

Clarke, M., Dufeu, F. and Manning, P. 2020. *Inside Computer Music*. New York: Oxford University Press. ISBN 9780190659653 (paperback).

Ambrose Seddon
Bournemouth University, United Kingdom
aseddon@bournemouth.ac.uk

Inside Computer Music is a striking achievement because it redefines the field of electronic/electroacoustic music analysis in terms of the methods employed, and the means of presenting the findings to the reader. The overall approach is to “explore the relationship between new technical innovations in computer technology for music and the creative practice of composers employing these new techniques” (p. 1), and this is done through nine case studies. The fullest experience is had through simultaneous engagement with the 400-page book, a collection of downloadable interactive software applications (one for each case study), and the accompanying website, which hosts instructional videos relating to the case study software. Significantly, the accompanying software allows the reader to try out, experiment with, and creatively explore emulations of the sound creation and sound processing techniques discussed in each of the case study chapters. The software also provides interactive structural charts (which look like simplified digital audio workstation sessions) illustrating where particular sounds occur within music. This allows the reader to audition the whole work or single audio components, as well as opportunities to reorganise the visualisation of those components in some cases. Instead of simply reading about an underpinning technique, readers can try it out for themselves, experiencing first-hand the opportunities that were available to the composer at the time of composition, and how they went about organising the musical material when composing. Video interviews are also embedded into the software, in which the composers discuss their approaches to using the various computer technologies. Accordingly, the reader’s own experience of exploring the techniques can be related to the perspectives of the composers themselves, and then on into the findings of the analysis in each chapter. *Inside Computer Music* offers an experience of interactive enquiry that builds on existing approaches of reading about a work in conjunction with a recording, by additionally engaging with: the first-hand perspectives and experiences of the composer; the technological tools and techniques involved in the creative process; and interactive structural charts that allow deeper aural interrogation of the sounds themselves and how they relate to one another in the final composition. As such, the reader is offered a uniquely empirical opportunity for investigation regarding these works and the technologies and techniques behind them. The clarity of the discussion and presentation makes the book and supporting materials suitable for undergraduate and graduate students, as well as composers, researchers and interested non-specialist listeners.

The selections for the case studies naturally reflect developments in computer technology, which is positioned as distinct from technologies associated with the

development of analogue electronic music more generally. Indeed, none of the case studies could have been composed without digital technology, and so they cover music composed between the 1960s and the 2010s. The selections settle around parallel developments in computer technologies in the United States, the United Kingdom, France, and Australia. In the introductory text the authors acknowledge the exclusivity of these settings - a main distinction between early computer music and the developments in electronic music using analogue technologies was that only those with access to institutional computers could explore such practices. With an evolving scene in the 1960s and 1970s, we learn of the systems that became established in universities in the United States, namely at Princeton, Columbia, the Massachusetts Institute of Technology, Stanford University, University of Illinois at Urbana-Champaign, and University of California San Diego. And in the 1970s, the Institute de Recherche et Coordination Acoustique/Musique (IRCAM) purchased a mainframe computer, and IRCAM would play a considerable role in the development of computer music.

Developments in computer music, from earlier works created on mainframe systems to those created using personal computers, are covered across the various case studies. It is worth briefly summarising the chapter topics here to illuminate the technological and geographical narrative strands, and the range of works under discussion. Chapter 1 begins with the work of Max Mathews and associates at Bell Telephone Laboratories from the mid 1950s onwards, and then looks at the work of John Chowning, and his composition *Stria* (1977), utilising frequency modulation (FM) synthesis on a large mainframe computer. Chapter 2 addresses Barry Truax's *Riverrun* (1986), in contrast composed using a powerful minicomputer that enabled a fully interactive and real-time implementation of granular synthesis. We then encounter Philippe Manoury's *Pluton* (1988) in Chapter 3, composed at IRCAM, Paris, and illustrating the shift from mainframe computing towards systems enabling real-time synthesis and signal processing. The developments at IRCAM are presented in some detail here because they are foundational to the subsequent development of important tools for computer music performance and composition. Chapter 4 investigates Hildegard Westerkamp's *Beneath the Forest Floor* (1992), exploring her work with soundscape composition in and around Vancouver, Canada, offering perspectives on computer music featuring ostensibly naturally produced sounds. We then return to Paris and work at the Group de Recherches Musicales (GRM) in Chapter 5. Beginning in the late 1970s, GRM's transition from analogue to digital technologies began in the late 1970s, and resulted in some significant compositional resources. These developments are discussed with reference to the work of Francis Dhomont and an analysis of his composition *Phonurgie* (1988). Chapter 6 explores important developments in the UK, where, from 1986, the Composers Desktop Project (CDP) aimed to offer powerful computer music resources that were affordable for individuals. Accordingly, the compositional and technological work of Trevor Wishart is explored in detail, followed by an analysis of his composition *Imago* (2002). Links to IRCAM return in Chapter 7,

