temporal linearity—the very aspect that Ms. Rodriquez was trying to break with—that became predominant in the listener's perception of this performance. The presentation in Berlin whets the interest for experiencing the spatial version of this composition.

*TEXTURE-MULTIPLE* for two winds, two strings, percussion, piano, and live electronics, by Agostino Di Scipio (b. 1962), is a piece that has been extended in every new performance since its premiere in 1993. Each of the instrumental parts is independent, taken from a very limited stock of practically identical elements but developed autonomously. Nonetheless, the voices can become transparent parts of a whole. During performance, the individual parts repeatedly come together as a collective ensemble, only to be destroyed. The computer intervenes in the instrumental action through a special technique of multiple granularization with different time-scale factors. This granularization is dependent on the resonant properties of the performance space, which is tracked by a microphone placed in the middle of the room. Mr. Di Scipio calls the resulting feedback loop an ''ecological system . . . in the triangle between musician, machine, and space.'' In his words, the composition is not so much a piece of interactive music as an attempt to ''compose interaction through which music is created.'' The result is a highly exciting affair, not only for the audience but also for the performers.

Both the composition *Kommen & Gehen,* for solo violin and live electronics by Orm Finnendahl (b. 1963), and his sound installation of the same name were originally conceived for the German Pavilion at Expo 2000 in Hanover. Starting with three prerecorded violin samples and sounds recorded directly from the violin during performance, a special recursive process of granular resynthesis takes place. Time scaling and overlapping of materials (at times on the order of a thousandfold) is used to generate the extremely thick sonic material of the piece. The interaction between soloist, with its hesitant, deliberately unstable tone, and the electronic manipulation of this material to overpoweringly engulfing waves of sound, is made evident for the listener through effects such as the apparent ''switching off'' of the computer-generated sound through Bartók pizzicati coming from the violin. Mr. Finnendahl's ability to simulate an almost tangible spatialization with eight loudspeakers was impressive.

For the composers presented here, all born in the period from 1959 to 1969, it has long since become the natural course to make use of computers at all levels of their compositional efforts, even in purely instrumental works. The musical results are accordingly widely diverse. The composers make use of available software, or develop their own extensions, without relying on dogma; working independently, for the most part, of larger studios.

The computer is used for a wide variety of tasks: as an aid in simulating the solution of harmonic questions (Mr. Poppe, Mr. Herrmann); for the creation of aleatoric works in which random number generators select and combine elements taken from predefined materials, transporting the resulting score to the performers directly on monitors (Ms. Rodriquez, Mr. Di Scipio, Mr. Muenz). It can be used in executing algorithmic compositions (Mr. Finnendahl, Mr. Herrmann, Mr. Di Scipio) or in pieces that work explicitly with spatial elements (Ms. Rodriquez, Mr. Herrmann, Mr. Finnendahl, Mr. Di Scipio). In concept works, which often critically scrutinize the relationship between human and (supposedly perfect) machines, the computer appears with an apparently subjective character as partner to the performer (Mr. Muenz) or meets the musician more as a traditionally ''playable'' instrument (Mr. Barrett). The composers play, more or less openly, with the effect of direct confrontation between musician and a rack of technical equipment, or the musicians' reactions to sounds echoing back at them from the concert hall. The associations generated in the audience by these effects are reminiscent of many communicational processes—both successful and failed—taking place between humanity and technology.

## Publications

### Eduardo Reck Miranda: Composing Music with Computers

Softcover, 2001, ISBN 0195058348, xvii + 411 pages,illustrated, bibliography, glossary of rules, subject index, subject index, Focal Press Music Technology Series, US$ 49.95, CD-ROM; Butterworth-Heinenmann, Linacre House, Jordan Hill, Oxford OX2 8DP, UK, or 225 Wildwood Avenue, Woburn, Massachusetts 01801, USA; telephone (+1) 781-904-2500; fax (+1) 781-904-2620; electronic mail orders@bhusa.com; Web www.focalpress.com/.

