Title: Musicking with Music-Generation Software in *Virtutes Occultae*

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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.

Link to relevant work streaming:
http://taylorbrook.bandcamp.com/album/virtutes-occultae

This paper explores concepts of compositional meaning that arise from co-creative 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 on the role of the composer. After an overview of how the music-generation software contributed to the creation of *Virtutes Occultae*, comparisons with generative commercial music software are made to draw distinctions between creating computer-generated music for extending aesthetic sensibilities versus computer-generated music that iterates on established commercial styles. Finally, the article proposes future paths for further investigation involving the development of new musical styles through computer-generated music and reactive computer improvisation.

Introduction and overview

Entrusting 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] this article will present some of my personal experiences and reflections on musicking with music-generation software towards the creation of the piece *Virtutes Occulate*. *Virtutes Occultae* is an electroacoustic composition for six physically modeled digital pianos with non-standard tunings published in December 2017. *Virtutes Occultae* is ninety minutes in duration and contains eighteen short pieces—an "album" form. Computer-generated music was incorporated throughout the compositional process for this work. While four of the eighteen pieces are made from the computer-generated material directly, the remaining twelve pieces were all influenced stylistically through quotation, variation, and imitation of the computer-generated music. This paper will discuss the 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 pre-conceived compositional ideas, but instead to generate music that pushes beyond the limits of my musical imagination. This unpredictability in the software was realized through random and weighted decision making as well as pre-determined mathematical structures that were 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, the computer-generated music became 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 programed 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 myself; my sense of authorship over the musical surface was distanced by using 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 computer-generated music and "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, as my exposure to the musicality of the software led to a reorientation of my own musicality.

My personal motivations for and experiences of incorporating computer-generated music carries potential aesthetic implications. These issue are part of a larger, burgeoning area of inquiry, including research by Martine Rieser and Andrew Hugill,[4] Sandeep Bhagwati,[5] Bruce L. Jacob[6] and many others. This article focuses on my interaction with computer-generated music to create compositional meaning by affording creative value to the software that generated 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. The software was designed 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♭. 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 twelve 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 the musical motivations behind the extended just intonation system are detailed in my article in *Sound American* that 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 co-composer 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.

The initial function envisioned for the software was to develop and explore the harmonic language for the piece, but the musical results were so alluring that the generated music was integrated into the piece in a substantial way. There is nothing groundbreaking about this software in terms of the field of algorithmic composition; its novelty lies in how it functions within a narrow focus on the unique extended just intonation harmonic system and instrumentation of *Virtutes Occultae*.

Software overview

The software outlined here was designed specifically to create *Virtutes Occultae*, and so the functions are limited toward achieving precise goals. Fig. 1 provides the front end of the *Virtutes Occultae* software 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. Various sequences of harmonic changes and rhythmic structures were employed to generate music over time. Additionally, the controls were mapped onto the sliders and dials of a MIDI controller, allowing for more immediate and intuitive manipulation of the software. By working in this way, the focus of the composer shifts away from micro decisions to macro decisions, entrusting the details of the music to the computer.

- Fig. 1 *Virtutes Occultae* music generation software front end controls (© Taylor Brook)

