

Music for the Augmented Pipe Organ

by
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Abstract

Music for the Augmented Pipe Organ is a composition for a 74-rank Casavant pipe organ which incorporates newly devised digital controls systems. The work stemmed from research into the confluences between the pipe organ and contemporary electronic and digital music practices. With a reflexive attention to the organ's spatial context and unique embodiment of the harmonic series, the work explores new sonic terrains that emerge through a digital approach to the world's oldest mechanical synthesizer. Through this process of hybridizing acoustic and digital sonic imaginations, the work creates a dialog between the vibrant material and ethereal space of the organ and the techniques of electronic and post-digital music forms. Site-specific elements such as the church's architecture and interior acoustics are further incorporated into the work through the use of a controlled feedback system and projection mapping, considering the resonant relationships between the instrument and its surrounding space as a generative element interwoven into the composition.

Keywords: pipe organ; post-digital music; machine listening; interface design

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Defence Statement

Background

The pipe organ can be considered one of the earliest forms of sound synthesis (d'Alessandro). Over centuries organ builders have experimented with generating new types of sounds through physical assemblages of wood, metal, and air. Due to the instrument's typically large size, the pipe organ has tended to be fixed into specific places and contexts, most commonly a church; imbuing the instrument with a lasting association with liturgical music. In the context of new music, many artists continue to pursue interesting possibilities with the organ by incorporating disparate practices and technologies of sound-making. For example, the organ's site-specific and spatial formations have provoked similarities to the practice of sound installation and its concern for the relationships between sound, space, and the social body (Fidom 27). The organ's functional 'background' support of the church mass has also drawn comparisons to acousmatic and ambient music aesthetics as well as to the anonymity of contemporary muzak (Anderson 323).

While there was a burst of attention towards developing extended techniques for the organ in the mid-20th century by composers such as Cage, Ligeti, and Kagel, attention to the instrument in the sphere of new music slowed while works using electronic synthesizers and computers began greatly expanding (d'Alessandro). Without much notice, the technology embedded inside pipe organs continued to evolve throughout the era of electro-mechanical innovation and more recently the phenomenon of integrated circuit boards and digital MIDI interfaces (Anderson 34). The newer technical affordance of the ability to control a pipe organ via a computer represents an expansive area of confluence between the digital and analog realms of sound which provoke new ways of working and thinking between instruments and interfaces. The resulting colliding and blurring of these two realms exemplifies what many describe as a broader 'post-digital' turn in the sonic arts as questions regarding the use of digital technologies in artistic practice take on new rounds of re-evaluation and self-reflexive attention (see Cascone 2000, Andrews 2013, Fleischer 2015). Invoking the critical ideas of a post-digital milieu to think through the wider relations between the materiality and the subjective affordances of a particular musical and technological assemblage, my

project conceived of a highly hybridized instrument that linked the computer's digital techniques with the electro-mechanical apparatus of the pipe organ to create new modes of interaction between the space, instrument, and composer. By exploring the pipe organ's wider sonic and social architecture in the process of creating the composition, I see the instrument as both a technical interface and a cultural reference point for particular kinds of listening.

Contemporary Context

French organist Christophe d'Alessandro has studied the history of organ building and broadly contextualizes many of its historical developments in relation to the field of sound synthesis. While contemporary practices in sound synthesis largely continue to take place in the digital realm, d'Alessandro posits that there are rich areas of confluence between the digital and analog realms, and in his artistic practice has developed projects which augment the pipe organ with techniques such as digital signal processing and multi-channel speaker installations (d'Alessandro et al.). d'Alessandro's approach to the organ was inspiring to me in that it developed a shared discourse between the organ, spectral-morphology, and electro-acoustic music while also considering the differences (or lack thereof) between analog (or materials forms of sound) and its contemporary digital mimics.

To further situate the organ as an extensively hybridized instrument, musicologist Roger Mosely offers an interesting observation in suggesting that contemporary uses of the terms 'analog' and 'digital' have eclipsed many of their historical connotations; instead together fusing into what he describes as a "mutually constitutive dyad" (69). Despite (or perhaps due to) the instability of these semantic boundaries and the multiple interpretations made of 'post-digital' aesthetics in music, I find the broad range of questions linked to the term helpful in thinking through the techniques used in my project. For example, Kim Cascone wonders how the aesthetics of music have changed after the "tendrils of digital technology have in some way touched everyone", noting trends that suggest an evolving artistic milieu where "the medium of digital technology holds less fascination for composers in and of itself" (13). Cascone sees a vital productivity in giving attention to aspects of the material world which are typically relegated to the background hum of contemporary electronic devices; suggesting new musical ideas can emerge from the manipulation and interrogation of the inner black-box

of technological interfaces (13). Furthermore, Cascone's writing on glitch and other interface errors as compositional tools is influential to my project in the examination of the organ's interface as a site of a reactive feedback system.

Rasmus Fleischer argues that post-digital aesthetics relate to a "politics of collective affectivity", where the contemporary super abundance of music for consumption (live-streaming, ipod listening, ect) creates a reactionary and heightened interest in the specificity of music's temporal and situational unfolding (256). These reactionary impulses also relate to the tactile realm, which emphasizes a focus on the felt dimensions of sounds as perceived by the entire body. This broadened lens of the post-digital is useful in describing other contemporary electronic music artists whose work draws from the organ in methods related to this project. Canadian artists Tim Hecker and Sarah Davachi both utilize organs and their sites as a method of bringing listeners closer to the material and spatial forms of sound. Hecker's dissertation research examined the early modern soundscape's relation with loud sounds, positing loudness itself as an affective zone utilized most often in musical contexts by the pipe organ (5). Hecker's high-decibel ambient performances, many of which occur in churches, frequently use samples of pipe organs as raw materials which are then processed beyond recognition into new forms of abstract soundscapes meant to induce a sense of the sublime and a loss of subjectivity. His aesthetic references a pre-amplification sonic era where the pipe organ was one of the few musical instruments that would provide the "opportunity of losing oneself, if for a short period, through the power of its enveloping material force" (Hecker 46). Citing influence from minimalist Arvo Pärt and La Monte Young, Davachi's work also considers the psychoacoustic and spatial qualities of sound, using the organ's ability to sustain long tones as a way to focalize a sense of the "perceptual interiority" of sound itself (Davachi 3).

