Musicking with Music-Generation Software in Virtutes Occultae

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This article explores concepts of compositional meaning that arise from cocreative composing with music-generation software. Drawing from an analysis of the 2017 electroacoustic composition Virtutes Occultae, the composer discusses the implications of computer-generated music for the role of the composer. After an overview of how the music-generation software he developed contributed to the creation of Virtutes Occultae, the composer makes comparisons between his process and the use of generative commercial music software to create music, in order to draw distinctions between creating computer-generated music to extend aesthetic sensibilities and creating computer-generated music that iterates based on established commercial styles. Finally, the composer proposes future paths for further investigation involving the development of new musical styles through computer-generated music and reactive computer improvisation.

The choice to entrust musical decisions to music-generation software represents a departure from traditional compositional methods and calls for an investigation into the significance of this departure. In the spirit of Christopher Small’s concept of “musicking,” which focuses broadly on collaborative musical activity [1], in this article I present personal experiences and reflections on musicking with music-generation software in the course of creating the piece Virtutes Occultae.

Published in December 2017, Virtutes Occultae is an electroacoustic composition for six physically modeled digital pianos with nonstandard tunings. Virtutes Occultae is 90 minutes in duration and contains 18 short pieces—it is in “album” form. I incorporated computer-generated music throughout the compositional process for this work. Four of the 18 pieces were made from the computer-generated material directly; the remaining 12 pieces were all influenced stylistically through quotation, variation and imitation of the computer-generated music. This article discusses my experience of musicking with the generative software, from the process of coding the software to the creation of the final musical work.

In creating the software to generate music for Virtutes Occultae, I had to decide what degree of unpredictability I would write into the algorithms. The goal of the software was not purely to simplify the compositional process by automating preconceived compositional ideas but instead to generate music that pushed beyond the limits of my musical imagination. I realized this unpredictability in the software through random and weighted decision-making as well as through predetermined mathematical structures that I mapped in a variety of ways to pitch, duration and rhythm generation. The design of the software was itself an aesthetic act, as Arto Artinian and Adam James Wilson state: “Computational creativity . . . is itself a consequence of human creativity” [2]. During the composition process, I found the computer-generated music to be artistically stimulating, and the software emerged as a creative partner.

Composer interaction with computer-generated music raises questions around authorship and meaning, particularly in the context of the increasing sophistication of various pieces of software that can generate commercial music through artificial intelligence and machine learning techniques. Despite having programmed the software for Virtutes Occultae, I experienced the sounding result of the computer-generated music as if it had been invented by the machine and not by me; my sense of authorship over the musical surface was distanced by my use of the software. During the compositional process, I found myself imitating the computer-generated music in the traditionally composed pieces, and a porous relationship developed between the computer-generated music and my “pen-and-paper” composition.

While the software developed for Virtutes Occultae does not have the properties of artificial intelligence, it does generate music that suggests rational organization. Reflecting the statement of Joanna J. Bryson that “artificial intelligence is not an ‘other,’ it’s just another way humans process and extend that tiny fraction of knowledge that we have . . . . It’s another tool we use” [3], the music-generation software extended my aesthetic sensibilities both directly, as it generated music beyond the limits of my imagination, and indirectly,
Brook, Musicking with Music-Generation Software in Virtutes Occultae

as my exposure to the musicality of the software led to a reorientation of my own musicality.

Incorporating computer-generated music into my composition provoked changes in my aesthetic sensibility. The idea that computer-generated music may stimulate the emergence of new styles is part of a larger, burgeoning area of inquiry, including research by Martin Rieser and Andrew Hugill [4], Sandeep Bhagwati [5], Bruce L. Jacob [6] and many others. In this article, I focus on an interaction with computer-generated music in which I sought to create compositional meaning by affording creative value to the software that generated the music for Virtutes Occultae.

