an autonomous work." The piece as it stands evokes visual imagery and does not hide its close relationship with the stage. I wonder if I should have watched the play to derive maximum pleasure from listening to this. As it unfolds and I listen repeatedly, I find more connections and put together some kind of mental plot, but it comes back to reconstructing in my mind what the original must have been like. Should this piece be able to stand on its own in concert as, say, *Petrushka* can be played without the ballet? Perhaps. It is for each listener to decide. In any case, the sounds of the actors at work and the inclusion of the aural environment of the industrial neighbourhood where the rehearsal building was located seem to add a dimension of "acoustic ecology" to the work, but maybe that is a facile reference. I am sure this piece will have a very diverse impact depending on how close you are to the original play and how much you enjoy "theatrical" environments. I can't separate it from the original idea, and I wonder, if I had not read the liner notes, whether the effort in aural reconstruction would have been equal to the pleasure I have had listening to other works on this disc. I think *Clair de Terre* (1999-2001), which also has a theatrical background to some of its movements, is worth listening to in order to more clearly show the dexterity with which Normandeau has surmounted these challenges in the past.

Book Reviews

Simoni, Mary, ed.
Analytical Methods of Electroacoustic Music
Routledge, December 2005
(312 p., ISBN 0415972694)
Reviewed by Kristian Twombly

The field of electroacoustic music is still quite young, and precious little exists in the way of analyses and published theoretical approaches to this music. It is only in the last few years that collections of such analyses have begun to appear, and Mary Simoni's *Analytical Methods of Electroacoustic Music* is a valuable addition to this important field of study.

The collection of essays represents a variety of musical and analytical approaches and, after an introduction from the editor, is launched with a welcome discussion of some basic concepts in acoustical and electronic analysis, written by Norman Adams. This essay briefly describes various methods of representing audio signals visually, from time-domain representations to spectrograms, each with numerous examples from a variety of audio sources. While the spectrogram is the primary representative tool used in the book, Adams' essay presents both the usefulness and drawbacks of each form of representation, including fundamental (and often overlooked) aspects, including logarithmic versus linear frequency graphing and window sizing.

The next essay, by Leigh Landy, is perhaps the most distinct in the collection. Most of the essays focus on timbral and compositional issues, but Landy presents what amounts to a sociological study on compositional intent in electroacoustic music. As the author states, "This investigation is based on the premise that certain forms of music deserve a larger audience than they currently have" (p. 29). The Intention/Reception Project therefore attempts to empirically measure audience response through questionnaires and post-listening discussion. For the purposes of the study, the study groups were divided primarily according to familiarity with electroacoustic music. Each group heard two different works—*Prochaine Station* by Christian Calon and Claude Schryer and *Valley Flow* by Denis Smalley—multiple times. Composer intent was determined primarily through answers given to a series of questions by each composer, and listener response was similarly garnered with the addition of a group discussion following each listening session.

This essay was challenging for a number of reasons. *Valley Flow* proved to be too long

to play in its entirety until the final listening session, and one wonders if perhaps a shorter work could have been chosen. Some data was disregarded due to varying testing conditions, and ultimately Landy proclaims "no large-scale conclusions should be drawn here due to modest sample sizes" (p. 35). The descriptions from the testing subjects reflect a desire to link the sounds heard to imagined sound sources, such as "a kettle," "recording of a stomach" and "animal sounds" (p. 45). While none of the composers stated expressly that they favored reduced listening practices[1], Smalley states that he wishes that the listener hold onto "the layering of sonic material, pitch, the work's sonic language" (p. 43). I can see the usefulness of continued study in this area, albeit for a particular style of electroacoustic music for which listener intent occupies a greater level of interest, such as soundscape composition. However, the implication that "intention information" demands consideration stands in direct contrast to those composers who might follow a different compositional methodology (a Cagean approach springs immediately to mind). While my feelings about the project remain guarded, I look forward to further research in this area with both a larger listener sample and an expansion of the pool of compositions utilized.

1 Pierre Schaeffer's *écoute réduite*. mentioned by Landy as a mode of listening that is nearly in opposition to what he wished to study, namely the "access to or the communication of meaning" (p. 31).

As If by Paul Lansky is the subject of the next essay, by editor Mary Simoni. This work for tape and string trio was composed in 1981 and 1982. Simoni's analysis focuses primarily on the pitch material, with an exhaustive set theory analysis for each of the four movements. While there are a few spectrograms that accompany the analysis, these are used primarily descriptively, and for the most part the tape is analyzed according to set theory principles as well. In fact, of the 34 figures and 8 tables that accompany the analysis, only 15 include spectrograms, with the rest comprised of lists of sets and musical examples from the score. However, given the pitch-based nature of the score and tape accompaniment, an analysis of this type is perhaps appropriate.

