# *Tec(h)tonic*: reimagining computer music techniques in the acoustic realm of sound production

Sippapas Thienwiwat

BM Candidate

College of Music, Mahidol University

sippapas.thi@student.mahidol.edu

February 23, 2025

# Abstract

*Tec(h)tonic (2025) is a 12-minute electroacoustic composition by Sippapas Thienwiwat for piano, subwoofer loudspeakers, and electronics, dedicated to Laphatrada "Pan" Wananukul. The work focuses on emulating physical modelling techniques from the realm of computer music through acoustical means of sound production, harnessing the driving forces of two 6.5-inch subwoofers on a grand piano, akin to the "exciter" and "material" components of physical modelling algorithms. Created with Pure Data, the piece employs various computer music techniques alongside extended techniques for piano to explore seldom-traversed sound domains. From the perspective of the composer, this paper aims to discuss the piece's compositional process, technical aspects, and challenges encountered during its creation, whilst serving as a form of documentation.*

# 1. Introduction

In January 2025, I finished composing my first-ever electroacoustic piece *Tec(h)tonic*. The piece was realized over the course of 3 months from late October 2024 to the later weeks of January 2025, but the concept for the piece came even earlier in the year. During the 2024 semester break, I have been experimenting with using audio-rate exciters for Karplus-Strong string synthesis in works like *Live at .init with NAKNAN (2024)* and *Dirge: For the Eroded (2024).* Inspired by results from this period of experimentation along with sonorous encounters during rehearsal sessions for the Thai premiere of Thai composer Nattakon Lertwattanaruk's improvisational work "to sink, slowly, into the silvery sea", *Tec(h)tonic* combines the required components of physical modelling with extended piano techniques. By combining the driving force of 2 subwoofers with the acoustical properties of a piano, I am able to extract interesting sonic material by repurposing the functions and properties of 2 sound production devices.

*Tec(h)tonic* involves two performers functioning as operators of the "acoustic physical modelling synthesizer". One performer controls the "control panel" of the "exciter" (subwoofer) while the other continually adjusts the structural properties of the "surface" (piano strings), akin to the normal parameter control panel of a physical modelling synthesizer.

The inclusion of the second performer came during the "workshop" process of the subwoofer technique, long before the conceptualization of the piece itself. While I am able to perform the piece alone (akin to Nattakon's "*to sink…"*), I felt the need for a second performer due to the limitations of what one performer could achieve with one piano and an iPad controller while in a fixed position at the sustain pedal. In that same time frame, I was also making acquaintance with fellow Music Technology major student Laphatrada "Pan" Wananukul, a formally-trained classical pianist with interests in audio engineering and contemporary music. As

we became acquainted, I found Laphatrada to be the perfect second performer with her eagerness to explore electronic sound production and her desire to explore the piano by going beyond pressing black and white keys. Through some negotiations, Wananukul agreed to the role as the second performer as *Tec(h)tonic* would be the first piece of modern Western art music that she had performed.

*Tec(h)tonic* was premiered on February 11, 2025, at the Composition Student Concert at the A407 Recording Studio, Mahidol University College of Music, by the author, Sippapas Thienwiwat, and the dedicatee of this work, Laphatrada “Pan” Wananukul.

# 2. Composition

## 2.1 Compositional Form & Analysis

As suggested by the piece's title, *Tec(h)tonic* draws inspiration from the movement of tectonic plates in the event of an earthquake, which became the basis for the compositional form. The piece is divided into 3 unnamed sections with 4 subsections in each section. The structure of a typical earthquake would be "Build Up-Release-Aftershock", which partly resembles the "Build-Sustain-Improvise-Release" form found in most of my works as a composer and digital artist alter egos. Tec(h)tonic calls for 2 performers: one operating the electronics (technical aspects are discussed in Section 3) while the other improvises and continuously prepares the piano.

