

Electroacoustic Works for the Solo Bassoon with Varying Compositional Techniques
and Mediums by Bolaños, Mellits, and Neuwirth

by

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ABSTRACT

In the not-so-distant past, bassoon music that required electroacoustic techniques and technology was a niche genre. The knowledge and accessibility required to use such equipment and develop the skills needed to perform electroacoustic music can present significant challenges. This project aims to highlight a variety of electroacoustic techniques used in electroacoustic music for solo bassoon, the ways that the electronics are generated as it relates to liveness, and how they interact with the performer. To do this, I will explore the inner workings of the hardware and software needed to perform electroacoustic music. The three works use contrasting methods of liveness: fixed media, live processing, and a mixture of both. This project is intended to help educate bassoonists on the topic, identify barriers to entry, and provide them with key information to broaden their musical palate. Each piece has been recorded and is included with this document.

DEDICATION

To my uncle Paul, who I believe has sat in the front row of every performance I have ever given.

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CHAPTER 1: INTRODUCTION

As the classical music world evolves, it is important for musicians to be advocates for the adaptation of our canon beyond its current usage of traditional techniques. Extended techniques have become more common, and it is because of the expanding of our techniques that it is ever more important for us to consider the relevancy of contemporary classical music now that we are now a quarter of the way through the 21st century. There has been an explosion in compositions with rich techniques and sonic experiences since the mid 20th century as a result of the electronic development and electroacoustic possibilities, especially so in the past 40 years.

Regardless of whether we, as musicians, are ready for these changes that have been booming around us since the mid 19th century, it's key that we maintain a relationship with these developments and engage with composers and developers. The world of the classical canon is highly respected and at the same time archaic. Some composers and musicians feel that this may help classical music catch up to the popularity of the popular music world, even if it may not always appeal to the average listener. Electronics also serve to create an extension of the instrumentation of a piece.

What does the classical music canon stand to gain from embracing electroacoustic techniques? The use of electronics in classical music might open doors to more complex and interactive solo, chamber, and orchestral music. The solo instrumentalist is no longer one musician or one voice and can react and be reacted to by the electronics. Moreso, chamber music featuring multiple acoustic instruments can be enhanced to create unique behaviors, sounds, and interactions. In addition to the possibilities of electroacoustic

techniques, I believe that electronic music may begin to appeal even more to a younger generation of musicians who have grown up with or are growing up in an age where technology permeates their lives and culture. It is my hope that this research will give bassoonists who are new to electroacoustic music more information for creating their own electronic setups and familiarity with the equipment at their disposal.

Terminology

Live processing is the technique used when an audio signal is recorded and manipulated in real time. This process takes different forms and is my reason for choosing two out of the three pieces (by Bolaños and Mellits) that will be examined. A patch is the sub-program that processes the media (in this case, a sound signal) in any way it is programmed to do. In *Los Minúsculos*, Gabriel Bolaños uses live processing through Max/MSP, whose patch is programmed to have a multitude of sonic behaviors that evolve as the piece progresses and the performer controlling electronics controls the cues and triggers for each section. In *Dark Matter*, Marc Mellits uses live processing via guitar pedals. This is considered a form of live processing because the audio signal is being changed progressively along the chain of pedals. The path that an audio signal follows is known as signal flow.

Signal flow refers to the chain that a sound signal is passed through, which is not always linear. This is particularly important to know when diagnosing issues with technology or certain effects that are not working properly. In an introductory article on the website mastering.com, Drew Swisher provides this helpful checklist for diagnosing problems in the signal flow chain:

- “1. The instrument or voice you’re recording.
2. Microphone
3. Audio interface [input]
4. DAW
5. Back out to the audio interface again [output]

6. And finally through your headphones and/or speakers”¹

While the intended audience for Swisher’s article is audio engineers, its information is necessary to know for performances that involve live processing and contains important skills for recording yourself in a studio, at home, or even analyzing practice sessions.

Isolating/troubleshooting is easier when you are able to go down Swisher’s list, knowing what parts of the sequence are functioning and precisely where the signal stops — or, put more simply, the sound is not passing through. Something important to note about this checklist is that it is only describing a signal flow that travels along a straight path. A signal flow can be as complicated as you wish to make it, especially if you want to be creative and add variables that manipulate the behavior of a single effect. For example, a low frequency oscillator (LFO) is a very slow oscillator that can control the delay time of a digital delay line. This is difficult to do with physical equipment but is very common in a programmable Max/MSP patch, which is the packaged code that is written in Max/MSP for the purposes of signal processing.

Liveness

Liveness in the context of electronic music, at its simplest, is the difference between electronics generated in real-time or ahead of time. This can also be referred to as live electronics vs. fixed media. This concept is not so cut-and-dry however: as there is a spectrum between the two. For example, a piece could use real-time triggers based on a

¹ Drew Swisher, 2024, “Boost, Overdrive, Distortion & Fuzz Pedals - What’s the Difference? - InSync,” InSync.

set of parameters, and when a parameter is met, the patch will play a pre-recorded sound file. Liveness can be further expanded to describe the connection between the process of creating and/or composing electroacoustic music and the perception of the listener. There are different methods of achieving liveness. When considering pre-recorded electronics, “the listener has little chance of knowing where instrumentality stops and where fixed object-like ‘tape’ music starts,”² since the electronics had to have been made somewhere before the performance. This concept implies that there is still a level of performance when it comes to listening to a tape or audio file. John Croft’s “Theses on Liveness”³ explores the relationships and behavior between a performer, instrument, and electronic sound. Croft lists five different paradigms that categorize these relationships: backdrop, accompanimental, responsorial/proliferating, environmental, and instrumental.⁴ It is my goal to use these terms to describe all three pieces in the scope of this research.

A backdrop relationship refers to the electronics’ role as a setting or background for the music being performed. Croft states that in a backdrop relationship, “There may be points of contact between the two worlds, but these are not perceived as causal.” Accompanimental relationships may seem similar to a backdrop, but act as accompaniment “in a more or less traditional sense.” This behavior may involve an element of live processing through more conventional means. An example Croft gives for this is a harmonization effect. Accompaniment can also involve triggering a sound file as dictated in a score and leans most towards fixed media. Responsorial/proliferating as

² Harvey, Jonathan, “The Metaphysics of Live Electronics,” *Contemporary Music Review*, Vol. 18 (1999): 79-82, <https://doi.org/10.1080/07494469900640351>.

³ Croft, John, “Theses on Liveness,” *Organised Sound* 12, no. 1 (2007): 59–66, <https://doi-org.ezproxy1.lib.asu.edu/10.1017/S1355771807001604>.

⁴ *Ibid.*

described by Croft is an “antiphonal relationship” with the electronic sound. This means that, to the audience, there are noticeable responses to the material in the electronics. Environmental refers to the manipulation of the live sound by electronics to replicate acoustic characteristics. Changing the range of harmonics (cut-off frequencies) using a filter and reverb are two examples of the relationship. Instrumental stands out as giving the electronics more agency over the piece as its own instrument. Croft states that the relationship of performer and instrument is “extended to include the live electronics . . . analogous to the way [they] would normally play the instrument alone.” He also refers to it as “instrument-plus-electronics.”⁵

⁵ Ibid.

CHAPTER 2: EQUIPMENT/GEAR

While the possibilities of electronic music are exciting, it is not without its pitfalls. An important aspect of playing electroacoustic music requires owning or having access to the technology, or “gear,” to actually perform it. Gear for electroacoustic music is not inexpensive, and in my own personal observation, can be cost-prohibitive, making it one of the biggest reasons not just bassoonists, but other acoustic musicians, might avoid electroacoustic music. Musicians who work with electronics usually spend thousands of dollars on microphones, audio interfaces, speakers/amplifiers, and a reliable computer. Aside from financial cost, for many musicians new to electronic music, they may find themselves having to spend a lot of time and effort learning how to use the software and hardware needed to perform the piece(s) they are playing. Software like Max/MSP or DAWs like Reaper or ProTools have a shelf-life, meaning that they will become outdated over time. If the piece calls for gear like guitar pedals, there is a learning curve to being comfortable with the muscle memory of where your foot needs to go. I will discuss this further in the section on Max/MSP. Because of the cost, musicians may turn away from the idea of even engaging in such music.

The equipment that I will discuss is my own personal setup. What worked best for me was something that I own and control somewhat autonomously. My gear is easily mobile and can be taken to any venue with a basic sound system. With all of these things combined, I have a lot of control over the electronics I use.