Other connections between the pipe organ and the post-digital lie in the realm of contemporary sound spatialization practices and 3D audio systems found in Berlin's Funkhaus studio ("Berlin's Centre for Spatial Sound") and EMPAC's 'Wave-Field Synthesis' system (Ascani et al.). These sound systems strive to artificially produce a surround-sound environment; an acoustic dynamic which can be traced back to the pipe organ's immense spatialization across large reverberant cathedrals (Zvonar). In this resonant and highly reflective architecture, sound was felt to come from all directions, and was frequently perceived as a force affecting not just the ears but the entire body.

These examples suggest that many 21st century electronic music, sound art, and sound spatialization techniques share similar linkages to the aesthetic remnants of the pipe organ.

Motivations and Related Projects

My research during the MFA program has broadly interacted with the fields of musicology, psychoacoustics, sound studies, and organology. Specific connective examples of these interests are my research on Western and Indonesian tuning systems, the history of the organ and keyboard, contemporary electro-acoustic music aesthetics, and an examination of listening itself propagated by soundscape theorists emerging from the World Soundscape Project. In relation to my practice and utilization of sound-reproducing technology, I often consider how to invite careful listening to sound in a way that foregrounds perceptual relationships between listeners, instruments, materials, and spaces. As an instrument builder and composer, the practical applications of my research have manifested as sound installations, experimental musical instruments, recordings and performances. Several of these research themes functioned as resources for the 1st year MFA project, directed study, research abroad, and other community-based projects which informed the creative process leading to *Music for the Augmented Pipe Organ*.

During my directed study I explored the idiosyncrasies of paired tuning systems in pipe organs and Indonesian gamelan instruments. I was interested in looking more closely at how both instruments use de-tuned pairings of pitches to create intentional beat patterns; a creative use of a sonic texture often thought of as dissonant in relation to Western tuning methods of 12-tone equal temperament. As a process of examining and refiguring aspects of each instrument's harmonic design, I devised a method of retuning a set of organ pipes to match the paired tuning of a set of Balinese gamelan instruments. I then created a composition which used the organ and the metallophones, using a set of contrasting beat frequencies produced from the paired tuning to create the rhythmic structure of the piece. The process informed and extended my approach to reimagining existing instruments as holding multiple and simultaneous possibilities for disparate tuning systems and sonic textures.

Similarly, the 1st year project, *no tree is untouched by the wind*, is an experimental musical instrument that refigures principles of existing instruments into a new form; in this case drawing from the designs of vibraphones and gamelan metallophones. My design comprised of 15 individually suspended aluminum metallophones with electro-mechanical mallets that could be spatialized into various configurations. As an architectural intervention, the distributed nature of the instrument is designed to map onto existing environments, folding along their contours to create a non-focal acoustic dynamic which blends into the ambient surroundings in unpredictable ways. Through this strategy of surround sound diffusion, the experience of each listener is subtly shifted as they move throughout the space, hearing across relationships held and revealed through different perspectives. Conceptually, the project was inspired by the commonalities between the discourses of sound art and geographic theories in the understanding and defining spatial relations, with both modes of thought often conjuring a type of spatial thinking “conceived as plural, as the outcome of social and material practices, and as indivisible from time” (Born 21). The installation also draws parallels to the ways that instruments such as the pipe organ can become a method to re-define space, becoming their own form of architecture to enact a specific experience of sonic dwelling.

Other instrument building projects have developed in a collaborative context, such as *The Re-Organized Organ* project held at VIVO Media Arts Centre in 2017. A group of ten youth convened weekly over three months to investigate the sonic potentials of e-waste materials as they created a collection of experimental instruments using parts from a discarded electronic organ and other electronics sourced from the organization Free Geek Vancouver. As one of the artist mentors for the group, I facilitated workshops exploring e-waste, acoustics, music technology, and instrument design, encouraging the group to explore the material realm of discarded electronics to find interesting ways of re-assembling them anew. The group process prompted several worthwhile questions regarding the use of technology in the wider context of e-waste; how do we foster critical thinking as users of technology? How do we avoid fetishizing its promises for new (and better) forms of expression? In constraining our materials to e-waste, we collectively ventured into many post-digital ways of working with sonic tools; reimagining objects with previously codified interfaces as raw materials for sculptural and technological works.



Figure 1. The Re-Organized Organ – Photo by Seoyeon Jeung

Lastly, my research travel to Bali, Indonesia further informed my approach to instrument design, allowing me the opportunity to attend concerts by composers who are actively experimenting with tuning systems and instrument designs. These experimental approaches typically require close communication between musicians and gamelan makers, as the former request modifications or new designs during the commissioning of the instruments. In this ongoing process of questioning what gamelan music can become, its material and sonic formations can be seen as constantly in flux as new instrument designs, altered tuning systems, and uncommon arrangements of traditional instruments are tested in relatively short amounts of time. While some dramatic experiments often don't gain enough traction to be used for more than a few compositions, other innovations frequently become emulated by gamelans throughout the island. These exploratory processes of an instrument's sonic and cultural logics draw comparisons to the pipe organ in interesting ways. Gamelan ensembles and pipe organs are both centuries old, large-scale instruments bound up with many ritualistic functions and sacred spaces. Both contain a multitude of sounding components that are conceived of as one instrument expressing the nearly full spectral range of human hearing. Furthermore, both instruments continue to be a dynamic site of shifting relationships between materials, cultures, and listening modalities.