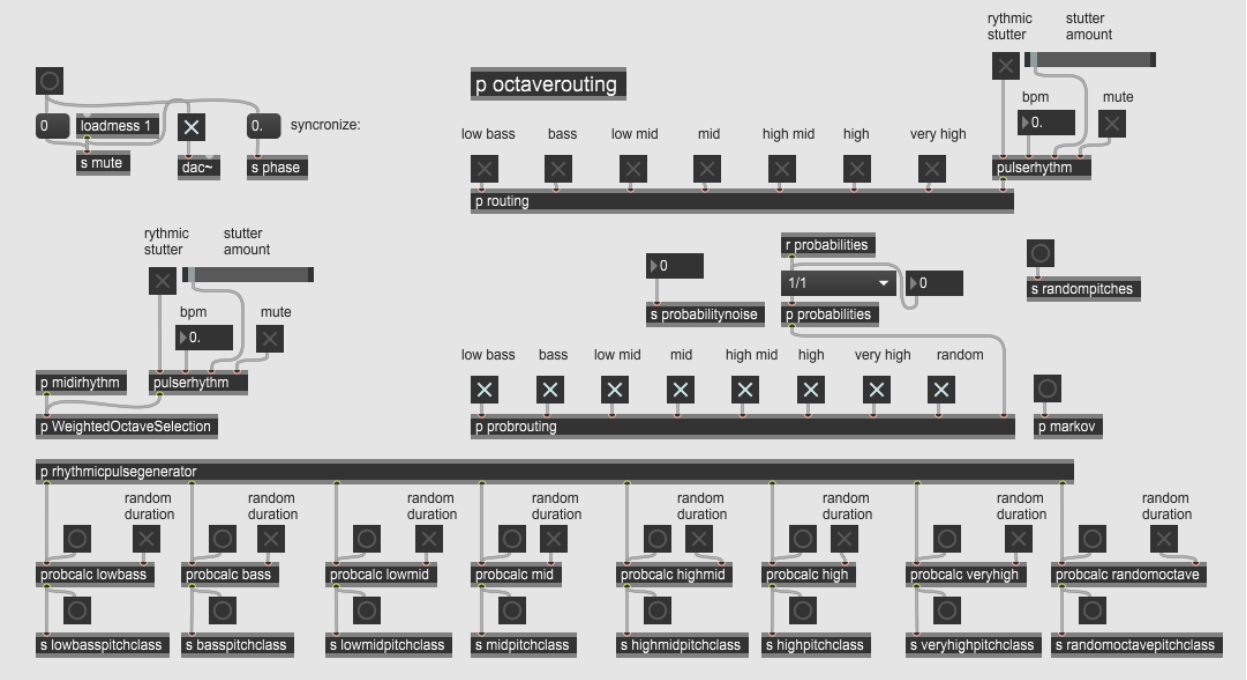
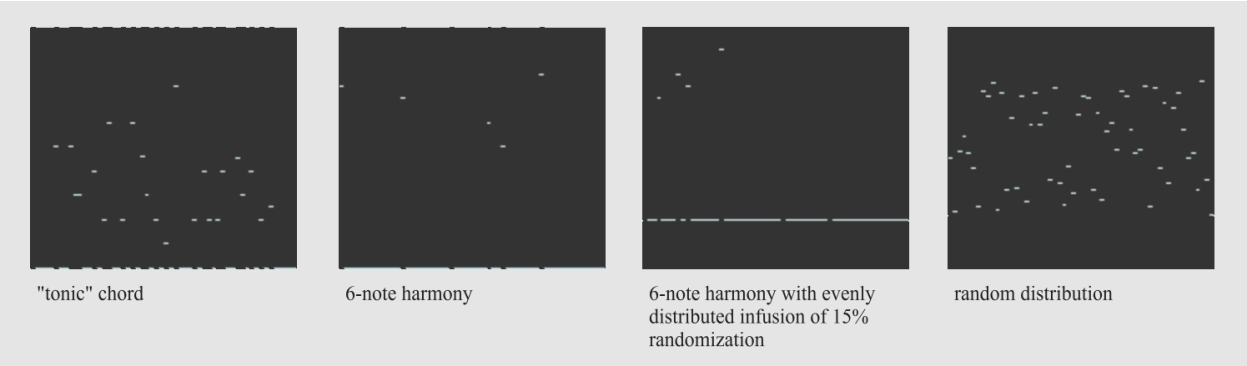


Fig. 2 provides examples of four probability tables, each containing 55 values on the x-axis corresponding to the pitch classes of the 55-note-per-octave just intonation collection employed throughout the piece. When queried, the probability table outputs a value that corresponds to one of these 55 pitches. 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.