Microphones

Woodwind instruments are multi-directional when producing sound, meaning that the sound does not flow out of one opening, but rather multiple. It can be difficult to have one catch-all way of recording the sound of the bassoon completely. For the sake of this project, I only used the “Little Jake” pickup bocal for the live-processing element of *Los Minúsculos* and *Dark Matter*. The rationale for this is that both pieces benefit the most from having a direct line signal to be processed. Adding extra acoustic/ambient sound can result in potential unwanted consequences for a piece like *Los Minúsculos*, and the use of guitar pedals in *Dark Matter* requires a single direct line signal because it is manipulating the raw sound from the bassoon through the bocal. There are other methods of miking (sometimes spelled micing) your bassoon but recording outside of the bocal requires a minimum of two microphones. One microphone would have to be fixed around the body of the instrument, with a second microphone at the bell to capture lower frequencies. This is a viable method of miking the bassoon, and while it is also inconvenient and expensive, it is worth it if you are looking for high-fidelity sound.

“Little Jake” Pickup Bocal and Preamp

The single most important piece of gear for this project, and for electrifying the bassoon, is the “Little Jake” pickup bocal (fig. 1), which was pioneered by the late Trent Jacobs. It comes with a custom-made preamp, simple, but fittingly constructed within an Altoids tin and a special screw-in contact microphone (mic) with a 1/4” tip and ring (TR) cable.



Figure 1: Pickup bocal “Little Jake,” preamp, and screw-in contact microphone

The pickup itself attaches to the bocal with a soldered threaded receiver for the contact mic. The contact mic then “picks up” the vibrations that are being sent through the bocal via the bassoon reed. It is a very raw sound but is comparable to the same method an instrument like the guitar uses for its own pickups in the center of a guitar’s body. The signal is then sent through the input of the preamp, which is powered by a 9V battery. This is the process of preamplification, which is needed to amplify the very low signal produced by the pickup itself. The preamp can then send the signal through the output to another 1/4" cable.

These pickup bocals are produced through Forrests Music⁶. There are two ways to get one of these for yourself: one option is to buy a pre-installed bocal from the Forrests Music shop or website, which has in the past been a Fox CVX bocal; the other is by

⁶ “Little Jake” Pickup Bocal, Forrests Music, <https://www.forrestsmusic.com/pickups.htm>.

sending in one of your own bocals to have the pickup installed. My own “Little Jake” pickup was installed on my personal Fox B2 bocal (fig. 2).



Figure 2: Pickup bocal “Little Jake” connected with preamp (back)

In the case of live-processing and recording, the you need to have a computer that is mobile and has sufficient power to process sound through programs like Max/MSP. My personal recommendation is a laptop that has at least 16 Gb of RAM. RAM (random-access memory) is a cache of volatile data that can be written or read by a computer.⁷ This is the most important part of the computer for audio processing aside from the mid-to high-range processor. For non-audio processing works, it is necessary to have a device that can also easily play back audio tracks and video files with minimal concern for

⁷ *Merriam-Webster.com Dictionary*, s.v. “ram,” accessed March 1, 2025, <https://www.merriam-webster.com/dictionary/ram>.

technical difficulties, which are inevitable. This brings up the topic of proficiency and basic understanding of the inner workings of the technology. Proficiency with electroacoustics requires a substantial understanding of the technology that is being used. Sound checks are crucial for electronic performances, even if the technology is as simple as using a microphone. Having to make ample time to ensure that the equipment is functioning properly, and that the levels are not set too high or low, and means there can be a high cost of time.

Clipping is one of the most common issues in sound checks. Clipping is when the amplitude of a waveform exceeds that of an analog or digital threshold, resulting in distortion of the sound waves due to the harmonics being cut off. Typically, the kind of clipping a musician would experience in a performance situation is what is called “soft clipping.” As the name implies, there is also a method of “hard clipping,” which is a heavier clipping of the wave. The different stages of clipping morph the timbre of a sound, which “changes the harmonic content of a note by adding new frequencies to its fundamental.”⁸ The furthest extreme of this technique distorts the wave so far that the waveform becomes extremely close to a square wave, which causes a very abrasive and hollow sound.

The musician must also factor in the time it will take to learn how to operate electronics for music. For some, it’s possible to learn on your own, but using online resources will help to speed up that process. Finding free resources online can be also challenging however, especially if the musician might not know what they’re looking for.

⁸ Nick Bowcott, 2024, “Boost, Overdrive, Distortion & Fuzz Pedals - What’s the Difference? - InSync,” InSync. Accessed March 2, 2025, <https://www.sweetwater.com/insync/boost-overdrive-distortion-fuzz-pedals-whats-the-difference/>

Digital audio workstations (DAWs) can also have steep price tags. For example, at the time of this project, a DAW like Pro Tools Studio costs \$299/year for professionals, and Max 9.0.5 (the most recent version at the time of this research) costs \$399 for a permanent license, which includes up to the latest update for that version, or a \$120/year subscription, which includes all future updates beyond Max 9. Luckily, Max/MSP does have a reduced rate for students. Universities and other institutions may have access to these programs for students for free, which provides them with an opportunity to experiment. They might also have loanable gear like audio interfaces and audio cables to help assist with cost-deterrence. Another option is to use Pd (Puredata), but it is not commonly used for compositions.

The classical music world does not always leave room for opportunities to experiment with electronic music because of the standard repertoire “canon” for acoustic instruments. This can be off-putting for musicians who make their living off of performing standard repertoire. Some bassoonists may overlook electroacoustic pieces due to the high barrier-to-entry, even if they might be open or interested in playing them.

For pieces requiring live processing, the bassoonist will need some kind of audio interface. An audio interface digitizes an analog audio signal for recording and/or processing, acting as a medium between an input and output, and also has the ability to control the gain (volume) of the inputs and outputs. There is nearly always a 1/4” headphone jack for monitoring, which allows for a direct feed of sound into a set of headphones. A USB 2.0 port on the back of the audio interface connects to your computer in order to provide an input for sound processing. I personally use the

FocusRite Scarlett 2i2 (third generation), which as its name entails, has two XLR⁹ inputs and two line-out stereo outputs. For pieces with spatial sound that go beyond stereo sound, which will require multiple speakers, you will need an audio interface that has more outputs like the Scarlett 4i4, or even the Scarlett 18i20 for even more outputs.

Working with audio processing is not complete without audio cables. The two types most common types of cables used are XLR and 1/4" cables. The difference between the two is the type of connector. Quarter-inch cables also come in two varieties: a tip-ring-sleeve (TRS) cable has two black bands on it and is capable of having both a mono and stereo output. The other kind of 1/4" cable is a tip-ring (TS), which is only a mono signal. To perform a piece like *Dark Matter*, you will need a 1/4" TS cable. XLR can also be converted into a direct-line cable and vice versa. When using the "Little Jake" with an audio interface, I use a direct-line 1/4" to XLR converter because most smaller audio interfaces, like the Scarlett 2i2, are XLR input only. Being familiar with the different types of cables can save musicians a lot of time and money.

As previously mentioned, Max/MSP is a program that allows you to "create your own interactive software."¹⁰ Max/MSP is its own programming language and is primarily based in a modular "map" style. This is a huge benefit from an accessibility standpoint because it is very easy to learn visually (fig. 3) and logically.

⁹ XLR stands for external line return

¹⁰ "What is Max?" Cycling74, <https://cycling74.com/products/max>.

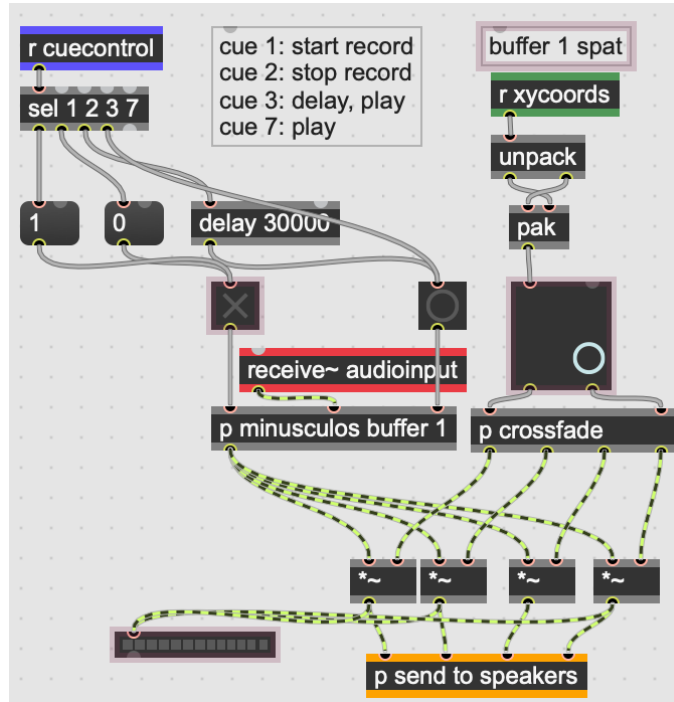


Figure 3: *Los Minúsculos*, Max/MSP speaker test and output

Each object is connected by “patchcords” and give a visual representation of signal flow. Every object has its own types of functions and connectors that affect its behavior. For example, the object to produce white noise (noise~) has one input for “control messages,” which can be influenced by many other objects to create unique and at times unpredictable effects. The object’s output can also be affected in its own ways. For example, noise~ can be selectively filtered to isolate pitches through subtractive synthesis.