The piece starts with a build-up of the sounds of the low strings through the use of the "rapid-fire" gesture, pinging the low strings shortly with the sustain pedal half-engaged, along with clothespins scratching at the low and middle strings. The soundscape thickens up with the "rapid-fire". These 2 materials are thoroughly explored while the subwoofers start to oscillate asynchronously, gliding from the rhythmic spectra to the zone of pitch formation. During the buildup, sandpaper is inserted between piano strings and the subwoofer to dissipate the spread of energy, creating a different excitation surface. Another crucial element is the sustain pedal, which helps sustain the vibration of the piano strings for a continuous rising in energy of the soundscape.

Two streams of grains continuously increase in frequency from the rhythm and tone formation spectra (~0-40 Hz) into the pitch spectra (40 Hz onwards), thickening into a dense sonic cloud. At the same time, the performer responsible for controlling the "structure" of the surface starts up the Oral-B Pro 2000 electric toothbrush, signalling the descent into

improvisation. The improvisatory section explores the previous materials with the electric toothbrush, acting as a “soloist” on the oscillating low-end bed. The electric toothbrush, spinning at 8800 revolutions per minute (~146.6 Hz), is extended with a clothespin attached right under the brush to focus vibrations into one focused point. Some of the predetermined actions for the improvisation section include but are not limited to “trading” solos, “low-end reinforcement” by putting the toothbrush on low strings, and “screams from the depths of hell” by pressing the toothbrush on clothespins at the middle strings.

Reaching the highest point of activity in the piece, the frequency of both oscillators drops down into the pitch formation spectra (~20-40 Hz). Both performers aggressively pull out the sandpaper beneath the subwoofers to create a hollowing echo. While the echo slowly fades out, both performers insert a polyhedral 10-sided die into the space of each subwoofer’s frame, creating secondary sounds within the subwoofer by making the dice vibrate. Sudden “after-shock” gestures come in, with the speaker rising to ~80 Hz in frequency and almost full amplitude before dropping down to the same state it once was. The “after-shock” gesture is repeated twice, with another icosahedral dice inserted before the last “after-shock” ensues.

The frequency of the last “after-shock” gesture slowly glides down from ~80 Hz to the rhythm spectra, reintroducing “rapid-fire” gestures. Fading out, both streams of grain reach 0 in both frequency and amplitude, leaving space for “rapid-fire” improvisation. The silence between each “rapid-fire” became more apparent as the sustain pedal was gradually released. With the last “rapid-fire”, both performers slowly release from the position and execute the 8-second “new music pause” in complete silence.

## 2.2 Instrumentation & “Workshop” Process

While the subwoofer is the main subject of *Tec(h)tonic*, a typical piece using extended piano techniques would not be complete without secondary elements that complement and extend the sonic possibilities of the main subject. During the drafting and “workshop” stage, the exact specifications of the limits of materials/objects for improvisation were determined. Materials are divided into two categories: materials that concern the subwoofer and materials that do not.

After a brief trial and error, the placement of the two subwoofers was designated to be at both ends of the low strings. (*Fig. 2.1*) Extension materials for the subwoofer include sheets of sandpaper and polyhedric-shaped dice, modifying the subwoofer's vibration behaviour. The sandpaper dissipates force, introduces secondary reflections in the piano, and acts as a resonator when curled up. In the last section, the polyhedral dice shake indefinitely when inserted into the frame of the speakers, akin to a dice roll, thus adding percussive elements to the softened soundscape.

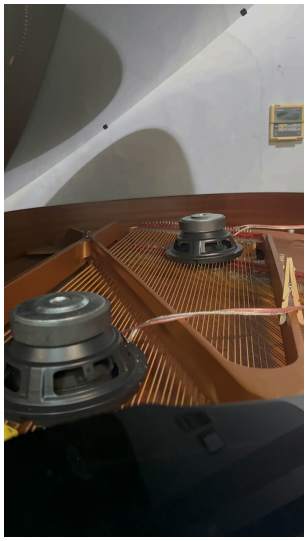


*Figure 2.1* Subwoofer placements

Materials not related to the subwoofer include an electric toothbrush and clothespins. Clothespins are mostly used to excite the piano strings manually by scraping the low and middle strings. On the other hand, the electric toothbrush is used in the manner of a soloist, performing gestures on top of the evolving subwoofer gesture. While the electric toothbrush can bring out a wide variety of timbres, I feel that by extending the toothbrush by attaching a clothespin to the neck of the brush, I could get even more timbres when interacting with the piano strings.