Brenjamin Broening's analysis of Alvin Lucier's classic *I am sitting in a room* appears next in the collection. Appropriately, Broening addresses the process-oriented aspects of the composition, comparing it to contemporary works by Steve Reich. In Lucier's work a text is projected into a space (in this case the composer's living room) and recorded, with the resulting recording projected into the same space and the process repeated until the original recording is destroyed, leaving only those resonant frequencies activated by the recorded speech. Spectrograms are used both to illuminate timbral evolution as well as the spectral degradation and filtration

that occur as the piece unfolds. Individual words are extracted and compared at both selected moments and for the all 32 repetitions of the source material. Broening ends the analysis with a comparison of Lucier's work with that of Reich's *It's Gonna Rain* and Luciano Berio's *Thema (Omaggio a Joyce)*, placing each within a greater context of compositions that explore the continuum between speech, sound and music.

Mortuos Plango, Vivos Voco by Jonathan Harvey is the subject of Michael Clarke's contribution. While this work is well known, Clarke's approach is novel—using Max/MSP and SYBIL (SYnthesis By Interactive Learning), a software program developed by Clarke, the reader is encouraged to explore various facets of the analysis in conjunction with any commercially available CD recording. The interactive analysis is not necessary to fully appreciate the essay, which itself is illustrated with Harvey's sketches, pitch diagrams and sonograms. Quite purposely, Clarke illuminates the fundamental aspect of all analysis: careful listening. The interactive analysis facilitates this process for novice and experienced analysts.

The interactive features of Phillipe Manoury's *Jupiter* are discussed at length in Andrew May's analysis. This influential work, composed at IRCAM in 1987 (and later revised), was one of the first works to use real-time pitch tracking and score following, first realized using Miller Puckette's Max language for the IRCAM 4x computer. May uses software code from the most recent version, written in Puckette's Pd software, as well as peak-graphs, examples from the score and numerous tables in his analysis. Ultimately, May illuminates the relationship of the live performer to the computer, weaving historical and technological information into this enjoyable essay.

Mara Helmuth contributes an analysis of Barry Traux's pioneering work of granular synthesis, *Riverrun*, composed in 1986. She worked closely with Truax, even gaining access to the computer system on which the piece was composed. *Riverrun* was originally composed as a four-channel work and released in stereo, but was realized in an 8 channel version in 2004. After an extensive discussion of the background of the work itself as well as some of the processes used to generate the sonic material, Helmuth adds a multidimensional analysis in which various methodologies are explored, arranged by levels. Level (1) presents a textual description, (2) groups events (or "phrases"), (3) describes pitch, (4) shows amplitude and (5) is a spectrogram. The entire composition is described in this manner, broken into 30-second segments. As one would expect, there are moments in which particular dimensions are more analytically useful than others, but ultimately the multidimensional approach

works quite well, giving a more complete view of this interesting work than any single dimension could. A minor issue is found in the presentation of the spectrograms, as it appears that a too-wide amplitude range was used in their generation, leading to dark pictures. I understand the need for this, as a narrower range sometimes fails to reveal sonic energy that one's ear perceives, but a wide range can produce results where the ear cannot perceive sonic energy (as can the application of a Fletcher-Muson curve), lending a quasi-perceptual interpretation to the amplitude shading.

The final essay, Momilani Ramstrum's discussion of another Philippe Manoury work, the opera *K…*, is an ambitious look at the entire production. With lavish staging, multiple channels, a mixture of live and electronic, solo and ensemble performance and a formidable length of three seamless Acts, Ramstrum does an admirable job with this challenging piece. After a look at the inspiration of *K…*, Franz Kafka's *The Trial* (itself a formidable text!), Ramstrum uses the MSD (Music Structure Discovery) software developed at IRCAM to illuminate the aural self-similarity in the Prologue and Scene XII. While a single chapter is not nearly long enough to tackle the analysis of an entire opera, particularly one as technologically and musically complex as K…, Ramstrum's descriptive analysis illuminates many aspects of the work, particularly for those readers that have not had the opportunity to experience the opera live.

A DVD is included with the book, containing most of the examples included in the text and short audio clips of some of the pieces analyzed as well as a few short videos from Manoury's opera K… This DVD plays on both a regular DVD player as well as on a computer, although not everything available on the DVD-ROM is shown when playing the DVD in a regular player.

A particular concern was with the figures in the text. Many of them are reproduced poorly and are difficult to read. Fortunately, many are reproduced on the accompanying DVD, but a computer is not always available when reading through the text. Also, some of the figures that are misprinted in the text (for example a figure in Simoni's essay is repeated, resulting in a "missing" figure) are also inexplicably missing from the accompanying DVD. Additionally, many of the spectrograms are missing vital information, such as the legend for the amplitude range, or the frequency scale. This information is essential to full understanding of these sonic representations, and if the scale is missing the reader is left assuming that two spectrograms show the same frequency ranges when in reality they may not.