THE ROLE AND TECHNIQUE OF COMPUTER-GENERATED MUSIC IN VIRTUTES OCCULTAE

The role of computer-generated music in Virtutes Occultae was focused and limited in purpose. I designed the software primarily to generate saturated, cloud-like textures that adhered to harmonic structures in an extended just intonation system of 55 notes per octave rooted in E\textsuperscript{b}. The 55 notes per octave are spread over six pianos in such a way that each piano conforms to Harry Partch’s concept of an “Otonality” [7]. Each of the six pianos is uniquely tuned so that sensory consonance is maximized within the 12 pitch classes on each piano and sensory dissonance is maximized between the pianos. Further information regarding the tuning of the physically modeled pianos, harmonic structures and musical motivations behind the extended just intonation system is detailed in my article in Sound American, which focuses on the influence of Harry Partch on my work [8].

The software I developed for Virtutes Occultae generates music algorithmically through automated processes and a variety of high-level controls on the part of the user. I adopted categorical distribution and stochastic algorithms similar to those employed by Iannis Xenakis in the 1960s [9] to generate musical structures. While this approach to generating music is highly controlled, the sounding results were often unforeseen. In Virtutes Occultae, the computer-generated music was altered freely. Just as the software influenced conventionally composed sections, I functioned as a cocomposer for the computer-generated sections by editing the raw data output. Although the influence of the generative software varied from piece to piece, the experience of musicking with the software was constant throughout the compositional process.

Initially, I had envisioned using the software to develop and explore the harmonic language for the piece, but the musical results were so alluring that I integrated the generated music into the piece in a substantial way. This software is not groundbreaking in terms of the field of algorithmic composition; its novelty lies in how it functions within a narrow focus on the extended just intonation harmonic system and instrumentation of Virtutes Occultae.

SOFTWARE OVERVIEW

I designed the software specifically to create Virtutes Occultae, and so the functions are limited to achieving precise goals relevant to the composition of the piece. Figure 1 shows the front end of the Virtutes Occultae software I developed in MAX. The software controls involve a selection of pitch probability tables, toggles for selecting register, note duration settings and rhythmic stutter. The amount of randomization injected into the pitch probability tables can also be adjusted, introducing the possibility of random notes outside the predetermined harmonies. The software employed various sequences of harmonic changes and rhythmic structures to generate music over time. Additionally, I mapped the controls onto the sliders and dials of a MIDI controller, allowing for more immediate and intuitive manipulation of the software. By working in this way, I (the composer) was able to shift my focus away from micro decisions and toward macro decisions, entrusting the details of the music to the computer.

Figure 2 provides examples of four probability tables, each containing 55 values on the x-axis corresponding to the pitch classes of the 55-notes-per-octave just intonation collection employed throughout the piece. When queried, the probability table outputs a value that corresponds to one of these 55 pitches. The rhythmic generation that queries these tables consists of the combination of metronomic pulsations with or without stutter, accelerating and decelerating predetermined shapes or predetermined rhythms.
There are four Cloud pieces in Virtutes Occulta that were largely computer-generated. The Cloud pieces are spread out as interludes over the course of the lengthy work, as pieces four, eight, 12 and 16: Cloud Perpetuo, Cloud Ticking, Cloud Fantasia and Cloud Pastoral, respectively. The remaining 14 pieces in Virtutes Occulta are not generated by the software but do rely on the computer-generated musical material to inform traditional methods of composing in terms of stylistic influence on intuitive compositional processes as well as through direct quotation, harmonic borrowing and variation techniques.

The four Cloud pieces contrast one another musically but share a common saturated texture reminiscent of the micropolyphony of György Ligeti. Figure 3 shows the unedited MIDI roll generated by the software, while Fig. 4 provides the final MIDI roll for Cloud Fantasia after manual editing. The untreated output of the software can be understood as raw material, which is then manually chiseled into final form. After a cursory glance, one can understand visually the process.
of sculpting away at the saturated texture of the raw MIDI in Fig. 3 to create the contoured shaping of the cloud texture of the final MIDI in Fig. 4. This example represents the most heavily edited of all the *Cloud* pieces.

**LISTENING AND MUSICALITY**

As George Lewis writes in “Too Many Notes,” regarding his seminal work on computer improvisation, “the subject of *Voyager* is not technology or computers at all, but musicality itself” [10]. In keeping with this emphasis on musicality, my goal in programming a computer to generate music for *Virtutes Occulta* was to question and enrich my musicality through heuristic experimentation. I positioned myself as open to new aesthetic experiences, listening for intriguing musical relationships that might emerge and redirect my compositional intuitions.

