also Zattra and Donin 2016).
5 Hans Peter Haller (1995) presents an excellent overview of this transition period seen from the perspective of the Heinrich Strobel Stiftung in Freiburg.
6 Musique mixte has been translated into Italian (Zattra 2008), but, to the best of our knowledge, not in German. The item entitled 'Elektronische Musik/Elektroakustische Musik/Computermusik' in the *Lexikon Neue Musik* contains a section on Live Elektronik Musik, but no mention of musique mixte (Supper 2016, 218–26).
7 La musique mixte est 'une musique de concert qui associe des instruments de musique d'origine acoustique et des sons d'origine électronique, ces derniers produits en temps réel – lors du concert – ou fixés sur support électronique et projetés via des haut-parleurs au moment du concert' (Tiffon 2005b, 23).
8 Echoes of this problem can be found reverberating through the literature down to the present day (Tiffon 2013, 1303–4).
9 A significant part of this shift is no doubt the rise of the spectral composers in France; notably, Gérard Grisey and Tristan Murail had a strong impact on how the composition and performance of music involving electronically generated sound was defined and discussed.
10 Discussions of the terms often cite the same exemplary works; see, for example, Tiffon's list of 111 works (2005b, 40–4).
11 Without indulging in cultural clichés, it is difficult not to notice the Latin desire for clarity and order in Tiffon's finely drawn typologies and precise categories of compositional strategies. By the same token, Emmerson's analysis of 'liveness' as a performance event displays the traditional English preference for pragmatic explanation.
12 'Associer la forme musicale proprement dit à une forme spatiale, statique ou cinématique, tel est le but de ce premier essai de projection en relief intégral, c'est-à-dire en trois dimensions' (Schaeffer, cited in Gayou 2007, 413).