THE ARPEGGIATOR: A COMPOSITIONAL TOOL FOR PERFORMANCE AND PRODUCTION

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ABSTRACT

The properties of the arpeggiator bring forth a creative process that marries production, composition, improvisation and performance in a manner that inspires the musician/producer, helped define the aesthetics, creative process, and social function of electronic music as a whole, while grounding that music in an association with traditional African-American music and notions of futurism simultaneously.

The arpeggiator's impact on aesthetics is explored, demonstrating how automation and repetition combine to inject mechanical aesthetics into music, reflecting society's immersion and fascination with automation and futuristic technology while redefining the creative process of the musician.

This paper establishes that the arpeggiator is more than just a series of knobs on a synthesizer that manipulate sound or act as a facilitator for performance. Rather, by referencing my creative process and compositions within the context of belonging to the lineage of African-American music, this paper will demonstrate how the arpeggiator is representational of electronic dance music's overall essential qualities.

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1.1. Leading into the Arpeggiator

Arpeggios have been a fundamental element of musical composition and performance throughout the world for centuries. The arpeggio as a popular form of musical object in Western classical music can be found in the music of Venetian musician Domenico Alberti, whose "VIII Sonate per Cembalo" of 1730 is cited as one of the earliest examples of creative arpeggiation (Grove 1890, 87).[1]

The arpeggio has been an indispensable aspect of composition and performance in countless pieces of music from the works of Bach (see Prelude and Fugue in C Major, BWV 846), through impressionism (Debussy's Etude No.11 is an obvious example) to the music of the New York Minimalists (Philipp Glass's "Two Pages"), and popular music of the 1950s and 60s (see the guitar and piano parts for songs such as Kathy Young and the Innocents' 1960 hit "A Thousands Stars") to the epic electronic soundscapes of the 1970s courtesy of Jean Michelle Jarre and Vangelis, into the 1980s British pop music of Duran, all the way to more contemporary RnB and Hip Hop (Brandy's 1998 "The Boy is Mine," Drake's 2013 release "The Motion," and Trey Songz's 2014 "Na Na,") to any other form of modern music one can think of: the breaking of chords into a rhythmic sequence of individual notes is an indisputable fundamental music practice found in a very wide range of musical genres.

[1] Musicians often refer to breaking a triad into a sequence of 1,5,3,5 as playing "Alberti bass." Some famous examples include Mozart's Piano Sonata K545.

Repeating rhythmic phrases permeate diverse categories of music to such a significant degree that the evolution of music technology over the last two hundred years has embraced the advancement of automated sequenced pattern playing in order to facilitate this pervasive musical element.

Some of the earliest mechanical sequencers designed to play patterns include the music box of the 1700s, the barrel organ, and the Fourneaux player piano[2]--emerging in 1863 (Arar and Kapur 2013, 383).

As technology progressed into the twentieth century, composers and engineers experimented with electronic instruments capable of creating sound through oscillators and filters.[3] Accompanying these early forays into the world of synthesizers was the advent of the electro-mechanical sequencer that initially appeared as a thirty-foot long unit brimming with a series of relays that triggered solenoids, control switches and tone circuits with sixteen individual oscillators. Invented by composer Raymond Scott in the mid 1940s, this sequencer, known as "the wall of sound," could be manually adjusted by Scott to alter patterns of sounds (Ibid., 384).

Scott's work paved the way for the first fully analog sequencer. Designed by Herbert Belar and Harry Olson at RCA in 1957, the RCA Mark II took the piano-roll concept of the Pianola and modernized it with analog electronics by utilizing hole-punched paper where the holes corresponded to a sequence of instructions for the synthesizer to play.

In the late 1960s, instrument designer Bob Moog would take his inspiration from Raymond Scott as well as the Mark II to create one of the first analog

[2] Which became known as the Pianola: an instrument that could automatically play a musical sequence or song triggered by paper punch-cards operating the hammers on the piano in a similar fashion to the music box that, instead, featured metal teeth of a comb being activated by a pin-studded rotating cylinder.

[3] There were other earlier experiments with automated musical pattern players such as the Rhythmicon invented by Henry Cowell and Leon Theremin in the 1930s. However devices such as these were not able to penetrate the music industry successfully enough to be a factor (Schedel 2002, 247-54).

step sequencers to be released on the commercial market: the Moog 960[4]—a sequencer containing three rows of eight knobs permitting a three-value sequence of up to eight steps controlled by a clock. Each of the three banks could route three different voltage-controlled oscillators, amplifiers, and filters. This proved to be a powerful "riff machine — Berlin-school electronic rock pioneers like Tangerine Dream relied almost entirely on banks of 960 sequencers for their rhythmic drive, both live and in the studio" (Leon 2003).[5]

These early sequencers made it possible for monophonic synthesizers to arpeggiate chords and prolong harmony through automation—a very useful option during an era when almost all synthesizers could only output one note at a time.

Circa1960, companies such as Hammond were positioning the electric organ as the instrument to replace the piano in people's homes. Before long, electronic organ designers and engineers would introduce an automated arpeggio accompaniment circuit patented as the "Electronic Organ Arpeggio Effect"[6] on home organs in the late 1960s and 1970s as a performance aide[7]—from generating ostinatos, to adding separate layers of rhythmic and harmonic content such as chordal accompaniment and bass lines that would play factory-programmed rhythmic patterns in order to auto-accompany a soloist at any tempo. These organs would repeat notes, chords or phrases in predefined rhythmic patterns (such as bossa novas, swing, polkas etc.) based on either single note input, or by reiterating a played chord[8]—This feature was offered as

[4] However Don Buchla's "Music Easel" is accepted as being built before the Moog 960.
[5] For more information on the Moog 960 and other creations of Bob Moog, see www.moogarchives.com.
[6] The patent for the first arpeggio effect device, listed as patent US3358070 A, was filed on Dec.3rd 1964 (courtesy of patft.uspto.gov).
[7] The Hammond X66, the X77, and various Baldwin and Yamaha units were among the first to feature the arpeggio effect device. Often this was included as part of a virtual rhythm section capable of executing bass lines, chordal reiteration and drum patterns that a musician could play on top of.
[8] Reiteration is where a chord is performed and sustained on the keyboard, and the organ repeats the chord in one of the selectable factory-preset rhythmic patterns for the duration of the sustained chord. This way, the organists would not need to worry about being coordinated enough to "comp" their own soloing. More information about automated chord rhythm systems for electronic organ can be found under their related patents: US3499091 A and USRE29144 E.

an attempt at minimizing the limitations of a musicians' keyboard proficiency, or their reliance on other musicians, to create musical entertainment at home. The organ was presented as more than just a keyboard: it was also a self-contained virtual organ trio. As such, the instrument leveled the proverbial "playing-field;" giving anyone with basic piano-playing skills the ability to execute music that was previously not possible to play by a single musician of that level.

1.2. RECENT UTILIZATION OF THE ARPEGGIATOR

The utilization of the arpeggiator was not widespread however until the late 1970s when a proper arpeggiator (not a step sequencer or a reiterating arpeggio effect device) was introduced onboard the very affordable and portable Roland JP-4 (also known as the Jupiter 4) synthesizer in 1978.[9] The arpeggiator onboard the JP-4, featured the up and down modes as well as the random mode. This synthesizer contributed and defined the sound of many influential artists and bands such as Gary Numan, Duran Duran, Stevie Wonder, Tomita, Michael Jackson, Vince Clarke, David Bowie, Vangelis, John Foxx, Tangerine Dream and more.

Circa 1978, Sequential Circuits released their Prophet V synthesizer that also featured an arpeggiator. Used by a vast array of influential artists including Kraftwerk, Pink Floyd, Teddy Riley, Pat Metheney, Jean Michel Jarre, Joe Zawinul, and eventually Nine Inch Nails, the Prophet was one of the first synthesizers capable of storing user settings as well as producing a polyphony of five voices.

Shortly thereafter, the arpeggiator became a standard built-in feature onboard the era's most popular and important synthesizers. For example:

[9] Other lesser-known synthesizers, such as the RMI Harmonic Synthesizer predates the JP-4 by a few years and featured digital keyboard scanning and arpeggiators. But because they weren't popular tend to be glossed over.

- Roland's Jupiter 8 (1982), which was released with a new "octaves feature"[10] in its arpeggiator was used by artists such as Duran Duran, Michael Jackson, Tangerine Dream and more.
- The Korg Mono-Poly (an analog machine under digital control) was utilized by Depeche Mode, 808 State and the Chemical Brothers, just to name a few.
- The Oberheim OB8 employed by some of the biggest names in the music industry of the 80s, such as Prince, The Police, Thompson Twins and Depeche Mode.
- Roland's Juno 60 was used by many noteworthy artists, including Ultravox, and Nile Rogers when it first was released in the market, and continues to be used to this day by dance music producers.
- Korg's Poly6 was popular among many artists including Jean Michel Jarre, Tears for Fears, continuing its influence well into the 1990's via bands such as Blur.
- The 1986 release of the Prophet VS was the first digital synth with arpeggiation and "extended mode" where a performer could add notes to the arpeggiated pattern in real time.
- The Roland JP-8000, which was released in 1996 introduced yet another innovative evolution of the arpeggiator known as the RPS arpeggiator.[11] This synthesizer was used on many important records by artists including drum 'n bass legend Goldie, industrial bands Front 242 and Skinny Puppy and eventually dance producers such as Paul van Dyk and Tiesto.

[10] With the push of a button, the octave feature prolongs the arpeggiation across a selectable range of octaves.

[11] RPS Patterns are short sequences (1 to 4 bars) that are assigned to various notes on the keyboard. The JP-8000 came with 48 Preset RPS patterns that musicians could choose from or could create their own.

The artists associated with the synthesizers listed above (as well as many other artists not listed here) were all influential in bringing forth new emerging trends in music and music scenes. Central to the music trends of the 70s and 80s was the synthesizer: the sonic possibilities they possessed, and the manner in which these sonic qualities were exploited presented an exciting option for up and coming musicians and producers alike.

The inclusion of stock features such as the arpeggiator on synthesizers not only followed an established sonic aesthetic originating from vintage analogue synthesizers and sequencers, but also, in keeping in the tradition of the electronic home organ, made music making simpler and more attainable. Automation allowed for an artistic approach that was embraced by trained and untrained musicians alike, resulting in new genres and musical hybrids, such as "Krautrock", industrial, electro-funk, fusion, synth pop and various dance music styles that spawned further movements and sub genres.

Starting in the late 70s, synthesizers were manufactured to be more affordable and less physically cumbersome than ever before and creating (electronic) music became accessible to anyone who could save enough money to buy a synthesizer. This influx of synthesizers left an indelible mark on the aesthetics and creative process of music making as a whole. In fact, an aesthetic founded in giant, virtually unplayable electro-mechanical devices has carried forward into the music of today via an ever-evolving technology of automated pattern creation. Presently there are many types of arpeggiators, including:

- "Virtual instruments," sometimes referred to as "soft-synths" or software plug-ins (many of which are modeled after specific vintage synthesizers mentioned above), these arpeggiators are software based and are hosted on a PC which get triggered by an external (MIDI) keyboard within a digital audio workstation (DAW) environment.

- Fractal arpeggiators that use advanced algorithms to permutate arpeggiated patterns, such as the functionality available on Korg's Electribe EMX.
- Hardware workstations such as the Korg Karma (a very advanced and versatile keyboard workstation that features a combination of a dynamically morphing auto-accompaniment and a feature-rich arpeggiator).
- The Monome/Arduinome/Chronome series of revolutionary grid-based controller/sequencer/arpeggiators.
- Hardware synthesizers that follow the tradition of featuring an arpeggiator mode or module on them. These are still prevalent and popular to this day and are among the most powerful synthesizers on the market.

