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Automated and Human Rhythm in "Alice in Wonderland (1915)" and "sportage"

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by

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Introduction

A great problem has arisen in Western Concert music in the past two decades. Since the late 1980s into the 1990s, music composed and performed using a computer has been able to be produced. Throughout the history of western concert music, it has been played solely by humans, who have the ability to stay in time with one another through the means of a conductor, body language, and a fluidity of rhythm. Although it is not always addressed, the ability to communicate rhythmic feel without needing to talk about it is what has made music work in time throughout its history. What is on the page and what is played has always been different with every performance, and people are revered not for how accurately they play the piece, but how interesting their interpretation of it is.

But, after the dawn of the Digital Age, composers and performers, including myself, have become more interested in the integration of computers into traditional ensembles. What makes the computer so drastically different from human performers is that they do not have this ability to communicate nuances in rhythm during a performance. Unless programmed specifically to do something outside of their standard way of playing music, a computer will reproduce the exact thing that it is told to do before the piece starts. There is no variance from how all of the sounds are mathematically placed out in time way before the start of the performance. This, obviously does not mesh well with the way a person plays an instrument. Humans are used to flowing on and off of the beat at their own leisure while still being able to stay in a general time with the rest of the ensemble. Once a computer's beat is offset, it remains that way for the rest of the performance and only another offset of the exact opposite of the first can bring it back to the initial beat.

Despite this, there is no question that the desire to integrate a computer into an human ensemble is still present. So then, *how does one perform a piece of music with an ensemble comprised of both humans and computers without getting off beat of one another*? This project is concerned with this phenomenon, and I, as a composer, test two possible solutions to this problem with my two pieces “Alice in Wonderland (1915)” and “sportage.”

“Alice in Wonderland (1915),” is a 45 minute film score to W.W. Young’s film adaptation of Lewis Carroll’s classic children’s story *Alice in Wonderland*. The ensemble is comprised of a full string section (2 violins, viola, cello, and double bass), flute, tenor saxophone, electric guitar, piano, an electric keyboard (that cycles between 3 different sounds: electric organ, electric piano and piano), one laptop (using Ableton Live synthesizers, percussion and vocal samples, performed live by the keyboardist) and another laptop, running an automated version of the film which had automatically triggered sound files at specific points in the piece, and a click track, which is only heard by the human performers, through headphones. The proposed solution to keeping humans in time with a computer, and vice versa, is that *the computer dictates exactly where the beat is at all times*, so the human players have no space to fluctuate outside of the beat. Because of this, this piece of music is more likely to be played as accurate to what is on the page as possible. There is no variance away from where the beat is, and the only room that performers have for distinct interpretation would be if they got off of the click track at any point. This, by a simple definition, would result in an error of performance. Since the objective of the piece is for the ensemble to be succinctly in time with one another, any deviation would offset the ensemble’s shared time, and they would have to stop the performance momentarily until they find their place. In case this were to happen, the entire ensemble is led by a conductor, whose main purpose was to communicate visually to the human performers where in the score the computer was at any given point.

The other composition, “sportage,” a 11-12 minute orchestral piece; scored for full strings, 5 winds, 3 brass, 2 percussionists and computer, is based around a car accident I had in December 2014, where I totaled my car, a Kia Sportage. The piece poses another possibility for the computer’s integration into a traditional ensemble. The orchestra, which has been the powerhouse of western concert music for the past 250 years, has almost always been directed by a conductor, who is the sole dictator of the beat, and any deviance from his or her beat means that the performer is at fault. So, how can a rhythmically precise performer such as a computer be dictated by such a fluid interpreter of time as a human conductor? In “sportage,” the computer has a series of sonic events that are triggered through a Max Patch[1] to play whenever a human operator commands it to. These triggers come up at specific moments in the score, but are placed close enough that if the rest of the ensemble slows down or speeds up more than is initially intended, there will be virtually no break or overlap in the sound events.

Out of these two propositions, which is the more suitable for an ensemble of computers and humans? Is it easier for the computer to dictate the rhythm of a piece of music through automation, or is it easier to tell the computer when and how to play through specifically triggered events? I think that they are both valid, but the outcome supremely relies on the actual performances of the two pieces. Through this experiment, I will find out which setup is more successful, based on what is presented in this paper.

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[1] Max is a computer music program, which allows virtually anything to be built and make sound or images. I built the player for “sportage” in Max so I could control exact trigger points, and set up delays as well as have a simple and easy-to-use interface like iTunes, or any other media player. More info about Max can be found at <https://cycling74.com/products/max/#.VyjiCyMrJD0>

Time, Rhythm, Recording, and the Internet

i. <u>Time / Rhythm</u>

Time is an organizational tool on a grand scale, with which we, as humans, can easily coordinate events around each other.[2] Physically, we sense time as the Earth's rotation on its axis, and its revolution around the sun. Day to night, year to year, we have something that we can measure the passage of time naturally with the sun. Built off of these concepts, the clock was developed, and once the mechanical clock's use began to rise in the 1300s (and especially the electronic clock of the 1800s), we could measure time more accurately - hour to hour and minute to minute. Hours and minutes used to be subdivisions of the daily cycle of the Earth's rotation. Musicians move through the subdivisions of the beat, without necessarily needing to know exactly where each one precisely falls, much like people who lived in the world before the mechanical clock. The computer, a musician, moves through the piece like people in the world after the widespread use of the mechanical clock. The computer has the ability to know exactly where every minute and every second falls while still being able to complete all of its other functions (lighting the screen, connecting to the Internet, etc.), without taking focus away from playing the piece of music. "As a piece of technology, the clock is a machine that produces uniform seconds, minutes, and hours on an assembly-line pattern. Processed in this uniform way, *time is separated from the rhythms of human experience*."[3] Think of an iTunes player - the