examining Jonathan Harvey's *Fourth String Quartet* (2003). The subject of the analysis is the creative exploration of real-time signal processing in combination with instrumental forces. Chapter 8 looks at *Music for Tuba and Computer* (2008) by Cort Lippe, who is both a composer and software developer with experience working at IRCAM before settling at the University of Buffalo, New York. Lippe's work largely focuses on music for instrumental performers and digital electronics, with software applications created for specific works. Finally, Chapter 9 explores Natasha Barrett's *Hidden Values: The Lock* (2012), with particular focus on advanced techniques for the spatialisation of sound materials in performance spaces. Recent developments in computer technology have made possible highly sophisticated tools for controlling sonic spatiality and spatial imaging, and Barrett's work with the spatialisation facilities at IRCAM whilst composing *The Lock* frames this chapter.

Evidently there is a great range of compositional approaches under investigation, although usefully each case study chapter follows the same simple overarching structure of: (i) Contexts, (ii) Inside [the composition], and (iii) Conclusions. I found the 'Contexts' sections to be extremely rich in background information regarding the composer and technical detail as related to the technologies underpinning the work in question. The 'Inside' sections delve deeply into the underlying techniques, creative processes and thinking behind the work, supported by the interactive software, interviews, and website instructional videos. And the 'Conclusions' naturally summarise but also make some sense of the findings of the analyses and the relationship between the composer and their software tools. All the chapters provide rich and informative discussions, dealing with often technical topics in ways that can be swiftly grasped. At this point is worth looking at some example chapters to give a sense of navigating the materials.

Chapter 2 concerns John Chowning's *Stria*.¹ The 'Contexts' section outlines the technological developments taking place at Bell Labs in the early 1950s, providing valuable historical perspectives on the work and the circumstances that enabled Chowning to compose *Stria* in the first place. For example, technological developments were focused on increasing the density of communications transmitted across the telephone network, involving the needs of speech but also music. The chapter also discusses relevant digital-to-analogue signal theory, and a summary of the development of the Music *N* programmes, what each iteration offered, and the technological and programming issues at play. We also learn of the various composer collaborators working with Max Mathews, including David Lewin, James Tenney, and Barry Vercoe (at the Massachusetts Institute of Technology). This all provides a rich impression of these pioneering years of computer music. Similarly, Jean-Claude Risset's innovative attitudes to the creative

¹ *Stria* has been examined previously from a variety of different perspectives, such as the philological investigation of Zattra (2007), Dahan's perceptual analysis (2007), and Meneghini's analysis of compositional techniques (2007) While elements of these previous articles are referred to in Chapter 2, *Inside Computer Music* offers its own perspectives and the potential for experiential insights.

manipulation of timbre and spectral components through analysis and re-synthesis techniques are given considerable attention. Risset began working at Bell Labs in 1964, and the discussion briefly turns to his composition *Mutations* (1969) and how it made use of Chowning's pioneering algorithms for FM synthesis. These algorithms then become the focus, along with some biographical detail for Chowning, and a brief account of the data coding 'error' that was Chowning's initial inspiration for subsequent explorations.

A clear yet detailed discussion of FM synthesis follows, and this is where the software and website videos come into their own. The software allows the reader to explore simple and complex FM synthesis first-hand to really understand the techniques involved, while the website videos provide demonstrations for each software activity to enable more informed play and experimentation. One needs to access both the website and the software for the fullest experience, as the demonstration videos introduce the aims and possibilities of the software in the first instance. Any reader who has attended or delivered a class about FM synthesis will know that discussions of sidebands and deviation become particularly meaningful when trying the techniques and hearing the results. Here we can experiment in such a fashion, whilst the visual nature of the software interface allows us to explore how the amplitude and frequency parameters interact, illustrating Chowning's discoveries and the innovations outlined in the book text. Indeed, a number of presets mimic Chowning's own settings. I found this chapter to be a very good way to encounter FM synthesis as a technique, to understand it in terms of the foundational principles, but also to see it in relation to a musical work. Chowning's *Sabelithe* (1971) and *Turenas* (1972) are discussed as the predecessors to *Stria*, featuring many similar techniques and musical approaches, not least ideas around the digital control of spatial projection. And Chowning's involvement with Yamaha and the licensing of the algorithm for use in their future hardware synthesisers is discussed, as well as his influence on developments at IRCAM in consultation with Pierre Boulez.