## 2.3 Improvisatory elements & score/directions

Like many of my works, *Tec(h)tonic* follows a set of instructions for improvisations rather than having fixed notation. The set of instructions is divided into 3 main sections with 4 subsections each (*see Fig. 2.x*). Particularly in the 3rd subsection shown in *Fig. 2.y*, the fully improvised section has little to no coordination. All the materials used in the improvisation section were either thoroughly explored before or are materials that will be introduced in the upcoming sections.

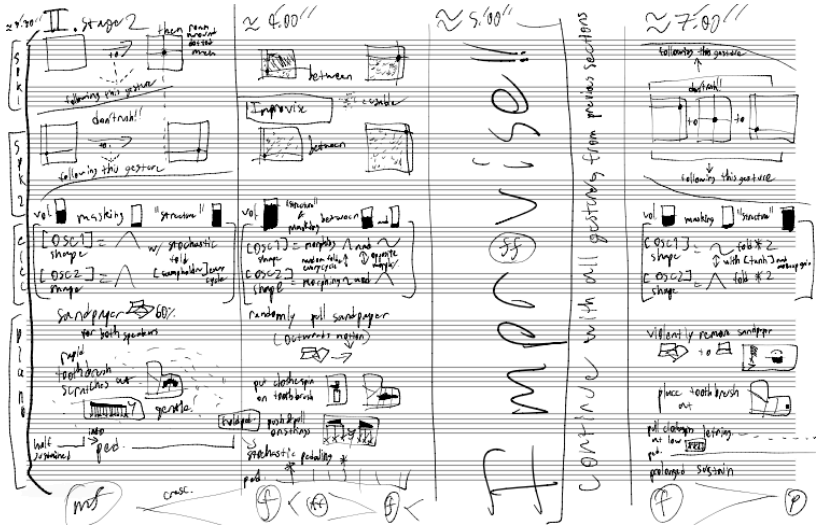


*Figure 2.x* Excerpt from the score of *Tec(h)tonic*

# 3. Technical

As the introduction (section 1) states, *Tec(h)tonic* uses the piano's physical properties to produce sound. When placed on the piano strings, the subwoofer's vibration transfers energy to the strings, forcing them to vibrate. The suspension of the piano strings also allows the subwoofer to resonate with the piano's body.

## 3.1 “Exciter” Section

While the piece is based on physical modelling techniques, particularly the Karplus-Strong string synthesis algorithm, the type of exciter used in the system utilizes components for microsonic sound synthesis techniques rather than the typical white noise burst.

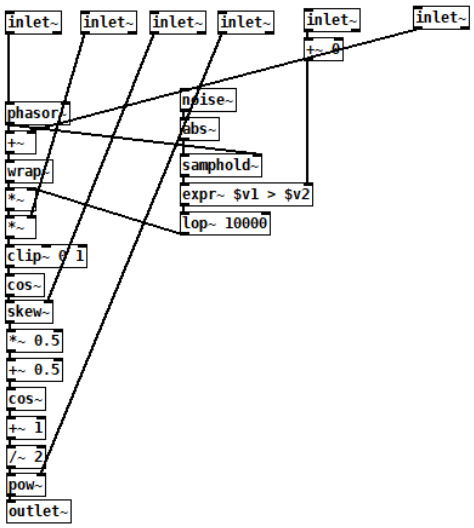



*Figure 3.1* Inside the [pt] abstraction

The main “exciter” component of *Tec(h)tonic* utilizes two unipolar pulse train oscillators (self-made [*pt*] abstraction in Pure Data, see *Fig. 3.1*) looking up cosine [*cos*~] and triangle wavetables (see *Fig. 3.2*), crossfaded together. [*pt*] has six (6) controllable parameters: frequency, duty cycle/pulse width, [*skew*~] value (ramp skew abstraction by Thanapat Ogaslert, see *Fig. 3.3*), [*pow*~] value, masking rate (Gaussian noise into sample and hold with “>” comparator) and [phasor~] phase offset/modulation input (not utilized in this case).