Arpeggiators have been firmly embedded into the ethos of electronic music—their sonic quality and the manner in which one interacts with the instrument are part of an evolution that has its roots in early twentieth century programmable pattern player technology and beyond.

1.3. The Grooving Cyborg: The arpeggiator as Sonic Vessel for Afro Futurist Aesthetics in Dance Music

The arpeggiator is important in electronic dance music (EDM) due in large part to its capacity for African American signification while simultaneously conjuring sonic representation of technology and, what Mark Dery describes, "a prosthetically enhanced future" (Dery 1994, 180). The arpeggiator informs EDM with mechanical/futuristic aesthetics by interconnecting the lineage of African-American dance music, science fiction (SF) trope, and Afro-futurism.

Accepting the notion that elements of music engage in dialectics with society,[12] the arpeggiator becomes a symbolic instrument of the late twentieth century: when dystopian imagery of social decay and mass industrialization combined with anxieties surrounding technological advancements became prevalent themes in literature, film and television.[13] These anxieties also brought forth "aspirations for a better world and an effort to imagine what the future might look and sound like" (Burke 2013, 186). Man being replaced or enhanced by machinery had become a reality, especially in 1980s Detroit—a city in decay due to "ever-increasing mechanization of production and new forms of global outsourcing" (Williams 2001, 157)—where techno was formalized as an influential genre of dance music by producers who incorporated the aesthetics of mechanized music production into an ethos for creativity.

Sonically, the arpeggiator, the sequencer and the sample and hold features of synthesizers are a central part of early electro, techno and house music of the 1980s, partially due to their specific ability to convey the association between computers, man, machines and fantasy. This association comes from a well-established lexicon of sounds and musical approaches that have roots in early SF radio dramas, films and television series.[14]

The otherworldly tones of electronic instruments have been linked with supernatural and SF trope since the early 1950s, when experimental composers, such as Louis and Bebe Barron, exploited the unnatural tonal qualities of early incarnations of synthesizers to score SF movies such as the soundtrack of 1956 *"Forbidden Planet."* Not long after, composers and sound designers like Daphne Oram and Delia Derbyshire of BBC's Radiophonic Workshop cemented the association between electronic instruments and themes of outer space and technology by employing tape machines, basic oscillators and early synthesizers to create music and sound effects for radio and television programs such as *Doctor Who* and *The Tomorrow People*

[12] See Joanna Demers "Listening Through the Noise" and Adorno's 1997 "Aesthetic Theory."
[13] See Ridley Scott's *Blade Runner* (1983), Alvin Toffler's *The Third Wave* (1980), and William Gibson's *Neuromancer* (1984).
[14] "Science fiction was the main genre to explore the burgeoning musical capabilities of electronics" (Tonks 2001, 57).

(Brend 2012).

Eventually, electronically-produced sounds became cliché in dystopian movies, such as *The Andromeda Strain* in 1971 and *Logan's Run* in 1976 (Reynolds 2009). The sequenced automated musical pattern became one of the musical features of SF aesthetics--whether the notes of the sequence appear to be outputted randomly, as the sequences that can be heard throughout *Logan's Run,* or, as a looping selection of notes, such as the arpeggiator appearing in Vangelis' "Blush Response*"* from the 1982 soundtrack for *Blade Runner*. From the 1960s into the 1980s, sequencers, sample and hold and arpeggiators became commonplace in soundtracks for accompanying visual scenes of computers, space ship cockpits, relentless machinery and robotics.[15] [16]

Arpeggiators prove to be very appropriate for musicalizing scenes depicting cyborgs and androids, as evidenced in many SF movies: from the end theme of *Blade Runner*; to the arpeggiator in the low budget *Robowar* (1988) used to signify the plodding cyborg killing machine; to the incessant looping bass sequence used in various scenes depicting the relentless *Terminator* (1984). The connection between the cyborg and the arpeggiator is an easy one to draw: the merging of the programmable machine with the soul of the human, i.e. automation to enhance musical performance. From the perspective of a composer, one could see how a programmable looping synthesizer could be used as a compositional analogue to represent computer, robots and cyborgs--all of which belong to SF trope.

Furthermore, the distinction between sound effect and musical score is often blurred in SF (and horror) movie scoring due to the experimental and atonal musical approaches adopted in these genres since the 1950s: sequenced synthesizers serve as

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[15] The connection between the steady bleeping synthesizer tones and imagery of super computers comes from the trope of "computer sounds" in countless SF movies and shows, such as *Fireball XL5* (1963)*, War Between Planets* (1966), *Cosmos: War of the Planets* (1977).

[16] Similar visuals became trope in the artwork accompanying African-American music that made use of electronic instruments: See album artwork for Herbie Hancock's *Thrust,* Or Parliament's *The Clones of Dr. Funkenstein.*

diegetic music/sound in film scores, as evidenced in the scenes presenting the "maze car" trains in *Logan's Run,*[17] or the hallway chase scene of *Star Crash* (1979), or even scenes of robot lovers in *Star Odyssey* (1979). The computers and robotics that are visible in these scenes (or, in some cases, not visible but are implied as being present in the futuristic environment) are assigned tonal sequences that, not only depict the technology in the scene, but serve for musical motif, reinforcing society's immersion with futuristic technology—akin to the conceptual aesthetics of electro and Detroit techno of the 1980s, where producers musicalized sounds of (imagined) futuristic technocratic society.

Synthesizers with onboard step sequencers, such as the Buchla 100 and 200 modular synthesizers were powerful enough to be used to create synthesized sound effects, the music score, and even sonic events that fulfill both of these roles simultaneously, as evidenced by a scene eight minutes into the movie *Galaxy of Terror* (1981), when a computer alarm is sounding in such a way that this sound becomes part of the musical motif of the scene's score.[18]

The diegetic use of electronic instruments that "sound" like, or signify, futuristic technology informed a new sonic landscape that European disco (such as Giorgio Moroder[19]), psychedelic bands (à la Pink Floyd) and Euro pop acts (most notably, Kraftwerk) would incorporate into their own records in the late 1970s.

The German electronic pop group Kraftwerk is acknowledged as inventing the metaphor for "symbiosis of man and machine" in popular and underground dance music (Williams 2001, 155) by presenting themselves as robots or cyborgs on stage and by incorporating sounds that had only been heard in SF soundtracks or experimental music with catchy and fun melodies. Central to the aesthetics of their

[17] The sequences can be interpreted as a musical motif, or the actual sound effect of the train's computer, or both.
[18] Composer Barry Schrader himself claims the soundtrack for this film was done completely on the Buchla 200 (Schrader 2010).
[19] Moroder's cosmic disco reputation would land him the Battlestar Galatica soundtrack composer job.

music are the machines responsible for generating the repeating precisely sequenced and automated synthesized phrase and its relationship with their "reconfiguring" of African-American dance grooves to create a unique tight funk feel--a relationship that resonated with African-American DJs and dancers in the late 70s and early 80s (Doershuck 1999, 205).[20]

DJs such as Afrika Bambaataa in New York, Charles "The Electrifying Mojo" Johnson in Detroit, Ron Hardy and Frankie Knuckles in Chicago and Larry Levan in New York were playing the likes of Kraftwerk, Cerrone, Moroder, Telex and other European electronic productions that were heavily sequenced, used arpeggiators, echos, drum machines and synthesizers in clubs and radio that targeted a mainly young Black and Latino audience. The cyborg aesthetics mixed with dance grooves became the inspirational spark for the creation of electro and techno: most specifically, Afrika Bambaataa who, with producer Arthur Baker, used two Kraftwerk Records ("Numbers" & "Trans-Europe Express") to create the first *bona fide* electro hit "Planet Rock" (1982). Circa 1983 in Detroit, Cybotron (Juan Atkins & Rick Davies) would sample the ever-rising sequenced loop of Kraftwerk's "The Hall of Mirrors" (1977) to create the first Detroit proto-techno/electro record (before these genres had a classification), titled "Clear" (1983).

The arpeggiator had a strong presence electro along with the drum machine, echo (or delay), and vocoder to signify technology of the future and outer space: a template first presented by Kraftwerk in songs such as "The Antenna" (1975) and "The Robots" (1978). The following list demonstrates the trend of the arpeggiator being used in early 1980s electro:

- Warp 9 - "Light years" (1983)
- The Jonzun Crew - "Space is the Place" (1983)
- Grandmaster Flash & The furious Five – "Scorpio"
- Charlie - "Spacer woman" (1983)

[20] Former Kraftwerk member, Karl Bartos stated that the group was consciously trying to imitate the rhythms of African American soul music (Sicko 2010, 10).

- Whodini – “The Freaks Come Out At Night” / “Friends”
- Cybotron – “Clear”
- Newcleus – “Jam on it”/ “Destination Earth” (1984)
- Shannon – “Let the Music Play
- Midnight Star “Freak-a-zoid”
- Afrika Bambaata & the Soulsonic Force - “Looking for the perfect beat”
- Twilight 22 – “Electric Kingdom” (1983)

Kraftwerk’s dehumanized/robot image and sonic aesthetics influenced the SF trope to a level of extreme kitsch in European disco circles of the late 1970s and early 1980s. A quick glance at European disco[21] songs with SF themes (titles, lyrics, even band names, robot and alien costumes) demonstrates that, along with vocoders, album artwork, and synthesized sounds associated with lasers and computers, producers gravitated to the arpeggiator to represent technology of the future and to add propulsion to the groove of their songs. For example:

- The Droïds – “The Force” (1976)
- Giorgio Moroder – “From here Until eternity” (1977)
- Cerrone – “Super Nature” (1977)
- Space – “Magic Fly” (1977)
- Dee D. Jackson – “Automatic Lover” (1978)
- Automat – “The Rise” / “The Advance” / “The Genus” (1978)
- Disco Dream And The Androids – “Dream Machine “(1979)
- Ganymed – “Future World” (1979)
- Bamboo – “Travelling through space and time” (1979)
- Methusalem – “Robotism” (1980)
- Laser – “Laser” (1981)
- R.E.M – “Computer Communication” (1983)
- Decadance – “On and On” (1983)

[21] Euro disco of the late 70s is often called Italo, or space disco.

Italo would be a major influence in the development of house music in Chicago and Detroit, as DJs relied on "imports" such as Italo, British synth pop (like New Order and Depeche Mode) after disco's fall from popularity in the late 1970s. For example, one of the most important protohouse records by Frankie Knuckles and Jamie Principle, "Your Love", is built from a three-note arpeggiator pattern and a bass line borrowed from one such import (Electra "Feels good").

The appeal of the arpeggiator, and one of the reasons it is part of EDM's lexicon, lies in how the arpeggiator re-contextualizes sound by expressing *machine aesthetics,*[22] or "aesthetics of the Machine" (Garnett 2001), by injecting sonic events that are blatantly machine-made, automated, acknowledging or inspired by technology, industrialization, or mass-production—a notion that ties into futurism and science fiction. For example, the arpeggiator in my composition "Pastiche" (track 13) that starts at 1:44; or the single looping note in my record "Mars" (track 11) at 0:49. This aesthetics is inescapable in electro, techno, deep house, drum and bass, trance and dub step.