This rich technological and musical contextualisation points towards the main subject of the chapter, 'Inside *Stria*'. We become quickly acquainted with the ways in which the computers of the time facilitated explorations of new pitch scales, spatial distribution of sound, and the macro and micro level control of musical materials. Underpinning principles, such as the use of the golden ratio to create pitch and temporal structures, and the spectral shaping afforded to Chowning through dual-modulator FM synthesis, are also discussed. The text guides us to the relevant website video or software materials throughout. For example, video interviews embedded within the software feature John Chowning discussing his creative process; these are signposted where relevant, providing invaluable perspectives. Similarly, 'two-modulator FM' configurations are discussed in the text, demonstrated in the website videos, and can be experimented with in the software. The software also provides an emulation of the complete synthesis algorithm used in

Stria. This algorithm is detailed in the text, noting how Chowning did not input data for each sounding element but rather used his SAIL program to define larger scale 'events' that comprised many individual 'elements', and then SAIL would calculate the data for each element. The SAIL program is described, and the software allows for further experimentation and play to replicate and then create sound events, with support from the demonstration videos. I found this to be an extremely rich resource - rather than just emulating *Stria*, the software allows for the adjustment of parameters to create your own version whilst developing a hands-on understanding of how parameter adjustment impacts on the algorithmic generation of the events. This is achieved through a visually oriented implementation of Chowning's algorithm in Max. The software also offers a command line interface version of SAIL akin to that originally used by Chowning, allowing you to get an idea of how the composer worked.

Finally, the text deals with the 'shape of *Stria*', addressing structural features. The software allows for a DAW-like overview of the various events and elements, but with extra flexibility. For example, while the X-axis still represents time, the disposition of events and elements can be rearranged in the Y-axis according to various sounding features such as duration (shorter elements at the bottom of the display, longer elements appear towards the top) or carrier frequency (elements with lower carrier frequencies at the bottom of the display, and higher towards the top, as one might expect). *Stria* is shaped by the data inputted to the SAIL algorithm to define the various events, and being a deterministic algorithm, SAIL could regenerate the entire composition if the same data were re-entered. Accordingly we gain fascinating insights into the nature of the system that Chowning created and used for composing. Other important features are revealed through the software presentation. For instance, Chowning conceptualised the structure as reflecting the shape of a typical amplitude envelope but inverted - instead of an ascending then descending envelope, there is a descent-ascent pattern. But viewing the whole work in terms of aspects such as carrier frequencies reveals greater pitch complexities at particular moments, which are commented on in the text. Or when viewed in terms of the durations of the 'elements', we see that there is a tendency towards shorter elements and events in the middle of the work.

The 'Conclusions' section summarises the chapter, but also reflects on algorithms and the role of the composer in the context of *Stria*, suggesting that the creation of the algorithms themselves is part of the compositional process and involves musical decisions. For *Stria*, any distinctions between creative and technical invention are blurred, if not eliminated, because they are both integrated into Chowning's compositional process.

But how might this methodology for exploration play out for computer music with a different creative focus? Having looked at music made with FM synthesised sound, for contrast we might usefully explore the chapter on Hildegard Westerkamp's

Beneath the Forest Floor, concerning music made with environmental sound, and then the final chapter examining Natasha Barrett's *Hidden Values*, focusing on the use of spatial techniques within the compositional process.

Chapter 4, 'Hildegard Westerkamp: *Beneath the Forest Floor*' investigates how computer technology has been significant in the development of music composed from naturally occurring sounds.² Again, the 'Contexts' section is rich in historical underpinnings and perspectives by providing a brief history of the World Soundscape Project (WSP) led by R. Murray Schafer at Simon Fraser University (SFU), Vancouver, beginning in the 1960s. We learn that the presence of Barry Truax and Hildegard Westerkamp was of great importance to the developing WSP at SFU through the 1970s, and that what is now called 'soundscape composition' developed by exploring the creative potential of sounds that were originally captured for the archival and analytical aims of the WSP. Some brief composer biographical information on Westerkamp is provided, followed by some foundational perspectives on soundscape composition from Truax, which will be helpful to those less familiar with soundscape approaches. The discussion is deeper and more nuanced than can be conveyed here, and draws upon both literature and interview sources to build a coherent summary of the activities of the WSP at SFU in relation to Westerkamp.