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[2] Peter Galison's *Einstein's Clocks, Poincare's Maps: Empires of Time* explains this more vividly: "Tides, planets, moons - everything in the Universe that moved or changed - did so, Newton believed, against the universal background of a single, constantly flowing time." This, of course, became a much different phenomenon after electrical clocks, "In Einstein's electrotechnical world, there was no place for such a 'universally audible tick-tock' that we can call time, no way to define time meaningfully except in reference to a definite system of linked clocks." Galison, pp. 13. Time, then is essentially the connection of clocks across the globe, in relation to the turn of the Earth.

[3] Marshall McLuhan, *Understanding Media*, "Clocks," MIT Press 1994. p. 146. Italics added by the author.

recording is a piece of music the computer is performing, and it can reproduce it exactly as it was set to, and gives a count up and countdown in minutes and seconds without affecting the performance of the music. If a human performer was playing a piece of acoustic music, there is no way for them to check their tempo context without an external time reference. They require a conductor, or a clock to keep the time for them, only looking up at different points in the piece to check their status in time.

How musicians who moved through time in the Renaissance, for example, was completely based on the physical. "Neither sandglasses, nor sundials, nor sextants could define or document the motion of music, which was most often referenced through the human pulse or tactus: the recurring rhythm of an individual's heartbeat, moving hand, or foot. Before the metronome, the time of music was definitively self-referential."[4] The metronome is an external timekeeper for musicians; it keeps a clear definition of what the tempo is and where the beats fall while the performer is trained to play along with. Since its invention in 1816 by Johann Maelzel, musicians have used this time keeping device as a tool to keep themselves more precisely in time, according to time measurements of the clock after its widespread use. When metronomes were first made, there were only a few tempo settings, which were roughly based around what different tempo texts were meant be at. A digital metronome, which is built into every computer, has the ability to be as precise as possible, allowing for tempo markings up to three decimal points. Several other programs, however, allow for as many decimal places as needed, and have no problem creating these clicks exactly in time with what it is asked to play.[5]

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[4] Alexander Bonus, *The Metronomic Performance Practice: A History of Rhythm, Metronomes and the Mechanization of Musicality*. Case Western Reserve PhD Dissertation. May, 2010. pp. 5

[5] This comes out of really my own experience, where in the click track I created for "Alice in Wonderland (1915)," the software I was using (Logic Pro 9) allowed me to automate tempo switches up to one thousandth of a beat per

ii. Recording

In "Alice in Wonderland (1915)" and "sportage," the computer, unlike the acoustic instruments, performs a sound file that was created during the composition of the works, and are only scored on the page by trigger points, and content markings. What makes this work on differently than acoustic music is that one computer can perform multiple pieces at the same time. Much like the difference between a single-voiced instrument (say, oboe) and a multi-voiced instrument (piano), the computer is able to play, in theory, an infinite number of sounds at the same time.[6] These sound files can be triggered live by an operator, like some parts of "Alice in Wonderland (1915)," and all of "sportage," or be automated within the framework of the piece, which is mostly how "Alice in Wonderland (1915)" works. Several years ago, just when audio recording was beginning to be experimented with, people had realized the potential for its extended use. "[S]ynchronization is no longer sequential. By electric tapes, synchronization of any number of different acts can be simultaneous."[7] After the dawn of recording technology in the first half of the 20th Century, sound was able to be directly manipulated, instead of having to go through a human performer with given instruction to change the sonic environment with music.

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minute. When I was writing, I thought I had to take a few measures out of a section, so in order to preserve the length of time the section took, I had to slow down the metronome by a specific amount, and this came out to something with 3 decimal places. The only spot with decimal points in the metronome marking in the final version is the last section, where the quarter note = 83.3 bpm. For instance, in Max, and in its open source counterpart Pure Data, the computer doesn't care how many decimal points are on a numeric instruction, it will perform the task exactly no matter what circumstance.

[6] This only depends on the processing power of the computer that is being used.

[7] McLuhan, *Understanding Media*, "Clocks," pp. 152.

iii. Internet

Vastly different from the age of analog audio, the Digital Age has a larger selection of sounds readily available to be manipulated. It used to be that for DJs, say, the piece of music desired had to be sought out at a record store, the record had to be purchased, and the physical record had to be present at the turntable once it's time to be performed came about. Now, a DJ is able to get on-the-fly requests, pull them off of YouTube with a third party conversion website,[8] then play the song directly, the whole process only taking a matter of seconds (depending on the strength of the WiFi). The Internet is one vast library of media; one that is completely unprecedented, and perhaps not fully utilized by the common user. Learning and listening is now open to the public in an almost infinite amount, with YouTube alone being host to thousands of hours of video in a vast array of genres, from music to cooking to vlogs and beyond. All of this material is available to the computer musician to sample and manipulate. A more open way of obtaining sonic information is the website archive.org, which is host to the largest media database on the Internet. Here, anything that is either under Public Domain or user uploaded is available for public use. Just as an example, I found the film for *Alice in Wonderland* by browsing this website's incredibly large archive of silent films. I had not heard of this film outside of this website, and the sole reason this project was able to come together was because I am a composer in Digital Age, where media is open for all to use in an ongoing collaborative process of creating New Media. The feedback loop of information and media that this poses gives the Artists of the future an even larger catalog to work from.