Techno evolved out of electro, European synth pop and disco in a manner that expresses machine aesthetics more acutely than any other EDM genre via excessively repetitive elements, electronic percussion, minimal melody, stark ambience, relatively static harmony and a conscious eschewing of acoustic (or simulated) instruments. Techno is not just transparently made by machines; it musicalizes (and practically fetishizes) our present-day immersion in repetitive, mechanized (sic.), computerized (sic.) systems (Kanzru 2004) and, in doing so, champions instruments that are capable of generating sounds that remind us of advanced technology and automation. The fact that the arpeggiator uses automation to generate musical content makes it even more appropriate for use in a style of music that prioritizes the role of technology in the creative process, affirming a relationship between man and machine that ties into SF trope. These factors point to why this instrument is featured in countless techno, electro and techno-influenced records.

[22] More often used in the world of architecture and modern design.

Techno aesthetics is at the core of most EDM sub genres that started to surface in disco/dance records of the late 1970s and early 1980s, in records as "I Feel Love" by Donna Summer (produced by Georgio Moroder in 1977),[23] and eventually permeated the spectrum of dance music, prompting further subgenre classifications such as "tech house" or "deep tech" (for example, some of my own music has been classified as "deep tech" at record stores such as Traxsource)[24]—aesthetics that is, as Mark Butler states, "not simply a by-product of technology; rather, it is an intentionally cultivated creative strategy. Electronic dance music is not simply made with machines; in several ways it aspires to sound like machines" (Butler 2014, 338).

Techno, as a defined music genre, emerged in early 1980s Detroit as a "self-consciously science-fictional music" (Williams 2001, 154) whose main progenitors (Juan Atkins, Kevin Saunderson and Derrick May) were influenced by futurist literature,[25] the soundtracks of SF movies, the dystopian state of their hometown, funk, European synth pop and disco (Sicko 2010). Techno embraces SF and futurist themes of space travel, alien(ation), cybernetics, dystopian vs. utopian imagery, mythology and emancipation through mastery of technology—themes that have an established precedent in African-American music courtesy of musical innovators, such as Sun Ra, Lee "Scratch" Perry, Herbie Hancock and Parliament, all of whom "call upon similar tropes and metaphors of space and alienation that link their common diasporic African history to a notion of extraterrestriality" (Mcleod 2003, 344).[26]

Robots, cyborgs, and SF themes that originated with Kraftwerk eventually permeated the bourgeoning electro[27] and techno genres of urban America of the early 1980s. Not only because of the attraction to the funky precision of the machine, but also because,

[23] Every sound in "I Feel Love" (minus the kick drum) was generated by synthesizers and sequencers (McConville 2014).
[24] As of writing this, "deep tech" as subgenre nomenclature has become passé and is hardly used.
[25] Of particular note is that Jaun Atkins named their emerging genre of electronic dance music after the "techno rebels" from Alvin Toffler's book *The Third Wave* (1980) (Sicko 2010, 12).
[26] SF trope is found in stage costumes, album artwork, song titles, as well as the music-making technology, such as synthesizers and computer software (Yusuf 2010) .
[27] Also known as electro funk.

as Tricia Rose states, "Adopting "the robot" reflected a response to an existing condition: namely, that they were labor for capitalism, that they had very little value as people in this society.[…] It's like wearing body armor that identifies you as an alien" (Rose 1994, 214).

The attraction to futurism and SF tropes in African-American culture has been linked to cultural alienation, as "African diasporic peoples were the first aliens, displaced through slavery in the seventeenth century" (Yusuf 2010). The connection between machines, outer space and musical innovation is based on a perspective that John Corbett formulates where "tradition = earth; innovation = outer space" (Corbett 1994, 17). Hence, SF trope that includes aliens, computers, robots/cyborgs, lasers, machinery, and space travel connotes "the future" and innovation—metaphors that provide alternative and empowering narratives for Black identity (Yusuf 2010). By "seizing the tools" that had been in the domain of white culture (Ibid.),[28] the Afro-futurist signifies on SF trope—in this case, the recognizable sound of futuristic technology, thereby redefining Black identity of the present and future through mastery of technology through the medium of African-American dance music.

In the context of African-American music, techno is acknowledged as a strand of the Afro-futurist narrative (Mcleod 2003, 344). Contemporary deep house music also has a sonic connection with Afro-futurism, as many songs often contain blatant techno elements, such as synthesized looping sequences, in combination with layers of explicitly traditional African-American dance rhythms and instrumentation,[29] as seen in my work "Dark Days" (track 10) and "Genetix Theme" (track 9). Many producers, including myself, consciously embrace established techno elements to add "futuristic" qualities into productions—a practice that reinforces a connection to the lineage of underground African-American dance music. As such, most of the "tech" elements of my own productions are expressed through the use of the arpeggiator, owing to the

[28] Music technology, such as synthesizers, computers and sequencers were domain of institutions such as universities and large companies until synthesizers and sequencers became affordable to consumers.
[29] This common practice in deep house has roots in other forms of African-American music: a perfect example is Herbie Hancock's "Rain Dance" from *Sextant* (1973) that uses a sample & hold feature to provide the synthesized groove.

fact that the characteristics of the instrument are greatly associated with early techno's fascination with science fiction and futurism.

Techno and Afro-futurism are both technological-visionary traditions that promote the merging of the human soul with the capabilities of modern technology to further advance art and society.[30] Through this perspective, the technology involved with the craft/labour of music making--which traditionally fell under the role of human agency--is championed among dance music producers (to almost spiritual levels for some), that "understand the machine as a product of human creativity whose parameters are always suggesting what's beyond them" (Rose 1994, 213). The arpeggiator, drum machine, sampler and sequencer all possess the necessary qualities for this purpose, as they represent:

- The continuation of African-American re-purposing of Western technology and musical instruments to communicate African-American diasporic traditions related to social ritual and congregation. As such, the arpeggiator in this role generates ostinatos and rhythms that can be applied to the creation of African-American musical forms.
- Democratization of the means/technology for music creation. Synthesizers and sequencers had been very expensive and under the domain of institutions until the 1970s. Synthesizers with arpeggiators gave consumers access to a similar palette of sounds that had been heard in science fiction media for years, but were inaccessible to consumers.

Furthermore, the arpeggiator extends modes of traditional African diasporic cultural expression via artificial means--a notion that reveals creative possibilities beyond the human scale. This in turn extends, or rather transcodes, elements of traditional African and African-American music (repetitive grooves, dissonant shrieks, etc.) into the (imagined) future/space age. The arpeggiator, along with the drum machine and

[30] For more information on Afro Futurism see *Black to the Future (Dery 1994)* and *Black Secret Technology* (Williams 2001).

synthesizers, serves in, what electro/techno pioneer Rick Davies states, “interfacing the spirituality of human beings into the cybernetic matrix: between the brain, the soul and the mechanisms of cyberspace” (Mcleod 2003, 344). Considering the arpeggiator’s capability for transducing basic human input into automated musical output with flawless accuracy, it is not difficult to see how this interface can be a considered as the musical metaphor for the cyborg.

Devoid of race, sex and soul, the cyborg in this context symbolizes the intersection between human advancement and human replacement. The arpeggiator signifies music of the future based on an established trope, and as a prosthetic extension of human creative output.

2. Aesthetics

INTRODUCTION

Characteristics pertaining to all manner of sonic quality such as timbre, tone and harmonics, as well as processing and arrangement, were the direct result of the manner in which ground breaking equipment was used to produce electronic music. However, other prominent characteristics of electronic music (such as experiments of tuning, a tendency towards steady rhythmic pulse and pattern repetition) were already recognized throughout the musical world prior to the existence of electronic music. These attributes are symptomatic of musical movements that came into the forefront of Western composition in the twentieth century, influencing countless Western composers across a wide range of genres, eventually becoming prominent in electronic music around roughly the same time. These attributes include African and Asian influence, the manifestation of minimalism, the influence of industry, the embracing of technology in art, experimental concepts and process *as* composition. By the nature of their limitations and capacity, the pioneering tools of electronic music (such as tape machines, synthesizers, sequencers and arpeggiators) had a propensity/predisposition to output these attributes and characteristics—a direct correlation to why so much electronic music is repetitive, "futuristic," unnatural sounding and very rhythmic.

A great point was made by Kim Cascone who took Marshal McLuhan's "the medium is the message" phrase and "remixed it" into "the medium is no longer the message; rather specific tools themselves have become the message" (Cascone 2003). The arpeggiator is one such tool that is emblematic of EDM. This instrument is the embodiment of the most prominent defining characteristics of electronic music: synthetic, precise, repetitive, an emphasis on rhythm and steady pulse, programmable, automated, and acting as an

extension or replacement of human performance capability. The sound of the arpeggiator is the sound of electronic music.

Therefore, employing arpeggiators into music production instantly injects a contextual aesthetics into the music**.** The arpeggiator is a holon of sorts: an element of electronic music and electronic music in and of itself. It carries a characteristic so unmistakable that proves almost impossible for it to not impact the overall style of the music that utilizes it.
Because of this holon we can use the characteristics of the arpeggiator as a guide to discuss the different aspects of the most common elements that defines the aesthetics of my music.

2.1. REPETITION

The most powerful trait of the arpeggiator, my music and EDM in general, is repetition since repetition can be seen as a device (or even as a technology in and of itself (Butler 2014, 247)) that facilitates and connects many interactive facets of music. Repetition is a musical ingredient found throughout the African diaspora and an almost unequivocal byproduct of automation—two points that shape the aesthetics of my own EDM.

Repetition is the most prominent characteristic of EDM aesthetics, and yet it is more than just a sonic trait: repetition is also a methodology for constructing form, presentation formats, and establishing groove—all of which are elements that facilitate the most important function of African-American music: dancing.

The arpeggiator is one of the instruments of EDM (along with the sampler and the drum machine) that defines EDM's aesthetics in that it is a device that introduces repetition of short musical segments that aid, strengthen and define

the groove of the overall work. Repetition is connected to tropes of technological advancements, industrialization and automation, while also being fundamental to trance and hypnosis (Sylvan 2002)--which explains why repetitive music of minimalist composers and the rhythms of house and techno are often called hypnotic. By automatically repeating synthesized musical phrases, the arpeggiator has the capacity to connote all that is synthetic and mechanical in our culture (Fink 2005) while, at the same time, promoting elements of African diasporic music (see section 1.3). In short, repetition is the most significant property of the arpeggiator that both traditional African-American music and EDM share. Therefore, it is not surprising that the arpeggiator has been a regular fixture in various forms of urban American dance music since the 1970s. For an in-depth history of repetition in the context of EDM and its origins in the Afro-diasporic tradition see section 2.3.

2.1.2. Defining Repetition

My music features repetition in different capacities, all of which are common in African-American diasporic music:

- The articulation of a steady pulse underneath repeating patterns and grooves as defined by a four-on-the-floor kick drum pattern (as seen in every submitted composition with this paper), which connects my music to techno, house, disco, and traditional forms of African percussive music.
- The prioritization of repeating musical objects such as motifs, bass lines, chord progressions, riffs, echoes (more specifically called “delays” in music production), arpeggiation and melodies, which musicologist Richard Middleton would describe as musical additives called “musematic” repetition (Middleton 1996).

- Sectional repetition, which Middleton would describe as "discursive" (Ibid).

Almost all forms of music contain repetition and recurrence to some degree. Recurrence is a musical segment that appears more than once. Repetition, on the other hand, indicates an immediate restating of the musical segment with little to no variance between the reiterations. This definition of repetition lends itself perfectly to tools of automation, which are common in EDM, that either replay musical objects over and over again (as is the case of a digital sample being looped, or a digital delay effect) or execute/regenerate the musical segment over and over again, such as a musematic phrase being performed by a sequencer, drum machine or arpeggiator, often referred to as looping.

