the signal. Here one is not restricted to conditions of orthogonality; functions can be selected from any collection desired. This is currently a very exciting area in signal processing (I may be biased, however, because this is the subject of my doctoral dissertation). In the world of computer music, this method provides the analytical equivalent to granular synthesis.

The final two chapters discuss in detail the application of wavelets to problems of signal estimation, and efficient coding of signals in the transform domain. In Chapter 10, Mr. Mallat demonstrates one of the most useful aspects of wavelets: denoising of signals. In contrast to methods using Fourier analysis, denoising can be effectively done using wavelets and thresholding of coefficients. More advanced techniques have been used to denoise, for instance, an early wax cylinder recording of Johannes Brahms playing the piano. Chapter 11, "Transform Coding," discusses the application of wavelets to signal compression, of which the best-known result has produced JPEG2000. After reviewing quantization, entropy coding, and compression optimized with respect to distortion, the author presents image and video compression using wavelets.

One of the most unique aspects of AWT is its "reproducible experiment" approach: "The reproducibility of experiments thus requires having the complete software and full source code for inspection, modification and application under varied parameter settings" (p. 17). Taking a bow to lessons learned from the history and philosophy of science, Mr. Mallat has made available the MATLAB (produced by MathWorks, Inc.) code used in producing all figures in the text in order to more fully demonstrate vital aspects of wavelets. Indeed the real results of much of this work are not embodied in terse mathematical expressions, but in the actual implementation with computer code. Working with the code of this book is just as important as reading it. The second appendix provides a list of this software.

The title of AWT makes it clear that this book is about the world of signal processing seen through the lens of multiresolution analysis. Whereas Fourier methods are quite well established in the field of computer music through uses such as pitch-detection and sound transformation, wavelets have found more use in practical applications, such as denoising, than in creative ones. Computer musicians have learned that wavelets are fragile entities, and even a minimal amount of modification in a wavelet representation can result in undesired artifacts. Interesting effects can be created, but to produce a desired effect, for example, pitch shift, is profoundly difficult. Wavelets will not replace Fourier analysis. Instead the two will complement each other and provide efficient and meaningful representations of signals. With the continuing development of decompositions using redundant and over-complete "dictionaries" of wavelets—so called "pursuit strategies" discussed in Chapter 8—such meaningful transformation of signal content will be possible with great precision in time and frequency.

There is nothing in AWT that I would suggest be changed. Mr. Mallat has done a remarkable job producing a rigorous and complete text that can serve as a textbook and a reference. It is refreshing to read a technical book written by an expert that remains approachable at many levels. *A Wavelet Tour of Signal Processing* is truly an essential guidebook to accompany travel through the sometimes steep, but never treacherous, slopes of wavelet theory.

David Borgo: Sync or Swarm: Improvising Music in a Complex Age

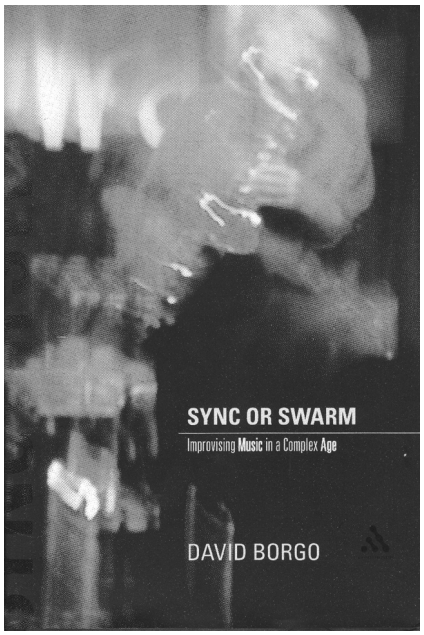
Hardcover/softcover, 2005, 272 pages, illustrated, references, index, audio CD, ISBN 0826417299, US$ 29.95 (hardcover), ISBN 0826419275 US$ 19.95 (softcover); Continuum Books, The Continuum International Publishing Group Inc., 80 Maiden Lane, Suite 704, New York, New York 10038, USA; telephone (+1) 212-953-5858; fax (+1) 212-953-5944; Web www.continuumbooks.com/.