The focus then shifts to Westerkamp's activities prior to *Beneath the Forest Floor* (1982). Interview quotes illustrate how creating works in the studio, combined with the potentials of environmental sounds, was exciting for Westerkamp, while the broadcast opportunities of Vancouver Co-Operative Radio offered a public outlet for the works produced. Westerkamp's developing practice in the 1970s and 1980s is discussed, during which connections between composition, acoustic ecology and activism through creative practice are brought into focus. The text also addresses the practice of sound walking and, for Westerkamp, its relation to composition, along with informative examination of pertinent works commissioned and composed in the 1980s, all of which set the scene for the subject of the chapter, *Beneath the Forest Floor*. I found this background discussion to be hugely valuable because it provides a clear sense of where *Beneath the Forest Floor* sits within the composer's broader practice, and the various creative experiences that were likely foundational to its creation, whether compositions, installations, or film soundtrack work. The text provides a valuable account of the breadth and depth of Westerkamp's practice. Finally, we learn that *Beneath the Forest Floor* was commissioned by CBC Radio and was realised in the company's digital Advanced Recording Facility in Toronto.

² Like *Stria*, this work has been examined previously elsewhere, for example, Landy's analysis focusing on the listening experience (2020), and the analysis of Duhaupas and Solomos, which considers "conceiving music as experience, and in particular, as experience of place" (2014: 6).

The section 'Inside *Beneath the Forest Floor*' provides further background information through programme note and interview quotations. We are told that the work was composed solely from sounds recorded in British Columbia, and in particular the old-growth rainforest of the Carmanah Valley in the southern region of Vancouver Island, which was under threat from logging at the time of composing. The intention was for the work to inspire listeners to go to and experience such places to understand why they should be protected and preserved. As with the analysis of Chowning's *Stria*, at this point we are directed to the accompanying software to see interviews with Westerkamp discussing her approach. We learn that digital technology afforded novel ways of thinking about composing, particularly regarding field recordings and the ability to capture detailed recordings of quiet environments, and to then edit and process them. Again, the software comes into its own here - raw field recordings let us get familiar with the environments and materials of the final work. The book text elaborates how and where those recordings are used within the work, and the composer's approach to treating those sounds - to treat some recordings as entire environments whilst, for others, to separate out specific elements using digital processing. The software again allows us deep insights - I was particularly struck by the 'genealogical' chart through which we can examine the successive steps of editing and transformation of the raw material within the compositional process and trace the various developments. This chart looks confusing to begin with, so I would strongly advise readers to watch the instructional videos on the website, as the various possibilities for exploration are not obvious, initially. A paradigmatic chart plots where the various sounds occur across the work, allowing the opportunity to audition them individually and compare the various instances. There is a section devoted to digital processing of environmental sources, covering techniques such as gating, delay & reverberation, and transposing and harmonizing, valuably exploring the creative application of the techniques and allowing the reader to try them in the accompanying software. The examples are extremely well curated to reveal the creative potential and possibilities of the processing, making excellent examples of transformational processes executed within a creative context. The penultimate section concerns assembling the final work through the creation of different 'pre-mix' files of the various sections, looking at how the digital technology allowed for these alternative mixes. Different amplitude levels amongst sounds are used to create different emphases, as well as the inclusion of new sounds in some cases and at the final mix stage. The accompanying software allows you to listen to these alternative pre-mixes. Finally, the structure of the composition is addressed, accounting for the sounds heard and some of Westerkamp's thinking behind their disposition. Four main sections are identified (Opening; Storm; Water; Ending) and their characteristics and significance to the musical structure are discussed. The paradigmatic analysis presentation within the software again allows us to see how the various sounds and sound types are organised within the work, with the timeline working in the vertical domain, top to bottom. The software offers the facility to indicate the occurrence of groups of sound events based on the degree of processing or the material type, and one can

listen to a specific sound by clicking on its 'object' in the chart. This tool appears to play back very specific time locations within the composition, guided by a graphical display of the occurrence of the various sound events of the work. Although a simple idea, it means that we can really get 'inside' the music through reading the book text and probing the sound material in a temporally focused and accurate way. This is an informative yet a largely descriptive section, incorporating interview texts to illuminate the compositional decisions at play. Perhaps some degree of interpretation of the music could have been valuably included, making some sense of what is heard from a listening point of view, although arguably this is beyond the remit of the book's approach and is dealt with elsewhere. Indeed, the texts of authors such as Landy (2020) and Duhauptas and Solomos (2014) are complementary to this analysis.