2.2. Groove is in the Heart of the Machine

Repetition is vital for the creation of danceable rhythms and groove, which is why dance music prioritizes repetition: "Groove is built around the extensive repetition of relatively short musical segments" (Hughes 2003, 15) and "this cyclicality of time is indeed a feature that all groove-based music [*sic*] share" (Wannenmaeker 2013). Groove, being one of the more esoteric elements of music, is not merely a collection of repeating riffs, but is also the resulting musical-timing feel of "micro rhythms" or "fine-scale rhythmic delivery" that emerge from "expressive timing" (Iyer 2002, 398) based on a musician's (or a collective of musicians') sense of time and swing. In other words, how certain units of a performed phrase are "consistently slightly ahead or behind a defined metric time point by a matter of milliseconds [*sic*]" (Wannenmaeker 2013). These microscopic nuances in expressive timing are built into the machine or the synthesizer's arpeggiator presets (usually either as factory defaults, or defined by the end user). Therefore, using a preset of an arpeggiator injects that synthesizer's or arpeggiator's particular

timing/feel/groove into the musical composition. More so, if we accept Anne Danielsen's observation that temporal aspects of rhythm cannot be isolated from aspects of sound, such as timbre, dynamics (or accents) and pitch (Danielsen 2010, 9), then we can start to understand how the qualities of an arpeggiated synthesizer preset impacts the groove of a musical production, and therefore features as an important part in the aesthetics of the overall work of music[31] – aesthetics defined by the machine, more than by the performance of a musician.

For example on my track Pastiche (track 13), the groove is the result of layering the kick, snare, hi hat, tambourine, bass line and the arpeggiators--the first of which is introduced at 1:44 – and is responsible for most of the rhythmic intricacy of the track. The traditional drum kit elements of the song convey a loose disco-rock feel, while the arpeggiator adds a very tight and robotic syncopated pattern. It is the arpeggiator that adds most of the *funk* aesthetic to the song—not unlike a lot of techno and house music that continues to represent a mechanical feel originally made famous by the German electronic-pop godfathers Kraftwerk (see section 1.3 on Kraftwerk's influence)[32] and their "machine-perfect sound" (Sicko 2010) whose "syncopated rhythms propelled Kraftwerk's sound into the realm of dance music, described by many American listeners as "so stiff it's funky"" (Ibid).[33]

There are many examples in EDM where a strong groove is created by layering a repeating sequenced synthesized pattern on top of a straight four on the floor disco/house beat, including the following selections:

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[31] Manipulation of the attack, sustain and release of each of the "steps" of a synthesizer's arpeggiated preset will have considerable influence on where a note is perceived to land on the metric time scale. That perception becomes a factor for establishing groove when the preset executes a sequence or arpeggiation.

[32] Kraftwerk would not only inspire synth pop and punk of the 70s and 80s, but early rap, electro and techno. (Barr 1999). See sections 1.3 and 2.5.

[33] This connection to Kraftwerk is not a difficult one to make, as Kraftwerk is on record saying they wanted to make music "with an American rhythm feel" (Sicko 2010)--aesthetics that is also felt in the post-disco British synth pop that emerged in the late 1970s and early 1980s.

- The 2013 release by Cajmere feat. Dajae "Satisfy" (composed of vocals, a single bar looping beat, intermittent synth riffs and an arpeggiated looping pattern consisting of three repeating 16th notes that mark the moments of heightened energy of the song's groove).
- Frankie Knuckles featuring Jamie Principle's 1987 "Your Love"[34]—a song that has a connection to Kraftwerk's aesthetics by way of Italo and British Synth pop of the late 1970s and early 1980s. "Your Love" is based around a simple beat, a bass line (that quotes a 1982 Italo release by Electra, "Feels Good (Carrots and Beets)") and a three-note arpeggiated phrase. A track so simple that it made aspiring producers believe that they too could start producing dance records using basic equipment (Brewster and Broughton 2006, 416).
- Robert Hood's 1996 stark techno anthem "Detroit: One Circle" – where a looping sequence very reminiscent of something Kraftwerk would create, is the sole provider of the groove until a kick drum enters after almost a minute further into the song, then followed by remaining elements of the electronic drum kit shortly thereafter.

2.3. THE AFRICAN-AMERICAN LOOP

Repetition in traditional African music is realized in the same way that "looping" features in electronic music. However, before going any further, some clarity on terminology that has already been used in this paper: "Effectively, loops are riffs of modular length that one strongly expects to repeat, and looping is the practice of layering, adding and subtracting loops, allowing for the seemingly paradoxical effect of an ever-changing same"

[34] Considered the very first record to be classified as house music.

(Garcia 2005). More accurately: looping is a technologically-aided process of composition or performance expressing African-American "cultural forms that emphasizes the continuity of the "changing same"[35] (Ibid.). The way in which the musical expression of repetition manifests as looping in EDM is, at its core, the same practice found in (antecedent) forms of African-American interdisciplinary artistic expression[36] exhibited within individual pieces of music (as demonstrated throughout this paper), as well as being an overarching trait that connects all African-American music genres via recycling, reusing, revising, remixing and repeating of an established vocabulary of riffs, harmonies, rhythms, phrases (Butler 2014) and tropes, tracing back to the music of the Ring Shouts of the 1800s,[37] through to pre-diasporic African culture.[38]

Furthermore, one could argue that the use of the arpeggiator in Black music is a technologically-aided form of *signifyin'* on the musical cliché of the Arpeggio; and the way in which arpeggiator's synthesized repeating tones tend to be manipulated via filters and resonance to varying degrees throughout a recording can represent "ways in which musical content can serve to make repetition seem like difference" (Margulis 2014, 85).

Traits of African-American music are found in much of the popular music styles that emerged during the twentieth century (Ramsey 2015) where "the influence of the

[35] See: Amiri Baraka's "The Changing Same (R&B and New Black Music)" in *Black Music* (New York: W. Morrow, 1967), 180-211; and Henry Louis Gates' "*The Signifying Monkey: A Theory of African-American Literary Criticism"* London: Oxford University Press, 1988.

[36] Looping fills the role of riffing and signifying found in all African-American music, visual art (as demonstrated in the repeating words and Yoruba-inspired motifs of the works of artists such as Basquiet) and also in oratory forms (as exhibited in beat poetry and spiritual sermons).

[37] Many ethnomusicologists consider the ring shout as "the mother of Afro-North American dance forms" (Hazzard 2011, 200).

[38] The re-stating of this vocabulary is what connects the various forms of African-American music into an informal canon that continues to be referenced in present day derivative musical forms via sampling, quoting, rehashing and imitation that frames the music as culturally authentic.

dances and the music of the Hoodoo religion[39] on the urban dance of America would reshape American and eventually, international, urban dance traditions" (Hazzard 2011, 206), as evidenced by the adoption of African-American musical styles such as jazz, blues, disco, RnB and techno across the globe over the last century—all of which are repetitive musical forms that emerged from gatherings centered around participatory dance throughout the African-American diaspora that include jooks, honky-tonks, rent parties, after-hours gatherings, membership clubs, dance halls, cabarets, discos, loft parties, roller-discos, and raves (Hazzard-Gordon 1990).

My musical productions accompanying this paper adhere to defined stylistic conventions associated with underground subgenres of the EDM idiom referred to as "deep", "soulful" or "tech" house. These sub strains emerged out of the predominantly Black, Latino, (and often) gay disco and soul music scenes of New York, Chicago and Detroit as the "electronic offspring of disco" (Fikentscher 2015, 330). As such, they contain blatant traits of African-diasporic music expressed through the following typical traits of African-American music:

- Syncopated rhythms and grooves (See CD track 7 "P Jam" and track 10 "Dark Days" for Afro-Caribbean styled syncopation).
- Sound choices reminiscent of traditional African music (especially with regards to percussive elements) (See track 7 "P Jam", track 6 "Vitamin S", and track 10 "Dark Days" for examples of traditional African rhythm sections combined with programmed electronic drums).
- Vocal delivery style (influenced by gospel and RnB) (See track 5 "New Day")
- Harmonies (from jazz, pop and soul influence) (See track 14 "Supernova" and track 8, **"**Cultured Girl").

[39] Hoodoo is a folk spiritual and medicinal system of the African American in North America that originated on the plantation of the old Southern US and is a reconstituting of several traditional African religious systems conflated with European spiritual traditions and beliefs (Hazzard 2011). The ring shout is a good example of Hoodoo ritual.

- Contrasting timbres and textures (See track 13 “Pastiche,” track 1 “Tsing Forest” or track 11 “Mars” for examples of raw percussive elements, smooth pads and abrasive synthesizers).
- Qualities where sounds are used to “translate everyday experiences into living music” (Burnim and Maultsby 2015, 8) (see track 12 “CTS Haunted Disco dub” that features Church ambience recordings).
- Music and dance’s fundamentally inseparable relationship. A relationship that prioritizes musical characteristics that encourage social and ritualistic dance congregations; specifically: call and response, repetition/looping, and structural form compatible with seemingly endless extended performances or functions.

The fundamental relationship of dance with African-American music manifests as a series of prioritizations that composers and producers take into consideration when creating music--compositional considerations that are usually based on observations from first-hand experience of attending venues where dance music is presented.

The musical format that these social functions are based on is relatively simple: amplified and uninterrupted music that grooves strongly for extended time and encourages inclusivity and participation. One thing that becomes very obvious to anyone exposed to dance music is that repetition is vital for the success of musical groove, group participation, extended and uninterrupted revelling. Therefore technology, such as the arpeggiator, which generates potentially endless looping phrases, becomes the perfect tool for the creation of music that prioritizes the fundamental principles of repetition and groove in dance music.

2.3.1. PARTICIPATION AND PREDICTABILITY

Music can be classified as being participatory in nature when there is an expectation that groups of people are to actively join the musical experience by dancing, singing, shouting and clapping along to the music (Turino 2008).
Predictability proves to be a crucial element in EDM because of the participatory aspect of dance music. Predictability in music strengthens the shareability of the music, which in turn cultivates social bonding and ritual. Therefore, the repetitious patterns being generated by arpeggiators prove to be very useful in participatory music.

The connection of physical movement with music (a relationship that, in many traditional African cultures is intrinsic (Burnim and Maultsby 2015) has been linked to the manner in which musematic repetitions create a sense of almost immediate "knowability" that helps music passages to be "imaged internally in the mental soundscape. The music-movement coupling brings about a virtual sense of sound production, as if the person hearing the music was actually producing it" (Margulis 2014, 340), thereby instilling an increased sense of connection and participation to the music. For instance, in my work "Vitamin S" (track 6), the arpeggiator onboard the "Albino" virtual synthesizer produces an ostinato that changes between 2 chords, every 4 bars (Figure 1). The listener should quickly understand that the harmony of this song only consists of two alternating chords (C minor and D minor 7b5) and be familiarized with the arpeggiator's very basic sequence after the second cycle of the sequence. Accordingly, the listener would internalize this ostinato, and then predict/know the arpeggiated musical phrase that continues throughout the track (from 0:51-2:05 and then again from 2:26-4:15), to latch onto that phrase by possibly humming along with the ostinato, or, with physical movement that reflects the rhythm of the looping 8^{th}-note sequence in real time.