CHAPTER 3: LOS MINÚSCULOS BY GABRIEL BOLAÑOS

Los Minúsculos by Gabriel Bolaños for solo bassoon and electronics, composed in collaboration with bassoonist Dana Jessen, is a programmatic work depicting the struggle and mass murder of Nicaraguan protestors in a mass crusade against citizens opposing the dictators Daniel Ortega and Rosario Murillo. The electronics are performed by a second musician who controls cues and gain (volume). *Los Minúsculos* uses Max/MSP for live processing, which is central to the piece, providing compositional texture and form. The live processing techniques used by Bolaños are delay, recording (through a unique buffer module), filtering, and spatialization. I performed this work prior to my intention on recording and researching it, and in my collaboration with Bolaños, he mentioned how there were many things he would have changed. He explained that the way his aesthetics as a composer have changed, as well as his understanding of the technology he used to write this piece, may be quite different. During our session, he said that there was a clear delineation between “Gabriel the composer six years ago, vs. Gabriel the composer now.” The techniques used in this piece still hold up even if these qualities of his work have evolved, particularly because the bassoon repertoire lacks a significant number of solo works for bassoon and live processing using Max/MSP.

The work’s requirement for a musician controlling the electronics adds a unique element of chamber music performance, where communication between both musicians is key in proceeding through the different musical sections and Max/MSP patch functions. There are moments in the score where the electronics performer has the opportunity to make musical decisions using the “live.gain” levels and the delay line

output inside the “controls” panel as shown in the main patch interface (fig. 4). The interface for the Max/MSP patch clearly outlines the functions of each cue and also several crucial performance notes.

**Los Minúsculos,
for solo bassoon and electronics.**

Gabriel J. Bolaños
gabriel.j.bolanos@gmail.com

Input
live.gain~
0.0 dB
Mic level
reset, for rehearsals

controls

Set the sampling rate to 44,100 Hz.
Trigger Cues based on numbers in score
0 8 9

Cue 4: you can control the input and level of the delay line
input, delay line output, delay line
live.gain... live.gain...

Cue 8: you can control the input to FFT filtering
live.gal... visualize fft: for cue 8

Cue 3: bsn is delayed: you can manually control level on delay line!

Cue 8: bsn is filtered into 4 bands, each to a different speaker. Every trigger on 8 rotates the filters. Use the message box "8" to trigger this cue multiple times.

Cue 9: buzzing sound

spat visualization

spat visualization

buffer 1 spat buffer 2 spat buffer 3 spat

x = recording is on!

output

master four speakers
live.gain-[1] live.gain... live.gain... live.gain... live.gain...

0.0 dB 0.0 dB 0.0 dB 0.0 dB 0.0 dB

p speaker test double click to test speakers

dac~ 1 2 4 3 1 2 1 2 for testing on stereo.
Replace with 1 2 3 4
1 = left front 2 = right front
3 = left rear 4 = right rear

Cues:

- 1 - Record buffer 1
- 2 - Stop rec. buffer 1
- 3 - Record buffer 2. Delay bang for 30 seconds to play buffer 1.
- 4 - Delay line on! Stop rec. buffer 2. Stop Playback of buffer 1.
5. Delay mic off, LV
6. Rec 3 on
7. Rec 3 off. Playback 1, 2, 3
8. Rotate Filter
9. Play end.aiff

Figure 4: *Los Minúsculos*, Max/MSP master patch

The electronics performer should ensure they have prepared the patch prior to performance. The notes in the patch and the score leave out key procedures for the electronics performer, likely assuming that they know how to use Max/MSP. If the

performer is not already familiar with Max/MSP, I've made a simple list of preliminary steps to make sure that the patch is ready to be performed or rehearsed:

1. Set the patch to presentation mode.
2. Lock the patch.
3. Click the EZ ADC object (this looks like a microphone), which turns the audio on.
4. Make sure the cues have been reset using the reset button (bang).

While the piece is written to be spatialized for four speakers, it's possible to adjust the patch for other speakers, but adding additional speakers will require altering of the spatialization sub-patch significantly and is beyond the scope of this research. In recording this piece, it's only possible to record in mono or stereo. However, the process of changing the amount of speakers is simple. To do this, set the Max/MSP to patching mode, which is the same button that turns on presentation mode. To the far right is the output patch (fig. 3). The instructions for switching the speaker output to stereo are next to the audio output (dac~) function. The variables for dac~ should be switched from 1-2-4-3 to 1-2-1-2. In the interface, Bolaños has indicated that the sampling rate should be set to 44.1kHz, which can be changed through the "audio status" menu in Max/MSP's settings.

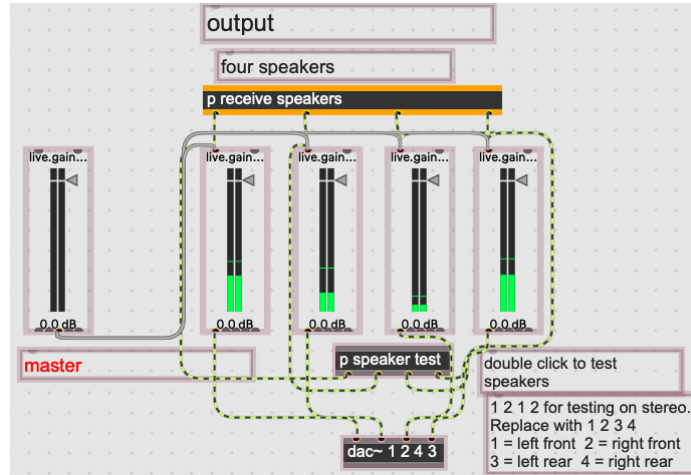


Figure 3: *Los Minúsculos*, Max/MSP speaker test and output

For soundcheck purposes, figure 5 is the sub-patch for testing your speaker's levels. Double clicking on the speaker test module will play white noise, alternating between different speakers. It is important that the peaks of each speaker, shown by the thin green line within the level bars, are even. The triangle on the right of each level allows for the adjustment of the speakers' independent gain. When troubleshooting and adjusting, be very careful of clipping.

For the purposes of understanding the process of what goes into a patch, I've included a picture of the first time the patch records the bassoon. (fig. 5) Following is an explanation of what the function of this patch does in chronological order:

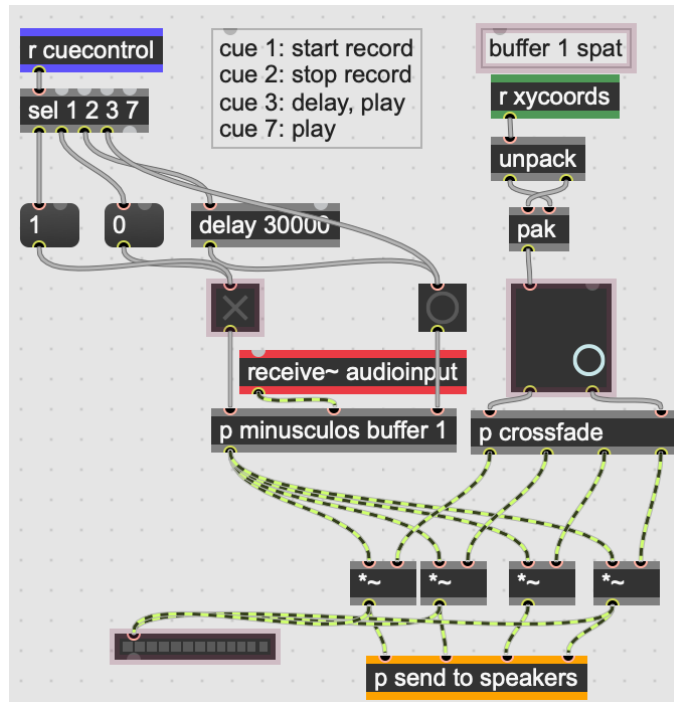


Figure 5: *Los Minúsculos*, Max/MSP buffer 1 patch

1. The top left (r cuecontrol) allows the cue number to trigger the different functions it is connected to.
2. The selector module (sel) is a controller that creates a signal output for each separate number. When the electronics performer advances to Cue 1, it will send a signal through Output 1.
3. The signal that is sent reaches a message module. A message module triggers a numerical value. In this particular instance, it is connected to a trigger module. The trigger module (X square) can only be turned on (1) and off (0). Since the 1 message is triggered, it will turn the toggle on. This trigger is to display whether the module has been turned on or off.

4. The toggle will turn on the sub-patch “minusculos” and records to a buffer and stores the recording of the input signal. This will queue up the sub-patch, whose function starts recording the input from the microphone. Within the sub-patch is a timer that will create a 60-second playback from the material it records to then stop recording when advancing to Cue 2.
5. The signal for the playback, which is notated as ~ in Max/MSP, is then spatialized with amplitude controls to all speakers using a multiplicative modifier (*~). This controls the amplitude. The spatialization module is located on the middle right. The circle is programmed to move between all four speakers.
6. The crossfade module allows the sound to travel smoothly between the speakers, creating the effect of the sound moving around the performance hall.