Interface Design

The development of *Music for the Augmented Pipe Organ* began after a series of correspondences with Johnty Wang, who had created a preliminary interface concept in Max MSP for a pipe organ as part of the University of British Columbia's Music, Sound, and Electroacoustic Technologies research group. At the time I had just completed *pulses // patterns*, an installation and performance project that involved augmenting a single-rank of organ pipes with computer controls. Johnty and I shared resources on our respective approaches to the organ and began outlining a plan to augment the Pacific Spirit United Church's organ, of whose congregation Johnty is a member. Since October 2017, I conducted a monthly exploratory session at the church. Initial visits involved the creation and revision of a digital map of the pipe organ's capacities into the Ableton DAW (digital audio workstation) such that the five divisions of the organ (Pedal, Swell, Great, Positive, and Choir) could be divided and represented in a clear way within Ableton. This allowed for five unique layers of MIDI note information to be sent to the organ simultaneously with the pitch information being anchored to the various levels of stops (32 ft, 16 ft, 8 ft, 4 ft, 2 ft ect.) with 'middle C' mapped to the 8 foot pitch range.

As the sessions progressed, Johnty assisted with the augmentation by developing a Max MSP patch that could control the stops (the various voices of the organ such as the flutes, strings, reeds, ect). This was achieved by using the layer of MIDI data known as 'System Exclusive' messages (SysEx) already present in the hardware controls of the organ console developed by the commercial hardware company Solid State Logic. The Max MSP patch mapped out the SysEx messages the organ needed to receive to switch on or off a given stop, and converted MIDI CC messages from Ableton to the corresponding SysEx control values. This allowed groupings of stops to be turned on and off in unconventional manners, such as being pulsed or changed at specified instances within the expression of a chord or melodic phrase. The sonic possibilities of such textures were interesting to my ears after learning that organ pipes typically take a short amount of time to move from a slightly noise-infused attack transient (what organists call 'chiff') to a more established and stable tone. When stops were activated for a second or less, the 'chiff' reversed roles to become the foregrounded tone colour.

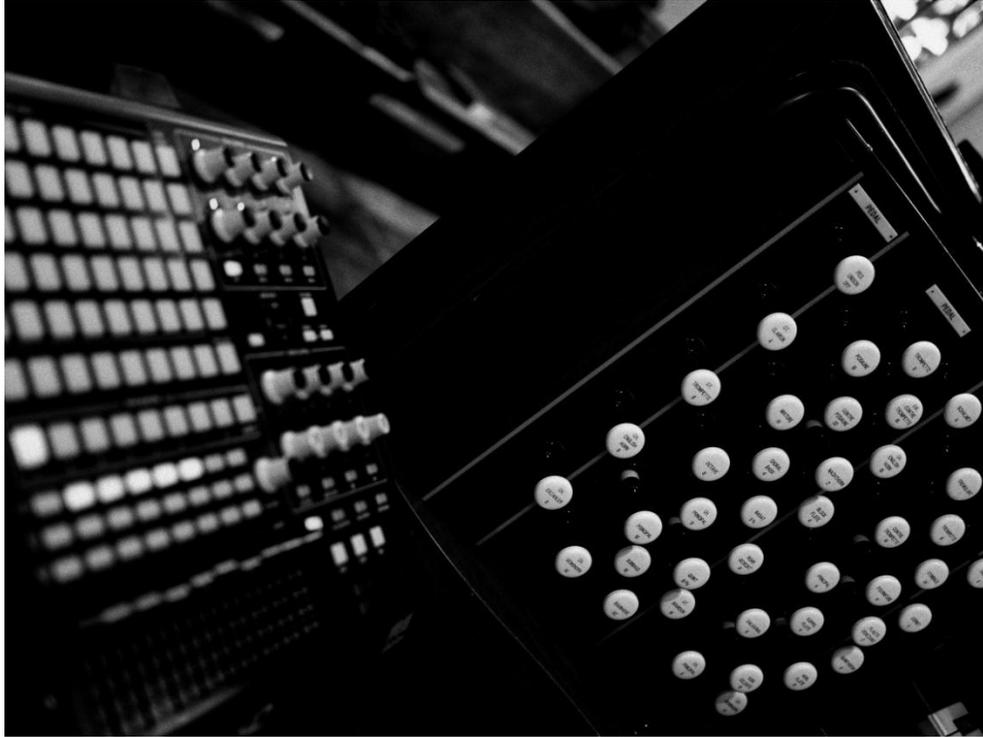


Figure 2. Digital and Electro-Mechanical Interfaces – Photo by Alistair Henning

Feedback System

My exploration of the organ also involved testing a feedback system that created a generative relationship between the hardware control system of the organ and the space of the church. The feedback system used a microphone placed in the centre of the church to pick up the sound of the organ in the room, which was analyzed and converted into MIDI information by pitch-tracking algorithms hosted in various software environments. These algorithms analyze the various frequencies of the input and deduce the presence of fundamental pitches from their spectral content by using the 'fourier transform' method (Thibault 2). Despite the intention of the algorithms to be accurate listening devices in service of 'real-time' audio to MIDI transcription, their methods can be thought of as existing in a liminal space somewhere between 'machine listening' and 'human listening' in that their imperfection produces results containing errors and other surprising interpretations of pitch and temporal information. Furthermore, the use of a microphone to capture the audio for processing further inflects this type of machine listening, as microphones have different biases towards the various frequency bands when compared to human listening.

These processes interact with the spatial and harmonic design of the pipe organ in interesting ways. Because of their size, organs cannot be heard in isolation as instruments; they are always perceived in-situ with the acoustic dynamics of their site. Thus, the reverberation time of the church acoustics is a variable in that it allowed tones to linger in the air as the reflective energy of sound waves takes time to dissipate. The architectural layout of the church also changes the behavior of the sound waves, emphasizing certain frequency areas and dampening others due to variable sympathetic resonances. In terms of harmonic design, many organ stops organize their frequency content at very finely tuned intervals, with many flute stops in particular only producing acoustic energy at discrete frequencies of the harmonic series. This means that overlapping overtones from simultaneous notes gather acoustic energy into new peaks, commonly at the octaves, 5th, and major 3rd intervals, which are interpreted by the pitch-detection algorithms as strongly indicating the presence of different fundamental notes. These additional notes generated by this algorithmic listening, in addition to correctly tracked pitches registered in a small time delay, were simultaneously sent back into the organ to be expressed as new note messages to produce the feedback. This created a dynamic and reactive effect that was collectively influenced by the interactions the organ's harmonic relationships, the variable resonances and reverberation time of the church's acoustics, microphone placement, and software controls.