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Eduardo Reck Miranda's new book, *Composing Music with Computers*, is an indispensable contribution to the scarce literature on algorithmic composition. In algorithmic composition, composers use formal processes to generate musical material, forms, or even entire pieces. *Composing Music with Computers* focuses on generative processes, those that formulate output from the operation of mathematical functions rather than from the manipulation or transformation of existing musical material.

Early on, the author identifies abstraction boundaries between the microscopic level, the note level, and the building-block level. The microscopic level is basically that of sound synthesis; the note level is traditionally represented by notation in a score; and the building-block level is a higher, formal abstraction combining and arranging sequences of notes. The processes described in the text can be applied to any of these levels, but for the purposes of discussion, the book focuses primarily on the note level.

Mr. Reck Miranda is certainly well placed to write this study: he has extensive experience as both a composer and a programmer of large-scale artificial intelligence systems. Moreover, he makes cogent use of cognitive arguments to characterize the nature of the composer's craft. The scope of the discussion, then, is daunting: from general principles of music composition through the cognition of composers and listeners to the algorithmic techniques of generating musical materials and form. Given that scope, the book is relevant to several different audiences. Of those audiences, including computer scientists, mathematicians, and researchers in artificial intelligence, the book is addressed most directly to composers.

For example, the second chapter, ''Preparing the Ground,'' leads the reader through some fundamentals of discrete mathematics, set theory, logic, matrices, formal grammars, probability, and computer programming. This material would be familiar territory to those with a technical background, but is very clearly explained and demonstrated for the benefit of those with more purely musical training. Brief introductions to serialism and formalized music follow that fill the opposite role: informing those with more technical training than musical.

Subsequent chapters extend the introductory material and relate it to compositional applications. Chapter 3 is devoted to probabilities, grammars, and automata. Building on the foundation of chapter 2, the reader is shown applications of random distributions, Markov chains, and so on, to music generation. Similarly, chapters 4, 5, and 6 cover iterative algorithms, neural computation, and evolutionary music, respectively.

In my experience, the greatest difficulty for students trying to compose algorithmically is not learning the procedures—it lies in imagining how the procedures might be used to produce their own music. Mr. Reck Miranda points to this issue himself when discussing the musical applications of iterative processes:

> However, finding an effective method for mapping the orbits [of an iterative process] onto musical parameters is not an easy task. This is one of the greatest difficulties composers face when working with algorithmic composition systems that use the output from essentially non-musical processes; that is, non-musical in the sense that they were not originally developed with a musical perspective in mind.

Some composers simply never will have a need to compose procedurally, no matter which tools they have, and others will see immediately how to employ algorithms in their work. For those in the middle, *Composing Music with Computers* is an essential guide. That said, the book may have been even more valuable to such readers with a greater range of worked-out examples. Throughout the body of the text, there are helpful illustrations with musical material provided at every appropriate juncture. These illustrations tend to be short and didactic, however, rather than elaborated and evocative.

The most useful bridge between theory and practice is provided by chapter 7, a group of three case studies showing in greater detail how finished musical material can be derived from algorithmic techniques. In particular, the first case study, titled ''From content to form,'' shows how to generate chordal material using a collection of generative modules and then to shape that material with a group of ''moulding rules.'' For example, Moulding Rule Two states that ''all ascending sequences . . . of notes are slurred in order to form an articulatory unit.'' At the end of the discussion is a measure of music for six instruments, complete with articulations, that clearly demonstrates the musical potential of the formalizations that are the subject of the book.

Beyond that, the accompanying CD-ROM includes many applications for algorithmic composition in full-blown or demonstration versions. These include Roger Dannenberg's Nyquist language, the OpenMusic programming system developed by Gérard Assayag and Carlos Agon at IRCAM, a prototype of Music Sketcher, an algorithmic composition tool designed by Daniel Oppenheim and his colleagues at the IBM Computer Music Center, and several others. There are entries for both Windows and Macintosh platforms, with documentation and supporting material. The CD-ROM alone makes the book well worth the investment for a serious study of algorithmic composition. With this toolbox, readers can immediately test their ideas using established and relevant software.