Extensive use of the composer's notes appeared in nearly every contribution in this collection. While these can be illuminating, I found myself wishing that less attention had been paid to these musical inputs (sketches, software code, musical scores) and more attention paid to the output—the actual sonic result. Spectrograms are merely representations of sonic energy and thus must be used with an analytical ear. Simoni's inclusion of a spectrogram of a cantor performing "Alleluia" in the introduction, for example, includes a discussion of the usefulness of the spectrogram as a possible tool for proper performance practice, but only briefly acknowledges the progression of vowel sounds from emphasis in the higher formant regions to lower formants. Ultimately this performance of a single word is a marvelous oppositional exploration of nearly the entire vowel formant range of the human voice, with a clear timbral evolution over this short example. Simoni goes on to present and analyze the same musical material performed by a synthetic bell but again focuses mainly on the differences in representation, rather than the clear lack of timbral evolution in the second example.

Overall, *Analytical Methods of Electroacoustic Music* achieves its goal of presenting a variety of analytical methodologies for a variety of musical works. Simoni has created a website, http://www-personal.umich.edu/~msimoni/analytical-methods/ for updates and supplemental materials.

Elizabeth Hinkle-Turner.
Women Composers and Music Technology in the United States: Crossing the Line
Burlington, VT: Ashgate Press, 2006
(301 p., ISBN 0754604616)
Reviewed by Jennifer Bernard Merkowitz

A person new to the field of electroacoustic music could easily assume that women have not played a significant role in the history of the genre. A brief inspection of two standard electronic music histories—Joel Chadabe's *Electric Sound* and Thom Holmes' *Electronic and Experimental Music*—reveals that in about 300 pages, these authors both mention about 20 women. In contrast, Elizabeth Hinkle-Turner's book *Women Composers and Music Technology in the United States: Crossing the Line* chronicles the lives and works of at least 165 women in the United States alone! A few, like Bebe Barron, Wendy Carlos and Pauline Oliveros, are already established "greats" in the field, and for good reason. However, as I was reading the book, I kept marveling over the amount of information that was completely new to me. It is information that should be shared with any young woman considering a career involving music technology. In addition, the snapshot of women involved in academia (circa 2005) will be helpful to young people researching college and graduate programs in composition and electronic music. The book also includes web resources and an

extensive discography for 91 artists.

Crossing the Line is arranged into seven chapters. The first chapter ("Introduction") contains a survey of previous scholarship on women in music and an introduction to the methodology of the book. The next three chapters "focus on women who have significant ties to the academic world either through their training, their engagement in the teaching profession, or their active participation in many academically-sponsored events such as workshops and festivals" (p. 10). These chapters are the bulk of the book, weighing in at just over 75% of the text. They progress chronologically according to the generation in which the women were born and educated. Chapter 2 ("Precedents and Pioneers") starts with Johanna Magdalena Beyer (1888-1944), whose *Music of the Spheres* was "one of the first pieces for purely electronic instruments" (p. 13), and carries us through the generation of women who were born in the 20s, 30s and 40s and were involved in early developments of electronic and computer music.

As the book progresses, Hinkle-Turner continues to emphasize the theme of mentoring (in particular the master/apprentice relationship) and networking as important to the emergence and encouragement of women in electroacoustic music. She notes that her own foray into the study of contemporary women composers was fueled by her search for a professional role model. This viewpoint has a large effect on the organization of the book as a whole. The women featured in Chapter 3 ("A Generation of Growth and Influence") studied with women from Chapter 2, and the women from Chapter 4 ("Continued Promise for the Future") studied with women from Chapters 2 and 3. Chapter 3's women were born in the 40s and 50s, educated in the height of the women's movement and mentored by early pioneers such as Pauline Oliveros, Alice Shields and Pril Smiley. The chapter is organized by centers of activity (NYC, Columbia-Princeton, Mills, UCSB, Stanford CCRMA, and "other West Coast." The rest of the country is lumped under "Other."

Chapter 4 explores the generation of women who came of age during the 1980s, when home digital technology expanded opportunities for women and other marginalized groups. The advent of MIDI technology enabled instrumentalists to explore new roles as composer/performers, while the growing availability of computer technology encouraged composers with technical aptitude to become composer/programmers. Hinkle-Turner also examines the next generation of independent composers in New York City and in academia, women with alternative careers and "creative expatriots" who were born in the US but are now based elsewhere in the world. The chapter finishes with a brief discussion of young women who were working on doctorates at various institutions at the time of publication.

Buried in this chapter is one of the most intriguing issues raised in the book: the notion, raised by Pamela Z, that the "women who garner the most respect in the area of electroacoustic music are those who take a proactive role in developing and inventing tools and theories of composition rather than settling for current perceptions and situations" (p. 135). These women have entered a realm of "true geekdom" where gender becomes irrelevant and "what is most valued is raw brain power and technical aptitude." Outside of the women who are designing tools, the women who act in acceptably "feminine" ways—for instance, the vocalist/composers who use their body to communicate—gain the most positive reactions from their audience. It is certainly a thought-provoking idea.