While this chapter focuses on the relationship between technologies involved and the creative process, the creation of sounds, and the deployment of sounds (as with Chapter 2 discussed above), the nature of *Beneath the Forest Floor* and its materials makes for a very different reader experience. The discussion explores a contrasting area of computer music creativity and the opportunities that digital field recording and sound processing offered Westerkamp, shaping the creation and development of the work, but also how such sound materials might be handled and deployed. I found the software presentation to be a rich collection of resources, comprising interviews, examples of processing, the paradigmatic chart, and the interactive structural chart, and is a collection that I expect to return to. The Conclusions section of course draws the chapter together, but also points to the fact that digital audio technology enabled Westerkamp's particular approach to composing with environmental sound, integrating detailed, naturalistic field recordings with much more processed materials, poetically connecting abstracted sounds with the originals.

Moving on to the final chapter of the book, 'Natasha Barrett: *Hidden Values-The Lock*', I was intrigued to see and hear how the spatial aspects of the composition were navigated within the discussion and the software presentations. Barrett's work is explored because it offers perspectives on the innovative use of modern digital spatial technologies within the creation of electroacoustic music, with an emphasis on "the use of spatial projection as a primary component of the compositional process" (p. 307). The 'Contexts' section outlines some early developments in spatial sound composition in the 1950s and 1960s through the works of Berio and Stockhausen, and the subsequent development of diffusion practices based on analogue systems in the second half of the 20th century. John Chowning's experiments with the Music IV system at Stanford University in the 1960s are also discussed - they led to ground-breaking 4-channel spatialisation techniques in the digital domain. Surround sound approaches are briefly surveyed, covering quadraphonic and octaphonic loudspeaker arrangements, and then Dolby Atmos in cinema contexts, all leading to a more detailed discussion of ambisonics, the system

employed by Barrett. In contrast to conventional amplitude-based panning techniques, we learn that ambisonics codes the sound amplitude, and vertical and horizontal positioning information in terms of vectors, to be decoded at the moment of playback (rather than sound being panned within a fixed surround sound loudspeaker format such as 7.1 or a 'circle of 8'). The ambisonics section provides a clear and thorough grounding in the concepts underpinning this approach, describing the foundational principles of sound field capture and decoding for playback. The subsequent discussion of the IRCAM Spatializer (Spat) system, as used by Barrett, covers the history and development of this tool. Spat offers a range of spatial audio tools, which are discussed here: (i) higher order ambisonic processing, (ii) wave field synthesis (WFS), and (iii) vector-based amplitude panning (VBAP), although we learn that Barrett has been "less persuaded" by the latter method (p. 321). The final contexts section concerns Barrett's work and research into spatial projection, which is detailed and informative in terms of her developing notions of space and spatiality in its various forms, and how this led her to focus on the possibilities and spatial positional accuracy of higher order ambisonic formats (HOAs). This discussion provides insights into Barrett's developing approaches to HOAs and how they were implemented within particular works, often in combination with conventional spatialisation techniques i.e. hybrid approaches to spatialisation. Once again we have a computer-based technology, described in pertinent detail, underpinning the creative concerns of the composer and addressed in the musical work in question.

The section 'Inside *Hidden Values - The Lock*' introduces the composition, which is part of a triptych exploring inventions that have affected everyday lives in many ways - *The Umbrella*, *Optical Tubes*, and *The Lock*. Composed during an IRCAM residency in 2011-12, we learn that the composition focuses on the exploration of different implementations of HOAs along with musical considerations: "distance information, enhanced spatial resolution, detailed recorded sound-fields to capture accurate real world spatial relationships and the control of sound points, and motions and masses in relation to both timbre and "extra-musical" meaning." (p.329). As before, the video and software aspects come to the fore in this section. Significantly, the software offers a variety of sound output formats - a binaural option is included for headphone playback, but the software can also cater for multichannel loudspeaker systems, enabling playback on 2D and 3D loudspeaker arrays.