During improvisation sessions when the organ was played directly through the keyboard or through software control, the reactive feedback would influence the harmonic direction as well as build up surprising textures, creating a type of cybernetic feedback loop between player and interface. These methods share some commonalities with the human-machine "improvisational relationality" of Andrew Brown's 2015 work *Ripples*, which used an interactive "player-paradigm system" comprised of two disklavier pianos and one live performer (5). In my approach, the feedback loop needed to be completed through the algorithmic listening of the space, rather than rely on direct access to the MIDI information of what the live performer or improviser played. The results of each monthly session were recorded, providing a chance to discern how different parameters influenced the feedback system, such as the placement of the microphone in the room and the application of different filters to the MIDI data stream. Moving from these reflections, I refined my approach each month to hone the system's ability to shift listening attention away from a focalization on the specific techniques

employed and towards a listening awareness of the composite effects of improvising and composed logics and its generative feedback devised in ways which were patterned by the acoustics of the room itself.

Structure

The work was presented in four movements.

I. too many stops

II. anonymous atmosphere

III. improvisation with Robyn Jacob and controlled feedback

IV. poly-rhythmia in C Major

Movement I began in a state vaguely reminiscent of a chorale prelude form used in liturgical organ music, establishing a false sense of familiarity before it quickly veered into a distorted space of glitch-like repetitions and a texture saturated with arpeggiation. The second half of this movement uses a texture amassed from an improvisation and successive layers of feedback that eventually became a fixed element.

Movement II is shaped by ambient music motifs in its slow exploration of shifting harmonics amongst a mostly static and consonant landscape. Micro frequency and amplitude modulations are used to inflect rhythmic beating patterns through the use of the 'celeste' voices (detuned pairs of organ ranks) in combination with the tremolo functions which mechanically pulse the wind supply to the organ.

Movement III began with a live solo improvisation by keyboardist Robyn Jacob, who established a motif in the 'positive' division of the organ that began to be influenced by the feedback system. The texture swelled as the feedback began to access the other four divisions of the organ, creating a swarming or flocking-like texture. As the feedback subsides, the role of improviser is reversed, as Robyn holds a 'D-Minor 9' chord and a new feedback texture is introduced as I manipulated it by gating the dynamic threshold of the microphone as well as altering which stops are available to be used to express the stream of digital feedback.



Figure 3. Music for the Augmented Pipe Organ - Photo by Yohei Shimomae

Movement IV was inspired by the principles of Henry Cowell's 'Rhythmicon' instrument, which was an early experimental electronic rhythm-generating machine constructed by Leon Theremin in 1931 (Cowell 171). The Rhythmicon orders rhythmic relations according to the harmonic series in relation to a fundamental pitch, such that harmonics 1, 2, 3 (or fundamental, octave, octave + 5th) sound as pulses 1 against 2 against 3 and so on. The movement used two layers of rhythmicon-esque polyrhythms to create a saturated texture that allows the listener to listen across various relations, and to choose which set of relations feels dominant. The density of the poly-rhythms and their harmonically-derived patterns is stretched throughout the movement to explore how the organ's own harmonically-derived interface would express this sense of time.

Visual Design

The visual elements for the work were co-developed with Hfour Design Studio, a Vancouver-based visual media studio which produced the projection mapping of the organ pipes. Together we integrated our various sound and visual control systems, creating connections between the digital data streams of the organ and the projection

software Resolume, such that note and CC MIDI information sent to the organ to control its sound also controlled visual parameters in real time. The visual elements included representational approaches to the linkages between sound and light as well as more abstract motifs of subtle textures and inert atmospheres.

The majority of visual elements were developed from manipulated source material I recorded over the past two years of different light patterns that arose through unique refraction patterns. In one example, I recorded a phantasmagoric light pattern on a studio wall where light was reflected from the ocean, filtered through swaying stands of trees in the wind, and refracted through the window of the studio. These video recordings were then processed in Resolume software to manipulate their dynamics over the course of movements II and III. In Movement IV a custom MIDI data visualization technique co-created with Hfour was used to map note-on messages into groups of illuminated organ pipes.

