Observations on Performing Sine Waves with an Oscillator Ensemble

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ABSTRACT

Founded in 2016 at Université de Montréal, Ensemble d'oscillateurs (French for "Oscillator Ensemble") brings together 10 musicians around old analog test equipment oscillators that produce audio sine waves. The ensemble performs new compositions while also arranging early electronic pieces. In parallel, the project has developed itself as a space to gather information and reflect on sine wave–based music. In this article, the author presents some of the key considerations and challenges in the formation of Ensemble d'oscillateurs. Based on observations made throughout the development of a body of work using these audio oscillators, he then aims to open a discussion on some aspects of the historical trajectory of the use of sine waves in modern music.

BACKGROUND ON PERFORMING WITH SINE WAVE OSCILLATORS

Since the advent of electronic music, sine waves have been one of the most common sound materials in the field. In the early 1950s, analog oscillators were among the first pieces of equipment introduced in electronic music studios. Composers like Delia Derbyshire, Pauline Oliveros, Daphne Oram and Karlheinz Stockhausen pioneered the artistic exploration of such devices by transforming them from their primary function as laboratory test equipment into creative musical tools. Despite revolutionary technological developments since that era, such that basic home computers are now capable of rendering complex sound waves, many artists still use sine waves as a compositional element.

Regardless of the significantly varied aesthetic and technical approaches between early and contemporary examples, scores written specifically for sine waves, and sine waves that can be performed, remain a rarity. Instead, the sine wave is often used as an element of a broader arrangement. There exist instances of scores written with parts for sine waves: Karlheinz Stockhausen's 1964 piece *Mixtur* [1], for example, and works of composers like Chiyoko Szlavnics, Jung Hee Choi and Alvin Lucier, who have written a number of pieces in which acoustic instruments dialogue with sine waves.

With the aim to stimulate compositions and performances for sine wave–based music, in 2016, I founded an ensemble of 10 musicians performing on analog oscillators (Fig. 1) under the name Ensemble d'oscillateurs. The ensemble was originally crafted as a performance course within the digital music program at Université de Montréal, in which students could play and improvise together while participating actively in a creative compositional process, including discussions with an artist to performance in a concert situation. The project has since evolved into a semiprofessional ensemble performing in professional venues and festivals. The repertoire of the ensemble is made up of pieces written specifically for it, including compositions by Francisco Meirino [2] and Maxime Corbeil-Perron [3]; the interpretation of graphic scores like those by Candaş Şişman [4] and Sébastien Roux [5]; and the creation of new arrangements of early electronic compositions like Pauline Oliveros's *Jar Piece* [6] or Else Marie Pade's *Faust* [7].

Fig. 1. One of the analog oscillators used by Ensemble d'oscillateurs: a Hewlett-Packard 200CD oscillator, generating signals from 5 to 60 cycles per second in five ranges, 2018. (Photo © Nicolas Bernier)

CHALLENGES IN FORMING AN OSCILLATOR ENSEMBLE

With an artistic background primarily rooted in sound composition, installation and performance, I had little experience directing music ensembles. More importantly, with no repertoire of music composed for 10 oscillators and no instruction manual, I had to do everything from scratch. I approached