Chapter 5 ("In the Spotlight: Role Models Rise in the Mainstream") breaks outside of the world of academia and covers "women who have made a contribution in more popular music, and who create most if not all of their electroacoustic work themselves" (p. 10). These include film composers, composers of commercial music, and audio engineers. Their work is particularly important because it is more in the public eye than that of their colleagues in academia, contributing to the public perception of women's roles in music technology.

The ability of visual and interactive technologies to add a further documentary or autobiographical element to one's work has contributed to making music with video "a powerfully feminine and feminist art form" (p. 245). Chapter 6 ("Finding Their Visual Voice: Composers Explore Multimedia Technology") focuses on electroacoustic music composers who use film and video in their work. The field is narrowed to discuss only women who create their own video, with only a few paragraphs reserved for collaborative endeavors—a great loss, in my opinion. The author places herself into the former category, which may have contributed to her neglect in the area of collaboration. She provides extensive discussion of her own work from a personal perspective, but one wonders if the material may have been better served by an unbiased assessment from an outside source.

It would seem, after reading this book, that the amount of female mentors in the field has grown dramatically and that the number of women in electroacoustic music will only continue to rise as a result. However, Hinkle-Turner focuses on the question of future women in her final chapter ("Where Are We Now?"), sharing the disturbing news that "research conducted in connection with this

text indicates that there may be an actual decline in interest and technical activity among young women." She discusses the possible reasons why, noting that in her research she has observed a difference in the way women talk about their work. "Many exhibited a reluctance to discuss equipment, programming languages and software for its own sake…Utilizing the medium because of its sonic possibilities took precedence over a desire to learn about technology for its own sake" (p. 250). The commonly held notion of the dichotomy between "boys with their toys" and "girls with their tools" may not be as black and white as some may think, but the remarks of the women interviewed for the book showed a definite bias for working toward a musical end product as opposed to concentrating on the musical means. If we are to succeed in encouraging more young women to become involved in music technology, this knowledge should have an impact on the way that we recruit and teach young composers in the field.

As Hinkle-Turner notes, "the majority of my research comes from the primary sources of personal correspondence and unpublished resumes, vitas, biographies, and program notes sent to me by the women themselves" (p. 11). This is really the great strength of the book. She has put together an invaluable collection of information that comes straight from the artists themselves. Indeed, she considers the book "a true collaboration between myself and the composers."

Women have been involved in electroacoustic music since the beginning, but we just don't read about them. This book brings to light many important women who are not normally mentioned in general electronic music histories. This, of course, begs the question of *why* they are not in mentioned. Certainly there are some women who are discussed in this volume simply because this is an in-depth study focusing specifically on women, but there are others who have played a pivotal role in the development of the genre and *should* be mentioned in general histories. (In particular, I am thinking of composers like Alice Shields, who played an important role at the Columbia-Princeton Electronic Music Center but is absent from both Chadabe's and Holmes's books.) Hinkle-Turner muses, "Perhaps the issue isn't so much a difference in gender and numbers but an issue of *documentation*" (p. 255), and indeed that may be the case. This is a project that has been long due, and it is one that will be a great resource for composers young and old, male and female. In particular, it serves as an inspiration for young women who find themselves the only female in their respective programs.

Unfortunately, something must be said about the awkward prose in this book. Hinkle-Turner's reluctance to use commas—particularly in long, run-on sentences—is particularly frustrating. The reader is forced to read a passage several times in order to grasp the information that is being

communicated. It is true that I am a copy editor, so bad grammar is a particular pet peeve of mine. But when I had to resort to reading with a pencil in hand so that I could parse convoluted sentences more quickly, I came to the conclusion that this was no small problem. I am alarmed that Ashgate Press released a manuscript in this condition.

The author intends to continue her research and release future volumes on continental Europe, the United Kingdom, Mexico, South America and Australasia. I applaud her for this, and only hope that she works more closely with an editor on subsequent manuscripts.

Gareth Loy
Musimathics, Volume 1: The Mathematical Foundations of Music
MIT Press, 2006
(500 p., ISBN 0262122820)
Reviewed by Brendan Aanes

Throughout history, the intersections of music and mathematics have been studied, pondered, and debated by practitioners of both disciplines. With the last century's advent of electronic sound as well as more numerically-focused compositional techniques, math and music have come together in even more ways. A trip to the library reveals thousands of books and articles in fields as diverse as analysis and acoustics, most of them intensely technical and full of the jargon of their subfield. To the musician seeking to understand the mathematical foundations of their art, it can be daunting. Gareth Loy's book *Musimathics* aims to change this by compiling basic (and some more advanced) information on the mathematics of music in a concise format, aimed at a wide audience of students, composers and mathematicians looking to expand their knowledge of a closely related field. One of the distinguishing characteristics of this book is that it only presupposes mathematical training through advanced algebra and geometry, further widening its audience.

Musimathics begins with a few basic chapters. The first covers "music and sound" (fundamental physical concepts of waves, forces, and harmonic motion), and the second covers the traditional representations of music in western culture (musical notation). The inclusion of these chapters helps make the book suitable for classroom use, but anyone with a background in either field could probably skip them. That Loy begins with physics instead of traditional musical concepts illustrates the book's main approach as examining music from the perspective of mathematics rather than the other way around. This isn't to say that Loy lacks sensitivity to musical issues, but that his focus, like much of the book's content, is scientific.

