Chapter 15

From Rhythm to Sound and Music

“Music is the arithmetic of the soul, which counts without being aware of it” (Leibniz)

INTRODUCTION

In early 1950s, Iannis Xenakis became the first composer to use stochastic processes to generate pieces of music, working by hand. The first entirely computer-generated composition was Illiac Suite for String Quartet, realized by Lejaren Hiller in 1956 (Hiller, 1970, 1981). In Hiller’s approach, all kinds of musical processes were coded and implemented by computer. In the ‘80s, David Cope created a computer-aided system allowing anyone to create new compositions in the styles of past composers. The system worked even for users with no skills in programming or composition. Cope thought that computers could be a good tool for studying musical style, encoding it into programs to increase musical creativity. So he began to study the essential elements that define musical style, creating an explicit definition he could encode in a computer program. What he was searching for were “patterns.” To investigate them he analyzed samples of a composer’s works, puts then on a database, and

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used computational functions to analyze the composer’s style. Xenakis, Hiller and Cope are just three examples of the tight relationship between technology, scientific models and music (Cope, 1991; Schwanauer and Levitt, 1993; Roads, 1996). It was their work that laid the foundations for algorithmic music composition, a style in which algorithmic encoding and decoding schemes are used to represent scientific theories in computer generated music. Theories that have been treated in this way include fractals (Mandelbrot, 1975), dynamical systems (Kramer, 1994; Witten, 1996; Bilotta et al., 2005; Cupellini et al., 2008), and Cellular Automata (Bilotta & Pantano 2001; Bilotta & Pantano 2002a; Miranda 2001). Since this initial experimentation, a growing number of composers have shown interest in using this approach in their own music (Bolognesi, 1983; Dodge, 1988; Leach and Fitch, 1995; Manaris et al. 2003) or in generating sounds (Voss and Clarke, 1975; 1978). In this way, computers have turned into a virtual environment in which researchers can recreate and experiment with biological processes. It is inside computers that we can produce “Artificial life.” And it is here that we can simulate natural and biological phenomena, studying them in ways that would never be possible in the natural world. In this spirit, the authors have used computers to develop theoretical hypotheses, concerning the construction of musical languages, the sound and musical quality of the resulting music, and its acceptability to musicians and non-musicians (Bilotta et al., 2000a; 2000b). Computers have also enormously broadened the scope of musical creativity. One particularly interesting area of activity is the creation of new instruments (Bilotta et al., 2002b, 2002c). Prior to the introduction of the computer, any musical instrument had to be physically reproducible, a challenging requirement. Today, by contrast, we can use digital synthesizers to create a wide range of instruments covering a broad and diverse spectrum of sound. One interesting area of work is chaos and complexity theory, which can be used to produce sounds with very special characteristics. This work is also very interesting for the development of music technology (Bilotta, et al., 2008; NIME 2008).

In previous chapters, we have described the use of mathematical models to simulate the key traits of biological processes. In this chapter, we show how we can map these models to musical structures. In other words, we return to Pythagoras’ idea of a tight relationship between music and mathematics. It was Pythagoras who first discovered the relationships allowing different notes to merge into harmony pleasant to the human ear (Frova, 1999). In his view, it was these numerical relationships that govern the universe. All that remains for human beings is to learn to read the music.

As we discovered in our investigation of CA rules, self-replicators display fractal-like behavior. Using statistical methods, we have used two and three dimensional shapes with different fractal dimensions to produce different kinds of sound and music. We presume that self-replication and self-similarity are consistent characteristics not only of natural and artificial systems but also of music. In this chapter, therefore, we map
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