Electronic Notation

The score contains both the bassoon part and electronics. The electronics refer to the cue numbers located in the patch, which the electronics performer will trigger throughout the piece. I will explain what each cue does in the patch.

Cue 1 begins at measure 1 and triggers the minusculos subject to record buffer 1 (fig.

Figure 6 shows the musical notation for the first measure of *Los Minúsculos*. The Bassoon part is written in bass clef. It begins with a box labeled '20' and the instruction 'as fast as possible, steady tongue ram, no reed'. The dynamics are *pppp*, followed by *pp*, *mp*, and *pp*. The tempo markings are *poco rit...* and *a tempo*. The Electronics part has a circled '1' and the instruction '(rec. to buffer 1, spat)'.

6).

Figure 6: *Los Minúsculos*, m. 1

Cue 2 begins at measure 5, which signals the minusculos sub-patch to stop recording. I recommend that the bassoonist and electronics performer should communicate just before this to proceed to the next section, as to pause and prevent recording material from the next section (fig. 7).

Figure 7 shows the musical notation for the fifth measure of *Los Minúsculos*. The Bassoon part has boxes labeled '5', '4', '5', and '4' with arrows. The dynamics are *mf*, *sf* (B), and *sf p*. The tempo markings are *simile...* and *slow, irregular*. The Electronics part has a circled '2' and the instruction '(end rec. to buffer 1)'.

Figure 7: *Los Minúsculos*, m. 5

During the fermata at the end of measure 8, the electronics performer will trigger cue 3, which plays buffer 1. Time in Max/MSP is measured in milliseconds and is set to

delay for 30,000 milliseconds, or 30 seconds. During this time, the patch will begin recording to a second track, notated as “buffer 2”, delayed by 30 seconds (fig. 8).

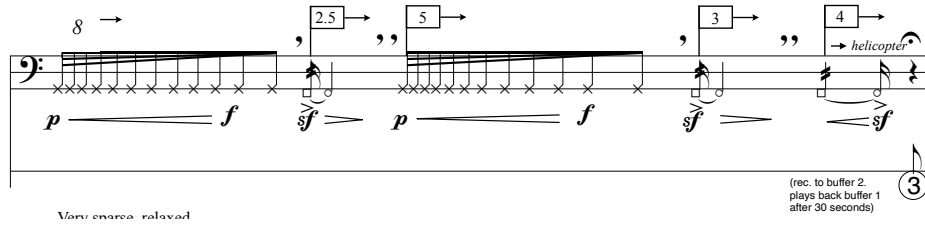


Figure 8: *Los Minúsculos*, m. 8

Cue 4 triggers the patch to end recording for buffer 2 and turns on a complex delay sub-patch. The delay patch is controlled by the delay line function as mentioned at the beginning of the chapter. The delay line control is located in the “controls” box on the interface and functions as a slider. The electronics performer can use this at their discretion and is truly able to influence the piece (fig. 9).

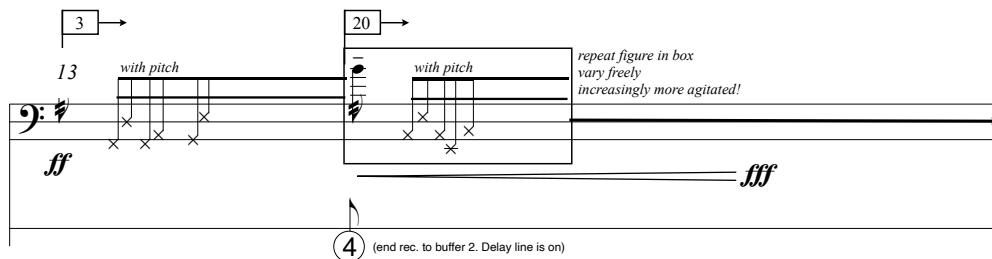


Figure 9: *Los Minúsculos*, m. 13

Shortly following cue 4, the electronics performer will manually increase the input gain through the patch’s gain control cue 5. This delay line gain is located within the controls box of the main patch’s interface (fig. 10).

Figure 10: *Los Minúsculos*, m. 14

Cue 6 starts the recording for the third and final buffer track (fig. 11).

Figure 11: *Los Minúsculos*, m. 23

When cue 7 is reached, all of the buffer tracks are played simultaneously. The 60-second duration of the tracks is intentional, so to time them all simultaneously for the same duration. It is difficult to tell where the track will end, and I would recommend using some sort of stopwatch (smart device, etc.) for this section. If the full minute is not reached, the tracks will continue to play into the next section and must play until they are finished (fig. 12).

~1:00 →

Improvise, stylistically similar to before.
 Combine these gestures freely, occasionally adding gestures from earlier.
 Vary durations, speed, dynamics, articulation, etc.
 All multiphonics should be loud, gritty.
 Get increasingly louder, more violent and agitated!

Figure 12: *Los Minúsculos*, m. 27.

controls

Set the sampling rate to 44,100 Hz.

Trigger Cues based on numbers in score

0 8 9

Figure 13: *Los Minúsculos*, Max/MSP master patch.

Cues 8 and 9 are unique in that they are separate from the functions of all previous cues. Each trigger of 8 and 9 are separate messages in the interface from the standard cues (fig. 13). The two performers play and trigger the cue simultaneously (fig. 14). Each trigger oscillates the band filter of the bassoon sound through all of the speakers. The mixture of limiting the harmonic series and spatialization create a very

unique effect that envelops and disorients the audience. This is particularly effective with the bassoon playing a “brutal multiphonic, with teeth.”¹¹

Many multiphonics that can be categorized as brutal and are entirely up to the bassoonist’s interpretation and capabilities. Many factors both human and instrument that are important to consider given the layered techniques being performed. In *Techniques of Bassoon Playing*, Pascal Gallois categorizes different multiphonic possibilities. The multiphonics shown in the book are not the only ones possible for the bassoon, but the particular section to be referenced are the fifteen stable multiphonics (section 3.2.3, appendix A)¹². The nature of multiphonics can change depending on the temperature, humidity, and reed.

28 →
il multiphonic, with teeth

fff fff fff fff fff ff f f mf

38 →

p

(playback of buzzing sound)

Figure 14: *Los Minúsculos*, mm. 28-38

¹¹ Bolaños, Gabriel, *Los Minúsculos*, BabelScores, 2018/2024.

¹² Gallois, Pascal, “Techniques of Bassoon Playing,” Bärenreiter Verlag, 2009.

The bassoonist will want to pick a multiphonic that is brutal, e.g., dissonant, while also very stable and easily articulated. I would choose from many multiphonics listed in Gallois' fifteen stable multiphonics specific to my current reed setup and bassoon.

It is possible to choose different multiphonics for this section, but the effect may be lost if there are too many. In my own live performance of the work, the first multiphonic fingering was one that I found through my own experimentation and is not included in the Gallois. For cue 8, I played a low F and added the B-flat key, which is a very stable multiphonic (fig. 15a)¹³. Bartolozzi's exploration into the possibilities of multiphonics for woodwind instruments led to his discovery of multiphonics, with the "main characteristic being that all sounds are of approximately the same volume and tone colour."¹⁴ The evenness in tone, color, and volume allows for more harmonics to be present, and paired with playing with teeth on the reed, exaggerates them even more. For the last measure, I decided to play a different multiphonic:

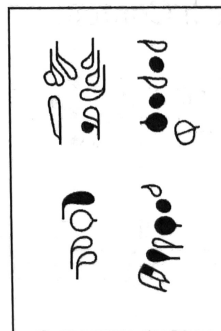


Figure 15a: Monovalent Multiphonics No. 70 - "Contemporary Techniques for the Bassoon: Multiphonics" by Jamie Leigh Sampson, pg. 50

¹³ Sampson, Jamie Leigh, "Contemporary Techniques for the Bassoon: Multiphonics," *Adjective New Music*, 2014.

¹⁴ Bartolozzi, Bruno, "New Sounds for Woodwind," Translated and edited by Reginald Smith Brindle. Oxford University Press, 1967.



Figure 15b: *Duo Sonata* by Sofia Gubaidulina, bassoon 1, m. 369

For the context of this last measure, I like the variety of timbres and pitches that are possible from the different voicings from the final multiphonic in Sofia Gubaidulina's *Duo Sonata* for two bassoons.¹⁵ This rolling multiphonic chord is comprised of open intervals, as shown in figure 15b. Four notes are present in this multiphonic, and there are four triggers for the duration of the multiphonic. The filter oscillation between speakers would isolate different pitches more, and sounds to the audience as if I'm changing notes while in fact I'm holding the same multiphonic.