The introductory chapters are followed by an encyclopedic but brief chapter on the

history and practice of tuning systems. Rather than simply enumerating scales along with their strengths and weaknesses, Loy first compares equal-tempered and just intonation, then guides the reader through the problems of such scales and the various solutions that have been proposed, including both western and eastern microtonal scales. The microtonal portion of this chapter in particular is extremely well written, and makes an excellent introduction to a topic that is often intimidating. My only wish was one that came up often in reading *Musimathics*: that Loy would extend the chapter and cover the material in more depth. Given the scope and aim of the book, this isn't a criticism but rather a testament to the openness and clarity of the author's writing.

From here, Loy moves on to the physical and geometrical bases of sound, each with their own chapter. Much of this part of the book covers basic concepts of physics and geometry, expanding on the first chapter. Despite the abstract nature of the material, it is explained with remarkable clarity, although here as in other chapters there are several confusing errors (corrections are listed on the website: http://www.musimathics.com/). Fundamentals out of the way, methods (RMS, peak, etc.) and motivations for measuring intensity are covered as well, leading to the evolution of the DB scale. While the material covered in these chapters is necessarily fundamental, their placement in the middle of the book is a little strange, particularly when there are already fundamental chapters at the beginning. However, given *Musimathics*' ambitious scope, there is no clear linear or growing path between all the material. When viewed as an encyclopedia rather than a narrative, it isn't a problem that the book suddenly shifts gears from detailed discussion of tuning systems to basic physics.

These basics aside, we come to the real meat of the book: chapters on psychoacoustics, acoustics, and vibrating systems, as well as a long chapter on composition and methodology. On the first three of these I have little to say, other than to echo my previous sentiments on Loy's remarkable clarity and ability to pack lots of information into a small space. Due to the expansiveness (and relative underdevelopment) of psychoacoustics, this chapter is broader than it is deep, but it adequately covers the relationship between objective and subjective variables, localization, sound masking, loudness and pitch perception, giving enough detail on each for the reader to understand many acoustic phenomena. As one would expect, the chapter on acoustics discusses the effects on sound of different media and their boundaries, again in an easy to understand manner. In his discussion of vibrating systems Loy describes the fundamental operation of almost every traditional instrument well enough that I suddenly felt qualified to build them. Again, although I have little to say on these chapters (other than to rave about their ease of reading), with a book like this that is a strong endorsement.

The last and most expansive chapter in the book deals with composition and methodology. Here, unlike in the other chapters, Loy necessarily departs a bit from his encyclopedic, mostly objective viewpoint to give some of his own views as to the principles upon which composition can be studied scientifically. Among these is the conviction that composition can be divided into its methodology and the choices made within that methodology by the composer. This approach defines the first half of the chapter, as he focuses on Guido d'Arrezzo's method of composing chant to fit a text, Baroque and Classical experiments of *Musikalisches Würfulspiel*, the serial methods of the Second Viennese school, and finally the stochastic methods of Xenakis. While each of these techniques is well described, Loy's examination of methodologies is limited to those which have a clear numerical basis and which dramatically reduce the element of compositional choice, or at least clearly limit it to a position defined by the system, and begs expansion into describing other methods. As much as this fits the book and chapter's stated purpose, the omission of many other styles of composition implicitly splits music into that which obviously has mathematics at its root and music that may not, raising aesthetic and philosophical questions that Musimathics does not explicitly address. If math is really the foundation of music and not just sound, shouldn't all music be easily describable, at all levels, through mathematical language as well? If it isn't, then what is the point of enumerating methods that are just special cases? I suppose these questions have not been adequately answered, so there is some merit to leaving them out of a quasi-introductory book. Also, I was glad that Loy did not try to force all music in to a reductionist mathematical framework. Mostly, the trouble with this section is that (in contrast to the rest of the book) it is incomplete both as an overview of compositional methodologies throughout history and as a mathematical theory of composition. It does, however, succeed as a relatively complete description of compositional methods that have deliberately embraced mathematics, and is certainly worthwhile reading for one not familiar with those methods.

After his description of methods used by composers to directly compose music, Loy enumerates a number of methods used by computers to compose, evaluating their success based on the belief that music is about the manipulation of "expectation and interest." As hesitant as I am to accept most attempts to define music, this ends up being a good working definition,

particularly given the nascent state of most experiments in automatic composition. Loy's explanations of varying rule-based systems, Markov Chains, and other methods are as usual elegant and clear and supported by various diagrams. In this section as well as the previous, many examples are given using the Musimat programming language that Loy has developed. Musimat is easily understandable by anyone familiar with C or similar functional languages, and an appendix is included so that those who are not familiar can learn the basic principles. While the inclusion of so many Musimat examples has the benefit of showing techniques concisely and in full detail, I am not sure how valuable it is in the long run. Many computer musicians could easily write the programs themselves given a verbal description of the procedure, and those without programming experience may find their understanding impeded by the unfamiliar method of presentation. Also, in order to use some of the techniques presented (such as operations on serial rows) without a computer, a reader would have to abstract the knowledge from the program into a manual procedure.

