It’s You!

A discussion of the aspects of reality that the digital world fails to reproduce, and the impact of this disparity on digital art; specifically electronic music.

... An Honors Thesis in Music by Mikah Feldman-Stein
On every level of existence, we as humans seek to create representations of the world. Within our brains, we hold a model of the external world. Within this model are the details of our environment, represented within the neuronal structure. Externally, we have other media for our representations. For visual content, we initially had drawings, for sound, wax recording media. These representations have evolved with each advancement in technology, not just in quality, but in scope. In general each advancement is initially regarded as a perfect representation, but over time, the distance between representation and reality becomes more obvious, and the tech becomes a step towards more believable, authentic representations that bridge the reality gap more effectively.

Fast forward to today. The internet enables representations not just of visual and auditory media, but of ourselves as well. Walter Benjamin discusses the idea of Aura in his piece “The Work of Art in the Age of Digital Reproducibility.” Aura, as he sees it, is the impression of authenticity and closeness one feels when they see a piece of art in its intended context. For example, the difference between experiencing a picasso in a gallery as opposed to google image search. Or, as is more pertinent here, the difference between seeing a live performance and listening to a recording of the artist.

[1] “The presence of the original is the prerequisite to the concept of authenticity.”

On The Frailest Thing Blog's Piece “The Self in the Age of Digital Reproduction,” (written by Michael Sacasas) Benjamin’s ideas are explored in the context of social media, and how the associated representations of self are created and interpreted. In this piece, Benjamin’s two major explanations of the decrease in aura (or “eclipse of the aura,” as it’s put), are aptly cited:

[2] “First, technological reproduction is more independent of the original than is manual reproduction. For example, in photography it can bring out aspects of the original that are accessible only to the lens … but not to the human eye; or it can use certain processes, such as enlargement or slow motion, to record images which escape natural optics altogether. This is the first reason. Second, technological reproduction can place the copy of the original in situations which the original itself cannot attain. Above all, it enables the original to meet the recipient halfway, whether in the form of a photograph or in that of a gramophone record.”

-- [1,2] Walter Benjamin,
Excerpt from “The Work of Art in the Age of Mechanical Reproduction”

Benjamin touches on an important point here, addressing how digital representations can, either in raw form or with modification, display content we would otherwise be unable to perceive. In many cases, digital representation does in fact diminish Aura in the way Benjamin describes. The Frailest Thing cites social media platforms such as Skype, as particularly subject to this phenomena of diminishing aura. One can even argue that technological advancement is in large part motivated by a desire to reconcile this loss. This extends to all forms of media, as in each
field there are people seeking to extend the capabilities of their representations. In video, camera definition is constantly improving and expanding in scope, now even venturing into the world of 3D video and virtual reality. In audio, new digital formats feature lossless encoding and new products are released every day boasting improved digital/analog conversion technologies. Each improvement brings to light a body of data that has the potential to expand our understanding of a representation, and hopes to expand the sensation of Aura that we feel. Benjamin might say this is a futile venture, but there is something worth considering. Part of what makes reality so immersive is the massive excess of information, of which we are only able to access a small part of it at any given time. It is therefore possible, that by continually creating new and expanded data from improving technology, that we begin to mimic the magnitude of information that is around us in reality, and thus better reconcile the representational loss of Aura.

On social media platforms, people take extensive measures in order to create a perception of authenticity, which is folded into the definition of Aura stated previously. One of the most common techniques to overcome this gap, is to share personal details from one's life, in a carefully curated manner. The goal here is to create a perception of closeness and honesty on the consumer end, and on its own, this methodology can seem revealing and vulnerable. However, we live in a time where the reproduction and distribution of self is understood, and are privy to the bias of these displays. This is a good thing, as we are not often duped into believing a self-curated collection of data is the whole of a person’s humanity, but the act of connection on the internet is meaningful to us regardless. Were this not the case, websites and applications with systems such as “Friends” on Facebook, or “Followers” on Instagram/Twitter, would not be nearly as successful.

If we look at all of this information from the right angle, we begin to see a pattern forming. With each advancement in technology, we are provided with a new set of data. On it's own, this new data is essentially meaningless, but it’s presentation is what makes it have impact. Put more simply, we only feel close to a digital representation when it effectively integrates this with other relevant data.