The interview footage is extremely informative, giving insights into the thought processes behind the compositional approach. Vocal and percussion sounds were developed into the core materials of the work, and these can be auditioned within the software using the presentation 'Genealogies of materials'. This section, as with chapter 4 discussed above, offers fascinating insights into the raw material and its subsequent transformations. The accompanying video is again essential by swiftly revealing how to navigate the software presentation. We learn that performances of

The Lock require live computer playback, using Steinberg's Nuendo for sequencing the sound material, and IRCAM's Spat library, hosted in Cycling 74's Max, for spatialisation. We get valuable insights into Barrett's approaches to playback and spatialisation of sound materials through the book text and interview videos, with audio examples embedded within the software. The 'Interactive structural chart' within the software offers an emulation of the composer's Nuendo session along with valuable visualisations of the SPAT positions of the various sounds, providing an additional layer of spatial detail to those listening with the binaural audio option. The chart illustrates both local and global aspects, with the possibility of playing back sounds individually and together. We also learn of the 3-dimensional positioning and movements that are implemented in performance using the SPAT suite of objects, offering sound source positioning as well as playback of pre-recorded spatial trajectories. Particular spatial techniques and approaches are discussed in detail - rotations, image transpositions, and spatial randomisation - supported by interview and video materials in the book and software.

I was especially interested in the final section, 'Spatialisation and dramatisation in the structure of *The Lock*', which effectively illuminates Barrett's attitudes to space and how they are embedded within the various stages of the compositional process. The book text addresses the spatial characteristics of the work as related to the computer technology, and the intentions of the composer; how these interlock with the two core elements, a soprano and percussionist, to create a spatial play; and insights regarding how spatialisation informs the structure of the music. All of this is supported within the software by further video discussions with Barrett, the paradigmatic chart, and the interactive structural chart. I found the book text discussions rich and informative, moving well beyond description of what we hear (though of course this is the starting point), and really getting to the heart of the poetic-spatial thinking. The 'Interactive structural chart', with its multichannel and binaural options, is invaluable for getting to grips with the finer details of the work, reinforcing the idea that this method of presentation will be informative for listeners, students and researchers alike. While the book text directs one's initial investigations of the supporting materials, there is much more to explore and to be discovered.

Each of the three chapters explored in detail here illustrate why *Inside Computer Music* is a major step forward for the analysis of digital electroacoustic work. It is clearly the culmination of extensive research and the development of a coherent analytical approach and accompanying software tools. The interactive approach is extremely important and innovative, redefining what is possible in the presentation of electronic/electroacoustic music analysis. A particular strength of the book is that it deals with technical aspects of computer music through the compositional lens, and while the technical discussions are often detailed, they are always extremely clear and tangible, making *Inside Computer Music* an excellent research and study resource. All the chapters offer rich insights into the works in question - each aspect of the contextualisations, analytical processes and discussions are worthy of merit in

themselves, and the creation of the accompanying software programmes for each case study are considerable achievements. Each chapter follows the same structure, and the software presentations are laid out consistently - I found this useful because it offers some degree of methodological consistency when discussing different kinds of work. But perhaps the most striking aspect of this publication is that a wide variety of analytical perspectives are drawn together in one place using a variety of pertinent tools. From a personal scholarly and compositional perspective, I found the volume to be of immense value, allowing deeper insights into works that I was already aware of, whilst also offering inroads into those previously unheard. These analyses will also be extremely useful to anyone teaching courses in computer music, electroacoustic music and sonic arts. Each chapter offers a rich contextualisation, an introduction to the underpinning technologies, opportunities to experiment with those technologies, and the option to examine in detail the variety of sound materials that constitute the work alongside the various structural features. The software presentations will likely raise expectations for future electroacoustic music analyses - the paradigmatic charts, for example, enable playback that can focus in on very specific features. And the opportunity to explore the actual techniques used by the composer, supported by interview footage, makes one feel engaged with the musical thinking and how it relates to, and is supported by, the technology.

References

Dahan, K. 2007. Surface Tensions: Dynamics of *Stria*. *Computer Music Journal* 31(3): 65-74.

Duhautpas, F. d. r. and Solomos, M. 2014. Hildegard Westerkamp and the Ecology of Sound as Experience. Notes on *Beneath the Forest Floor*. *Soundscape, The Journal of Acoustic Ecology* 13(1): 6-9.

Landy, L. 2020. Hildegard Westerkamp's *Beneath the Forest Floor* (1992). In M. Puckette and K. L. Hagan (eds.) *Between the Tracks: Musicians on Selected Electronic Music*. Cambridge, MA: MIT Press, 39-62.

Meneghini, M. 2007. An Analysis of the Compositional Techniques in John Chowning's *Stria*. *Computer Music Journal* 31(3): 26-37.

Zattra, L. 2007. The Assembling of *Stria* by John Chowning: A Philological Investigation. *Computer Music Journal* 31(3): 38-64.