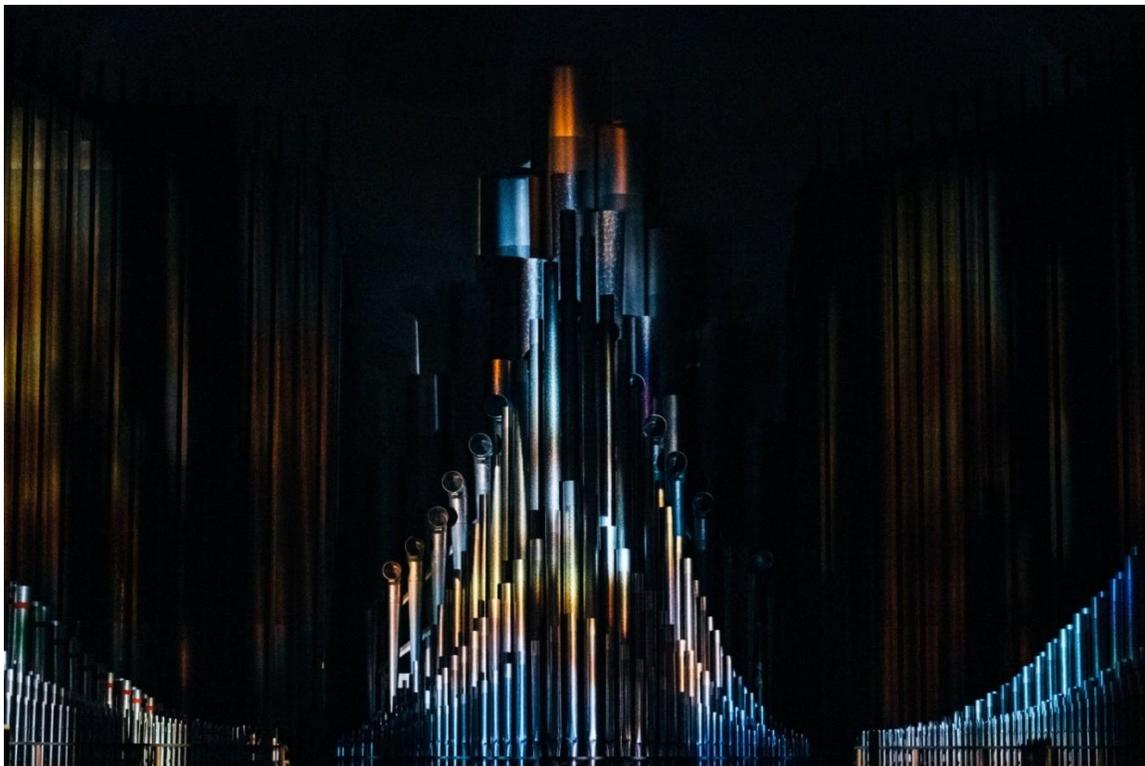


Figure 4. Music for the Augmented Pipe Organ – Photo by Yohei Shimomae

This representational strategy was used to provide a discrete visual choreography for the last movement to reinforce the interval relations of the poly-rhythms used, providing a sharp contrast to the washy and flickering visuals used in

previously movements; a gesture intended to signal to the audience their equal freedom to attend to or ignore the lighting design as a focal point throughout the previous movements.

Reflections

The considerations of space, culture, and technology that shaped this composition pushed me to use the pipe organ in new and exciting ways. As the novelty element fades into the background, I hope to continue to build upon the project and pursue other compositional methods and presentation contexts. While my work was shaped by that of an outsider's perspective to an instrument seemingly bound up with many religious and traditional spheres of music, I nonetheless sought to discern the ways in which my aesthetic goals rested upon the nuances of the specific materials of the instrument, site, and the sonic world it engenders. My intention was to do this without necessarily endorsing any specific religious or ideological dispositions towards society, except at least to point towards an engagement with music that plays a fundamental way to my (and perhaps others') sense of existence. In this sense, I entrusted the instrument to carry a signal to listeners, coded in ways which can be discerned relationally to my ideas of creating digital music which finds constraints in the physical world in ways that can be heard, felt and apprehended materially. In reference to my past works, this work continues further this process of interweaving these acoustic and digital imaginations of sound together.

As always, more time would have helped iron out some of the challenges with developing a new interface, such as attaining a higher degree of resolution for the ways of working that partially only exist in one's mind as an idealized space of potential; where every nuance and wish can be articulated. Furthermore, it would have been of interest to see how organists would have utilized or altered such an interface during the process of its research and creation. Were there other approaches and ideas that would have arisen out of such a conversation?

Artists often derive a sense of vitality in trying things out that seemingly challenge what appear to be stable conventions of their chosen medium(s). Throughout my project, the surrounding space of the pipe organ and the cultures of people who play and listen to it may have had a larger influence on my own process and imagined potential; co-

determining my ideas in ways I likely am not aware of yet. Though, I was always interested in the way my approach to the instrument could communicate a different imagination between sound and site; a recognition that no instrument has a fixed set of affordances. Thus, the project explored ways in which the pipe organ could function as a kind of transducer, enacting invisible architectures of sound, refigured and reimagined from the elements already present in its material and space.

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Appendix A.

Research Paper: The pipe organ and its sonic imaginaries

Introduction

The pipe organ can be considered one of the earliest forms of sound synthesis. Over centuries organ builders have experimented with generating new types of sounds through physical assemblages of wood, metal, and air. Due to the instrument's typically very large size, the pipe organ has tended to be fixed into specific places and contexts, most commonly a church; imbuing the instrument with a lasting association with liturgical music. In the context of new music, many artists continue to pursue interesting possibilities in the organ; many of which generate their meaning by referencing disparate genres and practices of music. For example, the organ's site-specific and spatial formations have provoked similarities to the practice of sound installation and its concern for the relationships between sound, space, and the social body (Fidom 27). The organ's functional 'background' support of the church mass has also drawn comparisons to acousmatic and ambient music aesthetics as well as to the anonymity of contemporary muzak (Anderson 323).

While there was a burst of attention towards developing extended techniques for the organ in the mid-20th century by composers such as Cage, Ligeti, and Kagel, attention to the instrument in the sphere of new music slowed while works using electronic synthesizers and computers began greatly expanding (d'Alessandro). Without much notice, the technology embedded inside pipe organs continued to evolve throughout the era of electro-mechanical innovation and more recently the phenomenon of integrated circuit boards and digital MIDI interfaces. The newer technical affordance of the ability to control a pipe organ via a computer represents an expansive area of confluence between the digital and analog realms. The resulting colliding and blurring of these two realms exemplifies what many describe as a broader post-digital turn in the sonic arts. It is my curiosity as a composer and sound artist to explore the notion of the post-digital aesthetically as well as the questions it brings up regarding the instrument's site and social conventions. Invoking this post-digital framework for thinking about the

pipe organ as both a technical *and* cultural interface, my project conceives of a highly hybridized instrument that links the computer's digital sound processing system with the electro-mechanical apparatus of the pipe organ while asking what modes of interaction between instrument, composer, and space would define a post-digital aesthetic?