Reviewed by Steven M. Miller
Santa Fe, New Mexico, USA

General

According to the publisher's introduction on the book's dustcover, *Sync or Swarm* is a "study of musical improvisation, using theories from cultural and cognitive studies and the emerging science of chaos and complexity . . . including perspectives from the study of embodied cognition, nonlinear dynamics, self-organizing systems, social networks, and situated and distributed learning." In investigating both solo and group improvisation through the theoretical constructs of complexity science, cognition, networking, and so on, Mr. Borgo brings new tools to bear on the study of a long-standing, though comparatively little-theorized, field of creative endeavor.

An audio CD of music examples is included with the text. Tracks by both well-known (Evan Parker, Sam Rivers, George Lewis) and lesser-known (the author's own ensemble Surrealestate) improvisers are offered



up as examples that are to varying degrees analyzed within the text itself. This is a welcome addition, as the ideas and concepts broached in the text are often rather abstract in nature (no pun intended). The music examples make the connections the author wishes to draw much clearer than they might be otherwise.

Organization and Overview

The first chapter, "The Sound and Science of Surprise," lays out the general terrain, providing a general introduction to the topics the book will cover and then laying out a chapter-by-chapter synopsis. Over the course of the book, an effort is made to balance the extra-musical ideas and concepts with specific applications and/or examples from the musical literature. After a survey of the contemporary improvisation scene and "the growing body of scholarship on the subject," the book in turn tackles concepts and ideas from fields as varied as cognitive linguistics, embodiment, and general systems theory in relation to the solo improviser (in this case, Evan Parker); nonlinear dynamical systems, state space transitions, and "phase space" applied to improvising ensemble dynamics (the Sam Rivers Trio with George Lewis); and chaos, complexity science, and analyses of "fractal correlation dimension" in a number of solo and ensemble improvisation recordings. Network theory, physical coupling, biological entrainment, emergent behavior, self-organizing systems, "scale-free" networks, and basic concepts of statistical distributions are all discussed in relation to the complex dynamics of ensemble improvisation. A final chapter, "Harnessing Complexity," examines "the ways in which learning and cognition are situated within and distributed across physical and social settings" (p. 11). The chapter culminates in a number of observations and propositions regarding current music pedagogy and the efficacy of integrating improvisation into the music classroom.

Strengths and Weaknesses

One of the major strengths of the book is Mr. Borgo's ability to summarize the issues and insights of dynamical systems theory and other recent developments in cognitive, biological, and computer sciences for the scientific layperson. Clear and concise explanations with just enough detail to flesh out the concepts make for a reasonable understanding of the significance of the theory in question and serve as entry into the author's application of it to the field of improvised music. Another positive aspect of the book is the degree to which examples of specific pieces of music—some of which are included on the accompanying CD—are integrated into the explanations and explorations. He subjects a recorded performance of the piece *Hues of Melanin* by the Sam Rivers Tri, to an extensive "phenomenological analysis" and charts out in detail the prominent musical transitions during the course of the 33-plus-minute work. In another chapter, visual displays of "fractal correlation dimension" analyses and correlograms (plots of periodicities in the spectrograms of the recordings) of recorded excerpts by Evan Parker, Derek Bailey, Peter Brötzman, The Art Ensemble of Chicago, as well as the aforementioned Sam Rivers Trio recording, are integrated into a discussion of fractal (self-similarity across hierarchic levels) aspects of musical development. Mr. Borgo's facility with the concepts and vocabulary, as well as his novel and creative applications of them to musical improvisation, are commendable.

A major flaw of the book, however, at least for this reviewer, results from the author passing quickly beyond using the complexity science models as mere metaphors into what often constitutes a very real case of "misplaced concreteness" (as defined by philosopher Alfred North Whitehead). Mr. Borgo makes the following disclaimer on page 12: "My comparison often occurs on the level of metaphor, but this should not be perceived as an inherent shortcoming." It is precisely, however, when he concretizes the relationship(s) between his models and the musical phenomena he is discussing that the trouble begins. When he states on page 69, for one example, that "[a]n important goal of this chapter is to study the structure of the phase space of improvisation," he goes beyond metaphorical description. In the ensuing section he directly applies the concept of "phase space," a very specific descriptor of nonlinear dynamical behavior predicated on the measurement of discrete values of a limited

set of behavioral dimensions, to a phenomenon (collective musical improvisation) that displays continuous variations across a virtually infinite set of behavioral dimensions. The problem is not merely philosophical. By concretizing his metaphorical relationships, he sets himself and his theories up for certain failure. Beyond a very real and limited degree, the mechanisms are often incompatible with the musical features he uses them to describe and explain. The comparisons simply do not hold up to deeper scrutiny. These mistakes of misplaced concreteness recur throughout the book.