[8] These sites are usually pretty easy to come by, but they are mostly seedy and can lead to some digital damages (legally or physically).

This idea of open collaboration and use and reuse of media on the Internet hints at a strong connection to memes. First coined by Richard Dawkin's 1976 book *The Selfish Gene*, a meme is an item of cultural information that is transmitted, and more importantly *replicated* through different permutations over the course of history.[9] Dawkins explains that, "[e]xamples of memes are tunes, ideas, catch-phrases, clothes fashions, ways of making pools or building arches. Just as genes propagate themselves in the gene pool by leaping from body to body via sperm or eggs, so memes propagate themselves in the meme pool by leaping from brain to brain via a process which, in a broad sense, can be called imitation."[10] With digital recording, paired with the Internet Archive, audio is able to be imitated exactly with the performance of a computer at any given moment. This performance influences a human being, a composer perhaps, and then the composer makes his or her own work of music either directly using this sound file, or heavily influenced by it, and uploads it to the Internet, for use by any number of others to use freely.

> The online version of a meme … is any good idea, new phrase, or catchy tune that becomes a societal riff and propagates itself by jumping from computer to computer as if alive … Fortunately or unfortunately … MP3 files are replicating freely and on a grand scale worldwide.
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> William Duckworth, *Virtual Music* pp. 134[11]

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[9] Richard Dawkins, *The Selfish Gene*, "Memes: The New Replicators," pp. 169-172. Accessed through an Online PDF April 9th, 2016, available at <https://ia802707.us.archive.org/4/items/TheSelfishGene/RichardDawkins-TheSelfishGene.pdf>

[10] Dawkins, pp. 172.

[11] William Duckworth, *Virtual Music: How the Web Got Wired for Sound*, "Art and Ethics Online," pp. 134. Taylor & Francis Group, 2005, Print.

So using the conceptual framework of memetics, composers are able to reproduce, replicate, and be influenced by the constant stream of audio that they are immersed in daily on the Internet. This applies drastically to both of my pieces, in which a lot of the sound files used for sampling or playback are grabbed and re-curated from the Internet, into a piece of music, which will itself be recorded, and uploaded to the Internet, available for all to listen to, or reuse in a new context.

Keeping time, rhythm, and recording in mind, the compositions begin to be more transparent. On the surface of the music, not all of this is apparent; once one really looks into the minute details of the works, one can really see how these ideas presented in the music come into practice. It is the Internet Age, and these two works, "Alice in Wonderland (1915)" and "sportage," are exemplary of how concert music can work in the 21st Century.

Experiment I: Alice in Wonderland (1915)

What sets Alice[12] apart from other music I have written (especially my electronic music) is its necessity to be performed live. This piece, unlike other pieces of music in general, is written specifically to be played live. A recording of this piece was made for archival purposes,[13] but it does not work on the same level as it does within a physical place. During the composition of the work, I kept two windows open on my computer - one was the notation software, Sibelius, and the other was the video file for the film, with a timecode at the bottom of the screen for me to specifically time musical events. Sibelius, which uses MIDI playback, works metronomically. This occurred to me pretty early on in its composition; the fact that humans will not be able to perform this music as I have laid it out on the page, specifically in time with the events on the

[12] For this section of the paper, I will refer to "Alice in Wonderland (1915)" simply as "Alice."

[13] This recording can be accessed at <https://www.youtube.com/watch?v=sOskS7M8__E&feature=youtu.be>

screen that I thought certain sounds would coincide with. So, an easy way to get around this would be for the performers to be given a click track to keep them metronomically in sync. However, even with the help of a metronome, the common performer is very likely to get off of the click at certain points because of his or her personal conception of how the beats flow in a piece of music, which is almost never mechanical. This, of course depends on the situation, though. What if the performer has been trained to play along closely to a metronome? What if the music has a straight rhythmic feel, which rarely changes tempo or time signatures? The only way I would be able to stretch this would be to write a piece of music that constantly changes tempo and time signatures, to keep the performer constantly on top of what is happening in the click track, and further make it harder for them to stay in time with it.

i. The Automation Setup

For the performance, it was necessary to surround the performers in a bed of electronics. The conductor, whose laptop was running the video file of the film, stood at the front of the ensemble. Next to him was a laptop, which was outputting its screen running the film through a VGA cable to the projector behind the ensemble, and was running its audio out through a stereo interface. How the video was set up made all of the automated sounds panned in the mix 100% to the right, so the right channel of the interface would act as an independent output into a mixer, out to a speaker, which was placed behind the keyboardist, at the center of the ensemble. The left channel, which again was panned 100% left, to act as its own independent output was being sent to the mixer, then to a headphone amp, splitting the signal eleven ways, to be distributed to the headphones of every human performer in the ensemble (including the conductor). This channel was playing the click that was built at the end of the composition process, following every single beat of the piece exactly as it was written in Sibelius.

The video file was made playable in a video editing software,[14] where I lined up the click track and the automated soundfiles with the MIDI performance of the entire piece. The MIDI information was exported from the Sibelius file to be performed exactly in time with the digital metronome - this is perhaps the only perfect performance the piece will ever see, since the computer is able to play the MIDI information for every voice exactly in time and in the pitch range of the MIDI keyboard. However, if this piece were played by the computer alone, it would be hard to view as a performance, since it would feel just like watching a movie in a theater.