The references are both a valuable resource for further study and an interesting indication of the author's influences in writing the book. From Paul Larivalle's ''l'Analyse (morpho)logique du récit'' to Mikhail Malt's ''Reflexiones sobre el acto de la composición,'' we are introduced to intriguing writing on form and composition that does not come from the usual English-language suspects.

Eduardo Reck Miranda's *Composing Music with Computers* addresses a field that is widely practiced but little described: probably the closest equivalent is Phil Winsor's *Automated Music Composition*, published in 1989. Not only is the book needed, but it is exceptionally well-written and, above all, clear. Composers, student or otherwise, will find a valuable resource for ideas, software, algorithms, and their underlying mathematics. This lucid and scholarly text will be read not only by computer musicians, but by everyone with an interest in the artistic possibilities of technology.

## Fred Lerdahl: Tonal Pitch Space

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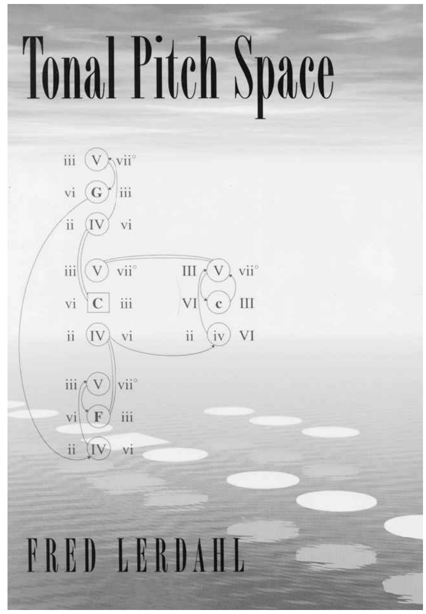


*Tonal Pitch Space*, by composer-theorist Fred Lerdahl, continues about 20 years of work that the author began with cognitive psychologist Ray Jackendoff in the late 1970s. The ''Generative Theory'' project's first major manifestation was the publication of the seminal book, *A Generative Theory of Tonal Music* (GTTM), by Lerdahl and Jackendoff in 1983 (MIT Press). The present volume (TPS) represents a coming of age of that project and the culmination of much of Mr. Lerdahl's published work from the 1990s.

Like GTTM before it, TPS is a broad synthesis of music theory and music cognition. It relies heavily upon a rule-based grammar of listening that descends from the original work that is presented in GTTM but which undergoes several important modifications in the first chapter of TPS. GTTM established four primary hierarchical structures for how a musical surface is ''heard'': Grouping Structure, Metrical Structure, Time Span Reduction, and Prolongational Reduction. I won't attempt to define these categories in detail here, but, roughly speaking, they translate how an experienced listener may be assumed to listen to a piece of music. In GTTM, this grammar was developed specifically to be applicable to how a listener parses common-practice Western art music. Some extension for application to non-Western musics and to post-tonal Western music was also proposed, but remained largely undeveloped in GTTM. In TPS, Mr. Lerdahl proposes the modification of both time span and prolongational reduction to include what he calls stability conditions. These are global features that are innate to the tonal system and which may be enforced across the common practice repertoire. These global stability conditions are treated in TPS through a richly developed theory of pitch space. The author's initial formulation of stability conditions was proposed ten years ago in his widely remarked article, ''Cognitive Constraints on Compositional Systems'' (*Contemporary Music Review* 6(2), 1992). TPS expands extensively upon that proposed model.

Pitch space itself is by no means a new concept. In recent years there has been a resurgence of interest in the late 19th-century music theorist Hugo Riemann, and from that interest has developed a variety of neo-Riemannian transformational theories. The *tonnetz* is the essential pitch space proposed by Riemann about a century ago and is probably