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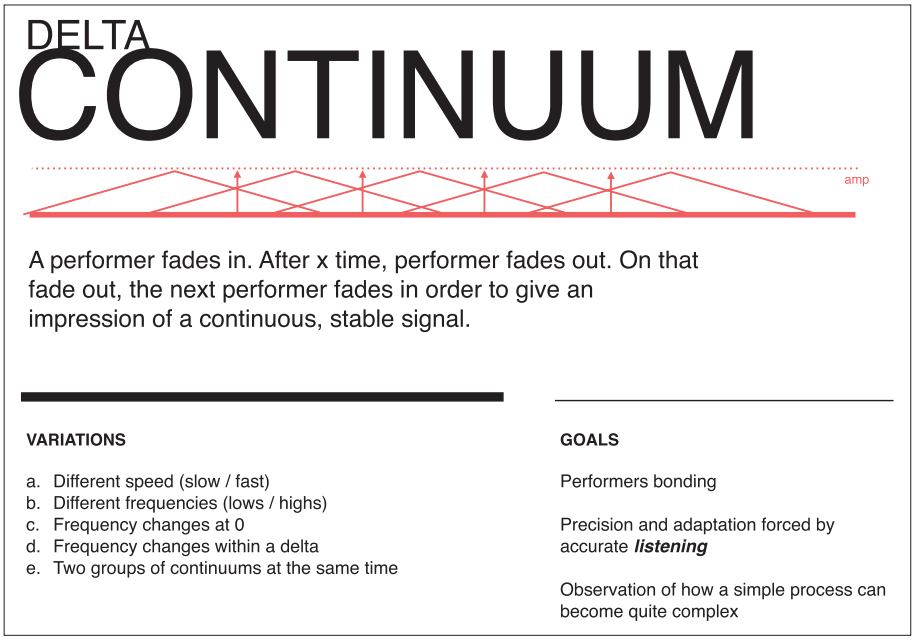

Fig. 2. Example taken from the exercise workbook of the Ensemble d'oscillateurs, 2017. (© Nicolas Bernier)

the project as I approach my solo artistic practice—through hands-on experimentation and without exactly knowing what kind of journey I was embarking on. Even the acquisition of the oscillators in a collection of objects was a relatively complex task that involved classifying the different models and itemizing the particularities of each instrument—these old machines each have their defects, which, as I discuss below, is part of their appeal.

With the help of the students taking the course, I started by creating exercises [8] that would help musicians get used to their machines while quickly developing their musicality and listening skills in the ensemble context. For instance, one of the first exercises (Fig. 2) simply instructs each performer to follow the fade-out of the preceding performer with a fade-in, to maintain the impression of a stable amplitude.

Simple in theory but difficult in practice, these exercises force the players into a focused listening mode, as it is the precision of their listening that will determine the success or failure of the exercises. Given that analog oscillators are not precise, the musician must rely on their own sensibility, on the precision of their own hearing, as opposed to the precision of the given instruction. Here, limited material is not synonymous with sonic simplicity, and even less with the simplicity of the listening. As in *musique concrète*, the ensemble members work with attentive listening, a notion composers must take into account when working with the ensemble.

The first composer to write for the ensemble was Kevin Gironnay, who was a master's student in 2016. Gironnay faced the daunting task of figuring out how to compose for this instrumentation—the simplicity of the sine waves and the control parameters of the oscillators does not mean they are easy to compose for and use in a performance.

Gironnay had direct access to the performers, to the director and to the instruments, and this is reflected in his 2016 composition *Ignis Fatuus (Solis)* [9]. As not all the composers would have this direct access, the ensemble quickly realized that they needed to develop a score-writing method. Inspired by the formal graphics of early electronic music scores like Karlheinz Stockhausen's *Studie II* [10], the ensemble created a vectorial graphic template with symbols (Fig. 3) that can be copied and pasted by composers.

The ensemble designed this vectorial graphic model to be adaptable in terms of precision while standardizing the way to write and read the three main performative parameters: frequencies, amplitudes and (human-made) modulations. As seen in Fig. 3, the upper half of each oscillator staff is used for the frequency, and the lower half is used for the amplitude. Modulations can be applied to both frequency and amplitude. Alongside the graphic model, a document with a detailed procedure and instructions is given to the artist writing for the ensemble.

As for the reading by the performers, the scores scroll in front of them on side-chained displays connected through Serial Digital Interface (SDI), one for each performer (Fig. 4), allowing a precise synchronicity of the performers' actions. The score is sent to the displays from a computer using Graphic Score Reader (GSR) [11], a custom score follower developed as a Max4Live device. GSR mainly allows image-scrolling in any direction. It can send different scores to different groups of musicians or, for instance, send a different visual to the audience. While the ensemble uses GSR, the graphic score model has been imagined independently: The scores are made up of simple images that could eventually be read and performed by other oscillator ensembles using different technical setups.