The physical setup, which I devised a few weeks before the performance, I think was the most effective way to allow the conductor's laptop to perform its part. The signal path of the computers to speakers and headphones was very clean and direct, which left for little room for technical error along the way. In order for the signal of the click to be strong enough to be split eleven ways, the output of the mixer was sent to a headphone amp, boosting the volume of the signal, allowing it to be output two ways, with independent headphone boxes to be placed throughout the seating of the ensemble in spots where each performer was able to plug their own pair of headphones in.

[14] For this, I used Final Cut Pro X, but any other video editing software would have worked as well.

ii. The "caterpillar" Problem

The outcome of this experiment is perhaps most obvious in the section subtitled "caterpillar."[15] For this section, the transition from the last section comes through the piano, which plays several phrases in different time signatures at a slow tempo (*see figure 1*), This phrase moves around for a few seconds until it falls into a groove in 7+6/16 - an odd time signature. Slowly, as the piano repeats a two bar motif, the rest of the ensemble comes in, until at measure 421 (*see figure 2*), the time signature changes to a different division of the same meter (4+9/16)[16] and the rhythmic tension that is built up for the last 24 measures is released with a simple statement of the main theme (Alice's theme) in 8/8.[17] What wasn't fully realized in the performance was that as the click went by, the pianist lost his spot, because the pianist lost his spot, the keyboard player lost his spot, the cellist lost her spot, etc. A chain reaction of human error based on the necessity of a player to listen to the ensemble over the click track made everyone get off of one another. The result was perhaps unnoticeable to most of the audience, none of whom have heard any of the piece before this concert, but the conductor was well aware of the mistake, and was able to set the ensemble back in time with the click at measure 423, one measure after the entrance of the main theme.

The interesting thing that this shows is that in order to correct a temporal error made by a human performer while playing electroacoustic music, another human is needed to act as a moderator between the timekeeping computer and the ensemble. In Alice, the conductor acted as

[15] In the score, this is rehearsal mark J (measure 397), and in the recording found on YouTube, it starts at approximately 16:35.

[16] $(7 + 6) = 13 = (4 + 9)$

[17] Although the notated time signature is 8/8, the click track played one beat per quarter note, which makes it 4/4.

a translator of computer/clock time to musical time. The click by itself proved to not be enough to keep the entire ensemble in sync with one another.

In a perfect performance situation (that is, with a 100% success rate)[18] the players would have a full understanding of the click track and how it works measure to measure. There is a necessity in this music to constantly be looking on both the micro and macro levels simultaneously. In the grand scheme, the music is to take up exactly 44 minutes and 49 seconds, as is notated in the score.[19] One must be aware then, of how long each note at each tempo should take. As stated, this is impossible for a human to do without the aid of an external timekeeper. However, it is almost just as difficult for a performer to maintain attentiveness toward the click, and to the action that they are completing as the click is happening.

iii. <u>"searching" for the Beat</u>

During an earlier section of the piece, titled "searching," an important transition moment was lost. The transition into this section from the previous ("animal convention") has the majority of the ensemble fade out as the saxophone and laptop have a duet while the low strings drone chords under them. Although the whole section is in an even 8/8, the phrases are mostly grouped in odd threes and fives, making the downbeat hard to find for the saxophonist. The laptop, which mimics a percussionist here, keeps an even beat for the saxophonist to play to (*see figure 3*). However, without the knowledge of the full score, and where his part lands with the

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[18] A "success" in this context is every performer playing every note in tune, in the rhythm on the page exactly in time with the metronome. I realize that this is an impossible feat for human performers, but the purpose of this experiment was to see how close to this metronomic precision humans can get to.

[19] At the top of each system in the score, there is a timecode for where the first beat falls, down to the hundredth of a second.

percussion, the saxophonist got lost in his phrasings, and offset the piece by a measure or two. Therefore, like in "caterpillar," this started a train reaction to where the pianist started his solo late, and was unable to find his spot in time, since his solo goes through a new time signature every measure (*see figure 4*). Ironically, the pianist lost himself in the beginning of "searching," which led the rest of the ensemble to "search," for where the beat is in time with the click. Luckily, in a situation similar to that in "caterpillar," once the rhythmic tension was released and the phrases went into a clean 4/4, the ensemble was able to find themselves in the right place, with the help of the conductor.

iv. <u>The Piece as an Experiment</u>

If Alice is solely meant to be a live piece of music, and given the example of its first performance, it did not fulfill the hypothesis. Even though I came into it knowing that it would be impossible for the human performers to play perfectly in sync with the computer timekeepers, I thought it would have yielded more positive results. Overall, the piece was not performed correctly, although only approximately 25% of it was played differently than anticipated, I hoped that the percentage would have been higher.

Moving past this, what was most interesting about what the performance proved rhythmically was that the sections that were in more complex time signatures were more likely to be played differently, and the more straight-forward ones, like those in 4/4 or 3/4, were more likely to be played closer to what was on the page. What this proves is that the time signatures that are more common in everyday music, that is what we hear on the radio or over loudspeakers at public places, is easier to comprehend on a mechanical level, since a lot of the production of those songs is electronic, and therefore works in the same musical time as a computer. We have internalized this as a culture, and the metronomic practice of pop music has so heavily influenced us, that we are more able to stay along to an automated click track in common time because we are so used to hearing all of this music made by computer musicians in common time constantly surrounding us.