The piece ends with the playback triggered by cue 9 (fig. 14). As stated in the score, it plays a buzzing sound as if the volume of the voice has gotten so loud that acoustic sounds from the space are being picked up, bringing full attention to the emotional weight of this piece.

Los Minúculos falls under the liveness category of both live processing and fixed media. The live processing used in the piece is achieved by the storing of the audio signal for playback. The feedback/buzzing sound at the end of the piece is fixed media, because it has been recorded in the composition stages. Storing audio for playback in *Los*

¹⁵ Gubaidulina, Sofia, *Duo Sonata for two bassoons*, Musikverlag Hans Sikorski, Hamburg, 1998.

Minúculos does not fall under the traditional idea of accompaniment, but it acts in every way as a very noticeable relationship between the bassoon and electronics. The patch's use of delay, reverb, and filters creates acoustic aesthetics in the performance, relating to the background of the piece. Small tongue taps cascade outwards into a cacophony of voices, which are then overwhelmed in the end by a dictator. These two key elements of the piece relate to the paradigms of accompanimental and environmental liveness. *Los Minúculos* is unique among the three pieces I chose because it is the only one that uses both fixed media and live processing.

CHAPTER 4: DARK MATTER BY MARC MELLITS

Dark Matter by American composer Marc Mellits for electric bassoon the use of effects pedals (also referred to as stomp boxes) as processed sound. The piece, originally written for the bassoon, takes the concept of an electric guitar and replaces it with another acoustic bass instrument. Mellits provides a list of effects pedals, including their model numbers (all Boss brand) and their respective effects controls, in order of signal flow (fig. 16)¹⁶:

1. Boss SD-1 Super Overdrive
2. Boss DS-1 Distortion
3. Boss AW-3 Dynamic Wah
4. Boss PS-6 Harmonist
5. Boss DD-3 Digital Delay
6. Boss CH-1 Super Chorus

Chain order:

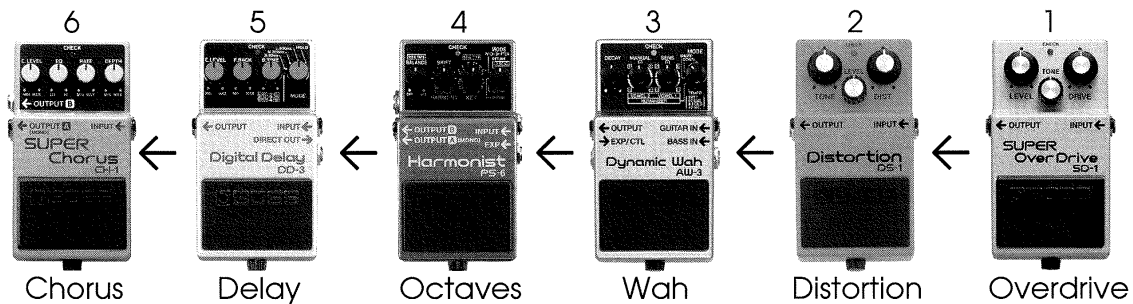


Figure 16: *Dark Matter*, pg. iii

¹⁶ Mellits, Marc, *Dark Matter*, Chicago: Dacia Music, 2018.

In the score notes, Mellits uses analog clock positions to instruct the performer on how their pedals should be set up to produce the proper effects for the piece (fig. 17).

DELAY:

Add approximately 12-16 steady eighth-notes, fading out.



Boss stompbox: Digital Delay DD-3
Settings: E.Level: 1:30; F.Back: 12:00; D.Time: 11:00; Mode: L.800ms

Figure 17: *Dark Matter*, pg. ii

Mellits states that *Dark Matter* was composed with the following Boss stomp boxes in mind (however other brands could be used).¹⁷ Personally, I used all of the same pedals listed in the score with the exception of substituting the Boss Distortion DS-1 pedal for an Electro-Harmonix Big Muff pedal.

While Mellits states that the electronics are integral to the piece and are not optional, but is open to other brands, I believe strongly that you should construct your board to make it unique to you. Pedals can create many different timbres, textures, and atmospheres. Certain effects like delay are integral to the piece and should be used, but you may choose to use a different kind of delay pedal. Different pedals have different behaviors, and experimenting with the ones you like is part of the performance practice.

¹⁷ Ibid.

Electronic Notation

Mellits uses a straightforward method of notating when the pedals should be turned on and off. At the beginning of the piece, he marks the pedals that should be on from the beginning of the piece (fig. 18).

The image shows a musical score for Bassoon in 4/4 time. Above the staff is a box containing the following text: OVERDRIVE:ON, DISTORTION:ON, OCTAVE:ON, CHORUS:ON. Below the staff, there is a first measure with a dynamic marking of *ff* and a tempo marking of ♩ = ca. 92. The notation includes a bass clef, a key signature of three flats, and a 4/4 time signature. The first measure contains a half note followed by a quarter note, with a fermata over the quarter note.

Figure 18: *Dark Matter*, pg. 2, m. 1

More often than not, the pedals are turned on/off one at a time while the bassoonist is playing. There are other examples from the piece, however, where Mellits instructs to turn off multiple pedals at the same time. Since this is a difficult task with muscle memory, a blank 1/4 bar gives the bassoonist a moment to turn on/off the correct pedal (fig. 19).

The image shows a musical score for Bassoon in 4/4 time, starting at measure 29. The notation includes a bass clef, a key signature of three flats, and a 4/4 time signature. The score shows a sequence of eighth notes. Above the staff, a box labeled OCTAVE:OFF has an arrow pointing down to the first blank quarter bar. Below the staff, a box labeled DISTORTION:OFF has an arrow pointing up to the same blank quarter bar.

Figure 19: *Dark Matter*, mm. 29-31

Guitar Pedals

Boss SD-1 Super OverDrive

The SD-1 Super OverDrive (fig. 20) is the first pedal in the signal chain. This makes it the foundation for the bassoon tone. As discussed previously, OverDrive pedals cause soft clipping, which Nick Bowcott describes as a “rounding out” of the sound while increasing the gain of the voice or instrument.¹⁸ Because of this, the pedal acts as a pre-distortion effect and is left on for the whole performance.



Figure 20: Boss SD-1 Super OverDrive pedal

The qualities that differentiate the Super OverDrive and a normal OverDrive pedal are the standard performance practice and style. A normal OverDrive pedal is designed for a more classic and clean rock guitar sound¹⁹, while Super OverDrive has a higher fidelity and raw effect that is designed to pair well with a distortion pedal.²⁰

¹⁸ Nick Bowcott, 2024, “Boost, Overdrive, Distortion & Fuzz Pedals - What’s the Difference? - InSync,” InSync.

¹⁹ “Boss OD-3 OverDrive,” Boss, <https://www.boss.info/global/products/od-3/>

²⁰ “Boss SD-1 Super OverDrive,” Boss, <https://www.boss.info/global/products/sd-1/>

Electro-Harmonix Nano Big Muff Pi

Electro-Harmonix is another standard guitar pedal company similar to Boss. The Big Muff Pi (fig. 21) in particular has a reputation for being a “staple of rock music from the 1970s”²¹ and was supposedly a favorite of Jimi Hendrix²², who was a friend and creative collaborator with Electro-Harmonix founder Mike Mathews²³ and Carlos Santana. The pedal packs a lot of punch and goes beyond just a distortion pedal, much to my shock. True to Hendrix’s style, it carries the trademark fuzz and feedback sound of that era and the genre that followed.



Figure 21: Electro-Harmonix Nano Big Muff Pi²⁴

²¹ “Electro-Harmonix Nano Big Muff Pi Distortion / Fuzz / Overdrive Pedal,” Sweetwater, <https://www.sweetwater.com/store/detail/NanoBigMuff--electro-harmonix-nano-big-muff-pi-distortion-fuzz-overdrive-pedal>.

²² Ibid.

²³ Rae, Kit, “Big Muff History,” Kitrae.net, last updated March 2020. https://www.kitrae.net/music/big_muff_history.html.

²⁴ “Electro-Harmonix Nano Big Muff Pi Distortion / Fuzz / Overdrive Pedal,” Sweetwater, <https://www.sweetwater.com/store/detail/NanoBigMuff--electro-harmonix-nano-big-muff-pi-distortion-fuzz-overdrive-pedal>.

Not only does the pedal feature the fuzz and distortion, it also has its own built-in overdrive. The pedal's controls don't independently control overdrive vs. distortion; it only has three knobs, each affecting volume, tone, and sustain. Combined with the Boss SD-1, this can have unpredictable results, and my constant tinkering happened nearly every time I played the piece. Different days, reeds, practice spaces, and hall acoustics created different kinds of feedback. I was excited to incorporate this into my board because it created a unique sound that carried that iconic psychedelic funk sound but, amplified by the other pedals, added more heavy-metal timbral characteristics. As someone who listens to a lot of metal and metal-influenced music, it immediately brought to mind the stoner metal genre, which has the same characteristics as the sound this pedal produces, particularly the Fuzz effect.²⁵ Combined with the low-frequency dominant timbre of the bassoon and the intentionally retro sound the Big Muff replicates, it fit a very specific sound like that of Black Sabbath that made my own interpretation of *Dark Matter* unique.