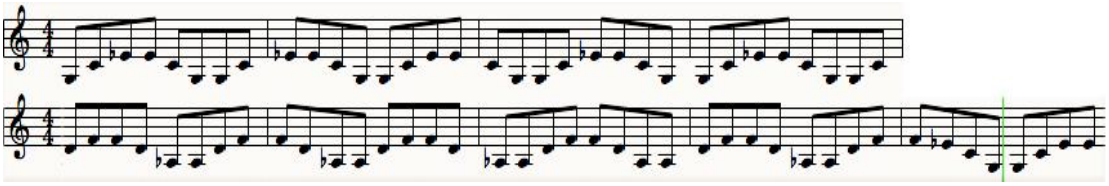

Figure 1. The Arpeggiation Pattern in "Vitamin S."

In her book, "On Repeat: How Music Plays The Mind", Elizabeth Margulis clarifies how predictability through repetition changes the way music is experienced:

> When temporal ordering is fixed, repetition welds the distinct component occurrences together into inseparable chunks, such that perceivers "listen ahead," with the expectation for forthcoming events literally alive in the present moment—expectations that are felt and experienced rather than cognized or articulated (Ibid., 172).

In other words, repetition begets predictability. The more predictable the music, the more music can be experienced and felt.

Repetitions are fundamental in dance music as they serve the practical purpose of allowing people to latch onto predictable phrases so they can participate in the dancing without being jolted by unexpected musical events. This socially inclusive feature of the music allows a neophyte to partake in dancing to a song he may have never heard before, with people he may have never met before, with little difficulty or inhibition, and therefore this musical attribute strengthens and promotes social bonding among the participants. The arpeggiator stands out as an instrument that enables this inclusivity because the looping phrases tend to be one, two or four bar loops, allowing participants to predict where the pattern will loop, rather than wait for whole sections of music to start or end.[40] The more repetitive, the more inclusive the experience can be, simply because repetitive musical events are easy to learn, predict and

[40] Changes in EDM structure, melody or layers "occur on multiples of four—either four beats, four bars, eight bars, 32 bars or more (Garcia 2005) Thus, the arpeggiator works perfectly in this model due to the propensity of 2 or 4 bar loops within arpeggiator.

therefore participate in. Hence, “repeatability in songs become property of a group or community instead of an individual” (Ibid., 30), which is why repetition is a key component of secular and spiritual ritual.

The aesthetics of this type of repetition that promotes shareability has a foundation in the socio-cultural associations of rhythm and dance in African diasporic culture, where musical individuality emerges from participation by way of contributing into an overlapping structure of repeating rhythmic patterns, so that personalized expressions can occur (Monson 1999, 51) (as described in chapter 3.2.2 with regard to jamming). There are continuities between communal bond, ritual structure and the shared musical experience that repetitions enable: “In music, random improvisation and imprecision spoil the delicate structure of rhythms, and in society, random expressions spoil the delicate structure of communication” (Chernoff 1979, 167). These are undeniable continuities from the aesthetics of participatory African ritual and EDM trope. In fact, some of the earliest forms of underground dance music can be classified as “soulful” because of the overt connections to African-American musical traditions--many of which have a strong foundation in gospel musical qualities and the ritualized participatory activities of worship that not only became standardized in the Black church, but are also a fundamental aspect in the relationship between repetition and participation in African-American cultural expression (Snead 1990, 222). The manifestation of repetition in the Black church is apparent when observing how a minister strategically uses repetitions in spoken language to infuse rhythm and predictability to control a congregation’s focus and energy by repeating certain key words or themes (Ibid.). This enables the minister to control the pace of the proceedings and build intense crescendos that unifies the congregation’s energy into an intense peak, often resulting in the compulsion of many individual participants to express how they “feel the spirit” by dancing, “speaking in tongues” or “testifying” (Snead 1990, 223, Fikentscher 2000, 103).

The similarities (or rather, continuity) between the Black church and the relationship between the EDM record producer, DJ and dancer is uncanny.[41] The way the DJ controls the pace of the night organizing their playlist and manipulating the records to build towards unified emotional peaks (Fink 2005, 40)—an experience of shared energy among the group of participants in unison.

Unsurprisingly, there is a gravitation towards using instruments that loop, because repetition promotes the most fundamental aspects of Black expressive forms characterized by the "integration of song and dance, that is, synchronized movement to the music", where "dance and music become vehicles for individual and collective affirmation and celebration" as ritualized activity without clearly defined boundaries between the secular and spiritual (Fikentscher 1995, 94-101).

2.3.2. TRANCE, RITUAL, PREDICTABILITY AND PARTICIPATION

Unlike sacred or ceremonial dancing, which is believed to be the foundation for all dance (Kilbride and Algoso 1979, 5), social dance can be defined as the gathering of a mixed group of people into a collective, social bond—brought together by the physicality and energy of the act of dancing (and its surroundings). Accordingly, the sense of community is cultivated in venues where EDM is played via dancing to a central source of rhythm, where participants can experience and share "euphoria of joint, synchronized movement" (Margulis 2014, 140) that is common in ritual (Koelsh 2010). However, the initial attraction of underground dance music can be simply

[41] Gospel-styled organ playing, vocal delivery and lyrical content with references to "Him," "Praise," "The Light," "The Spirit", etc. is prevalent in the music of important house music producers and artists, such as the music of Kenny Bobien, Michelle Weeks, Tony Humphries, Marlon D. and many others. Even early techno producers were acknowledging ties to the church as exemplified by Inner City's 1992 releases of "Let it Reign" and "Hallelujah", Octave One's 1995 "I Believe," Model 500's 1993 "I See the Light," just to name a few (Sicko 2010, 108).

explained as teenage kids wanting to find escape and release through music (Sicko 2010, 13). Even so, the socio-cultural activities surrounding underground EDM are an organic extension of gospel. Such activities have evolved from the Ring Shout, Hoodoo and (West) African possession rituals (Sylvan 2002)[42] and therefore share qualities that also breed similar physical reactions in their participants: "Because of the high amplification and pounding insistence of the house music beats, which are felt in the body as much as they are heard by the ears, the groove is often compelling to the point of trance induction for the dancers" (Sylvan 2002, 119). Moreover, according to the research of Elizabeth Margulis, familiarity of repeated music has the tendency to:

> […] Induce dissociation from surroundings paired with a deep absorption with sounding music because unfamiliar sounds raise vigilance and conscious awareness, elements antithetical to trance. The more familiar a piece is, the more a listener can respond automatically, allowing for the suppression of explicit thought and an increased sense of bodily involvement with the music (Margulis 2014, 163).

Prolonged exposure to loud, drum-heavy repetitive music; the interlocking polyrhythms of layered repeating riffs and loops; the disorienting lighting of clubs and raves; communal gatherings towards a unified experience; and the prevalence of psychedelic narcotics are aspects of EDM trope that foster the altering of a participant's self-awareness by reducing certain cognitive processes, such as inner language and explicit memory via sensory stimulation and depravation (Crowe 2004, 313). A listener's perception of time can be affected by the fact that EDM's looping phrases that gradually fade in and out have no clear beginning or end. This is another factor as to the hypnotic effect of repetitious music. Essentially, these "agents of destabilization and patterning are psychophysiological manipulations of the human brain"

[42] The deep house scene, in particular, is rife with connections to hybrid/diasporic cultural practices of Hoodoo and Santeria. Not just because there are DJs and producers who practice the Santeria, but also evidenced by record labels, song themes and parties that adopt some of the same language from Yoruba--most obvious being Yoruba Soul Records. and Ocha Records, dance parties such as "Bembe," and lyrics or song titles that mention Orishas and other elements of these cultures.

(Ibid.).[43] The use of repetitive passages of music in ritual to alter states of consciousness is common in many cultures, including traditional shaman techniques that incorporate repetitive loud drumming to produce alpha brain wave shifts in participants during ritual (Ibid., 315).

The trancelike state of participants is not a coincidental by-product of dance music. Rather, falling into a trancelike state is seen as one of the goals of party-goers, where religious and spiritual terminology is often referenced to describe how participants "lose themselves in the music" (Sylvan 2002, 119-124). The trope cultivated around enabling this sense of unity and affirmation where audience and performer merge into one, not only goes back to the first proto-disco underground dance music venues of New York's loft scene, but also has traces throughout the African diasporic tradition where musical repetitions help in fostering a "sense of boundary-collapsing communication that can awaken a range of experiences" (Margulis 2014, 178) in the participants. Thus, the arpeggiator proves to be a perfect instrument to cultivate a trancelike receptive state as it can introduce seemingly endless repetitions into a musical production or performance.

[43] See *Shamanism: The Neural Ecology of Consciousness and Healing* (Winkelman 2000).

2.4. Arrangement And Form: Non-Teleological Trajectories

A work of dance music comprised of looping musical objects, such as arpeggios and ostinatos, harbours a subjectivity that "emphasizes a certain non-teleological attitude, intimating that something within that sound itself, rather than an aim toward which things are driving" (Margulis 2014, 141) should be the focus of attention—"the particularity of Black music—that it draws attention to its own repetitions" (Snead 1990, 222). In contrast, a lot of European art music traditionally is structured around *classical teleology,* demonstrated by a clear narrative outlined by a harmonic or melodic developmental trajectory toward a goal.[44]

An EDM composition, however, is produced using technology that favours the loop. The combination of the looping objects becomes the subject of the work--where teleological build is defined mostly by textural changes, or subtle alterations to the looping objects, eventually culminating towards peaks and climaxes of energy that unfold in a manner beyond a traditional song-based time scale: what Robert Fink describes as *recombinant teleology* (Fink 2005). The music does not necessarily need to "go anywhere"; however, over the span of night, the energy of the musical *experience* does. As such, "highly repetitious melodies produce a hypnotic effect. The music always fulfills our most basic subconscious expectations about how a phrase will round out. Instead of being jarred by unexpected shifts, we are lulled into a receptive state" (Miller 1999, 268), allowing the producer and the DJ to physically affect the captive listener by building tension and climaxes using any combination of:

- Slowly changing the textures of these loops via filters, equalizers and effects (such as digital delays that add more repeating polyrhythmic layers to the music).

[44] Western classical or rock music that often builds towards the *climax* or resolving on the *tonic* would be a perfect example of teleological song.

- Adding or subtracting more looping objects to the music (see accumulative form, and combinatory presentation in section 2.4.1).
- Changing the notes of the looping phrases to create very subtle variations that impact the energy of the phrase.

These techniques have been used in house music since before house music was a clearly defined genre. One only needs to listen to Georgio Moroder's production of Donna Summer's "I Feel Love" to understand how the texture of looping sequenced bass line, in conjunction with extended format (the song is 8:15 minutes long), use of 16^{th} and 8^{th}-note delays on top of the bass line (and panned to one side), and lack of classical teleology all combine to create a hypnotic piece of dance music (Baumgartel 2013) (Fink 2005). This methodology continued into present day EDM by way of producers' sampling and editing elements of disco, soul and electronic European music over drum machine loops; early techno producers' stripping electronic music elements down to their raw groove-inducing ingredients; and a 1980's Chicago style of underground dance music known as "Acid house."