Loy follows his description of the basic theoretical procedures of computer-based composition with some real-world examples such as Hiller and Isaacson's *Iliac Suite*. That few of such early attempts were successful, even by Loy's simplified definition, clearly shows the complexity of compositional activity. Loy dedicates much space to David Cope's Experiments in Musical Intelligence (EMI), which have been remarkably successful at composing new Mozart symphonies based on the analysis of Mozart's own music. Like the earlier descriptions of methodology, this section of *Musimathics* provokes philosophical questions on the nature of music and composition, but this time the author does begin to address them. In his belief, a system like EMI passes a musical "Turing Test" by being for all intents and purposes indistinguishable from human composition. Despite its success, it is worth noting (as Loy does) that such a system is based entirely on previously-composed input. Although we like to think otherwise, composers are all affected by outside input, and so this actually isn't such a failure. Loy suggests an experiment in which EMI is recursively fed its own results to mimic the process by which a human composer develops their own style; the results of such an experiment would probably be quite a development for the field of computer composition as well as setting a model for future tests.

A book as broad as *Musimathics* is usually a bit unfocused and sprawling, but Gareth Loy does an admirable job of organizing and explaining his subject matter. Musimathics makes an excellent introduction to the topics it discusses and gives a solid footing on which to expand. While I think the book will be of most value to students, experienced musicians will probably also find at least a few things to learn within it, and due to its rigorous organization it is easy to pinpoint the sections one wants to find. On the whole, I would highly recommend *Musimathics* to anyone interested in learning about the basic intersections of math and music, and have already loaned my copy to several friends.

Gareth Loy
Musimathics, Volume 2: The Mathematical Foundations of Music
MIT Press, 2007
(576 p., ISBN 0262122855)
Reviewed by Brendan Aanes

Gareth Loy's first volume of *Musimathics: The Mathematical Foundations of Music* provided an excellent overview of many areas in which music and mathematics intersect. The second volume of this series aims to provide the same lucidity to the much narrower area of digital audio. Unlike the first volume, this narrowness allows the book to become more encyclopedic, through its focus on a single umbrella of topics rather than a tangentially related set. On the other hand, unlike tunings, psychoacoustics, and compositional strategies, which were covered in the first volume, the Fourier transform, spectral analysis, and the other topics of this second volume involve more higher math, in the form of calculus and differential equations, which fewer readers are familiar with.

Musimathics Vol. 2 begins with a novel description of sampling and other basic concepts of digital audio. Loy asks the reader to imagine a seismograph-like system for recording the height of waves as they pass by a buoy anchored to a piling; an attached pen records the height of the bouy relative to the piling. This metaphor is then extended with a sample-and-hold system to represent sampling of the continuous wave motion, as well as the low-pass filter found in the typical ADC. Loy's metaphor seems like an effective description of the basics of sampling, even as the mechanical system described becomes rather complex by the time the full ADC is modeled. On the other hand, it also seems that Loy is reinventing the wheel; many readable explanations of sampling already exist. Still, it is always good to have different explanations that may appeal to readers with different backgrounds or learning styles.
After explaining sampling in terms of his tidal metaphor, Loy switches over to a more traditional and technical account of sampling, which is then followed by information on encoding, quantization and distortion. Continuing the standard set by the first volume, well-labeled graphs abound when appropriate. Loy's language here is concise, yet somewhat more technical than one would expect after his metaphorical introduction. Still, this chapter provides a

detailed look at sampling that should be understandable to readers willing to put their mind into it.

The second chapter in *Musimathics Vol. 2* plunges even deeper into mathematics, beginning with a very brief explanation of complex numbers. Here, Loy relies far more on equations than he did at any point in the first volume, although in his defense that book used simpler math. I'm unsure as to the value of this section. Those who have no familiarity with complex numbers will likely have a hard time understanding them with such a short explanation, and those who do understand them won't need to read this. Readers who did learn about complex math at some point but haven't used it for a while will probably be the only ones to get much out of this section, but even then some portions of it are very terse and equation-dependent.

Loy continues to build an increasingly complex set of equations once the reader is familiarized with complex numbers and their associated properties. He then uses this mathematical vocabulary to discuss sinusoidal motion and phasors, aiding the reader by returning to more verbal than mathematical descriptions. This portion of the book is very abstract, forming the background for much of the material found later. However, I had a hard time following it. Gareth Loy clearly has an incredible ability to make complicated mathematics understandable through verbal description and metaphor, but here he seems more interested in getting on to the more musically-interesting later chapters and hesitant to fully deploy this skill.