To unpack this broad question, I will specifically look at three interrelated questions contained within:

In what ways do extra-musical qualities such as space and culture inflect or embed themselves in the composition and listening practices of organ music? In what ways can the surrounding space and materials of the instrument be reconfigured or reflexively considered as a compositional affordance? In what ways can the use and/or misuse of analog and digital technology transformed compositional and listening conventions of the pipe organ?

To provide viable answers to these questions, this essay will unpack the relevant attributes of the post-digital artistic age and link them with a survey of contemporary artists who make use of pipe organs in ways which disrupt or alter its seemingly historically-stable musical idioms. Furthermore, research of the pipe organ's technological and social dynamics over the last century will provide a backdrop with which to foreground the historical contingencies of contemporary practice.

Post-Digital Musics

To situate my research of the pipe organ along a historical continuum that can account for changes and contingencies in both technology and artistic practice, this essay draws extensively upon the notion of the *post-digital* as it relates to contemporary music, popularized by Kim Cascone (2000) and expanded by Rasmus Fleischer (2015). On the surface the term *post-digital* highlights a productive tension between the analog and digital realms, a tension which musicologist Roger Moseley argues has led to the gradual eclipse of many of their respective historical connotations, instead fusing together into what he describes as a "mutually constitutive dyad" (69). Despite having multiple valences in the artistic discourse related to music and media art, I find the broad scope of the post-digital helpful in thinking through the organ as a connective site between various sonic, social, and technical inquiries.

Kim Cascone initially popularized the term 'post-digital' in relation to music. In his influential essay from 2000, he wonders how the aesthetics of music have changed after the "tendrils of digital technology have in some way touched everyone", noting trends that suggest an evolving artistic milieu where "the medium of digital technology holds less fascination for composers in and of itself" (13). Cascone considered artists who work with techniques of glitch and other interface errors as a compositional tool influential in exploring a new relationship to the digital; one that highlights its errors and faults. Cascone argues that failure itself has become a "prominent aesthetic" which draws attention to the fallibility of technology and our illusion of control over it (13). He sees a vital productivity in giving attention to aspects of the material world that is typically relegated to the background hum of contemporary electronics; data flows, whirling hard drives, computer fan noise, and other soon to be objects of e-waste. Cascone cites Luigi Russolo's *The Art of Noise* manifesto (1913) as an early example of attention and artistic interest in transforming the background noises of early-industrial soundscapes into foregrounded materials for sonic compositions (14). Cage's *4'33"* (1952) is another well-known example of this reversal between background and foreground in its invitation to a to treat all incidental sounds as compositional materials (Cascone 14). With this allowance to all sound, Cascone sees new music in the post-digital era as emerging from the manipulation and interrogation of the inner black-box of technological interfaces. This attention to the background workings of an interface is applicable to my examination of the pipe organ's interface and the affordances uncovered by transgressing its codified player-instrument relationship.

Artist-scholars John Ferguson and Andrew Brown extend the parameters of the post-digital to encompass a shared trajectory with live electronic music which builds from a self-reflexive "sociocultural engagement with technology" via processes of performer-driven modification and augmentation of the tools of music-making (127). They argue that the post-digital is not necessarily a genre of music, but is more accurately described as a broad ranging shift in the culture of electronic music aligned with 'DIY' maker movements which prioritize more direct "user" intervention in the technology of instruments and interfaces. Ferguson and Brown argue that there are many positive attributes that have emerged from this more open-ended relationship between musicians and their technologies, such as an unprecedented array of electro-mechanical devices,

experimental software interfaces, and other affordances of hybridizing analog and digital musical instruments (129).

As the pipe organ exists in a social context most commonly associated with the church, post-digital music(s) also fold back reflexively towards the social in ways relevant to this project. Rasmus Fleischer argues that post-digital techniques belong to a “politics of collective affectivity”, where the contemporary super abundance of music for consumption (live-streaming, ipod listening, ect) creates a reactionary interest in the specificity of music’s temporal and situational unfolding (256). These reactionary impulses also relate to the tactile realm, which emphasizes a focus on the felt dimensions of sounds as perceived by the entire body. This phenomenon is theorized as being intertwined with an anxiety around the generalized “waning of affect” within listeners due to the infinite access to media (Rasmus 256). One example of an emerging aesthetic which has gained popularity in electronic music is the emphasis placed on the bass spectrum in the genre of dubstep music which relies on a sonic force which could only be fully sounded by large sound systems in live music venues (Rasmus 265). In this view, the post-digital is not only a reference to specific techniques and aesthetics in new music practices, but relates to an emerging sensibility among both consumers and producers of music which considers the extra-musical traits of spatial and temporal context as well as music’s political economy as foregrounded elements.

The 20th Century Organ

While the pipe organ appears to have had a relatively stable physical appearance over time, its mechanical inner workings and sonic logics have been a site of constant development and questioning. The period of the early 20th century in particular ushered in a dramatic reshaping of the instrument as it became increasingly used in cinemas, theatres, and other monumental civic spaces. Organ builders in North America offered these multi-media events a new style of instrument called the *theatre organ*, which increased the loudness and power of the instrument by running much higher wind pressures (Anderson 14). New organ sounds were also added to theatre organs, many propagated by organ builder Robert Hope-Jones who was hailed as both an innovator and a disruptor to the tradition of organ building (Anderson 14). Hope-Jones is credited with propagating the fog-horn sound of the diaphone into theatre organs as part of an overall project to maximize the dynamic range of the organ (Hecker