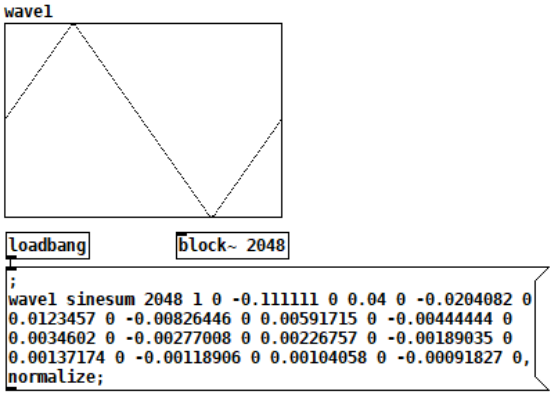



*Figure 3.2* Generating a 2048-point triangle wavetable in an array using the *sinesum* message.

A separate “one-shot” version of this wavetable lookup exciter is also utilized in the “rapid-fire” gesture by using a [phasor~] wavetable lookup patched into a [*~] object for amplitude control. The [*~] is controlled by [vline~], producing decay-only envelopes triggered by the TouchOSC interface (see section 3.2).

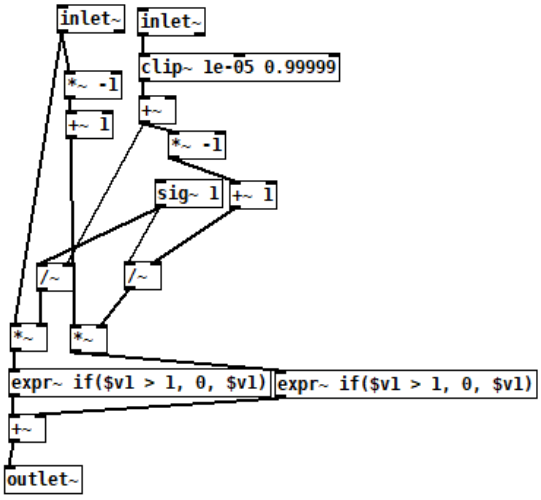



*Figure 3.3* Inside the [skew~] abstraction

Other controls for the exciters include 4-stage wavefolding, with the drive value controlled by the same controller parameter that controls [skew~] value.

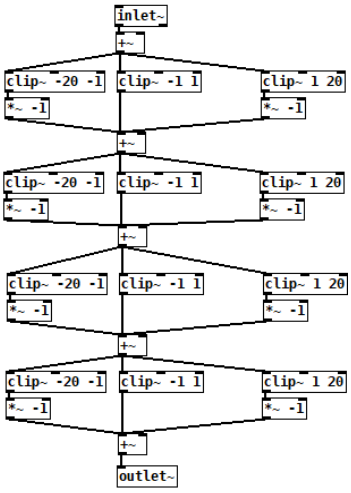



*Figure 3.4* Wavefolder function inside a [pd] subpatch

## 3.2 TouchOSC interface

The TouchOSC interface (*see Fig. 3.5*) for *Tec(h)tonic* was designed with input from Laphatrada during the workshop stage. The control parameters (premiere version), from left to right, are for the following parameters: “rapid-fire” decay time, “rapid-fire” trigger pads, XY pad for the oscillators (X-axis controls frequency, Y axis controls amplitude), wavetable crossfade, [skew~] value, [pow~] value, masking rate, and master volume. The main interface was designed for performance on the iPad Air 4, but the .tosc file can run on any other iPad device with a screen resolution of at least 1920x1080.