The arpeggiator is the vehicle that many producers, including myself, use to build musical tensions and climaxes by establishing predictability in combination with changes of textures to the predictable phrase. For example, "Genetix Theme" (track 9) is built around a basic house groove and a repeating eight-bar chord progression (||: Dmin9 | Amin9 | F#min11 | FMaj7#11| Esus4 7| F#7#9 | B7alt | E7#9 :||) with no significant development until the introduction a two-bar loop consisting of a straight 16^{th}-note arpeggiation at 2:33 (see Figure 2). At that point, the arpeggiated 16^{th} notes, doubled by a tambourine, energize the track. This energy begins to grow as the

texture of the arpeggiated synth becomes increasingly altered via tweaking of the filters and resonance.[45]

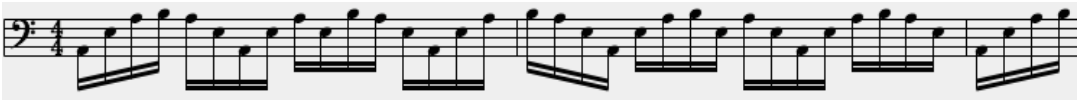

Figure 2. Arpeggiator pattern in "Genetix Theme."

From 4:08 until roughly 6:50, the synthesizer's arpeggiated textures and amplitude, shaped by the constant flux of resonance vs. low pass filter, cut off and varying levels of harmonic dissonances, which the arpeggiator outputs under the superimposed chords, dictate the amount of energy that "Genetix Theme" creates.[46] The music does not develop in the same way a story unfolds in a classical work of music: instead, the predictability of the looping phrases invites the listeners to embody the music on a more subjective stratum, where they can (virtually) ride the looping 16th notes for over four minutes through the various peaks and valleys of energy.

Similarly, the arpeggiator on "Praying For Rain (dub)" (track 4) is the foundation of the track. As is the case with many tracks built off a loop, the arpeggiator redefines a sense of trajectory away from being a linear forward-moving development, to a gradually building cyclical motion—a recycling hypnotic form of forward momentum while remaining in the same place, where only the introduction of gradual changes creates momentum. The gradual injection of slight changes in texture, in conjunction with subtle alterations of the ostinato is an example of patterning and disruption that can have physical effects on the participant. In songs such as "Praying for Rain," I purposely create and disrupt patterns in ways that lull or jolt a listener in a manner affecting how connected they are to the track at various stages of the

[45] The tweaking of the synthesizer is in conducted in the tradition style of 1980s acid house.
[46] There are also additional percussion sounds and subtle changes in the layers on top of the arpeggiator that also complement the overall energy changes of the track.

listening experience. I not only tweak the filters and cut off frequencies of the arpeggiator during the whole piece to introduce changes of energy, but also change the pattern of the phrase by triggering notes of the chord at varying points throughout the arrangement. The preset configuration of the arpeggiator ensures that the groove does not get too varied in a way that would intervene with the dancer's ability to ride the hypnotic rhythm, however, by triggering the chord on different beats, subtle changes are added to the original ostinato (as illustrated in Figures 13 and 14) in ways that alter the energy of the piece and more so, at the listener's level of musical immersion without losing energy of the pattern.

This recombinant teleology is typical of instrumental dance tracks that have minimal amounts of melody. This also exists in vocal/melodic EDM songs, such as my vocal record "Cultured Girl" (track 8), which is built around a cyclical chord progression that has no tension or release, nor does the composition have a clear distinction between verse and chorus. Instead, the song is built around two chords (F Major7 and F Minor7) and moves in a linear fashion: development being defined by the addition of musical elements to the arrangement. The inclusion of elements such as the bass line and the chordal comping, outlines a more extended harmony by transforming the two looping chords into upper voices for the four chords of D minor9, A♭ Maj7, G sus4, D♭ Maj7, while the harp-like arpeggiator and cello ostinato continue to outline the F Major7 and the F minor7. The contrast between the linear form and cycling harmony constantly tugs at the listener's perception of time. Repetitions fulfill the listener's predicted expectations but the new elements subtly re-contextualize these expectations. The two chords of "Cultured Girl" are revealed to be voicings of four chords, but there are enough musical elements creating an inclination in the listener's perception that the song is really based two chords: the song moves forward constantly, yet the piece ostensibly goes nowhere.

The arpeggiating synthesized harp (from 3:06 to 4:08) reinforces this perception as the notes used in the arpeggiating phrase are equally harmonically consonant to the F Major-F minor voices, as well as the four-chord enharmonic progression (D minor7, A♭Major7, Gsus, D♭Major7) at the same time.

2.4.1. Dance Music Form: (Ac)Cummulative And Combinatory

Dance music tends to feature minimal amount of melodic content and harmonic development therefore has a propensity to rely on changes of texture and timbre to define thematic development. For example: Drexciya's "Wavejumper", Underground Resistance "Base camp 808", Robert Hood's "Detroit: One Circle" all espouse traits where repetition experiences gradual timbre change. The way in which the timbres change over time can be perceived as the narrative of the musical work. Elizabeth Marguilis notes:

> If things are repeating but timbre is changing, timbral contrast becomes something the piece is "about—Ravel's Bolero is a good example. If notes and rhythms are repeating but the texture is changing, texture becomes highly marked and expressively relevant—Beethoven's 32 Variations in C minor (Margulis 2014, 177).

Techno and "minimal" forms of dance music, such as Robert Hood's "Detroit" listed above, often utilize the repeating arpeggiated phrase as the main anchor of their music, much like the minimalist music of Philip Glass, Terry Riley and Steven Reich. Whereas the music of these "New York" art music minimalists is often considered anti-teleological (Fink 2005), techno and "minimal" dance music use morphing arpeggios as tools for building tensions and climaxes within the pieces of music and as part of a DJs mix**.** However, these climaxes are not built around resolution, they are the result of an accumulative process of layering.

EDM follows a traditional element of African-American music, where groove is established via the layering of repeating short riffs (Butler 2014). In EDM, these repeating riffs are individual loops that are treated as stackable musical objects that accumulate and subtract over time to create varying levels of energy that subsequently defines musical development and structure. This type of musical arrangement can been referred to as "(ac)cumulative form"[47] [48] and has dominated the way EDM has been produced and arranged since the earliest Detroit techno and Chicago house productions(Butler 2006).[49] This type of musical construction can be heard across the African diaspora including traditional Afro-Cuban ensembles, where songs start with a single musician playing a looping rhythm, such as a son clave, until more musicians join in performing individual short repeating phrases on top of the looping son clave culminating into a dense climax of polyrhythms (see "Ritmo Nuevo" by Chaparro y Su Orquesta as an example**).**

Mainstream forms of EDM, including *trance* and *progressive house,* commonly employ multiple layers of arpeggiator patches to create this type of arrangement: for example, "Tilt vs. Paul Van Dyk – "Rendezvous (Quadraphonic Mix)" where different layers of arpeggiators are used simultaneously for the bass line, chordal comping and riffs on top of each other.[50] [51]

One of the by-products of accumulative form is how music tends to begin and end with fewer layers. Having drum breaks at the beginning and ending of records is standardized practice in EDM arrangement, and can be found in most of the records I produce. This is one of many examples of the symbiotic relationship between the DJ,

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[47] See Mark Spicer, "(Ac)Cumulative Form in Pop-Rock Music," *Twentieth-century music* 1 (2004): 33.

[48] Not to be confused with "cumulative song" where development occurs through addition of musical passages at the end of repeating verses a la "Twelve Days of Christmas."

[49] (Ac)cumulative form is very common in repetitive music in general, including "minimalist" music of Philip Glass, Steve Reich and Terry Riley (Mertens 2004).

[50] A comparable example would be the layered ostinatos of "Sly-Ed" (2000) by Man With No Name.

[51] Arpeggiations are easily recognized as a popular musical device used in EDM's *trance* subgenre.

who is entrusted with playing uninterrupted music, and the dancing audience, who has an expectation of seamless transitions between records, and the producer who makes creative decisions catering for the dancer and DJ by embracing repetition as a way to prolong sections of composition. All of which contributes to the "extended time format" of EDM, which ties into elements that mute self-awareness of the participants where the trajectory of energy throughout a night is not necessarily contained within each individual song played, but instead the overall mixed set of music that the DJ puts together.

This translates into an interesting compositional consideration for producers such as myself: we accept that our music is meant to be only one portion of a curated presentation, consisting of different artists and music. Simply put, "dance tracks came to be understood as representative of a wilfully incomplete form" (Sherburne 2004, 320), where musical objects are not only stacked to create the form of an individual piece of music, but are also intended to be combined with separate compositions during the performance of a DJ.

Almost all of my music follows a similar trajectory: gradual accumulation of layers towards the highest point of energy materializing as the "climactic accumulation of riffs into a texturally thick groove" (Garcia 2005), followed by the practice of reversing the order of development.[52]

Arpeggiation, by definition, is a musical phrase that repeats; therefore it is of no surprise that a traditional musical convention that repeats would be utilized in repetitive music such as dance music or minimal music. However, the arpeggiator not only fits within EDM's repetitive formulas, but more so re-affirms aesthetic clichés of dance music. For example, we can use my work "Memories" (track 3) to illustrate how the arpeggiator's ostinato bass-line creates groove and provides variance in

[52] However, I will often introduce some variance to the reversing of development by introducing new riffs (such as the melody in "Memories (track 3) which can be heard starting at 6:30). Another common practice is to retain specific layers that were introduced half way through the track (as opposed to subtracting them), such the arpeggiator line of "C.T.S Haunted Discotheque" (track 12). This gives sense of thematic consistency to the work.

energy, while serving as the musical anchor for the accumulation of musical layers to build on top. In other words, the arpeggiator acts as an agency for the injection of musical repetition that permits musical form to be constructed.

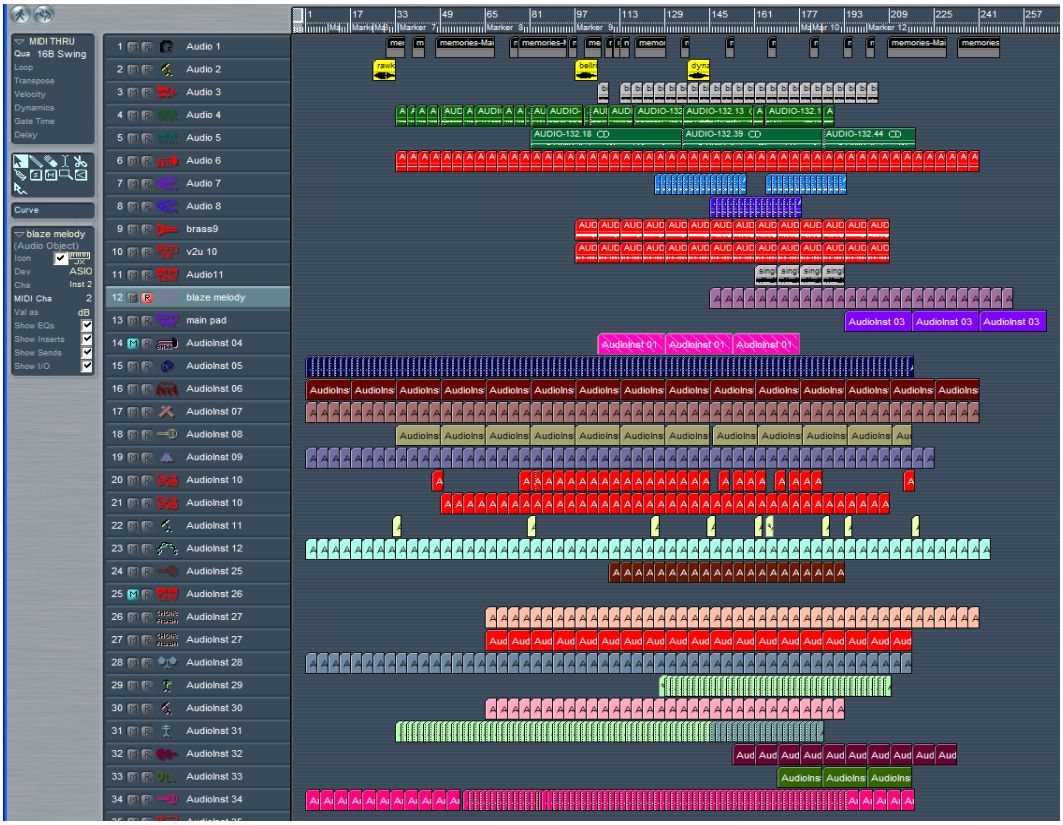

Figure 3. The arrange page of "Memories".