In the program notes for the concert, I posed the question to the audience, "can a rather large group of human beings be conducted and disciplined within musical time by an automated program? Is it possible for a group of performers who all have their own internalized concept of rhythm to be in sync with something so strictly measured as a digital metronome?"[20] To answer these two basic questions about the piece, along with the evidence provided earlier, I think that yes, a group of humans can be conducted by an automated program- there is just a necessary protocol to follow in performing the piece:

(1) There must be one member of the ensemble whose sole duty is to maintain a close watch on the score, and be able to recognize when, where, and how any one of the human members of the ensemble is getting off of the computer's time keeping and be able to visually communicate how to get back on the click in the shortest amount of time possible. This, of course would be a conductor.

(2) All members of the ensemble should have a tight grasp on the full score of the piece. They must know where each one of their allotted phrases falls within the larger picture. The ability to look on both the macro and micro level is completely necessary in order for

[20] From the program notes from the premiere of "Alice in Wonderland (1915)" on November 13th, 2015 at Bard College. A PDF of these are available upon request.

the piece to be as close to a 100% success as possible. This all can be aided with a computerized version of the performance, through general MIDI, which is easily available through any notation software the composer is working in.[21]

(3) The members of the ensemble must practice their parts on their own with a click track. Since pieces with precise metronomic time are harder to play because of their need to be exact, the musician must be fully aware of how much more rigorous the rehearsal period of a piece of this nature calls for.

If every member of the ensemble follows this protocol, I think that the piece would ultimately be more of a success than the first performance of Alice was. This of course is a lot to ask of a performer, especially student performers who aren't getting compensated in any way (like those in my ensemble), but I think if the members of the ensemble are passionate enough about pushing the boundaries of concert music, and open to experimenting new possibilities for electroacoustic performance, playing a piece of music in a metronomically precise idiom would be extremely rewarding.

Experiment II: "sportage"

"sportage" first and foremost is a piece of music for orchestra. Taking influence from some composers in the generation directly before mine, namely Mason Bates,[22] the goal of

[21] This does mean that the composer of the work **cannot** write the music with a pencil and paper. A piece of music involving a computer should be composed at the computer, not at the piano.

[22] Bates is a particularly interesting composer, mostly because of his background in both Electronic Pop music, as a DJ, and a serious composition background, with degrees from Juilliard and USC Berkeley.

"sportage," from a bigger perspective, is meant to de-emphasize the use of a computer musician in the orchestra. It calls for pieces in the electroacoustic orchestral repertoire[23] to take the spectacle away from the fact that electronics are new and rare for the orchestra, and to make them more integral to the function of the orchestra as a whole. This means that instead of the piece being for orchestra and computer, the piece is really just for orchestra, with a section of the ensemble being the computer. Here, the computer acts similarly to any other section of the orchestra (strings, winds, brass, et cetera).

Of course, the trouble with this integration is the progression of time throughout the piece of music. The computer, as has been established, moves through time mathematically, and the human musician does not. The orchestra, which is generally the largest an ensemble gets in Western Concert Music, has their time, among other things,[24] dictated by a conductor. So then, how can the human conductor remotely control a computer's timekeeping?

i. How the Computer's Part Works

The proposition in "sportage" is for the computer's predetermined and automated part be split into a number of smaller sections, and triggered to be "played" at various points on the score. Since the computer's performance is solely of pre-recorded and manipulated sonic material, its time is predetermined and therefore completely inflexible. This sonic material, in the form of sound files, was sourced from a number of places both in the physical world, and from the Internet. Included in the material is:

[23] Most, if not all of which has been cataloged extensively by Frank J. Oteri at <http://www.americancomposers.org/orchestratech/oteri_list.htm>

[24] Phrasings, articulations, dynamics, and general tone are some examples of what the conductor is usually in charge of.

(1) A field recording of a Kia Sportage running, and the sound of its horn.

(2) An interview with my two friends, Charlie Muscarella and Troy Gerrity, who were both passengers in my car at the time of the accident.

(3) A phone interview with my sister, Caitlin Sylvester, who gave me the car after she moved to South Carolina in 2014, on the topic of the car and her history with it.

(4) A phone interview with my dad, Patrick Sylvester, who was the legal owner of the car, and who came up the day of the accident to help me better understand what happened.

(5) Audio from several YouTube videos of used car dealerships selling 2008 Kia Sportages.

(6) Audio from a few YouTube videos of dashboard camera footage of accidents involving Kia Sportages

(7) Audio from a YouTube video of a Kia Sportage's crash testing.

With all of this material readily available to me, I assembled the sound files into a narrative arc which follows that of the acoustic aspect. The assembly was done according to the MIDI realization of the acoustic part, which I had to cut for the introduction of the piece, as it holds for approximately 13 seconds in order to give the computer's part a formalized introduction (*see figure 5*). After this, I exported each speaker's track as independent sound files and realigned them to a recording of "sportage" I did April 3rd, 2016 with a live orchestra, and tried to see where the best points to trigger the sounds were. Wanting to keep the trigger points around rehearsal marks, as is notated in the score (*see figure 6*), I found several points that would allow for the time difference between the computer and the rest of the orchestra to be virtually undetectable, and cut those timed sections into separate .wav files. Some of the sounds, however, play over rehearsal marks, and in order to maintain that effect without splicing a sound in the middle of its iteration I combined a few sections and set up timed delays of others, so if only one speaker goes over the rehearsal mark, the three other speakers could be cut at the rehearsal mark and the next section be triggered with the one speaker delaying its start by the exact amount of time it goes over.