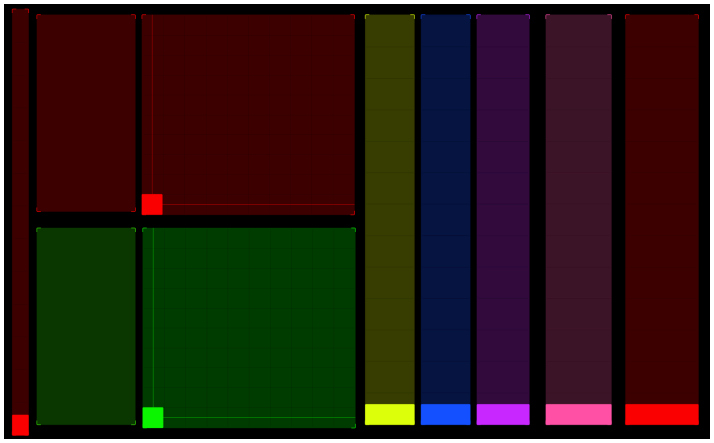


*Figure 3.5* TouchOSC interface

# 4. Challenges

## 4.1 Rehearsals

*Tec(h)tonic* marks the author's first collaboration with Laphatrada (*see Fig 4.y*), introducing several variables into the piece. In the first weeks, the biggest problems were her unfamiliarity with extended techniques and fear of breaking the piano. However, these factors slowly disappeared as we explored contemporary music both within and outside the context of *Tec(h)tonic* together.

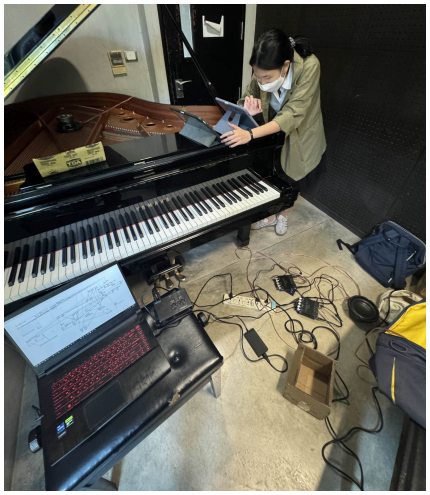


*Figure 4.x* Taken from one of the rehearsal sessions. Pictured: Laphatrada Wananukul.

After Laphatrada agreed to be the second performer, I quickly created a 12-section sketch of the structure and sonic materials for *Tec(h)tonic* (see *Fig. 4.y*). The sketch originally indicated the use of four subwoofers and a contact mic. However, due to problematic encounters during rehearsal, the final draft ended up with only two subwoofers and no contact mic. Many new gestures and a new ending were added to the last draft of *Tec(h)tonic*, which is why I decided to give this particular work a year marking of 2024-2025.

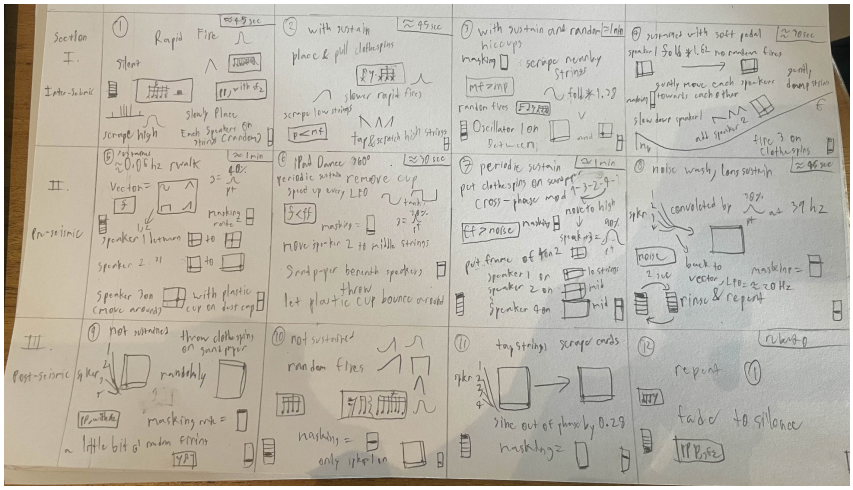


*Figure 4.y* Working draft of *Tec(h)tonic*, originally designed for 4 subwoofers.

With improvisatory elements present, I had to teach Laphatrada the basics of improvising sound arts from the ground up. During rehearsals, I had included a TouchOSC visualization panel in the Pd patch (see Fig. 4.b) to monitor input activity from Laphatrada in real time. This real-time system enabled me to quickly give feedback on improvisatory techniques to Laphatrada, which helped her to improve her improvisatory skills rapidly.