Because technology grows as an organism, advancements in one field can have widespread applications. For example, the technology surrounding collection and analysis of biological data has expanded in both accuracy as well as accessibility. As a result, we have the ability to observe aspects of the human existence previously beyond the scope of our perception, and non-invasively. This technology has been applied outside of the medical field; Products like FitBit encourage consumers to track their internal states, and share these with the world through the internet. Benjamin’s analysis of Aura applies here, as there is an immediate loss of proximity that one experiences when viewing someone’s life and well-being as a collection of data. A question presents itself here, is there any way to bring the human back into the data? In this context, there is! The closeness and humanity of this data is reestablished when the data is interpreted, and then discussed with the medical patient. This reintegration is a crucial step in the preservation of Aura, and is cognitively separate from the interpretation and
analysis of data. This also raises questions about possible methods of integration of biological data in other media, and even music performance.

When discussing digital representations of art, we are sometimes presented with situations where the digital representation has become the art. Examples include most modern photography and videography, as well as recorded and electronic music. However, electronic music stands alone in that there is no “analog” being represented. Because it exists entirely within the digital realm, electronic music is not in of itself a representation, though there is still a loss of Aura when the music is presented in the live setting. To clarify, having the ability to improvise with music, to make small or sometimes drastic adjustments, and most importantly, make mistakes, is in part what makes live performance so exciting, and makes the audience feel like they are experiencing something novel. When there is no risk for the performer, what stops the audience from disconnecting and the performance from becoming boring?

As it stands now, most electronic music performed live is presented in largely rigid form, with limited capability for modification and improvisation. While often accompanied by some form of visuals in an effort to make the show more exciting for the audience, these visual displays are more often than not set up ahead of time and left to run, so we run into the same problem of rigidity as with the music. Consequently, the issue is left unsolved, and we are left to wonder if these visuals do more to draw the audience’s attention away from the music than increase their feeling of closeness to the music and performer. Many would argue that electronic music as it is performed today, creates a huge divide between performer and audience. In most large electronic music shows today, there is substantial physical distance between even the closest audience members and the performer, which is inevitably disconnecting for the audience. Additionally, there is often a computer running software that only the performer can see, placing a screen between them and the audience. This is contradictory to what has historically made musical performance exciting. With analog instruments and improvised music, the audience feels it has access to most of the same information as the performers, and knows to some extent, what to expect from them. When they can see where each sound is coming from, hear the chord progression, see the potential for mistakes and problems, observe the intricacies of interaction between the musicians, the audience is able to imagine themselves in this context, and feel a sense of proximity and empathy that leads to excitement when the musicians do something unexpected or phenomenal. This is the same reason we get excited watching trapeze artists and acrobats, we imagine ourselves in that position, get a sense of the immense risk, and consequently are moved when they succeed, and when they come up short. Electronic music presents a point of difficulty here, in that the breadth of capability of computers as instruments makes it much more difficult for the audience to place themselves in the same position as the performer. Another factor that has electronic music at a disadvantage is that electronic instruments struggle to mimic the reactive nature of analog instruments, often hindering their performability. Consequently, people have long searched for other ways of interfacing with electronic sound on a more personal level, even going so far as to have their internal biological states be the stimulating factor for audio creation.
The act of taking data from the internal world and bringing it into the world of electronic music isn’t a new concept, and has historically been a popular approach in experimental music circles. In the 1940’s Dr. R. Furth invented the *Encephalophone*, which used an EEG (Electroencephalogram), and converted incoming signals to sound with the purpose of locating injured brain cells (Henry, *"The New York Times"*, 1943). The idea for this technology was primarily for diagnostic purposes, but was applied musically by Erkki Kurenniemi in the early 1960’s, who was a Finnish composer and musician. One of the more notable works extrapolating sound from this type of biological data is “Music for Solo Performer” by Alvin Lucier, first performed in 1965. This piece was the product of collaboration between Lucier and a scientist who had been studying alpha wave activity using EEG ("No Ideas But In Things - The Composer Alvin Lucier - Music for Solo Performer"). Alpha waves are low frequency brain waves that are most prominent in periods of relaxation or meditative states ("Bio Cybernaut, Alpha Waves"). In his piece, the performer was required to sit quietly with their eyes close in an effort to stimulate alpha wave activity. The EEG was connected to the performer, and when Alpha Wave activity was detected, one or a number of percussion instruments was triggered. This is a difficult piece to execute under pressure as it requires deep meditation on cue, a state of mind not easily attainable on stage. David Rosenboom took this technology a step further when he applied EEG signal to analog and digital synthesizers to create sound.