In order for the performance of the piece to work, the computer's part could not be automated fully, which is how the piece was intended to work. There needs to be a human operating the computer, just as another musician would operate an instrument. And, just like other musicians in the orchestra, the conductor needs to cue the computer operator at those points which are designated in the score, which function the same way as entrances do for other members of the ensemble.

A problem with these trigger points is that if the acoustic aspect of the orchestra plays the piece slower or faster, the computer's operator, as well as the conductor, is almost completely unaware of where they could be in the piece. Because of this, there is a need for some sort of content marking on the score, which shows what is supposed to be happening in the computer part at certain points in relation to the rest of the orchestra. Throughout the part are placed certain phrases or descriptions of phrases that are audible at a given point in the piece (*see figure 7*). These are written at the top of the staff over measures where they are supposed to fall within. Rather than notating the rhythm of where exactly these items of speech are to be recited by the computer, just having the text in an approximate zone of time lets the the conductor and the operator know if the electronic part is off from that of the acoustic. This still leaves an amount of interpretation on both the operator and the conductor's end, because they are given a longer space of time in which to fit certain aspects of the computer's part.

With all of the performative aspects cleared up, the only problem left is placement of the operator. An acoustic musician is sitting directly where the sounds they are producing are coming from. Most acoustic instruments produce their sound directly out of their instrument, allowing their players to easily hear their dynamic level in relation to the rest of the orchestra. The computer musician, however, is more often removed from the output of the sound they are producing. Unless the only speaker their sounds are coming out of is exactly where they are placed, they cannot know how they sound in relation to the rest of the ensemble. Because the speakers the computer's part is being played through is surrounding the orchestra at four points (*see figure 8*), the operator has to be sitting in a position where they can hear the whole mix of the acoustic orchestra and the sounds that the computer is producing, and have independent volume control of all four speakers. A position for the operator would then be in the audience, off of the stage and facing the rest of the orchestra. The problem that this poses, then, is that conductor does not have a constant and direct line of sight at the operator, and would have to turn away from the rest of the orchestra in order to cue the operator. This is a very minor problem, and is definitely preferred to either the operator sitting with the rest of the orchestra, where they would not be able to properly hear themselves, or the conductor not cueing the operator, who would have to trigger the sound events following along with their own rhythm, rather than the conductor's. This could also be avoided by making the conductor operate the computer, or having a dedicated sound engineer remotely mix the piece while the operator sits in with the orchestra.

ii. Fluidity of Rhythm

Given that the conductor, rather than the computer, is the timekeeper in "sportage," some more traditional rhythmic nuances are encouraged in the performance. As has been stated, since a large portion of western concert music was written before the invention of the metronome, the traditional performance of music in this idiom has always been fluid. This means that rather than the spaces between beats being equally measured out at a specific speed, a performer dictates the speed of the piece, the conductor in this case, and each individual musician is playing at basically the same speed (although not always exactly) and they have the ability to take some amount of interpretation of where the subdivisions of the beat may fall.

The performers are encouraged in this piece to act almost as if the computer's part wasn't present. If the acoustic musicians were to get caught up in the mechanized rhythm of the computer, it would greatly influence their own playing, and due to training with a metronome, which is common practice for most musicians, they would subconsciously fall into a stricter tempo, making the piece less fluid, and more metronomic. If the piece were to be played metronomically, there would no real need to have the computer's part split up the way it is, and the players would listen to a click track, much like in "Alice," and keep in exact time with the computer.

As a timekeeper, the conductor must be aware of the entire ensemble's rhythmic performance at all times. They have to be able to tell the difference between their personal time, and the time of the piece being played at each moment. This is a difficult task when the ensemble is comprised of only human beings, and once a computer becomes involved, it only becomes more difficult. The conductor uses visual gestures to communicate to the entire ensemble what is to happen at each moment of the piece. Unless the computer is rigged up with a webcam that can recognize specific gestures and be able to react to them with no time delay, it is incapable understanding these visual cues. So, even though the computer is the actual performer of the music, there is a need for a human being to translate the conductor's gestures to the computer via triggered events or a MIDI interface. As the conductor is giving these visual cues, the operator triggers the computer's part in their own personal rhythm, giving the computer a less metronomic feel, allowing for events to be slightly off of what they are supposed to be, according to the score. Without this, the computer's part would not fit solidly into the rest of the piece.

Findings: Onto a 21st Century Music

In the performance of these two drastically different pieces of music, what has been found? In order for a piece of electroacoustic music to be performed properly, there first must be a more exact layout of how the piece works before it is given to any performers. This weight solely rests on the composer of the works, and they need to make sure that the integration of the electronic aspect into the acoustic one is seamless and able to be realized without any major difficulty on the acoustic and electronic performers. Since a computer has to be told specifically what to do throughout the piece, all of the programming has to be done ahead of time, either by the composer themselves, a programmer, or other computer operator. A computer works through a time that is in exact measurements, based off those of a metronome or clock. Therefore, either the human beings in the ensemble have to be willing to work in a metronomic time arc, or the computer's programming has to be altered and arranged in a way that allows for the fluidity of human rhythm to be translated accurately.