A related problem is that of appropriate scale. Mr. Borgo's use of complexity models to explain behavioral mechanisms at work, rather than merely describe similarities between different domains, ignores disjunctions across micro- to macro-level descriptions of behavior (e.g., subatomic particles display quantum behavior yet individual humans can be unambiguously located in terms of both position and velocity). This is an example of what Leonard B. Meyer, in his book *Music, the Arts, and Ideas* (1967, Chicago: University of Chicago Press), refers to as "the assumption of hierarchic uniformity." Mr. Meyer observes that "it is . . . a serious mistake to assume that the principles or 'laws' governing the organization of one hierarchic level are necessarily the same as those of some other level" (p. 258). I take this to be relevant to Mr. Borgo's project in the following way: As anything other than descriptive metaphor, the mechanisms of complex dynamical systems operate on a behavioral hierarchic level incommensurate with many of the author's propositions. The level of conscious individual artistic choice, intimately involved with improvisation (and creative production in general), is not the level at which dynamical systems theory articulates with the fields of psychology and social dynamics. An individual's autonomous conscious choice is at a different hierarchical level than that of, for example, social and cultural conditioning, large-scale group dynamics, or evolutionary biology, each of which displays a high degree of complex interdependence among autonomous subsystems characterized by, for example, strength of coupling, degree of hysteresis, coevolution, and so forth, which are statistically modeled at a hierarchic level above or below that of individual autonomous choice. To take individual artistic behavior so far out of the realm of autonomous decision-making assumes for it a degree of classical mechanistic causality no longer typically recognized in the social sciences. Any study of improvisation that leaves aside issues of autonomous conscious choice in deference to underlying or overarching issues at other hierarchical levels seems at least somewhat misguided.

When he restricts his explanations to sonic phenomena on the level of sound waveforms, however, he's on safe ground. In subjecting recordings to analyses of fractal correlation dimension he deals with the sonic tracings of musical behavior rather than the behaviors themselves. In applying ideas of coupling and biological entrainment to an examination of ensemble rhythmic interaction, the author is again on solid footing, discussing the contribution of biological mechanisms to the embodiment of complex physical tasks. Unfortunately, Mr. Borgo slips rather seamlessly back and forth between appropriate and inappropriate applications along the continuum between metaphoric description and concrete comparison, without seeming to notice the difference.

Another lesser problem with the book is a serious omission in the section "Time and the Qualia of Experience" in the chapter "Rivers of Consciousness." Though he is dealing with the hierarchical nature of music perception, parsing the continuous flow of musical sound into "chunks," from sections and phrases to individual elements, etc., Mr. Borgo never mentions the groundbreaking work of James Tenney in this field, in particular *Meta-Hodos* (1961), META Meta-Hodos (1977), and *Hierarchical Temporal Gestalt Perception in Music* (with Larry Polansky, 1978). In this trio of writings Tenney lays out the gestalt psychology and cognitive science underpinnings of a new phenomenological approach to music theory. Long available from a variety of sources, these writings form a very sophisticated basis from which to explore the hierarchical nature of music perception and cognition. Mr. Borgo's discussion of the qualia of music perception, and the hierarchical nature thereof, would undoubtedly have been considerably strengthened to the degree it referenced and built upon this earlier set of works.

Lastly, the operational definition of "music" that Mr. Borgo explicitly adopts in the introductory chapter caused me some concern. On page 5, among the other requirements listed for his "understanding of music," is the proposition that "[m]usic is an event centered on the real-time production of sound; music is not an abstraction, such as a score, transcription, or recording." This is tantamount to declaring that visual art is centered on the real-time production of visual images, leaving no room for studio art practices. By carefully, not to say conservatively, circumscribing his domain of interest to live performance, the author clearly leaves a great deal of the electroacoustic and computer music of the last six or so decades outside the declared scope of the book. He is apparently uncon-

cerned with (or unaware of) the possibilities of non-real-time improvisation. Whether Mr. Borgo is ignorant of the long-standing studio practice of electroacoustic music is unclear. That his current book's insights into the relationships between musical phenomena and dynamical systems theory, and so on, is not intended to apply there, however, is not. Given the very real applications of various scientific, mathematical, and cognitive science concepts within the domain of electroacoustic music over the past 60 years or so, this seems unfortunate indeed. Mr. Borgo's narrow definition of music (or at least the music with which he is concerned) would seem to have needlessly impoverished his set of source materials.