During rehearsals, I encountered several problems with the electronics setup not working properly due to outdated hardware, limited computational power, and improper equipment storage. The audio interface I used for *Tec(h)tonic* is the MOTU MicroBook II, which is notorious for its connectivity issues, limited processing power, and outdated firmware, resulting in unexplained disconnections. While the rehearsal took place from mid-December to early February, there were 3 instances where I had to re-solder the speaker cable to the subwoofers' terminal due to improper way of storing them.

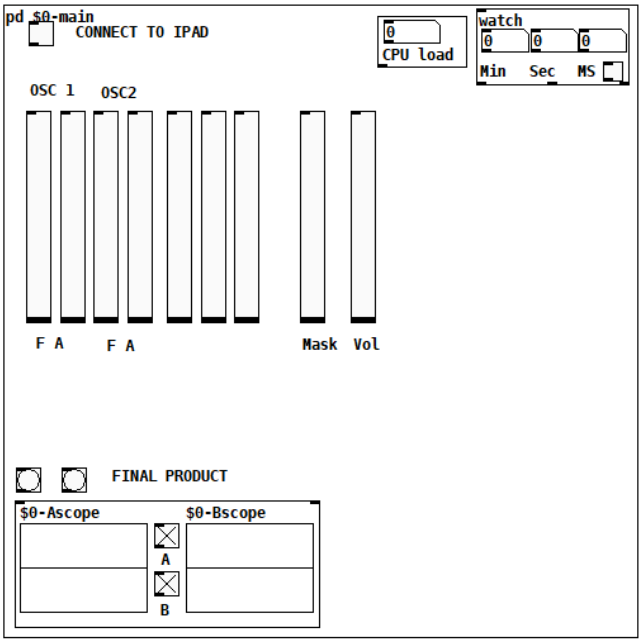



*Figure 4.b* Pure Data patch for *Tec(h)tonic* displaying values from TouchOSC

After the last rehearsal, I had the chance to sit down with Laphatrada and reflect on *Tec(h)tonic* in a privately conducted interview (footage unavailable). While Laphatrada's repertoire for her major instrument private lessons mainly consists of 20th-century piano music, taking the plunge to perform a full-fledged extended piano technique piece was another story. *Tec(h)tonic* gave her experience in exploring sounds, confidence in improvising using extended piano techniques and overcoming the fear of breaking the piano.

## 4.2 Premiere

On Tuesday, February 11, 2025, the premiere of *Tec(h)tonic* was presented by Laphatrada and Sippapas at the A407 Recording Studio, Mahidol University College of Music (*see Fig. 4.z*). Due to college policy, we were only allowed to perform extended techniques on the Yamaha grand piano at the A407 recording studio, which led to some unforeseen circumstances during the premiere. Relying heavily on acoustics, Tec(h)tonic did not translate well in recording studios due to the “dead” design of the A407 room. Another problem I encountered involved the amplification, which did not work as I expected due to the miking distance being too far from the source (piano). Other than these problems, there were no problems encountered with the electronics.

The audio recording from the Composition Students Concert is available on the SKYKYS SoundCloud profile. The piece is recorded using a stereo pair (ORTF miking technique) pointed at the piano and blended with the main pair in the XY90° setting.

*Figure 4.z* Moments during the premiere. Photo by faculty member Dr Thomas Hyuk Cha

## 5. Conclusion

The adaptation of computer music concepts for sound production in *Tec(h)tonic* by repurposing sound production devices produced a new set of sonic palettes that can be endlessly explored and customized. Working through my first electroacoustic composition proved fruitful in being more considerate about compositional form, interchanging acoustic and electronic sonic elements, and creating a proper score/instruction sheet. *Tec(h)tonic* also gave me the invaluable experience of working with a performer as a composer, helping me to improve my ability to communicate and work with a performer. Laphatrada, on the other hand, had her first encounter with an improvisatory-based Western Art music, which will pave the way for her to become a sound artist and improviser in her ways.