Working with Ensemble d'oscillateurs, I was immersed in sine waves for several hours a week, not only in the ensemble's rehearsals but also as I listened to the existing repertoire of sine wave–based music, trying to find compositions that could be arranged for 10 oscillators. Having developed a better knowledge of sine wave–based music—and now equipped with procedures for the rehearsal, writing, transmission and performance of the ensemble's music—I started wondering

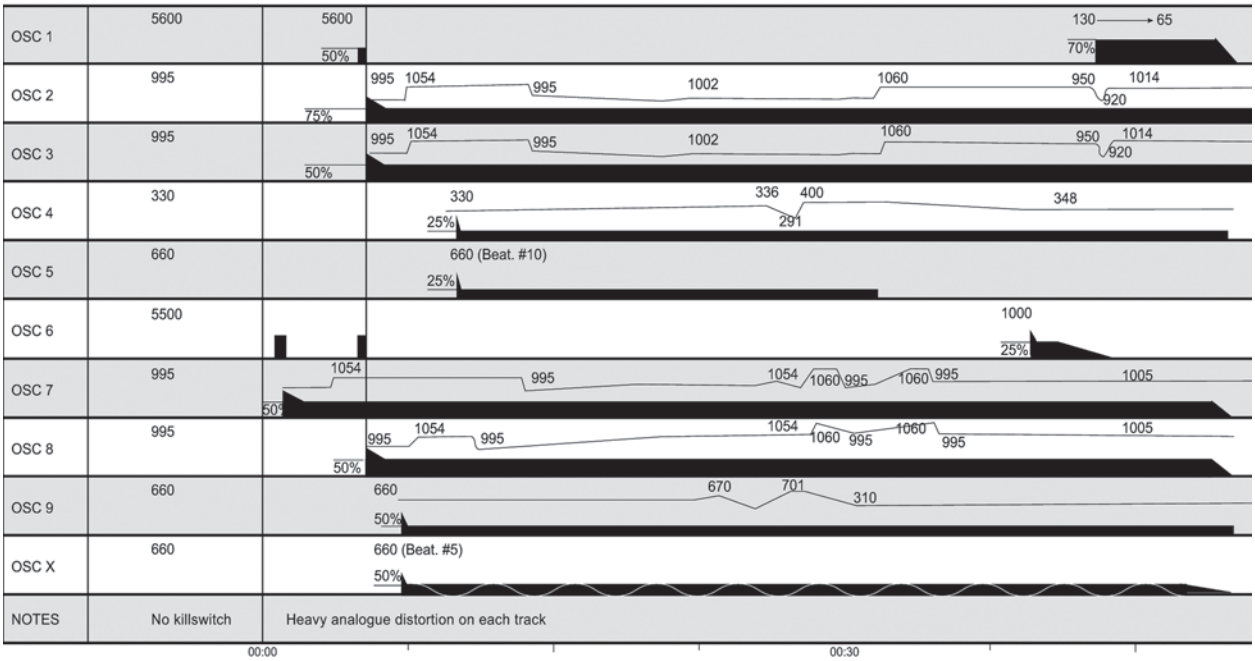

Fig. 3. First seconds of a score using the vectorial graphic model developed by Ensemble d'oscillateurs, 2019. The template with complete symbols and indications can be found at www.LFO-Lab.ca/ensemble-oscillateurs. (© Nicolas Bernier)

Fig. 4. View of the side-chained display on which the musicians of Ensemble d'oscillateurs follow the scores, 2019. (Photo © Soft Melancholy / MUTEK Montréal)

why there was no previous repertoire for this kind of ensemble. I asked myself why I thought it was relevant to undertake such a project today.