I designed the software to create cloud-like textures that are aesthetically alluring and coherent with the harmonic system. With access to 55 notes per octave spread out over six pianos, the computer improvisor functioned in two key ways. The first function was to generate music that would be difficult to achieve with traditional notation or chance operations. The second function was to help me accustom myself to the novel and complex harmonic language developed during the precompositional phase. The latter purpose is where cocreativity with the software first emerged, as the computer-generated music informed and influenced my musical decisions as I listened to and analyzed the results of the algorithmic processes.

Simply put, I discovered new ways to be musical in the harmonic system through experimentation inside the software. For example, a gradual expansion of register in a cloud-like texture that begins with a predetermined six-note chord that is gradually infused with increasing pitch randomization could be programmed into the software rapidly. Various iterations and variations of this gesture could be created, reflected on and experimented with toward the emergence of a distinct sense of style and musicality. This is one example of a tangible process in which the use of the software-provided stylistic pathways could then be further explored with or without the software.

**RELATIONSHIP TO COMMERCIAL COMPUTER-GENERATED MUSIC**

Recently developed commercial software (AIVA, Jukedeck, Melodrive, Google Magenta, etc.) boasts algorithms that generate commercial jingles and soundtrack music. These programs create music based on a user selection of high-level parameters: Fast or slow? What kind of mood? In what style? With what instruments? For how long? After a few clicks, the user can prompt the software to create an original piece of music instantly. The AIVA (Artificial Intelligence Virtual Artist) engine promotes a particularly uncanny function in which the user selects an existing piece of music—a nocturne by Chopin or a Bach fugue, for example—and then moves a slider between “similar” and “vaguely similar” to generate a derivative work [11].

Whether the music generated by AIVA is altered by a human or not, there is an implicit devaluation of the composer as this technology improves. This commercial music-generation software provides a glimpse into a possible world in which traditional modes of composition become outdated, inefficient and irrelevant in many contexts.

While software like AIVA creates music for commercial purposes in easily identifiable soundtrack styles, I have employed similar techniques in creating noncommercial music in *Virtutes Occulta*. The automation of composition— as proposed by AIVA and other commercial solutions—values efficiency, standardization and marginal utility. Even in art-making with an overtly anticommercial perspective, algorithmic generation of art is often framed in terms of automation and efficiency, sometimes described as a “nanny” or as “creativity enhancement” [12]. Indeed, my initial purpose in developing the software for *Virtutes Occulta* was to create a compositional aid, helping me accustom myself to the harmonic possibilities of the novel 55-notes-per-octave scale used throughout the piece before taking on a more profound role.

Returning to Bryson’s statement, she demystifies artificial intelligence by saying that it simply extends our knowledge and is “another tool we use” [13]. AIVA is a tool that iterates on established styles, while the software for *Virtutes Occulta* is designed to accommodate the emergence of new styles by relinquishing conventional and expedient musical formulas. Through the process of listening to and analyzing the computer-generated materials, I found that my aesthetic sensibilities were subverted and extended.

**FINAL REFLECTIONS AND NEXT STEPS**

In creating the computer-generated music in *Virtutes Occulta*, I sought to afford the software a sense of agency, or at least value and reverence, by musicking alongside the computer in search of new forms of musical expression. Traditional notation and my learned compositional tendencies would naturally resist the injection of unpredictability and the breaking of the preconceived harmonic structures, the injection of unmetrical rhythmic structures and the superhuman saturation of notes that the software produced. But I had entrusted the production of musical materials to the computer, creating an interdependent relationship between the software and myself. Indeed, the potential objections to this composition process—that something inhuman was being injected into the music, or that the tools were directing me toward unforeseen modes of composition [14]—were aspects that I embraced in creating *Virtutes Occulta*.

The development of *Virtutes Occulta* points toward potential further explorations of how computer-generated music may be harnessed toward stylistic expansion. Through the integration of computer listening, real-time audio analysis and reactive behaviors, a more dynamic iteration of the software could be realized in future projects.
References and Notes


13 Bryson [3].


TAYLOR BROOK is a Canadian composer who has been based in New York since 2011. His music explores microtonality, imaginary tradition, technology and the interaction between electronic sound and live performers.