58). Beyond the realm of the theatre organ, the types of voices traditionally associated with the organ, such as variations of flutes, strings, and horn-like sounds, were also a site of continual development, with examples of new pipe shapes and mixture designs being actively created into the 1970s (Anderson 24). The role of technological change is also most dramatic during this century, with the introduction of electric wind supply, electro-pneumatic key action, and new types of digital augmentation such as sample-based playback and MIDI. The effect of these technologies on how the organ was actually used compositionally is ambiguous, with one historian suggesting that these changes “may have made life easier for organists but have meant almost nothing to tonal design or the music written for the organ” (Anderson 34). Yet there are many counter-examples of avant-garde composers who have been attracted to engaging and altering the technology of the organ. Arvo Part’s organ piece *annum per annum* (1980) begins with a massive and sustained chord which gradually dissolves to silence as the harmonics slowly filter away; an effect achieved by instructions to turn off the electric wind supply which is powering the organ until it runs out of breath (Anderson 71). Organ builders even responded to contemporary composers who wanted a means to manipulate wind pressure in real time over the course of a piece by altering their designs to the organ (Anderson 71). Composers such as Dieter Schnebel became interested in the background noise of the organ’s inner workings, using microphones to foreground its shifting mechanical sounds in his 1966 piece *Choralvorspiele I/II* (Anderson 63). Overall the most dramatic changes to organ music came about from the processes of altering its textures in the new music trends influenced by Cage’s prepared piano pieces and Varese’s spatial thinking (Anderson 60). Generally less interested in inventing new melodies and harmonies, composers such as Kagel, Cage, and Ligeti drew upon tone clusters, aleatoric procedures, and the incorporation of noise while continually exploring ways to heighten other amorphous and textural qualities in their attention to the organ (Anderson 60). This concern for texture and atmosphere is generally still present in a large contingent of new music aesthetics and is further reflected in early 21st century works for the organ.

The Pipe Organ in 21st Century Electronic Music

Beyond the 20th century examples referenced above, the lens of the post-digital is useful in examining the work of other contemporary artists who reference the organ

within the field of electronic music. Canadian artists Tim Hecker and Sarah Davachi both utilize organs and their sites as a method of bringing listeners closer to the material and spatial forms of sound in ways which are similar in mindset to my project. Hecker's own academic research examined the early modern soundscape's relation with loud sounds, positing loudness itself as an affective zone utilized most often in musical contexts by the pipe organ (5). Hecker's high-decibel ambient performances, many of which occur in churches, frequently use samples of pipe organs as raw materials which are then processed beyond recognition into new forms of abstract soundscapes meant to induce a sense of the sublime and a loss of subjectivity. His aesthetic references a pre-amplification sonic era where the pipe organ was one of the few musical instruments that would provide the "opportunity of losing oneself, if for a short period, through the power of its enveloping material force" (Hecker 46). Citing influence from early American minimalist such as Terry Riley and La Monte Young, Davachi's work also considers the psychoacoustic and spatial qualities of sound, using the long-sustained sound of the organ as a way to focalize and manipulate the expression of these elements for listeners (Davachi 2013). Other connections to the realm of the post-digital lie in the realm of contemporary sound spatialization practices and 3D audio systems found in Berlin's Funkhaus studio and EMPAC's wave-field synthesis system. These sound systems strive to artificially produce a surround-sound environment; an acoustic dynamic which can be traced back to the pipe organ's immense spatialization across large reverberant cathedrals. In this resonant and highly reflective architecture, sound was felt to come from all directions, and was frequently perceived as a force affecting not just the ears but the entire body. These examples suggest that many of the 21st century aesthetics within electronic music, sound art, and sound spatialization techniques can be linked to aesthetic remnants of the pipe organ.

Instrument as Interface

The examples of changing aesthetics and technologies in organ music over the 20th and early 21st century demonstrate the ways in which the instrument functions as a hybrid human-mechanical system shaped by the collisions between new music aesthetics, evolving social forms of listening, and a technologically-assisted interest in the sonic qualities of the material world. I would like to delve further into these sonic qualities of the instrument by turning attention away from the musical aesthetics

investigated above and towards the interior material realm of the organ itself. It is my goal to tease out other realms of the instrument, in a method of inquiry that recognizes that “sound becomes the means through which we perceive the affordances of objects” (Wöllner 117). In terms of a comparison to other musical instruments, the primary sound-making function of the organ can be categorized as an aerophone using the Hornbostel-Sachs instrument classification system; meaning that the primary source of sound derives from a body of air that is vibrating (as opposed to the strings which vibrate inside a piano or ‘chordophone’). In order to sound this aerophone, a keyboard or other switching mechanism is required to operate the valves which open the air passageway for each pipe. This connection often uses electronic relays to send the signals from key to pipe and can sometimes span a distance of hundreds of feet in the case of a large concert hall or church. Thus, the keyboard acts as a central mediator between player and instrument, functioning as a kind of pure interface itself linking player and distant sonic events.

Unique to the organ is another type of keyboard-esque interface known as the stop controls which interacts simultaneously with the keyboard to activate different types of organ pipes. The combining of these two interface systems gives each organ a unique tonal system derived from harmonic principles of the octave, fifth, fourth, third, and other fractional harmonic ratios which can all be mixed together at will. While many organs have theoretically thousands of different combinations of tone qualities, in practical terms the instrument’s possibilities meets various constraints imposed by the interface, which “trains its players by establishing its affordances and mapping them onto a delimited range of sonic outcomes” (Moseley 90). Extending this attention towards the agency of interface further, Moseley suggests that interfaces such as the keyboard do not simply serve as a transparent mediator, it also “acts as a generator, processor, and transducer” (6). This idea of the interface as a source of generative agency is one I will return to later in reference to my project. Broadly speaking, reflexive thinking about the agency of such tools reveals the ways they channel users towards certain outcomes; extending a user’s capability while also circumscribing a bounded and limited sonic space.