Exploration of this field continued to be somewhat popular into the mid 1970’s, but the cost of technology and lack of further technological development inhibited progress. While some people who pioneered this exploration continued their work into the mid-70’s, most ventured elsewhere. Only recently has the technology come to the point of allowing new exploration to occur, with decreased cost of acquisition and wider availability of relevant information. Open source projects on the internet have facilitated this widespread sharing of information and experiences regarding custom EEG construction as well. In 2012, Masaki Batoh released an album titled “Brain Pulse Music,” which used a custom built EEG machine that converts the incoming signal to Radio Frequency, then to wave pulses, and ultimately into sound. He refers to this machine as the “BPM Machine.” “Brain Pulse Music” was written in lieu of the tsunami in Japan, and features a variety of haunting pieces. For some, the BPM Machine would sonify eye movement as Batoh would show the subjects pictures or paintings, while in others, the EEG information would cause traditional Japanese instruments to be played (Batoh, "Brain Pulse Music").

Another more recent exploration of the sonification of EEG data comes from musician and artist Lisa Park, and her pieces Eunoia and Eunoia II. In Eunoia, Park uses an EEG headset to monitor her emotional state, causing one of 5 speakers to disrupt a pool of water, creating distinct ripple patterns. In order to process her emotional state, Park used the incoming data from the MindWave Mobile EEG Headset, and using software such as Processing and Max/MSP, was able to pick out five consistent patterns of brain activity associated with emotions felt when thinking about particular people. She took this piece a step further with Eunoia II by increasing the number of pools of water/speakers to 48, and upgrading to a more
comprehensive consumer EEG headset, called the Emotiv EPOC. This allowed for a greater number of identifiably distinct mental states (Lisa Park, "Eunoia, Eunoia II").

One of the major ways neurofeedback has been applied to music is in the realm of improvisation. Eduardo Miranda has taken steps in this field with his piece, “Activating Memory.” In this piece, 4 performers are connected via EEG to computers, which convert this information to algorithmically generated sheet music. This sheet music is passed in real time to the BCMI (Brain-Computer Music Interface) String Quartet, who perform the music as it appears in front of them. Miranda uses OSC to transmit clock data over local Wifi, allowing for synchronization between individuals in terms of serving music to the ensemble, and uses local UDP to transmit data from the headsets over bluetooth to the computers (Eduardo Miranda, "Activating Memory"). The MiND ensemble has also entered the realm of improvisational neurofeedback performance by connecting 4 performers to Emotiv EPOC EEG’s, and using a Max/MSP-designed synth to process an amalgamation of the incoming data ("The MiND Ensemble", p. About). This synth is available for download, which has the potential to lend additional information on how the data is being processed. The ensemble has taken a unique approach, pushing the envelope of music performance more into the realm of performance art, fully integrating neurofeedback into the performance.

A final approach to neurofeedback is in generative, collaborative neurofeedback, which is the area I’m most interested in exploring. While exploration into this realm is relatively thin, the iOS App Conductar takes neurofeedback to an interesting place. Premiered at Moogfest 2014 in Asheville, NC, Conductar takes information from MindWave Mobile EEG headsets connected to iOS hardware, as well as geolocation data, in order to create a virtual remodeling of Asheville in 3D, that can be navigated by navigating the real Asheville. However, in the virtual world, there is a graphical representation of brainwaves overlaid on the buildings, dependent on where people attending the event were located when experiencing certain brain-states. Users were effectively able to manipulate this representation in real time, using only their minds (Pangburn, "The Creators Project"). While difficult to directly apply this technology to onstage performance, it shows the possibilities for bringing together EEG from multiple sources to create collaborative content.