Boss AW-3 Dynamic Wah

Wah is a very recognizable guitar pedal effect, most commonly associated with the funk genre. A standard Wah pedal is controlled manually using a potentiometer inside the pedal, which is rocked back and forth, causing the overtones of the sound to change. The more pressure you put on the pedal, the stronger the effect becomes. This creates the vowel-shape sound you hear in funk music. The Boss AW-3 Dynamic Wah (fig. 22) is

²⁵ Overs, Anthony. "Sweet Leaf – The Rise of Stoner Metal," *The Riff*, December 27th, 2023, <https://medium.com/the-riff/sweet-leaf-the-rise-of-stoner-metal-5a039e52c41a>.

designed to eliminate the manual controls of a standard Wah pedal. It is programmed to humanize an Auto-Wah function, which “provide[s] variable effect[s] based on picking (guitar picks) strength.”²⁶ The picking strength as it relates to bassoon is affected by the articulation and volume of a note.



Figure 22: Boss AW-3 Dynamic Wah pedal

In *Dark Matter*, the Dynamic Wah pedal is only ever turned on when the Octave is also on. It’s possible to choose either “guitar in” or “bass in” for different equalization effects. In the journal *Bass Player*, Bill Leigh goes in-depth on a magazine advertisement, discussing some of the functions of the pedal. The ad says that if you try to plug your bass through the “guitar in,” it will come out sounding “thin and weasly.”²⁷

²⁶ “Boss AW-3 Dynamic Wah,” Boss, <https://www.boss.info/global/products/aw-3/>

²⁷ Leigh, Bill, “Boss AW-3 Dynamic Wah PH-3 Phase Shifter,” *Bass Player*, 09, 2001, 68, <https://login.ezproxy1.lib.asu.edu/login?url=https://www.proquest.com/magazines/boss-aw-3-dynamic-wah-ph-phase-shifter/docview/199902221/se-2>.

Boss PS-6 Harmonist

The function of the PS-6 Harmonist pedal (fig. 23) is for octave doubling below the sounding pitch. The configuration of the pedal is set to pitch shifter mode and to have no key. This will match the pitch of the sounding note. The Harmonist pedal is a very strong one because it has several possibilities for harmony: for example, a single pitch (octave) like in the case of *Dark Matter* or the ability to create a three-part harmony.²⁸



Figure 23: Boss PS-6 Harmonist pedal

The Harmonist pedal is used throughout most of the piece and provides support for the bassoon sound, giving it much more power and presence. When you hear an electric guitar or bass guitar, you're likely to feel the floor shaking. With this pedal, the

²⁸ "Boss PS-6 Harmonist" Boss, <https://www.boss.info/global/products/ps-6/>

bassoon achieves that effect. The pedal is turned off periodically to allow for a break from the heaviness, usually to punctuate the beginning of a new section, building tension. In figure 24, specifically mm. 51-63, the bassoon plays two two-measure phrases. Every two-measure phrase alternates between having the octave pedal on and off. This pattern of alternating on/off follows through similar developmental material until the arrival of a new section at m. 63, beginning the section that will make use of the delay pedal.

50 WAH:OFF OCTAVE:OFF

53 OCTAVE:ON OCTAVE:OFF

56 OCTAVE:ON

59 OCTAVE:OFF OCTAVE:ON

62 $\text{♩} = \text{ca. } 87$
 delay *sim.*
 DELAY:ON match delay time to equal chosen tempo eighth-note

Figure 24: *Dark Matter*, mm. 50-66



Figure 25: Boss DD-3 Digital Delay (OLD) Figure 26: Boss DD-3T Digital Delay (NEW)

Boss DD-3 Digital Delay

The Boss DD-3 Digital Delay pedal (fig. 25) is used during the middle section of the piece, first seen at m. 63 (fig. 24), and again from mm. 81-142 (fig. 27), to create a consistent pulse of, as Mellits specifies, “approximately 12-16 steady eighth notes,” which decay over the course of 800 milliseconds. The DD-3 is toward the end of the signal flow, so it isn’t modified by many other effects aside from the Chorus, which only affects timbre, whereas the Digital Delay only could be affected by an effect that changes the sound envelope (e.g., attack, decay, sustain, release of a note) in some way. The Boss DD-3 has been discontinued and replaced by the DD-3T (fig. 26), which adds many other new effects; the addition of a tempo input, the ability to control the tempo of the delay in real time by holding down the pedal then tapping the desired tempo, and many

other new effects. The DD-3T, according to Boss, is the fully updated and “industry-standard” model.²⁹

The image shows a musical score for two staves. The upper staff is in treble clef and the lower staff is in bass clef. Both are in 4/4 time. The score starts at measure 80. The upper staff has a 'delay' annotation above it. The lower staff has a 'DISTORTION:OFF' box below it. Dynamics include *mp* and *sim.*

Figure 27: *Dark Matter*, mm. 80-85

The function of the delay in the context of the piece is notated on a line above the score. As the bassoonist plays arpeggios, the Digital Delay will continue to play anywhere from 12–16 eighth notes, depending on the adjustments of the rate knob the bassoonist decides to use.



Figure 28: Boss CH-1 Super Chorus

Boss CH-1 Super Chorus

²⁹ “Boss DD-3T Digital Delay,” Boss, <https://www.boss.info/global/products/dd-3t/>

The Boss CH-1 Super Chorus (fig. 28) is designed to create a “clean classic chorus sound” and was created with the intention of having very present upper harmonics.³⁰ It also features a stereo output and could be used if the bassoonist wishes to use a stereo setup for performance. A Chorus effect is created by multiplying the signal and causing a shift in pitch and phase. This is not just an electronic affect, but is also an acoustic phenomenon in itself, where the minuscule discrepancies in pitch and timbre create a unique series of harmonics that have a “distinctive, shimmering quality.”³¹ The electronic effect is created by copying the signal, modulating by a very small frequency, and adding a negligible amount of delay. According to Native-Instruments.com, the amount of delay is only about 15–35 milliseconds.³² All of the effects of the pedal are also modulated by a low-frequency oscillator (LFO), which creates a humanlike behavior to the signal.

The Super Chorus pedal is the last pedal in the signal chain and is important to keep at the end at the chain. This will make it so that each of the effects of the pedals farther up, like the Digital Delay, are affected and not the other way around, as the Delay would be trying to apply the affect to a signal that is being modulated at different rates. Having the pedal at the end of the chain also allows for stereo output.

Reverb and Amplification

³⁰ “Boss CH-1 Super Chorus,” Boss,. <https://www.boss.info/us/products/CH-1/>

³¹ “What is the chorus effect? How to add depth and texture to your music,” Native Instruments, May 11, 2023, <https://blog.native-instruments.com/chorus-effect/>

³² Ibid.

The easiest piece of equipment to use for audio output and reverb is an amplifier. Generally, a practice amplifier of some kind is acceptable for performing the piece in a hall. I bought a secondhand Orange Crush PiX 20LDX (fig. 29)³³, and for the purposes of the project, it was acceptable and had the most of what I needed as an entry-level piece of an equipment. There is a caveat, however. If you decide to use this amp, you will be sacrificing a significant amount of tone quality, which it makes up for in the easy accessibility to a multitude of effects (reverb particularly) and equalization. I chose this method for convenience, but reverb can be added through several ways including a mixer or software like Max/MSP, while there also many different options for amplification. You can use an audio interface like the Scarlet 2i2 and have an output to a PA system.



Figure 29: Orange Crush PiX 20LDX

Purchasing a higher-quality amp is a much larger investment. Considering something entry level like an Orange brand amplifier is a good starting point. Amplifiers

³³ "Orange Crush PiX 20LDX," Orange Amps, <https://orangeamps.com/products/guitar-amp-combos/crush-pix-cr20ldx/>.

often have a built-in delay effect, which you will always want to apply to the end of the signal chain, so it affects the whole range of pedal effects.



Figure 30: Boss RV-6 Reverb pedal

If you decide to use a higher-quality amp and it does not have any effects options, you will have to use a reverb pedal. An option for this pedal may be the Boss RV-6 Reverb (fig. 30), as Boss is very reputable and the pedal will give you more agency over the wet/dry levels of the effect (based on presets), equalization, duration, and the amount of tone (cut off frequency) of the signal.³⁴

³⁴ “Boss RV-6 Reverb Pedal,” Boss, <https://www.boss.info/us/products/rv-6/>.



Figure 31: CIOKS DC7

Power Supply

To perform *Dark Matter*, you will need a power supply with six ports for your pedalboard. The best budget power supply I found was the CIOKS DC7 (fig. 31), although it will be the single most expensive piece of gear that you will need for this piece. It comes with the AC adapter cables for the pedals, with varying lengths. It is simple to set up, only needing the user to make sure that the voltage is correct, which is already set to the default voltage of what you will need for the pedals.