Returning to more familiar territory, Chapter 3 covers spectral analysis and re-synthesis, heady topics by most standards. Here, I found Loy's explanation of the operation of the Fourier transform to be incredibly understandable, and the final description of a "real-life" discrete transform seemed obvious based on the preceding steps. I would highly recommend this chapter to anyone seeking a thorough understanding of Fourier transforms and related operations. Although most readers will probably not be interested in going out and writing their own FFT implementation, understanding these mechanisms leads to a better understanding of how to work with FFT-based applications of many types.

The next chapter's introduction of convolution begins again with an unusual metaphor. Rather than stating the typical (and simplistic) explanation of convolution in relation to spectral multiplication, Loy describes the operation of a moving-shutter camera and its effect on images, likening convolution to this mechanism's effect of "scaling and time shifting." He then gives an equation for convolution and moves on to simple convolution of sets of numbers, followed by windowing and musically-relevant convolution applications. This approach has the downside of seeming overly abstract at first, but it pays off by thoroughly explaining the operation of convolution. Also in this chapter, Loy references his Musimat programming language. My thoughts on this remain ambivalent: to a programmer, the Musimat examples don't provide anything that isn't already in the text, and to a non-programmer they only complicate things unnecessarily.

Most computer music textbooks introduce filtering well before Fourier transforms and convolution, but in *Musimathics* Gareth Loy places these topics before his extremely in-depth look at filtering and resonance (one chapter each). This is probably a good choice because the math involved at this level makes a little more sense when introduced in the context of the Fourier transform than it would have if it had been introduced alongside filtering. Another mark that sets Loy's treatment of filters apart from most is that, writing in the age of computer music, he can approach them from a mathematical standpoint that correlates directly with the operation of digital filters, rather than getting caught up in the necessary design concerns and components of analog systems. That said, Loy's take on filtering is again heady but manageable. More so than in the previous topics, he returns again to extensive use of equations, which make the chapter more difficult. Again, the greatest complaint I have about Loy's writing is that sometimes his faith in the comprehensibility of well-presented equations leads him to trust them over his excellent capacity for verbal explanation. This is somewhat less the case in the chapter on resonance. Although the requisite calculus is, like complex numbers previously, given a whirlwind introduction, this brief chapter comes out much more readable than its predecessor.

Taken together, *Musimathics*' next chapters, "The Wave Equation" and "Acoustic Systems," can be seen as a comprehensive exploration of sound production by any instrument or source. Although they are equation-heavy and utilize a lot of calculus and trigonometry, Loy here provides more commentary on his equations than in some other chapters, making it possible to either quickly read and grasp without working through what is going on mathematically, or to dig further into the inner workings of sound production. There isn't much else for a reviewer to say on these chapters; although the subject matter is very complex, the presentation of it on multiple levels is very welcome. Like the chapter on Fourier transforms, these segments of the book provide valuable knowledge that will be useful to musicians and readers from diverse backgrounds and fields.

The second-to-last chapter of *Musimathics* is a brief encyclopedia of synthesis techniques. Being a new book, *Musimathics* has the advantage of being much more up-to-date than the classic computer music textbooks, and in addition to going into more detail than usual on the old standards also devotes considerable space to developments in physical modeling. Beginning with the classic Karplus-Strong algorithm, Loy moves on to Julius Smith's waveguide synthesis, a new development that generalizes the Karplus-Strong algorithm to form a model based on the reflections of waves in media. Everything in this chapter is well explained, and it makes an excellent and very deep introduction to the field. Following this look at synthesis techniques is a chapter on "dynamic spectra," most of which is spent discussing the short-time Fourier transform and its applications. This chapter was, for me, one of the best of the book, and although I'm not sure why it didn't come nearer the chapter on Fourier transforms, it provides an excellent note on which to end.

On the whole, *Musimathics Vol. 2* is an interesting examination of the mathematics of computer audio. Although at times it fails to deliver on its promise to make its topics easily understandable, it is still easier to read and more in-depth than many of the classic computer-music texts, even as it lacks some of their depth. Together with its companion volume, it forms an excellent work suitable for musicians of varying experience levels and a useful reference for those working with computer music.

Simon Emmerson
Living Electronic Music
Ashgate Publishing, 2007
(195 p., ISBN 0754655482)
Reviewed by Margaret Schedel

(Editor's Note: This review also appears in an upcoming issue of the Computer Music Journal; this is the first of what we hope to be more cross published articles.)

Living Electronic Music is a direct and careful treatise about the performance, practice and perception of electronic music. Aimed at composers, researchers and musicologists, it is more than a historical overview—Emmerson blends the philosophical, the scientific, and the musical into his wide-ranging thesis. He "asks questions that may have no answers" and throughout the book casts questions, invoking glimmers of meaning instead of making declarative statements. Full of cerebral provocations, this book needs to be discussed rather than simply read. The full experience also requires listening—the book boasts an extensive discography full of pieces both in the electro-acoustic canon and others less familiar. Emmerson doesn't simply list these works; he places them into a larger context, giving the reader a rudimentary listening guide.