The technological innovations associated with the pipe organ are also implicated in other new sonic technologies at the turn of the 20th century which pushed composers and listeners towards new compositional ideas and new understandings of sound. For example, composer Erik Satie had a heightened identification with new sonic tools, often

requesting to be introduced before his concerts not as a composer but as a “phonometrographer”; a reference to an early sound-wave measuring device he frequently used to examine the harmonic spectrum of sound (Auner 25). Auner convincingly suggests that these new technologies have a productive agency intimately bound up with rapidly changing musical practices in the 20th century, though he cautions against any deterministic model in speculating on these quasi-vibrant objects by asserting that “in every case compositional developments were shaped by multiple historical factors, with technology often providing a catalyst for trends already long in place” (28). For example, sound measuring tools helped confirm and popularize a way of thinking about sound as a tactile medium which can be analyzed as various periods of physical vibration. This way of thinking of the physicality of sound waves had been known since the days of Pythagoras, but with new devices came more methods to translate sonic forces into other mediums to be examined and manipulated (Auner 30). This “tympanic hearing” as Jonathan Sterne labels it, assisted both composers interested in the spectrum of sounds in between the dominant 12 tone equal tempered system as well as instrument designers interested in the affordances of invented electro-mechanical instruments (Auner 31). One groundbreaking example of such a newly invented instrument at the time is the Telharmonium; a warehouse sized electro-mechanical synthesizer modeled after the pipe organ which predates both phonograph and amplified sound (Holmes 36). It was a radical technological project that ushered in new synthesis techniques of sound as well as new distribution methods to a listening public. Thus, new ways of thinking sound through synthesizing it were intimately bound up with the tactile dimensions of the organ and its mechanistic ways of delineating the sonic affordances of the material world.

Considerations of Space

While the material world of each musical instrument can be studied in an organological context to draw out relations to the wider social-cultural era in which they are made and used, their sound making always occurs *somewhere*. This spatial context is neither a neutral container for sound nor should it be considered as extraneous to the more traditional subjects of musicology such as notation, recordings, and compositional intent (Wöllner 113). The vibration patterns that instruments produce are always shaped and molded by the acoustical properties of the space they occurs in, providing the

possibility for critical aural intelligibility (or lack thereof) to the music performed. Spatial information such as combinations of reverb, echo, and delay further inflect sound waves, providing cues to the size and shape of the environment where listening occurs. Because organs are most commonly experienced as installations in churches, the acoustics of these sacred spaces have shaped aspects of the music in both a compositional sense and an experiential sense for listeners. The acoustics of large reverberant cathedrals were perceived to enhance the qualities of polyphonic choral music and are conducive to styles of music that emphasize sustained tones rather than the short attacks of intricate percussion-based musical genres. However, evolving discourses around acoustics and building designs in the early modern era began to change aspects of the relationship between sound and space. In her study of the modern era in North America, Emily Thompson suggests that shorter reverberation times and increased speech intelligibility became primary acoustic concerns in the construction of new civic venues, concert halls, and sacred spaces (3). Acoustic dampening techniques became widespread as a tactic guided by an acoustical way of thinking most heavily inflected by the technical language of the engineering profession; a profession that was instrumental in applying sound measuring devices to chart and analyze the acoustic behavior of building materials (Thompson 144). For example, new gothic-style churches constructed during this period in North America were treated with sound-absorbing tiles as a way to identify them within the modern telos as an improvement upon medieval gothic churches widespread in Europe (Thompson 187). This 'modern' ability to make malleable the relationship between space and reverberation time departs from pre-modern church designs where high reverberation times contributed to a surround sound experience imbued with a sense of old world mysticism. Thompson further details how the practices of reigning in reverberation time in modern monumental spaces proliferated as a design goal for all types of spaces inhabited throughout daily life; their generalizability leading to a gradual flattening of the variability heard in interior acoustic environments. Similarly, the organ's site specific installation qualities mean its acoustic properties could also manipulate the listener's perception of space by design. Organs alter the architecture of the room, and in a way become their own form of architecture to enhance a specific kind of sonic dwelling. Throughout the early modern era, this sonic dwelling was one of the few means of hearing loud all-encompassing music across the full frequency range of hearing (Hecker 84). This was the time of crackling radios and minimal access to the instruments of

recording and playback; a time when music needed to be experienced in the moment; a situation quite opposite to what Fleischer characterizes as our current superabundance of music in the post-digital era.

Music for the Augmented Pipe Organ

The considerations of space, culture, and technology explored throughout this essay have prompted me to view the organ as quasi vibrant object. Viewed as such, I have sought to discern the ways in which my aesthetics goals rest upon the nuances of the various social, spatial, and technological realms of the instrument. In this sense, the instrument is entrusted to carry and transmit semantic messages that can be discerned relationally in the context of post-digital music forms. In terms of my artistic interest, many of my past works have focused on interweaving acoustic and digital imaginations to create hybrid works which extend the sonic arts into further interdisciplinary realms. There are two inter-related techniques used in the development of my project using the pipe organ at the Pacific Spirit United Church that exemplify these interests. The first is the use of a computer-controlled MIDI interface to send messages that sound the pipes and change the stops in real time. The second is the use of a feedback system to create a dialog between the space and the instrument in a real time. Together, these two techniques create a method of using the organ that hybridizes its acoustic sound and physical space with digital control techniques (both deterministic and aleatoric). These methods of reflexively drawing upon the interface and the surrounding space to generate new compositional processes are the primary features of the body of work I've called *Music for the Augmented Pipe Organ*. Because the work utilizes many electronic and computer-based compositional techniques while remaining expressed as acoustic sound, the perception of the music's medium-specificity used to guide listening is confounded. In this altered state, I aim to shift listening attention away from a focalization on the specific techniques employed and towards a more generalized awareness of the composite effects of combined improvising and composed logics, its generative feedback and their situated acoustic qualities in the room itself. Thus, this site-specific work aims to transform the listening conventions of the pipe organ towards a new sonic imagination; one that builds on an experimentalism that follows from the many dramatic changes brought upon the instrument throughout its history.

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Appendix B.

Video Documentation

Videographers:

Luis Guerra and Daniel Wester

Audio engineer:

Jonathan Adams

Editor:

George Rahi

Description:

Video excerpts of the performance held on November 23rd, 2018 at the Pacific Spirit United Church, Vancouver

File Name:

musicfortheaugmentedpipeorgan.mp4