By looking through the chronology of EEG-based music, we can see a clear progression of technological advancement. As the technology has become more readily available, there has been an increasing amount of exploration into the field of neurofeedback, with increasing levels of complexity. Prior to the year 2000, people were fairly limited in their options for EEG units, usually having to build them themselves, and requiring a fairly in depth understanding of electronics and design. However, in the last 15 years, a variety of open source projects have become very popular on web forums that have enabled easy construction of EEG units, with comprehensive online guides. The most prominent of these projects is the OpenEEG project, which allows people to easily build a simple 2 node EEG from parts that can be conveniently purchased from their website ("The OpenEEG Project"). Additionally, a recent surge in the popularity of monitoring biological data with products such as Fitbit, has brought along with it
new, cheaper biofeedback technologies that are working out of the box. An example of one such technology is produced by the company NeuroSky, called the MindWave Mobile. This EEG headset is characterized by a simplistic design, utilizing only one electrode, to pick up Alpha, Beta, Gamma, Delta, and Theta activity, as well as blink data. Amongst its strengths are its inexpensive price, of only around 100$, as well as it’s easy setup and connection to a computer/iOS device (Neurosky EEG Headsets, "Mindwave Mobile"). This makes it an effective tool for quick experimentation and application of data, though maybe not the most accurate option for detecting the more complex brain activity, such as theta waves and eye movement, amongst other things. One will notice the use of this headset in a variety of modern application such as Lisa Parks “Eunoia I” as well as the iOS app Conductar. In order to get the higher resolution data, one needs to acquire a more comprehensive headset, such as the Emotiv Epoc, which uses 15 nodes of connection to pick up a much wider array of information, including eye movement, and emotional states beyond “Attention” and “Meditation.” This technology has been applied in Lisa Parks “Eunoia II,” the MiND Ensemble, amongst others. The major strengths in this technology are in it's fairly accessible price of around 500$, and drastically improved resolution by using saline nodes as opposed to the dry metal used in the MindWave Mobile. However, access to the raw data from this unit requires a secondary software to convert it to OSC, increasing overall load to the computer (Emotiv Website, "Epoc").

For the performance aspect of my own exploration, I tried to maintain the fluidity of live acoustic performance and use novel interfaces to reveal additional layers of connectivity between the performers. Initially, I wanted to show theta wave correlation between co-performing musicians, a phenomena documented in a recent neuroscience study. However, I quickly realized that it would be nearly impossible to capture this deep brain activity with any degree of clarity without a medical grade EEG. As a result I had to find alternative methods of illustrating the connection between the musicians. In order to accomplish this, I integrated live electronic instruments and sounds, acoustic instruments, and improvisation, alongside basic biometrics from a single source, which proved to be an effective reconciliation of the original concept with what is actually in the realm of possibility at this level of exploration. Also, by placing additional emphasis on improvisation, the interplay and communication between musicians becomes clear to the audience, as they work with and off of one another to maintain group organization and structure while being instantaneously creative. The potential for failure becomes especially evident in this context, so when electronic sound is integrated into the music, the improvisational process makes the experience of the electronic textures easier to connect with, and more effective to the audience.

The instrumentation of the performance was selected in order to maximize ease of movement between acoustic and electronic textures. Personnel included Becket Cerny on drum kit and electronic drum pad, Johnnie Gilmore on electric bass and Moog Sub-Phatty synth, Adam Rochelle on keyboard/digital synthesizer, and Justin Friedman on Guitar with digital effects. I played saxophone, EWI (Electronic Wind Instrument), and sang, though not at the
same time. On my voice, I was using a VoiceLive vocal processor, which allowed for live effects such as reverb, delay, hardtune, doubling, and harmonization, and thus a more dynamic vocal performance.

In order to create the fluidity in performance I was looking for, I needed to create an environment in which musicians were able to easily modify the electronic sounds they were producing, and allow them employ a variety of audio processing techniques normally only available during post-production. Ableton Live made this possible, as it is music creation software geared towards live performance. It was used on three separate computers throughout the performance and performed very different functions on each. One computer was responsible for all electronic sound creation, the second was set to record the whole ensemble, and the third handled monitor mixes and visual generation. (Routing map of MIDI and Audio, Appendix B, B.1).