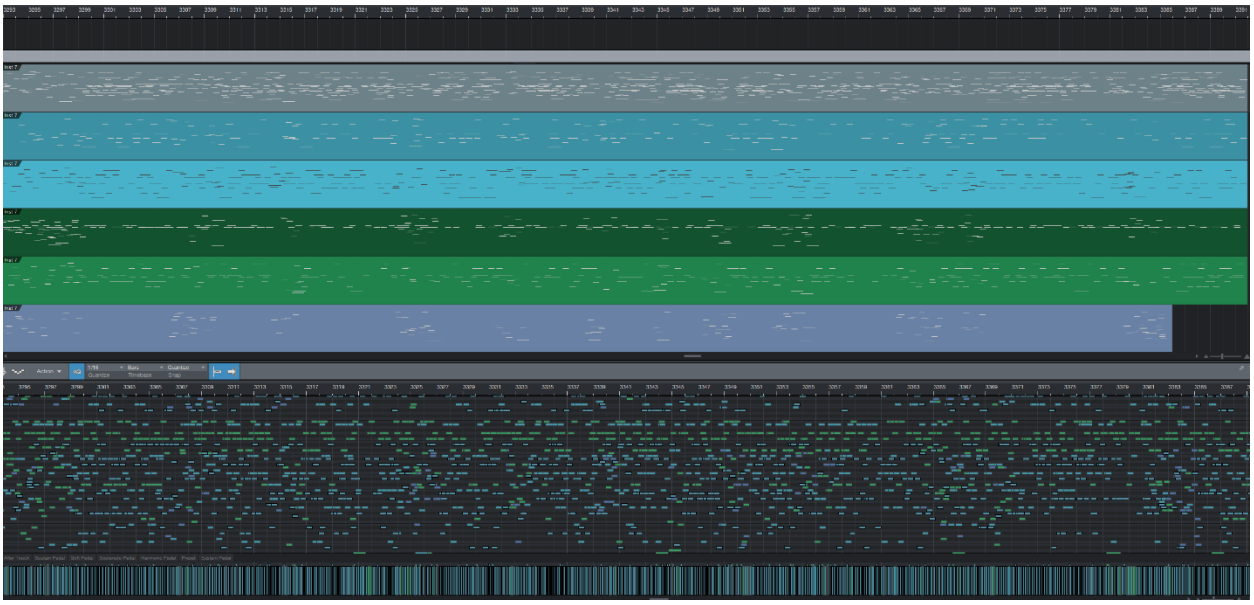
• Fig. 2 Examples of probability tables used for the selection of pitch. The x-axis represents the 55 potential pitches per octave and the y-axis represents the probability weighting (© Taylor Brook)