"Memories" has been mapped into a reduction of its accumulating loops to illustrate how the process of gradual accumulation of a relatively small number of loops creates a musical trajectory and forms the piece (see Figure 3). "Memories" follows the archetypical techno formula where "repetitive sonic patterns dominate the music, and the rate of change is slow. Music development in a techno track consists of the building of layers, becoming more syncopated and complex, all the while layers gradually enter and exit" (Price 2010, 942).[53]

[53] The techno side of EDM heavily influences "Memories"—both in the use of certain synth sounds (such as the synth stabs, the tweaking filters of arpeggiator, and resonating sub bass), its static harmony, and in the way the arrangement unfolds through the gradual building of layers.

The arpeggiator stands out from all of the other instruments in "Memories" as being fundamental to the thematic cohesion and development of the composition: the arpeggiated bass ostinato repeats the same phrase for almost the entire piece. However, the methodology employed to alter the arpeggiator's sonic qualities through real-time manipulation of the cut-off and resonant frequencies of applied EQ filtering gives the listener a sense of motivic development. There is a perception that the music is on a trajectory building towards a climax because of the way this looping arpeggiator phrase gets "tweaked" at an increased amount over time. The arpeggiator's phrase is manipulated sonically as opposed to melodically, to create the "changing same" (see section 2.3). The track continues to grow in energy, even though the song revolves around only two chords. Added layers of percussion contribute to the momentum of the work, as the groove becomes increasingly emphatic as each rhythmic element is added. Chords slowly fade in on top of percussion phrases to strengthen the cyclical rhythm while simultaneously reinforcing the harmony of the song. Even without any significant voice leading, there is an expectation of climax due to the steady accumulating of layers on top of the arpeggiator. However, before a full climax is realized, layers begin to be subtracted from the arrangement, starting with the removal of the chordal comping at 6:01. Layers of percussion, such as cymbals and shakers, are slowly removed one at a time. A mellow breathy synthesizer introduces a looping two-bar melodic figure at 6:03 that slowly becomes isolated as more and more layers are subtracted from the arrangement, slowly thinning out the piece. The overall energy of the work during the outro is in obvious retrograde as the arpeggiator grows increasingly muted, until the arpeggiator is completely removed from the arrangement near the closing stages of the piece at 6:56.[54] In this sense, the arpeggiator is not only important as a melodic motif of the piece, but also as part of the rhythm section—a core purpose of the arpeggiator.

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[54] In EDM, outros are commonly defined by a marked decrease in layers of instrumentation.

The removal of the arpeggiator along with the more energetic percussion elements brings down the momentum of the song. The purpose of the thinning out of layers is not just a matter of ending the work; rather, it is based on the understanding of the format of the work and how it will be presented: the thinning out of the layers within a musical arrangement permits the DJ to slowly combine two records together by mixing another record into, in this case, the outro of "Memories."

This decision to accept that your music will be presented in a *combinatory* format (Sherburne 2004, 320) (see section 2.4.1) via DJ selection manifests in creative ways. For example, in "Supernova" (track 14), after the second break starting at 4:20, the energy drops as I remove most of the elements that make up the groove; only the kick and Roland 909 percussion are left to state the core pulse and rhythm. The vocals, consisting of a simple repeating hook enter, followed by different elements fading in and out, such as the harp-like arpeggiator outlining a B-flat Minor chord, followed by a five-note Giorgio Moroder-influenced arpeggiating bass-line sequence at around 5:50 (with very pronounced staccato delay effects adding rhythmic complexity and movement to the relatively basic bass line). While this section adds a refreshing deviation from the established structure of "Supernova" as the Song's "C" section, the impetus behind this vamp-out is so that DJs can either let it play out towards the outro, or they can get creative and mix a new record into this section.

In the case of "Supernova," the harmony during the vamp becomes static, giving the DJ more options to find complementary records to mix with. The chord progression and bass line of the verse section is replaced by single bar repeating objects. The arpeggiator in this case is the only multi-bar phrase, which helps prolong the static harmony by spanning its repeating pattern over two octaves, pushing the music forward and giving it a sense of "forward motion and impetus" (Dean 2009, 165). Functionally speaking, this section, with its short repeating objects that fade in and out and heavily echoed effects

and instruments, is relatively open-ended giving the DJ many possible start points to creep their next record in, rather than be trapped into cueing their music within a sixteen bar verse or eight-bar chorus structure. Similar to how repetitious music encourages interaction from dancers, repetitious music also enables the injection of other musical elements from the DJ as the looping objects create the order and backbone for artistic expression: “the modern club DJ is not so much presenting discrete records as combining them to make something new” (Brewster and Broughton 2006, 26). As a producer, the aesthetics of musical form is influenced by the ultimate function of the song. In this way, tools, such as arpeggiators and the methodology employed towards these tools to successfully enable function, become standardized in EDM.

2.5. Arpeggiator Aesthetics = Electronic Music Aesthetics

Electronic music is a broad musical term that refers to any form of music consisting of sounds produced by oscillating electric currents either controlled from an instrument panel or keyboard or pre-recorded on magnetic tape (Collins and d'Escrivan 2007). That is to say, making music with an electronic instrument that can (re)produce and (re)organize sound (such as a synthesizer or sampler) is all that is needed to define music as “electronic”. However, these instruments are more than mere neutral tools for production: their capabilities and limitations are defining characteristics of the musical output itself because they provide compositional options to the composer in the form of a sonic and timbral language that does not exist in the world of acoustic music. Many of these characteristics have remained constant throughout the technological advancement of electronic musical instruments and are found in practically every music genre and subgenre from the 1950’s to the latest incarnation of EDM.

The arpeggiator can be employed as part of an electronic music production kit; however, a single arpeggiator is all one needs to create a *bona fide* piece of electronic music—either in real time, or by layering/overdubbing different recorded takes of arpeggiated patterns from the unit without the use of other instruments, such is the case with Vangelis' "Spiral" on RCA (1977).

Table 5 demonstrates that the most common facets of EDM are also present in a typical arpeggiator unit. Such characteristics are so unmistakably "electronic" that employing a single unit in an otherwise acoustic ensemble instantly impacts the way the ensemble's music would be classified. For example, returning to Herbie Hancock's 1974 recording "Nobu," Hancock is improvising over a rhythmic track courtesy of the sample and hold feature on an Arp 2600 (Vladimir Bogdanov, Chris Voodstra, and Erlewine 2002) that many synthesizers and (their) arpeggiators, such as the PPG Wave 2.2, or the Zebra2 virtual synth, can be programmed to imitate through randomization and sound shaping. Stylistically, his soloing is not unlike a typical solo you would hear from him on jazz recordings. Yet, the synthetic repeating rhythmic output from the Arp 2600 renders "Nobu" as an almost unclassifiable form of proto-techno[55] jazz fusion on records unavailable outside of Japan until the advent of online record stores.

[55] To further this point, well respected Detroit DJ Theo Parrish often includes this record in his live DJ sets, mixed with house and techno music (see mixed CD: Theo Parrish "Yellow Double Lines").

Table 1. Arpeggiator traits as EDM traits.

EDM Traits	Arpeggiator Traits
Unnatural/synthetic sounds	Unnatural/synthetic sounds
Repetitive rhythmic patterned-based music	Outputs Repetitive rhythmic patterns
Reliance on electronic studio equipment/ instrumentation and/or computers	A piece of electronic hardware. Often a module on a synthesizer or as a virtual plug-in
Rhythmically very precise	Timing is synched to clock, thus timing is very precise

Conversely, an instrument that is traditionally associated with jazz, such as a saxophone, can be employed in rock music without diluting the song's authentic rock aesthetics (see: The Rolling Stones' "Brown Sugar" or Bruce Springsteen's "Born To Run"). However, one would never find an arpeggiator in a traditional jazz ensemble. This is not merely because the arpeggiator is electronic in an otherwise acoustic band. Rather, this is due to the arpeggiator's footprint being so contextually "electro(nic)" (both sonically, and the way one interacts with it) that it becomes impossible to insert the instrument into a jazz ensemble format without trampling over customary practices of the ensemble's idiom. Synthesizers have featured in jazz recordings for decades without the need for new sections in record stores to be devoted to them (as long as they are used as instruments for soloing or layering),[56] while drum machines and all manner of synthesizers and effect processors have been fully adopted by pop, rock and RnB production practices since the second half of the twentieth century. This is not the case with arpeggiators. Adding an arpeggiator or "arpeggiator-esque" elements to a musical work to provide or strengthen the groove will often result in the music being acknowledged as having some form of "electro" "techno," "dance,"

[56] See Miles Davis, Chick Corea, Joe Sample and a multitude of ECM recordings that feature synthesizers.

"industrial" or "futuristic" influence (with very few exceptions), the same way that adding a sitar to a jazz or rock ensemble changes the perception of the music as now having an Indian/spiritual/psychedelic influence.[57]

Some examples of arpeggiators having a significant influence over a song's aesthetics:

- John Foxx "No One Driving" (1980).
- Cerrone "Supernature" (1977)
- Sparks "Beat the Clock" (1979)
- Orchestral Manoeuvres in the Dark (OMD) "Messages," "Maid of New Orleans" and "Enola Gay" (1980)
- Depeche Mode "New Life" and "Sometimes I wish I was dead" (1981)
- New Order "Blue Monday" (latched arpeggiator figures are from the Arp Quadra) "Temptation" and "Confusion" (1987)
- Japan "Ghosts" (1981)
- Yazoo "Don't Go" and "Only You" (1982)
- Eurythmics "Love is a Stranger" "Here comes the rain again" and "Sweet Dreams" (1983)
- Heaven 17 "Temptation" (1983)
- Pet Shop Boys "Opportunities" (1986)
- Kraftwerk "Autobahn" (1974)
- The Normal "T.V.O.D" and "Warm "Leatherette" (influenced by Moroder and Kraftwerk) (1978)
- The Human League "4JG" (1977)
- Throbbing Gristle "Still Walking" (arpeggiator is the source of rhythm on very experimental track) and "Hot on the Heals of Love" (practically disco) (1979)
- Fad Gadget "Back to Nature" (1979)
- Visage "Fade to Grey" (1980)
- The Human League "Don't You Want Me" (1981)
- Philip Oakey & Giorgio Moroder "Together in Electric Dreams" (1984)
- Duran Duran "Rio" "Hold back the rain" "Save a prayer" (1983)
- Fabio Frizzi "Zombi 2" (1979/2012)
- BBC Radiophonic Workshop "A Retrospective"(2008)
- Vangelis "Spiral" (1977)
- Cyndi Lauper "Girls Just Want To Have Fun" (1983)

[57] The way in which an arpeggiator is used in music will directly affect the strength of this point. For instance, 1980s pop acts such as Duran Duran's used arpeggiators to add texture as well as a layer for rhythm in songs like "Rio." While they are not a "dance" act, "punk" or "industrial," they were one of the flagship bands that popularized the New Wave sound of the UK that emerged from England's dance club scene that had already embraced electronic music and the influence of American dance music (Whalley 2009).