Summary and Conclusion

On the whole, there is much to recommend in this book. It applies a number of recent developments in the sciences to a musical domain that, until recently, has received relatively little serious academic attention. It provides clear and concise explanations of complex concepts for the scientific layman, and profitably uses numerous musical examples in doing so. The downsides are real enough, though perhaps not fatal. Given a reader with a sharp eye and discerning intellect, they should not stand in the way of the important contributions the book makes to the study of improvisation.

Recordings

Lydia Ayers: Virtual Gamelan

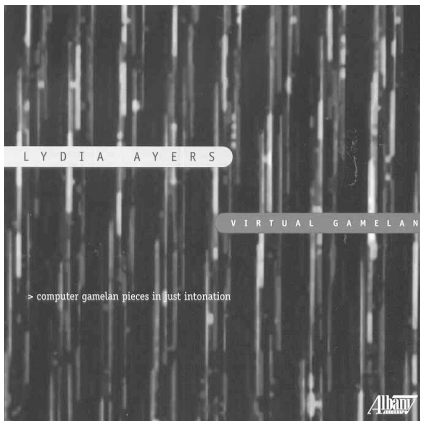
Compact disc, Albany Records TROY874, 2006; available from Albany Records, 915 Broadway, Albany, New York 12207, USA; telephone (+1) 518-436-8814; electronic mail infoalbany@aol.com; Web www.albanyrecords.com/.

Reviewed by Elizabeth Hinkle-Turner
Denton, Texas, USA

Virtual Gamelan provides a thorough documentation of the research of Lydia Ayers in the areas of Csound synthesis, just intonation, and both real and virtual instrument design.

Featuring computer gamelan pieces in just intonation composed from 1977 to 2006, the listener is treated to Ms. Ayers's compositional and research evolution during a time period of almost 30 years. For persons unfamiliar with Ms. Ayers's work, the Hong Kong-based composer has a variety of interests and accomplishments including two books and several articles about Csound; dozens of publications in the field of music education, flute performance, and just intonation; and years of teaching and study with the likes of James Beauchamp, Charles Dodge, Morton Subotnick, and Robert Dick. Ms. Ayers is also an accomplished flutist and was co-host of the 1996 International Computer Music Conference (Hong Kong).

Ms. Ayers writes in the recording's liner notes that the music on this CD "is inspired by the music of composers such as Harry Partch and Lou Harrison, the antics of the family cats and experiences in Indonesia . . ." Her music features microtonal experiments with many scale systems and tunings, compositional structures based on Eastern musical forms, and sound synthesis modeling of a traditional gamelan and the Woodstock Gamelan, a tubular percussion instrument developed by the composer and built to her specifications by Woodstock Percussion. Several of the works on the recording show variations on a composition and research theme. For example, *Tala Malika Jak* (2005), *Catjak* (2005), and *Tala Malika Gong* (2006) are inspired by different aspects of the Indonesian "kecak" (monkey chant, pronounced "ket-jack") and the Indian "tala malika." According to Wikipedia, talas ("claps") are rhythmic patterns that determine the rhythmic structure of a composition. *Tala Malika Jak* utilizes recordings of Ms. Ayers's students saying the word "jak" and these samples are developed in a solo and chorus format into a variety of rhythmic structures in a three-part compositional form. Fairly literal and rhythmic layering of the samples is featured first with the second section utilizing a less rigorous rhythmic structure in which the sounds are elongated and further processed. The more straightforward rhythmic patterns return in the final section but at a faster pace and in a canonic form. The sounds are treated spatially in a circular fashion. The composer herself shared with me that both *Tala Malika Jak* and *Catjak* were partly written to show her beginning composition students the possibilities they had in sounds they could make themselves.



This three-part formal structure is