Assembly of Board and Troubleshooting

Assembling your pedalboard is fairly simple, provided you have the right parts for the job. It is important to make sure you have one 1/4" TRS cable (two rings) for your mono output, or two for a stereo output. You will also need a 1/4" TS cable (one ring) for your input. I ran into this firsthand, having purchased the wrong types of cables and mistakenly thinking there was something wrong with the guitar pedal I was using. It took me a considerable amount of time to figure out why my signal was not passing through

the Super OverDrive pedal until I tried a TS cable. In order to run the “Little Jake” through the pedal, it needs an unbalanced cable (TS). After a lengthy reordering process, finding out that I was trying to put a TSR 1/4" cable into a mono input was quite inconvenient. I’ve included a picture of my own pedalboard I used for performing and learning *Dark Matter* (fig. 32).



Figure 32: Pedalboard setup, Benjamin Kearns

On the spectrum of liveness, *Dark Matter* falls under the category of live processing, because the sound of the bassoon is being directly manipulated and sent out as its own distinct voice. The pedals change the sound of the bassoon in many ways, and depending on the performer’s interpretation, they can decide if they want to more prominently feature the sound of the pedals, the bassoon, or have an equal balance of both. Mellits’ use of a direct audio signal fed through a series of guitar pedals very clearly

exhibits the paradigm of instrumental liveness, because the acoustic sound has been morphed by a multitude of effects and sonic behaviors. To use Croft's analogy of the instrument-plus-electronics, the bassoonist is now playing a bassoon-plus-electronics as opposed to bassoon with electronics.³⁵

³⁵ Croft, John, "Theses on Liveness," *Organised Sound* 12, no. 1 (2007): 59–66, <https://doi-org.ezproxy1.lib.asu.edu/10.1017/S1355771807001604>.

CHAPTER 5: TORSION BY OLGA NEUWIRTH

Torsion is a piece for solo bassoon and pre-recorded electronics by Austrian composer and mixed media artist Olga Neuwirth. While upon first glance, *Torsion* may seem like a standard contemporary solo bassoon work, Neuwirth uses five audio samples throughout the second half of the piece. Because these are just pre-recorded audio tracks, there is requirement for using the “Little Jake” or a microphone. These so-called “void” samples all play an integral role in the aesthetics of the work, relating to her relationship with mixed-media art.³⁶ The moments of pre-recorded audio are the primary voices, and the bassoon takes on an accompaniment role, particularly in Voids 3 and 5. The electronics in *Torsion* are able to be triggered by the performer or someone off-stage. If the performer triggers the electronics, it can be done by having some kind of MIDI controller. It is possible to map a Bluetooth foot pedal to a play/pause function on your laptop or smartphone when pressing one pedal. There are also other midi controllers that can do the same. If the performer takes this route, they should make sure to have their playback device connected to a sound system in the performance hall. This is the easiest way for the performer to trigger the electronics, provided the controller is something that doesn’t require the performer to fully stop playing. The caveat of this is that it will require a significant amount of preparation; having the correct equipment, sound checking to make sure the controller actually functions correctly and adjusting the balance of the electronics during the performance as needed. If someone is off-stage

³⁶ Service, Tom, “A guide to Olga Neuwirth’s music,” *The Guardian*, August 7th, 2012. <https://www.theguardian.com/music/tomserviceblog/2012/aug/07/contemporary-music-guide-olga-neuwirth>.

reading the score, they can easily control the electronics from the press of a button, but it can be difficult for the two individuals to communicate. Having direct sight between the two is important to make sure that the trigger and the performer line up on their entrances.

In an interview at the 2002 Lucerne Festival, Neuwirth says this about the various “void” sections in the piece: “I have taken the name from the empty, quasi-silent spaces in the Jewish Museum in Berlin, referred to as ‘voids’ by the building’s architect Daniel Libeskind.”³⁷

The jagged architecture of the museum is reflected in the sharp musical gestures in the score (fig. 33). These sharp gestures are shown through the large intervals that are staccato and constantly jumping between different parts of the bassoon’s range. Neuwirth marks “s.c.” in m. 16 which stands for *son cuivré*, meaning “brass sound,” but in this context likely refers to “overblown” playing.³⁸ In the performance notes, Neuwirth also writes “staccato mit der spitze des rohrblatts,” which translates to “staccato with the tip of the reed.”³⁹ She makes no reference to the V on the note stems but given the context, I would conclude that it refers to the “staccato with the tip of the reed” articulation.

³⁷ Allenby, David, “Olga Neuwirth: Composer Interview,” Boosey & Hawkes, August 2002. https://www.boosey.com/teaching/news/Olga-Neuwirth-composer-interview/10312_

³⁸ *Merriam-Webster.com Dictionary*, s.v. “cuivré,” accessed March 24, 2025, <https://www.merriam-webster.com/dictionary/cuivr%C3%A9>.

³⁹ Neuwirth, Olga, *Torsion*, Berlin, Germany: Boosey & Hawkes (Bote & Bock), 2003/2005.



Figure 33: *Torsion*, mm. 114-117

The architecture of the Libeskind building is intentionally designed to “make it impossible to see where each floor begins from the outside”⁴⁰ (fig. 34), which is quite noticeable in this section of the piece, where there are few notes that fall on the down beats. This syncopation, along with mixed meter (m. 114), creates the feeling of a lack of foundation while listening to the piece, even if the material is repetitive and incessant.

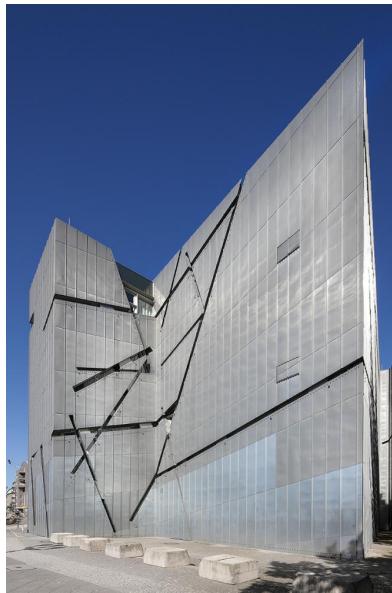


Figure 34: *The Libeskind Building’s Titanium-Zinc Façade Makes It Impossible to See Where Each Floor Begins From the Outside.* Photo: Jens Ziehe

⁴⁰ “Libeskind Building, The,” Jüdisches Museum Berlin, <https://www.jmberlin.de/en/libeskind-building#media-13052>.

Each void in the piece reflects the five voids found within the building. They “cut through the entire vertical axis of the building,” are not all accessible, and “largely lack[s] artificial lighting” and airflow.⁴¹ The Jüdisches Museum Berlin website says that Libeskind “uses the voids to address the physical emptiness that resulted from the expulsion, destruction, and annihilation of Jewish life in the Shoah, which cannot be refilled after the fact.”⁴² These spaces hold room for different art installations, like Memory Void’s *Shalekhet* installation by Menashe Kadishman (fig. 35).

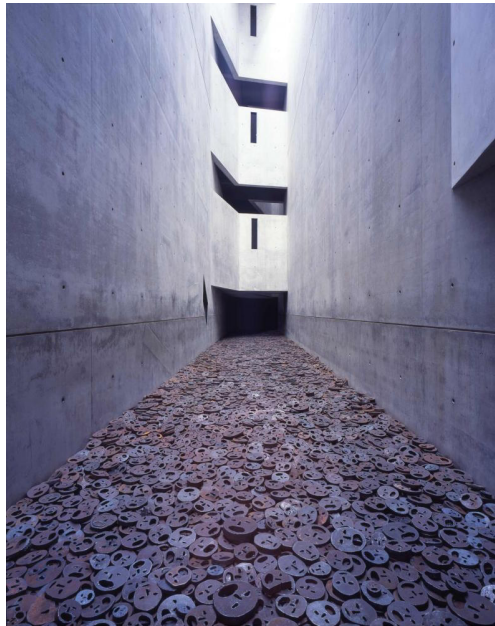


Figure 35: Memory Void’s *Shalekhet* installation by Menashe Kadishman;
Jewish Museum Berlin. Photo: Jens Ziehe

Each of the void’s samples in *Torsion* have their own purpose. They denote a new section and mood. Each section introduces new motives that begins to morph subtly. It is

⁴¹ Ibid.

⁴² Ibid.

not clear exactly what each audio sample's source is, with the exception of voids 3 and 5.