The first computer using Ableton was set up as an environment that made performing with electronic instruments a more versatile experience. In order to make it simple and expedient for the drummer to move between different drum samples on the electronic pad, I set up a sample selection system within Live that allowed him to change samples, not just by drum kit, but also by individual drum using a MIDI controller that sat next to him. Additionally, this selector system was equipped with effect macro controls, so that Becket could make subtle changes to the same sample over the course of the song, giving a more organic texture to potentially repetitive sounds.

For Adam’s synthesizer and keyboard sounds, we created a system of macro controls that allowed for fluid blending between sounds, rather than switching quickly between them. We mapped these macros, in addition to controls for effects, and looping, to a MIDI controller easily accessible to Adam.
In addition, Live passed all incoming MIDI data from the keyboard to VoiceLive 2 vocal effect pedal, allowing for vocal harmonies that would move with the chord structure in real time. All MIDI data was sent to and from the computer via USB, and the audio from the electronic drums and keyboard respectively, was sent out of individual outputs for the sake of control over the mix, both live and post-production. A third output bypassed the output to the speakers and recorded mix entirely as it was for a metronome send to the headphone monitor mixes only.

For the monitor mixes, I set up an instance of ableton that took audio from a number of sources, including each instrument, alongside a metronome and talkback microphone. There was also a return track corresponding to each musician, set to a distinct output of the audio interface, into which the musicians plugged their headphones. A MIDI controller was given to each musician and mapped to their respective send on each incoming channel, allowing them to control the amount of each sound in their headphone mix, without impacting anyone else’s preferred settings.

Also on this computer was a plugin that I created using Max For Live, which is a tool that allows the extension of Ableton Live’s capabilities by integrating the Max/MSP software by Cycling 74.

This particular Max patch was designed to create a number of visual elements that bring to light relevant information about what is happening on stage at any given moment. For each performer there is a panel of display, featuring a visual representation of the waveform coming from their instrument in real time, alongside a 3D particle system. This particle system was modified by variable points of gravity corresponding to the relative volume of sounds in the headphone mix. In keeping with the spirit of improvisation, these displays can be controlled and played with by the performers via MIDI controller.
Another segment of the visual program was designed to interpret biological data, especially EEG data. In this panel, incoming data from a Neurosky MindWave Mobile EEG can be processed through a mathematical “Superformula” that mimics some of the geometric symmetries of biological organisms (Gielis, 2003). While the ratio of different types of brain waves was not made clear through this mathematical application, two major and largely mutually exclusive types prefrontal cortex activity, alpha and beta wave activity, were more clearly illustrated by modifying ARGB values of a solid color or video background. In addition, the scaled raw values of these major points of activity are displayed clearly on top of these graphical representations in real time.
The final panel of visual content was designed to show the degree of correlation between any two performers monitor mixes in a node graph. In order to avoid having to deal with the n-body problem, I modeled correlation as the average volume being requested of a particular instrument in all other performers monitor mixes. This average value acts as a vector on the graph, pushing nodes closer to the middle. However, the more of one's own instrument is requested in a headphone mix, the further their respective node is pushed from the origin. Essentially these value are added to create a resultant vector that tells Max where to plot the node in 3D space.

Though I tried to include as many of these visual extensions of the music and musicians as possible, some were lost in part due to difficulty with the technology. The panel of the visual display that was intended to fread EEG data, was functional on a Macbook Pro Laptop, when brought to a more graphically enabled Windows machine, it ran into issues day of. This was largely due to the fact that in order for Max to understand the incoming EEG signal, a secondary OSC interpretation program was needed. In this case, I was using an open source software called BrainWaveOSC for communication with the Mindwave Mobile EEG headset. Unfortunately, this software was not making connection between the headset and my Windows machine at the time of the show, so no data was making it to the visualization program.
Another issue I ran into was with the visual panel behind each performer. While the particle system was present, and was working as hoped, it was not nearly as dynamic as expected because the musicians only modified their monitor mix briefly at the start of the show. I ran into further issues with live display of waveforms due to high overall load to the GPU on the computer. This was likely due to the seven separate instances of OpenGL inside of Ableton Live, and exaggerated when fed to two distinct displays.