Living Electronic Music is divided into six chapters with an introductory essay called "Between Disciplines." Emmerson designed each chapter "to be a self-sufficient essay, yet all cross reference and 'need' each other to get the bigger picture." The chapters are paired: Chapter 1 (Living Presence) is paired with Chapter 2 (The Reanimation of the World), which discusses the two-way exchange between the animate presence and inanimate worlds. Chapter 1 is further subdivided into three parts: physical presence, psychological presence and personal/social presence. This pair of chapters is the most challenging in terms of introducing new concepts to the average reader. Chapter 3 (The Human Body in Electro-Acoustic Music) examines the physical body in electro-acoustic music, and is paired with Chapter 4 (Playing Space), which unfolds the personal and public space surrounding the physical body. Chapters 5 (To Input the Live) and 6 (Diffusion-Projection) are the easiest to understand, and deal with transducers that are the paths between the "animate" and "inanimate" worlds: microphones and speakers respectively.

I wished for a concluding essay. Though Emmerson feels that "no chapter is really first or last and there are no definitive conclusions," I would have liked some sort of final essay to balance the book, even if it simply contained more questions about the bigger picture. The introduction ends with the provocative question, "exactly what is it to be alive in music making?" while the last sentence in the entire book reads, "nonetheless an 'authentic sound' from any of the last eight decades would demand attention to the loudspeaker construction of that time." I had to return to the introduction to feel fully satisfied with the book.

Emmerson is a strong and clear thinker; he is able to turn the most complex philosophies inside out so that we can see the seams and understand how his thought process is put together. While I appreciate his desire to make each chapter function on its own as part of a larger whole, I wanted more substance after Chapter 6. Perhaps this is a great compliment to Emmerson's writing, but I think the same system of organization would have worked just as well with a concluding essay tying themes from the various chapters together.

As a writer who is sensitive to cadence, variety, accent, and nuance, Emmerson has created a book that is a bit dense in places, but still a pleasure to read. He is also a very thorough researcher. For example, there are seven citations in the second paragraph of the introduction alone. These range from the expected (Pierre Schaeffer and Jean-Jacques Nattiez) to the surprising (James Gibson, a perceptual psychologist, and even Tim Ingold, a social anthropologist). This slim volume contains fifteen pages

of references to books, articles, scores and CDs. One minor annoyance is that the references for recordings and books are not clearly located for the reader. They are cited identically within the text, but are then found in different sections in the references. The reader must look both in the "books and articles" section and the "scores and recordings" section, as it is not clear where an individual citation might be.

Emmerson does a beautiful job of integrating various streams of history, philosophy, ethnomusicology, and auditory perception together to demonstrate key theories in composed and improvised electo-acoustic, acoustic, and a few popular(!) musical compositions. The text is illustrated with a small number of Venn diagrams showing areas of overlap and enclosure in the philosophical realm. These figures helped my understanding of the broader concepts Emerson presented in the text.
I have decided to use this book as the primary text for my class in the fall entitled "Electronic Music of the 20th and 21st Centuries: Using Technology to Create Music." I am looking forward to delving deeper into Emmerson's view of electronic music with my students and creating a stronger "relationship to the sonic resources around us."

Lektrowsky's Will

by Max Mathews

At his keynote address at the New Orleans ICMC, Max Mathews referenced a short story he had written. He graciously allowed us to republish it in Array.

"The future may be a fiction."
- Anonymous survivor of a
New Jersey mugging

New Universe Spaces, June 13, 2165

John Lektrowsky, the world's only STARNAUT, joined the Chewlard Order yesterday. The massive gates of the students' portal of the Chewlard Monastery opened briefly to receive his body and instrument. He entered clad in the traditional "Tails" with violin (the 1704 Betts Stradivarius) under right arm, Tourte bow dangling from thumb and forefinger, and the page of manuscript in left hand. Observers speculated that it was the opening of the Back Chaconne, but, of course, this information is not revealed by the Order.

Lektrowsky's sensational return from Alpha Centauri preempted the headlines nine months ago. He was the first and only STARNAUT to be declared sane on arrival, although some consider his subsequent application to the Chewlards at the certified age of 35 to be an indication of, at least, judgmental disequilibrium. Others attribute it merely to long practice or time alienation from the world. Lektrowsky, himself, maintained that his choice was a reasonable consequence of 20 years acceleration during which space he practiced the Chaconne and that only the impossibility of playing the music preserved his motivation and sanity. Whether or not his opinions are believed, the Chewlards broke their traditional rule limiting novitiates to five years of age or younger. The argument over Lektrowsky's age has never been satisfactorily resolved. He was born August 14, 1985, entered space in the year 2001, and returned in 2164, earth time. According to both his records and the certifying physiologists, he spent twenty life years under acceleration attaining a speed greater than 99 percent of the speed of light. Physicists still have not been able to explain the time discrepancy. One group maintains the theory of relativity must be revised, another that he passed close to a Black Hole.

Lektrowsky left a will to be made public in two weeks.