## Acknowledgements

The conceptualization of *Tec(h)tonic* would not have been possible without the support of my teachers, Thanapat “Ryan” Ogaslert and Dr. Tyler Capp. I would also like to thank my colleague and best friend Nattakon Lertwattanaruk, who inspired me to work more with extended piano techniques. Last and most importantly, I would like to acknowledge the contributions of the piece’s dedicatee, Laphatrada “Pan” Wananukul, for her role as a performer and beyond. Her eagerness to explore the sounds within the piano helped form the backbone of the piece; she is the inspiration of the work and helped bring it to life. (see *Fig. 99.1* & *Fig. 99.2*)

*Figure 99.1* Rehearsal wrap-up selfie. Left to right: Laphatrada Wananukul, Sippapas Thienwiwat

*Figure 99.2* After the premiere of Tec(h)tonic. Left to right: Laphatrada Wananukul, Sippapas Thienwiwat

## References

Xenakis, I (1971) *Formalized Music.* Bloomington, Indiana University Press.

Wishart, T. (1996) *On Sonic Art*. Harwood Academic Publishers.

Wishart, T. (1994) *Audible Design: A Plain and Easy Introduction to Practical Sound Composition*. York, UK: Orpheus the Pantomime.

Xenakis, I (1971) *Formalized Music.* Bloomington, Indiana University Press

Puckette, M. (2007). *The Theory and Technique of Electronic Music.* Singapore, World Scientific Press.

Gabor, D. (1947) "Acoustical quanta and the theory of hearing." Nature 159(1044): 591-594.

Roads, C. (2001b) Microsound. Cambridge, The MIT Press.

Roads, C (2001a) “Sound composition with pulsars.” *Journal of the Audio Engineering Society* 49(3): p 134-147.

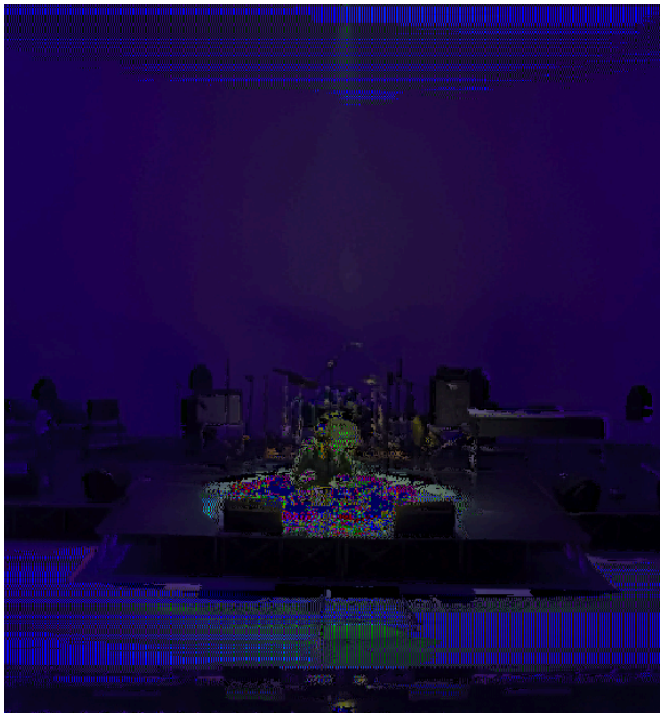
Roads, C (2015) *Composing Electronic Music: A New Aesthetic.* New York, Oxford University Press

Aronson, I., and L. Tsimring (2009) Granular Patterns. Oxford, Oxford University Press.

Roads, C (1996) The Computer Music Tutorial. Cambridge, The MIT Press.

Karplus, K; Strong, A (1983). "Digital Synthesis of Plucked String and Drum Timbres". *Computer Music Journal.* 7(2) MIT Press: p 43–55.

## About the Author



Sippapas Thienwiwat is a Thai audiovisual artist, sound practitioner, video artist and composer tackling man-machine interaction in digital audiovisual landscapes through improvisation. As an artist and composer, his works have been selected for performance at many institutions and venues around the world. His flexibility as both a performer and an artist often finds him in collaborative environments, working with interdisciplinary practices involving music, sonic arts, visual arts, and performance arts.