Following the performance, I came to the realization that the data behind these visual displays was largely unclear to the audience, which could have easily been rectified with a succinct verbal explanation. In future iterations of this project, I intend to take more time to explain the content behind each visualization to the audience. Additionally, when revising the visual component, I intend to make the visual content more concise and clear. Had all the software worked as it was intended to, a screenshot would have looked like the one below:

![Screenshot of visual panel behind performers](image.png)

Though the visual exposition of the internal world was limited during the performance by a number of factors, the musical component went largely without issue. Throughout the concert, we moved between electronic and acoustic sound, as well as ensemble and solo compositions. Each composition pertained in some way to the issues of digital representation discussed up to this point, striving to bring the audience closer to the performers, and allow a deeper connection to the music itself.

The first piece was an original song, titled Nicole Benjamin, partly in reference to Walter Benjamin. This song addresses the way romance has been affected by internet dating services, such as Tinder. The lyrics of this song illustrate the story of a woman, likely an escort/webcam model, and the illusion of romance she provides in exchange for money in the digital world. Sonically, the song brings the distance between real and feigned emotion to light by using
strong electronic components, such as lush saw wave sounds from a VST synthesizer, and positioning them within and against largely acoustic textures. To drive this point further, the song transitions quickly to almost exclusively electronic sound, building in intensity before bringing both the acoustic and electronic together for a climactic ending. (see Nicole Benjamin Chart, Appendix C, C.1)

Much later in the show, we performed another original composition titled A Love Letter To My Pancreas, which is in reference to my experience as a Type 1 Diabetic. The melody and chords to this song were written the night before an incident resulting in my hospitalization. Following this experience, I realized just how important it was to keep in control of my condition, and wrote lyrics reflecting this moment of clarity. The song begins with a strong 7-8 pulse, with a Moog synth bass and piano arpeggiating the harmonic structure of A section in unison. After a cycle the bass drops out, leaving space for the vocal to enter with the line, “I know, that you will always be with me, will be with me” which references the lack of a cure for Type 1 diabetes at the moment and for the foreseeable future. While the pulse is a clear 7, the rhythm of the melodies imply a 6-8 feel on top of the 7-8 groove. For the chorus, the end of the verse line is morphed into “What will, Will Be, will Be, what will be, we'll be.” This gradual shifting of the phrase is further shaped by the 7-8 pulse, as the odd number of beats places the downbeat on different words in the repeated phrase “What will be,” causing the ear to pick up on a few permutations in the sentence. As this is much less obvious when read as text, some of these are, “What will be will be,” “Be what will,” “We’ll be,” and “What will be?” Between the fast tempo, uneven meter, and disjointed melodic rhythm, this creates a sense of constant unease, as one might feel living with a chronic condition. After a section of improvisation, the 7-8 groove thins out, leaving only a descending melodic line on the saxophone, and increasingly sparse drums. Eventually only accenting the first beat of each measure. This leaves enough space between beats for a straight 4/4 groove to take over, simultaneously bringing back the whole group and the phrase “I know that you will always be with me,” which is repeated to fade. This progression in rhythm, structure, and lyrics hoped to bring to light some of what I experience every day as a diabetic, both in terms of physical sensations and cognitive processes. (see A Love Letter To My Pancreas, Appendix C, C.2)

In the spirit of breaking things into their parts for a deeper understanding, I made an effort to write solo compositions for each performer. The first of these was for the keyboard player, Adam Rochelle, and featured piano melodies both composed and improvised. This was accompanied by an ambient sample, but the piano loop was abruptly stopped, leaving only the ambience. However, the final chord was sustained at a low level below the sample, which was only revealed after the sample cut out.