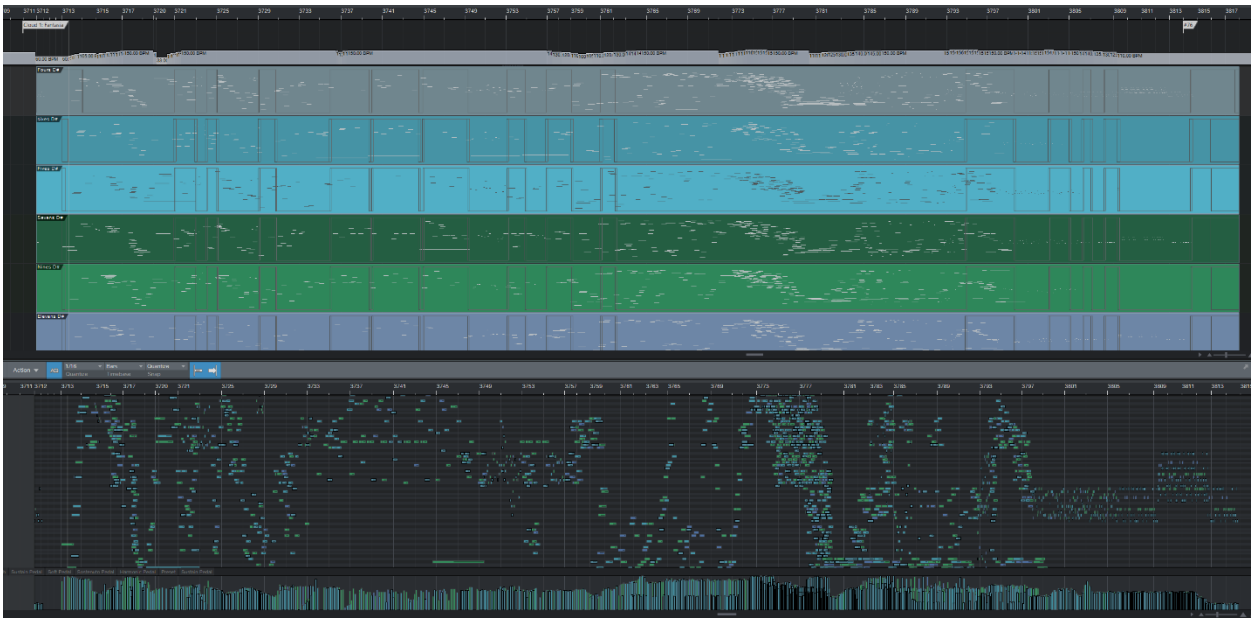
Generating and shaping cloud textures

There are four "cloud" pieces in *Virtutes Occultae* that were largely computer-generated. The "cloud" pieces are spread out as interludes over the course of the lengthy work as pieces four, eight, twelve, and sixteen: *Cloud Perpetuo*, *Cloud Ticking*, *Cloud Fantasia* and *Cloud Pastoral* respectively. The remaining fourteen pieces in *Virtutes Occultae* 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 each other musically but share a common saturated texture reminiscent of the micropolyphony of György Ligeti. Fig. 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 the all the "cloud" pieces.

- Fig. 3 MIDI roll showing raw output for part 12, *Cloud Fantasia* (© Taylor Brook)



- Fig. 4 MIDI roll for final version of part 12, *Cloud Fantasia* (© Taylor Brook)



Listening and musicality

As George Lewis wrote 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 Occultae* 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 may emerge and redirect my compositional intuitions.

The software was designed for the creation of cloud-like textures that are aesthetically alluring and coherent with the harmonic system. With 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 accustom myself to the novel and complex harmonic language developed during the precompositional phase. The latter purpose is where co-creativity 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 6-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 upon and experimented with toward the emergence of a unique sense of style and musicality. This is one example of a tangible process where the use of the software provided stylistic pathways that 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 upon a user selection of high-level parameters: Fast or slow? What kind of mood? In what style? With what instruments? How long? After a few clicks the user can prompt the software to create an original piece of music instantly. The AIVA (Artificial Intelligence Composing Emotional Soundtrack Music) engine promotes a particularly uncanny function where the user selects an existing piece of music—a nocturne by Chopin or 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 presents a glimpse into a possible world where 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 non-commercial music in *Virtutes Occultae*. 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 anti-commercial 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, the initial purpose of the software developed for *Virtutes Occultae* was to help accustom myself to the harmonic possibilities of the novel 55-note per octave scale used throughout the piece. In response, we return to the statement of Joanna J. Bryson demystifying artificial intelligence, stating that it extends our knowledge and is "another tool we use."[13] AIVA is a tool that iterates on an established style, while the software for *Virtutes Occulate* is designed toward the emergence of new styles, of relinquishing conventional and expedient musical formulas. Indeed, through the process of listening to and analyzing the computer-generated materials, my aesthetic sensibilities were subverted and extended.

Final reflections and next steps

My approach to the computer-generated music in *Virtutes Occultae* was 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. 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 are resisted by traditional notation and my learned compositional tendencies. The production of musical materials has been entrusted to the computer, creating an interdependent relationship between the software and myself. Indeed, the potential objections that something inhuman is being injected into the music, or that the tools are directing me toward unforeseen modes of composition[14] are embraced in *Virtutes Occultae*.

The development of *Virtutes Occultae* points toward 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.

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