The important aspect of performing in an electroacoustic ensemble is that *there needs to be a person whose sole job in the ensemble is to translate human time to computer time or vice versa*. In "Alice" it is the conductor, and in "sportage" it is the operator. Without this key person in the ensemble, there is no way for an electroacoustic ensemble involving a computer to function in a live performance setting.

Having these two experiments as possibilities for live performance including both humans and computers, we, as a generation of musicians working in the Digital Age, can start to figure out what is the most effective way of making a computer a fully functioning musician in an ensemble primarily comprised of human beings. After what has been found in the performances of "Alice in Wonderland (1915)" and "sportage" it can rightly be said that these are two working examples of how to go about solving this problem. However, since both of them worked effectively, it can also be said that *these are not the only two ways to perform electroacoustic music*. The possibilities are endless, and they all depend on how the piece of music functions on a rhythmic level. It means that the composer of an electroacoustic piece of music must be willing and able to fully think out which possibility works best with their vision of the music. Music of this caliber comes from the mind of composers, no matter what that mind is influenced by; composers are ultimately the final decision maker, and the master of their own work. The computer is a musician in an ensemble that has to be written for specifically. Like any acoustic instrument, the computer's part must be in the realm of possibility for the instrument, and more importantly, it needs to be easily recognizable by the performer and the conductor given what is on the score. Notation is the backbone of all of western concert music, and it is what really sets western concert music apart from other musics. The computer is able to process written music just as well as any other classical musician, and as long as the idea is clear on the page, it will be clear to the listener.

<u>Appendix</u>

Figures:

Figure 1: Piano Solo at the beginning of “caterpillar” from Alice in Wonderland (1915), measures 397-404. First two measures are in 4/4.

Figure 2: Full ensemble playing in 7+6/16 in Alice in Wonderland (1915), measures 417-421.

Figure 3: Transition moment from "animal convention" to "searching" in Alice in Wonderland (1915), measures 296-301.

Figure 4: Piano Solo with changing time signatures in "searching" from Alice in Wonderland (1915), measures 322-337.

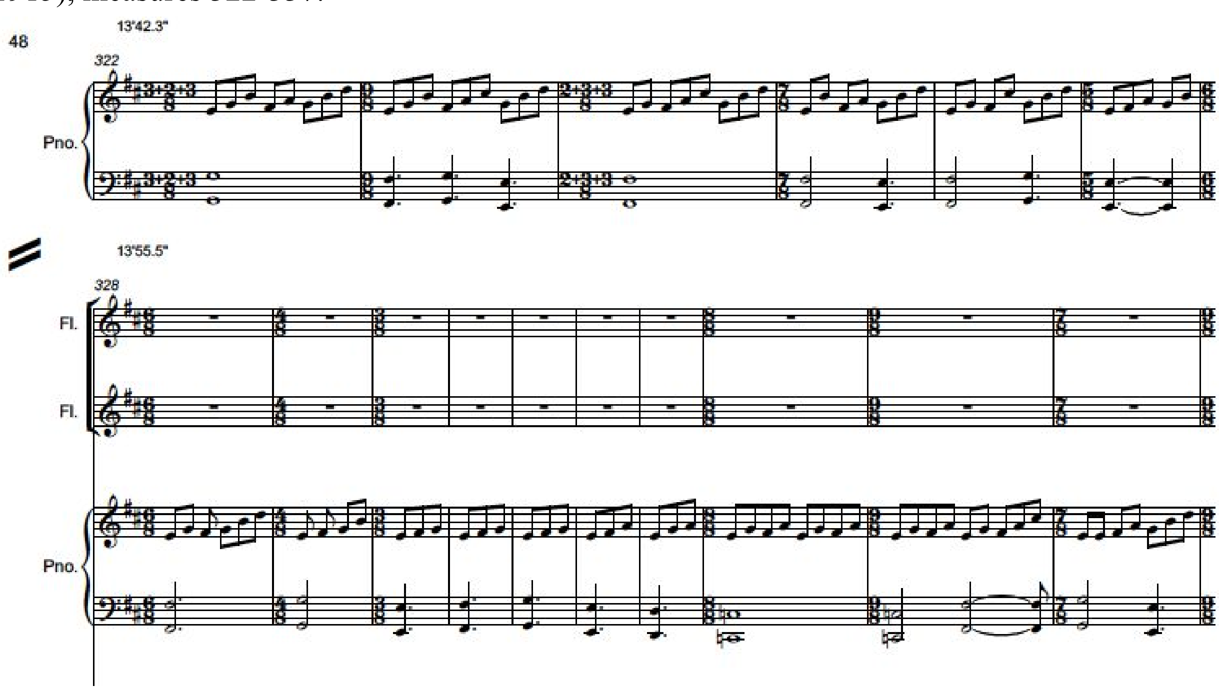


Figure 5: Screenshot of the arrangement/orchestration of "sportage" with MIDI Orchestra in Logic Pro 9