The second solo piece was written for and with guitarist Justin Friedman. Rather than remaining strictly a solo composition, this piece progressively became a quartet, adding bass, drums, and on the last bridge, saxophone. Justin is a talented jazz guitarist, and has the ability to play beautiful melodies inside unique extended voicings. I hoped to showcase his influences and
strengths with this ballad, which he interpreted and expanded upon beautifully. (see Guitar Solo Piece, Appendix C, C. 4)

The final solo piece was co written by it’s intended performer, bassist Johnnie Gilmore. This piece had no accompaniment whatsoever, which allowed Johnnie to extend into parts of his playing he is unable to showcase in an ensemble setting. For example, the opening and concluding melody is created by struck harmonics in the upper register of the instrument. Furthermore, there was a substantial portion in the song structure devoted to improvisation, allowing him to push even further into his extended technique. (see Bass Solo Piece, Appendix C, C.5).

In addition to these original compositions, we performed covers of electronic music that I felt would be conducive for extension with improvisation. The first of these was a cover of Film, by Aphex Twin, who is notorious for his high paced drum and bass tracks. In general, his music has sequenced drums that are often heavily distorted and processed. In our cover, we didn’t use the electronic drums, instead employing a variety of methods to mimic the characteristics of the drums on the original song, including placing a cymbal on his floor tom, and striking the drums in unconventional ways. There was also extended improvisation by both Becket on drums, and by the rest of the ensemble over the harmonic structure of the song. In the original track, there is an effective contrast between the high paced and spastic drum rhythms and long, flowing melodies. This creates a dreamlike sensation, bringing intensity but not aggression. When rehearsing this song, we focused on preserving as much of this tone as possible. To do this with our instrumentation I used heavily reverbed piano sounds for melodies, supported by held guitar chords and pure, strong bass tones. During sections of more percussive melody, I had the keyboardist play short notes on the bottom of the piano range in unison with the bass, creating an interesting bass texture. In an ideal situation, a bass clarinet would play the unison line as well, but for the performance I played it on tenor sax, though only at the end of the song.

The second song we covered was Unluck by James Blake. While originally created electronically, this song is particularly conducive to adaptation for live performance, as Blake already performs with other musicians during his live show, providing a point of reference for the initial arrangement of the song. In the original song, the vocal moves between a number of audio effects, including vocal doubling, tuning, delay, and reverb. By using a digital vocal effects processor, I was able to use these same effects in the live setting. Additionally, the MIDI information from the keyboard allowed the vocal to jump in intensity during the choruses by adding in digitally generated harmonies. This song further showcased the ensembles ability to perform electronic music a fluid manner by incorporating electronic sound into the textures of every performer. For this song, much of the drum sound came from samples, the bass was played on a synthesizer, and the keyboard part was a dynamic layering of two distinct digital synthesizers. Even though this song was deeply rooted in digitally produced sound, the

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1 It should be noted that referenced Appendix does not include chords for the bridge of the bass solo piece
versatility of the setup enabled the musicians to extend the song far beyond its initial scope, in terms of both texture, and structure.

While not every aspect of this discussion of digital and analog experience was outwardly addressed during the performance, it was still possible to determine if this integration of electronic music, improvisation, and extended interaction with the digital world was effective in giving the audience a deeper understanding and appreciation for what was happening on stage. From the conversations I had with the audience, the essential message of this exploration was conveyed, and the integration of the seemingly disparate worlds of sound/data was both musically effective and intellectually compelling. This is not so much conclusive, as it is indicative of potential. If anything, the positive reaction to this performance has made clear the need to develop and refine of the concept going forward.
Bibliography:


Appendix A: Supplementary References

A.1.1 Mathematics Behind Correlation Window (2 pages)

Thinking About Graphs.

What I Need:

- Represent Max x as a node/vertex graph
- 5 nodes, 5 vertices

Distance from node to edge, not being repeated
by other node, against wall being repeated by

How to Get There:

1) Add all values of node "w" being repeated by nodes N_x
   · Thin divide by total nodes N_x
   · Now this is an average value of Node "w" distance

2) Add all vector lengths, row values, and divide by total vectors
   · Achieve average length. This is average value
     · Subtract any length from each v to get your

3) Add weight of each vector:
   · divide two value by sum of all values for vector length

4) Subtract vector lengths:
   · Subtract any length from each vector weight.

This is doable!!!