HIGHWAY TO COMPLEXITY: HISTORICAL OBSERVATIONS ON THE USE OF SINE WAVES IN ELECTROACOUSTIC MUSIC

> *But aesthetics seems to thrive on controversy, even to demand it: on the conflict, typically, of new and old and of simplicity and complexity.*
>
> EDWARD LIPPMAN [12]

Simple tones were used before the advent of analog oscillators, with instruments like the theremin or ondes martenot; simple tones were even used as a sample fixed on a record in John Cage's seminal 1939 composition *Imaginary Landscape No. 1* [13]. However, the accessibility and the ease of use of analog oscillators could have called for an expansion of new compositions for performed sine waves. Perhaps in search of timbral complexity, composers did not engage with using basic sine tone generators as a musical instrument as much as they might have.

The sine wave was in fact hardly considered as a musical material of interest rather than as a tool that allowed the creation of complex timbres. This might explain why there was no repertoire for analog oscillator ensembles prior to Ensemble d'oscillateurs. As disconcerting as it might be, is it possible that the sine wave—the most fundamental material in electronic music—was neglected by electronic music pioneers who didn't write much music for analog oscillator trios, quartets or ensembles?

Effectively, it seems that the complexity of timbres made possible with electronic means was a material more interesting to compose with than the basic sine wave. For instance, electronic music pioneer Daphne Oram described the sine wave as "musically not very interesting—it is a thin flute-like sound" [14]. In search of timbral complexity, Belgian composer Henri Pousseur found that there were "much faster ways than using sine waves to realize the intended sounds" [15]. Even Karlheinz Stockhausen, creator of one of the most foundational pieces of electronic music, *Studie I* [16], expressed at one point a rather pessimistic view of the sine waves produced by the audio generators of the Cologne electronic music studios:

> In addition, there is a beat-frequency generator, which produces sine tones. These basic instruments for sound production yield nothing usable. . . . It's only with the ring

> modulator that one can begin to work on sound combination. . . . These multiplication sounds seem, as far as I can see, to lead further [17].

Stockhausen, "the prophet of the sine wave" [18], seems to have dismissed pure sine waves as material not musically appealing in itself. It is no secret that Stockhausen was in fact looking for complexity, following the idea that "new timbres could be constructed synthetically in a music based on the simplest elementary sounds" [19].

Such remarks by pioneers of electronic music feed the assertion that the sine wave was barely considered a relevant aesthetic element in itself. In fact, the sine wave was often treated as a material to be modified, as a material that could be transformed into something else, something more interesting than what it actually is. In his thesis, *Sine Waves and Simple Acoustic Phenomena in Experimental Music*, John Blamey points to one of the reasons why the sine wave tends to be undervalued as a musical element per se:

> Once identified and explained, the significance of the sine wave seemed to be exhausted, and so was left aside in pursuit of more interesting and complex acoustical phenomena. As such, the sine wave seems a fait accompli—a given, containing no real interest in and of itself, except for what might be constructed from multiple sine waves [20].

In their quest for timbral complexity, electronic music composers seem to have overlooked the sine wave as a musical material, and, possibly, the analog oscillator as a musical instrument enabling the performance of music written specifically for sine waves. Even in a piece like Stockhausen's *Mixtur*, whose instrumentation includes four sine wave generators, they are used mainly to modulate other instruments rather than for the musical appeal of the actual sine waves' sounds.

In a way, Ensemble d'oscillateurs is filling this historical gap by developing a substantial repertoire of compositions and performances of electronic music based primarily on sine waves and performed on analog oscillators.

MORE OR LESS PURE: ON THE MUSICAL RELEVANCE OF SINE WAVE OSCILLATORS TODAY

Not only is the sine wave often described as a pure sound, but the mere fact that the members of Ensemble d'oscillateur perform on old analog oscillators (Fig. 5) emphasizes the pure/impure dichotomy and how our perception of this dichotomy evolves over time and with our tools. Some early electronic composers such as Louis Barron "felt that [the use of laboratory equipment] was the wrong direction, because laboratory instruments are made to be very precise and very definite, and people aren't. Art isn't" [21]. Further, author and composer Curtis Roads points to sterility as the reason for the hasty abandonment of the sine wave: "Stockhausen's sinusoidal *Electronic Etude I* of 1953 was important in its day, but now sounds like a sterile exercise. The initial enthusiasm for composition using only sine waves soon evaporated" [22].