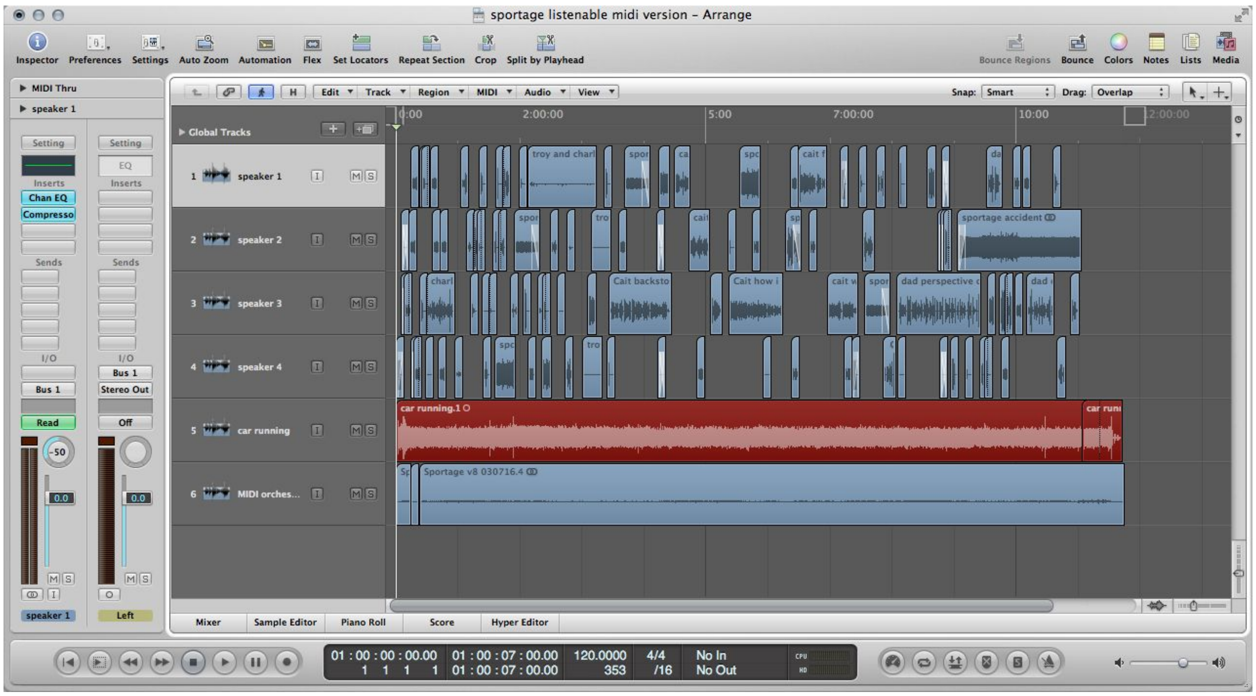


Figure 6: Example of a trigger point at rehearsal mark G, measure 134-137

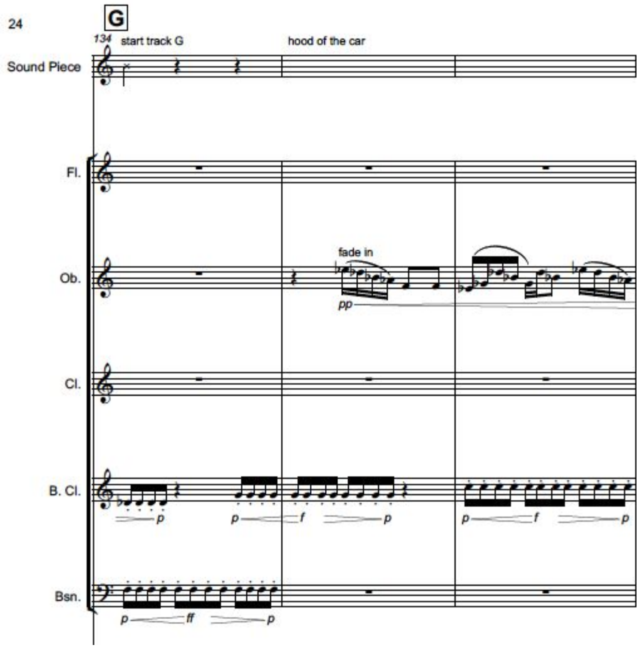
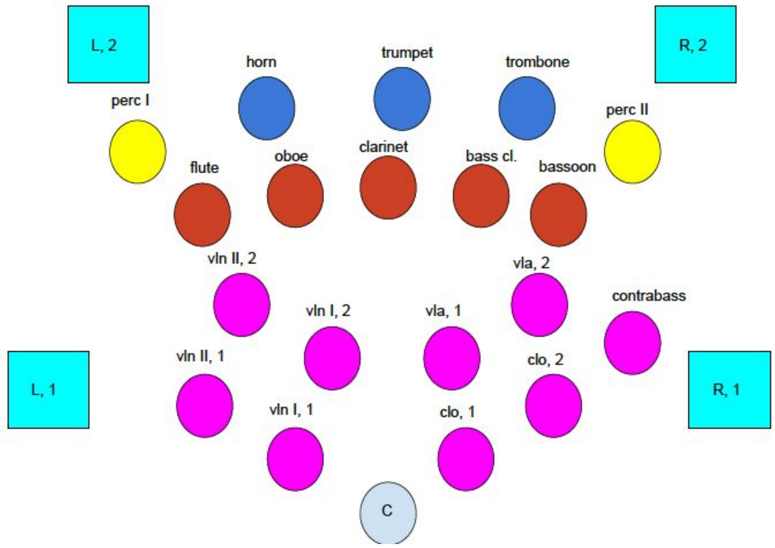


Figure 7: Content descriptions from “sportage,” measures 185-190.

Figure 8: Approximate stage plot of the Orchestra for a performance of “sportage.” Note that this has changed slightly for the actual performance, where the strings will be arranged in one row, the winds and brass in a single row behind them, and the percussionists behind them. The speakers will be placed in the same formation around the orchestra.



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