Next Step:

Determine angles of nodes A, B, C
- Extrapolate xg, yg, z coord. from angle +
  anywhole of vector.

(continued...)
360° = 120° between nodes in horizontal plane.

Distribution: (On-axis vs. Off-axis Nodes)

On-Axis:
- A: +Z direction (0, 0, +z)
- D: +Y direction (0, y, 0)
- E: -Y direction (0, -y, 0)

Off-Axis:
- B: 120° from A in +(-x, 0, -z)
- C: -120° from A in -(+x, 0, +z)

Calculations

- Origin, (0, 0, 0): 
  \[ \sqrt{(y_{1} - y_{1})^2 + (z_{2} - z_{2})^2} \]

- Node B:
  \[ \sin(\theta) = \frac{y_{1}}{r_{0}} \quad \cos(\theta) = \frac{z_{2}}{r_{0}} \]

For point B: 
- (cos(θ), sin(θ)) + m

For point C: 
- (cos(θ), sin(θ)) - m

**DONE!!!**
Appendix B: Performance Planning Documents

B.1: Signal Routing Map for Live Show

B.2 Stage Layout
B.3 Screen Layout Plan

B.4 MIDI Allocation By Instrument
B.5 General MIDI Map for Video Control

B.6 Full Equipment List
Appendix C: Song Charts

C.1 Nicole Benjamin

\[ \begin{align*}
\text{Form} \\
\text{Intro: } 2 \times A & \quad \text{Horn Line: } 2 \times A \\
\text{Verse 1: } 2 \times A & \quad \text{Ambient: (hint: B)} \\
\text{Chorus: } 2 \times B & \quad \text{Horn Line: B \quad \text{just sax, no bass}} \\
\text{Guitar Solo: [A]} & \quad \text{Horn Vocal: B} \\
\text{Verse 2: } 4 \times A & \quad \text{Horn Vocal + Drop: B} \\
& \quad \text{Drop + Sax: B} \\
\text{Chorus: } 2 \times B & \quad \text{Horn Vocal + Keys: B} \\
& \quad \text{Keys out: B etc.} \\
\text{Organ Solo: [A]} & \\
\text{Horn Line: } 2 \times A & \\
\text{Sax Solo: [A]} & 
\end{align*} \]
C.2 A Love Letter To My Pancreas

Form
Intro - Piano arp over A

Verse 1 - A
Chorus - A
Vamp - A
Bridge Melody - A
B Section - Bv2
Soprano Solo - [A7]
Keyboard Solo - [A7]
Bridge Melody - A
B Section - Bv2
Verse 2 - ?
Outro - TBD
C.3 The Vamp

\[ \begin{array}{cccc}
A^7 & B^7 & A^7 & C^7 \\
\end{array} \]

1.

\[ \begin{array}{cc}
D^9 & G^7 \\
\end{array} \]

2.

\[ \begin{array}{cccc}
C^7 & F^7 & B^7 & B^6 \backslash 7 \\
\end{array} \]
C.4 Guitar Solo

Guitar Solo (Rough)

A

\[ \text{C}^\#7,9 \quad | \quad \text{Eb0/6(E)} \quad | \quad F^\#6 \quad | \quad D^7 \]

Bridge

\[ \text{C}^\#9 \quad | \quad F^7 \quad | \quad D^6A7 \quad | \quad D^7^\#9 \]

\[ \text{G}^m \quad | \quad C^7 \quad | \quad D^7^\#13 \quad | \quad F^0 \]

D.C. al Fine

To Verse...

\[ \text{D}^7 \]

[|]
C.5 Bass Solo

*Ebato, in one*

**Bass Solo Chart**

**Intro:**

- Form: Intro, (A/A'), (A/A), B, (A/A'), Outro
- Harmony melody

**A/A':** (4/4)

1. \[ G^7 | C9 | A^5 | Fm9 \]

**A/E:** ...

2. \[ A^7 | D^7 | E^7 | Dm7 \]

3. \[ A^7 | D^7 | E^7 | Dm7 \]

**B:** (out of time, arpeggiated, move into improvisation)

\[ D(A) | D^b(A) | / / \]

**D.C.**

Dm11...

*There: Outro goes as intro*