However, compared with the precision of today's computers, the oscillators of yore can now in fact represent the opposite of what they were at the time: While they were once considered precise and sterile, this is no longer the case considering the perfect reproducibility of a digitally made sine tone. In fact, analog oscillators can be controlled only to an approximate degree, and their output is often a signal with defects and imperfections. In a performative context, the imprecision of the human gesture, however well one might try to perform, adds to the imperfections of the outcome. I argue that this combination of human and mechanical imperfections is a key to giving some kind of musical sensuality to music composed for sine waves.

Accordingly, Ensemble d'oscillateurs belongs in some way to the return to control interfaces, buttons and analog synthesizers that follows a computer-centric period in electronic music creation. Curtis Roads describes some of the flaws in the interface of old oscillators: "Their multiple rotary knobs and switches did not allow the user to switch instantly from one group of settings to another. Because of the weakness of their temporal controls, these devices imposed strict practical limits" [23].

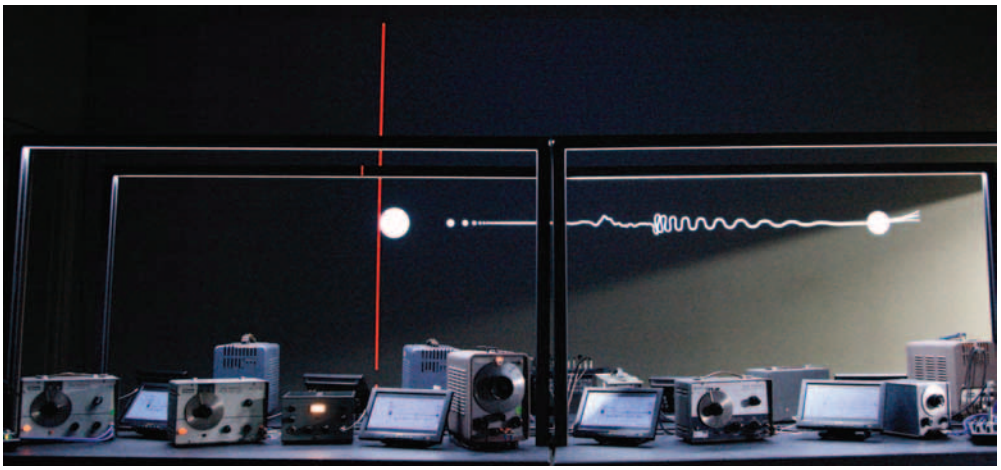

Fig. 5. Global view of the instruments, with five oscillators on each side of the tables, 2018. Projected on the back wall is a portion of Candaş Şişman's graphic score *SYN-Phon*. (Photo © Nicolas Bernier)

This might give some clues as to why there are no scores written for oscillator ensembles: While the sine wave as a recorded or computer-controlled material is entirely malleable, the sine wave manipulated in real time on an analog oscillator is rather difficult to control with precision. Roads also points to the "sterility" of today's digital music, in a way in which electronic music pioneers might have described laboratory equipment in their era:

> Digital sound synthesis techniques inhabit a virtual world more pure and precise than the physical world, and purity and precision have an undeniable charm in music [but] the overuse of precision and purity can lead to sterile music [24].

Therefore, what Roads identifies as defects of the analog oscillator might actually be key to the establishment of an equilibrium between precision and imprecision, perfection and imperfection, in the making of sine wave–based music. Manipulated by human performers in a live performance setting, with no second chance to record a more precise signal or gesture, the oscillators produce sine wave–based music that can be qualified as lively, warm and even sensual.

Philosophers Gilles Deleuze and Félix Guattari once said that "one needs a very pure and simple sound, a transmission or wave without overtones, so that the sound can travel and one can travel around the sound" [25]. Ensemble d'oscillateurs fuels this type of travel by stimulating the creation of sine wave–based compositions and performances, restoring the sine wave to the place it deserves as a musical material that—despite its being known for its sterility—musicians can joyfully play with.

Acknowledgments

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