There are too many of these small gestures to list for this research, but I will provide a few examples from

void 1:

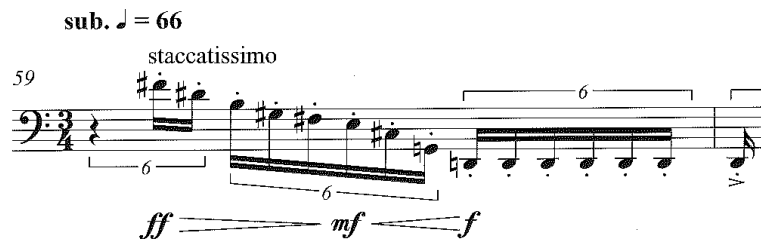


Figure 36: *Torsion*, mm. 59-downbeat of 61

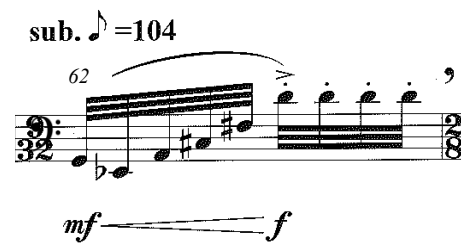


Figure 37: *Torsion*, m. 62

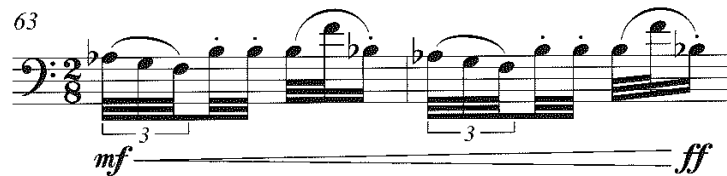


Figure 38: *Torsion*, m. 63

Voids

Void 1's sample (fig. 39) sounds like the ambience of steady winds, but there are no sounds that interrupt or distract from it. The sample lasts for approximately one minute, while the bassoonist holds a low Eb at pianississimo for the full duration.

sample 1
VOID I

51 C.B. ca. 1'

ppp

Figure 39: *Torsion*, m. 51

Void 2 is very similar to void 1, but other sounds have crept in. There is a creaking, almost machine-like sound with a very hollow timbre (the pitch C#5 is very present) that blends well with the low D the bassoonist is holding throughout (fig. 40). In m. 87, the bassoon plays the same C#5, which then is underblown to produce an underblown C# multiphonic (fig. 41). This is one of the multiphonics shown in the first category of twelve stable multiphonics in Gallois' *Techniques of Bassoon Playing* (3.2.1)⁴³ (fig. 42).

sample 2
VOID II

84 v.s. C.B. ca. 1'

ppp

Figure 40: *Torsion*, m. 84

⁴³ Gallois, Pascal, "Techniques of Bassoon Playing," Bärenreiter Verlag, 2009.

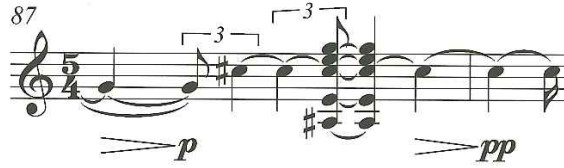


Figure 41: *Torsion*, m. 87

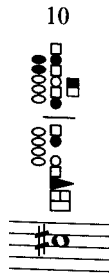


Figure 42: *The Techniques of Bassoon Playing*, 3.2.1 First Category:
twelve stable multiphonics, pg. 42

Void 3 (fig. 43) marks an aesthetic shift. During the industrial ambience, an old recording of Klezmer music, of which a clarinet is the only barely audible voice, gradually fades in. The music disappears suddenly, with a heavy reverb effect tailing behind. This sudden cut aligns with Libeskind's vision for showing the literal void left behind by the Holocaust.

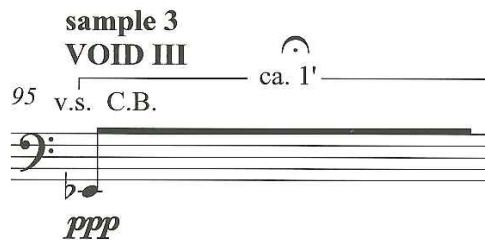


Figure 43: *Torsion*, m. 95

Void 4's (fig. 44) sample is nearly identical to void 1, but most of the prior thematic material or variations return in smaller cells. Neuwirth doesn't make explicit connections to which voids in the Jüdisches Museum Berlin correspond to which void sample, but this sample seems to act as a sort of reset because of the recapitulation of the various motives.

sample 4
VOID IV

ca. 1'

44 C.B.

ppp

Figure 44: *Torsion*, m. 124

In void 5's sample, the Klezmer music returns but is much more audible. This time, percussion is heard among the clarinet and sounds much more celebratory. The low D in the bassoon provides a distinct tonal accompaniment to the sample from the other voids and is the only consonant material throughout the piece. This is a moment of true reprieve, met with a harsh, angry response from the bassoon afterward (fig 45).

sample 5
VOID V

ca. 1'

164 C.B.

sub. ♩ = 66

ppp

ff \rightrightarrows *mf*

Figure 45: *Torsion*, mm. 164-165

On the spectrum of liveness, *Torsion* is a piece that uses fixed media exclusively. The relationship between the bassoon and electronics are nearly completely separate from each other, despite being played at the same times. The paradigm of liveness that *Torsion* falls under is less obvious than the prior two works. For the listener, the void interludes may be interpreted as solely a backdrop relationship, but for voids 3 and 5, an accompanimental relationship would better suit those sections due to the old recordings of Klezmer music. The unique instance of this accompanimental relationship between the bassoon and electronics, however, is that the bassoon has an accompanimental role to the electronics rather than the other way around. Pieces that use electronic tracks like *Torsion* are great for bassoonists that want a piece that low maintenance in terms of the technology being used.

CONCLUSION

Los Minúsculos by Gabriel Bolaños, *Dark Matter* by Marc Mellits, and *Torsion* by Olga Neuwirth are all works that achieve unique relationships between the bassoonist, bassoon, and electronics. These contrasting works envelop a variety of styles and techniques that, while challenging, are worth preparing and understanding for the purpose of understanding the relationship between bassoon and electroacoustics. We have limited electroacoustic pieces for the bassoon, and those that are available are not easily accessible in terms of the time and money it may cost to perform. These engaging and thought-provoking works prove that there is value in creating steppingstones to electroacoustic works for solo bassoon as valid and standard additions to our steadily growing repertoire. Each piece I explored covers different techniques that composers can use to help facilitate composing pieces that are attainable and rewarding. While these three pieces are difficult to perform, the techniques and equipment used could be extended to more entry-level electroacoustic music. It is also doubly important that we continue to create more resources designed for bassoonists to give them a broader understanding of the equipment available to them, such as the “Little Jake,” Max/MSP, and guitar pedals. The cross-section with popular music in *Dark Matter* has the potential to be very appealing to bassoonists who also enjoy non-classical music genres, as well as non-classical audiences.

It is my hope that as we progress into a future of classical music with ever-growing creative opportunities, we can call on composers to collaborate with bassoonists to write pieces for bassoon and electronics of all playing levels. I believe it is crucial to help introduce more bassoonists — particularly those in their studies to become well-

rounded musicians — to the opportunity electroacoustic music provides for growth and collaboration with technology, composers, and other collaborating musicians.

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APPENDIX A
MULTIPHONIC FINGERINGS

**3.2.3 Dritte Kategorie:
Fünfzehn stabile Mehrklänge**

Fünfzehn weitere sichere und stabile Mehrklänge (jeweils möglich von *p-f*):

**3.2.3 Third category:
fifteen stable multiphonics**

Fifteen other reliable and stable multiphonics all of which can be played in *p-f* dynamics:

**3.2.3 Troisième catégorie :
quinze multiphoniques stables**

Quinze autres multiphoniques sûrs et stables (tous jouables dans les nuances *p-f*) :



<p>1/35 M1</p>	<p>1/36 M2</p>	<p>1/37 M3</p>	<p>1/38 M4</p>	<p>1/39 M5</p>



<p>1/40 M6</p>	<p>1/41 M7</p>	<p>1/42 M8</p>	<p>1/43 M9</p>	<p>1/44 M10</p>



<p>1/45 M11</p>	<p>1/46 M12</p>	<p>1/47 M13</p>	<p>1/48 M14</p>	<p>1/49 M15</p>

Auf diesen 15 Mehrklängen können Bisbigliandi bzw. Klangfarbentriller gespielt werden.

It is possible to do bisbigliandi or timbral trills on these 15 multiphonics.

Sur ces 15 multiphoniques, on peut faire des bisbigliandi, ou trilles de sonorité.

APPENDIX B

TRACK LIST

Track Number	Title	Composer	Producer
1	<i>Los Minúsculos</i> (9:02)	Gabriel Bolaños	Gabriel Bolaños
2	<i>Dark Matter</i> (7:55)	Marc Mellits	Albie Micklich
3	<i>Torsion</i> (15.25)	Olga Neuwirth	Joshua Gardner

This recording was made on January 6, February 10, and March 28, of 2025 at Tempest Recording Studios in Tempe, AZ

This recording was recorded, edited, and mastered by Clarke Rigsby, and the recordings are produced by Gabriel Bolaños on January 6, Albie Micklich on February 10, and Joshua Gardner on March 28.