- Queen “Action To This Day" &” Las Palabras De Amor” (1982)
- Images In Vogue "Lust For Love” (1983)
- Cajmere feat. Dajae “Satisfy” (2013)
- Herb Alpert “Beyond” (1980)
- Frankie Knuckles “Your love” (1987)
- Master at Work “Voices” (1994)

Many rock & roll artists implement arpeggiators, however they end up being used for special effects, such as The Who’s “Baba O’Reiley” (1971) who used the organ reiteration feature to imitate the music of minimalist composer Terry O’Reiley (Rowley 2005)**,** or Pink Floyd’s “On the Run.” Otherwise, they tend to be featured on songs built from four-on-the-floor or dance grooves, such as Talking Heads’ “Once in a life time,” Paul McCartney’s 1980 release “Secret Friend,” The Who’s “Eminence Front” (arguably their funkiest song) and Hall & Oates’ aforementioned “Out of Touch.”

In fact, it is difficult to compile a list of “unquestionably pure” rock songs that featured an arpeggiator (as demonstrated by the list above), as there seems to always be a link to either dance music grooves or highly conceptualized electronic music influence à la Jean Michelle Jarre.[58]

Employing an arpeggiator as an element of composition, not only facilitates the process of music making, but also colours the music aesthetically, in a matter that is representational of electronic music as a whole. In fact, by adding an arpeggiator to a work of music, the piece becomes formalized as, either “electronic” music outright, or, at a bare minimum, falling under an “electro” or “techno” influence—more so than just using a drum machine or adding a synthesizer to a production.

[58] Barring a few exceptions (which could include Alan Parsons Project’s 1981 release “Games People Play”), the only way arpeggiators avoid “un-rocking” songs is when they are only used marginally in certain sections of songs, such as the intro of Rush’s “The Weapon” and the bridge of Queen’s “Action This Day”.

3. Creative Impetus and Creative Results from Interacting with Arpeggiators.

3.1. Inspirational Tool or Compositional Crutch?

The arpeggiator facilitates musical creativity encompassing all manner of sonic organization by promoting the combination of the processes of composition, improvisation, production and performance.

Most of my musical work, and certainly every composition accompanying this paper, incorporates the aforementioned processes. Therefore, in order to frame the discussion about my work correctly, defining the processes of improvisation, composition, performance and production is a necessary first step.

When used as a musical term, "performance" is the act of playing, creating and organizing sound into music in a free flowing uninterrupted physical operation. Performance is the action and expression whereby a composition is rendered, or an improvisation executed. This leads to the challenging step of addressing the difference between improvisation and composition without changing the scope of this paper.[59] My perspective on this matter is informed by my experience as a musician of the modern jazz and classical forms. As such, the primary distinction between improvisation and composition that I subscribe to lies in temporal difference: improvisation happens in real time along a continuum, and is therefore intrinsically linked to action of performance. Composition, on the other hand, is a process that can occur separately from the act of performance. Therefore composition is a process often divorced from a (linear) continuum, which consequentially permits a work in progress to be interrupted for contemplation and alterations. For

[59] For a more in-depth investigation into composition vs improvisation, see "Thoughts on Improvisation: A Comparative Approach" (Nettl, 1974), "The Semiotics of Improvisation: The Pragmatics of musical and verbal performance" (Sawyer, 1996) and "Saying Something: Jazz Improvisation and Interaction." (Monson, 1996).

instance, composing can occur over an indefinite number of "writing" sessions, allowing for reviewing and editing (correcting, revising and eliminating) previously composed content—all of which is impossible to do while improvising because improvisation is the creation of music *as* the sonic events are being created: each note performed is instantly and irreversibly "printed" as an element towards a presented product in real time. Improvising is an action of commitment where generating a perceived sound is equal to publishing a composition.

The line between composition and improvisation is blurry at best of times, and even more so when technology is factored in—advancements in technology for recording, sound creation, programming, editing and processing enables content to be performed and recorded in real time, and then edited/manipulated in a separate session. Equally, the manipulation of sound can take place during the performance in real time *as* part of the performance. Either way, the manipulated sound is a component of the completed piece and therefore adds a layer of discussion to the improvisation/composition dichotomy.

All manner of sonic organization and manipulation traditionally falls under the auspices of "production." However, electronic music, at its core, is a music created by processes of production more centrally than any other process—where technical mastery of the tools that create and manipulate sound is as important as the trait of musicality, and, *more* important than mastery of traditional musical instruments and theoretical knowledge. Furthermore, the tools for manipulation of sound can also be used as tools for musical expression in the same manner as a traditional musical instrument is "played" (Hebdige 1987). In fact, audio manipulation has become an increasingly important factor in the arrangement of sonic events constituting a finalized piece of music—so much so that the use of the technology as musical expression is often responsible for the fundamental ingredients of

compositions. This has led to the re-defining of the compositional process altogether; due to the proliferation of electronic and digital audio tools and instrumentation across countless genres of music, aspects of compositional process have grown to be indistinguishable from processes of production.[60] Tools of production such as the arpeggiator bestow additional dimensions to the creative process by any combination of:

- Providing instant musical inspiration in tandem with improvisation.
- Acting *as* the platform or instrument for improvisation.
- Creating and organizing musical content.
- Being a crucial instrument of a meticulously planned process occurring outside of a real-time continuum.[61]

With regards to my work, and the work of musicians who have influenced me, the processes and tools of production are intrinsically embedded within the process of composition, improvisation and performance.
In the following subsections, the arpeggiator will be discussed as a tool that introduced a new approach to performance, opening the door to interactive processes of composition and production where humanly unplayable passages of music became *bona fide* musical content, empowering musicians and defining the musical landscape of the lineage to which my music belongs.

3.2.1. INTERACTION

The ability to play along with automated sequenced musical phrases predates the "electronic organ arpeggio effect" by way of the arpeggiator's previous incarnations in the form of the programmable step sequencer, as well as the "sample and hold" feature available on various analogue synthesizers (as

[60] Some overlapping concepts can be drawn from "process music" of the 1960s. However, the divergence from a production process can be traced to approaches of practice, instruction and control.
[61] This includes everything from changing sonic quality of recordings to sound creation to programming automated rhythmic sequences to be injected as a layer into a work in progress.

demonstrated by Herbie Hancock's recording of "Nobu" from his 1974 CBS album, "Dedication"). However, arpeggiators have a real-time performance application**,** which further advances man-machine interactivity—where the instrument (a synthesizer in most cases) takes real-time performed input and instantly creates a completely different organized sonic output from that information—promoting and inspiring further creative output from the musician. Moreover, arpeggiators offer a form of sequencing without requiring you to decide what the sequence will be beforehand: "Jamming along to an arpeggiator can be an exhilarating experience, since you have the freedom to change chords or time signature at will" (Ward 1996).

3.2.2. JAMMING

"Jamming" is a process that describes musical interactivity; traditionally inferring multiple musicians playing live together**,** where much of the musical content includes ad-libbing, riffing or improvising over an understood set of constraints and parameters (such as a 12 bar blues shuffle in F) while feeding off of each other's musical output in real time. In an EDM context, jamming specifically describes music making that occurs "freely, against or "above" certain technological and musical constraints. When one is jamming, a recording device is rolling, and the music is repeating in constant, potentially endless loop-based cycles" (Butler 2014, 232).
Much like jamming or improvising in a traditional sense, one cannot revise. However, in EDM, the musician jams with the performance interfaces, and with ever-present recorded sound" (Ibid., 233).[62]

The jamming that Butler is referring to is a common practice belonging to performance as well as production and composition—where a musician has a

[62]"Recording" in this case includes MIDI recording, because this process extends beyond sonic material. Electronic composers record velocity and note information as MIDI data that can then be assigned to different sources of sound outside of real-time performance temporal constraints. This then blurs the line between performer, composer and producer.

section of a recorded (or produced) piece of music looping continuously**,** which the musician uses as foundation (sometimes referred to as a bed track, or a musical surface) for playing or composing on top of (in the manner of soloing or experimenting with chord progressions, melodies, percussion layers, musical development or more). The ad-libbing and improvisational processes within jamming, combined with inspiration musicians get from the instant feedback from the musical interaction with the performance interfaces, have proven to be pivotal for my own creative and compositional process.

In EDM, this approach to jamming often employs multi-track sequencers, samplers and previously recorded music tracks. However, an arpeggiator, with its innate auto looping and instant phrase creation**,** is also one of the most flexible performance interfaces used in this manner. As such, the arpeggiator is the perfect bridge between performance aide and an inspirational tool for creativity and composition.[63]

For myself and countless other musicians, the impetus for creative ideas during the process of musical composition or production often comes from exploratory phases of improvisation that employs this very same manner of jamming. Jamming with the arpeggiator has proven to be very inspirational for me as it provides immediate rhythmic, harmonic and sonic content, which can spark ideas from which to build a whole composition: the arpeggiator can fill-in, or even replace, the role of another musician much more inspirationally than other previously listed tools because it can follow my musical direction in real time while responding in turn by providing musical content. This content often manifests as a combination of (often pre-existing, pre-determined, or pre-programmed) elements, such as: the tempo, groove, or pattern sequence); musical surface (i.e., a bed track, which could include a bass line, ostinato,

[63] The arpeggiator can be used on its own (as the sole element of a bed track) or as one of multiple tracks or layers in a multi track sequence.

texture or percussion rhythm track); and building block (i.e., constructive elements for composition, such as a riff, motif, phrase or loop).
This interactivity is similar to traditional jamming in that the foundation for composition is often the consequence of a feedback loop of sorts: where the input from one musician inspires output from another, who responds with an inspiring output in return. As an interactive interface, the arpeggiator proves to be exceptional for the building of further musical objects and motifs by the performing musician.

3.3.1. Dichotomy of the Arpeggiator: Inspirational or Just a Shortcut?

The process of interacting with a machine such as the arpeggiator begs a crucial question: is such a process inspirational?
On a basic level, it is very easy to chalk the arpeggiator's usefulness up to the fact that the machine, and not a performing musician, is creating music content—a sort of "cheating" for lack of a better term. According to this line of thinking, the arpeggiator could be seen, not so much as being inspirational, but rather, as a type of short-cut for composition and performance. In fact, much of the criticism of electronic music is that producers of this type of music do not need to have talent because prevalent music tools such as the arpeggiator, the drum machine or the sequencer are often responsible for the performance of musical passages, and therefore *anyone* can make electronic music, including non-musicians. A related point along the same lines is that a fair amount of music production takes place outside a linear flow of time, or "real time," where notes can be drawn or programmed in a computer application one at time with ample opportunities for revision and editing—a luxury not afforded during real-time performance. This point of view is not totally without merit. To counter that argument, one can point to the large number of talented musicians that have delved quite heavily into the creation

of electronic music, exploiting tools of automation in order to take advantage of their expressive potential, rather than use them to make up for a lack of skill.[64]

Technology that enables automated performance does make it "easier" for people lacking musical technique to create music. This is more of a positive than a negative consequence of automation. Once we permit a machine to contribute a humanly unplayable passage into a musical performance the potential for a new musical landscape that includes the unnatural and the artificial is born-not just on an aesthetic level, but also in the social division of musical labour (Lysloff 2003, 45).

Musicianship is usually expressed through an action of performance, which can be considered more an agency of interpretation rather than an act of raw creativity. In traditional music, "virtuoso musicians are valued for their technical skills in performance in the way that athletes are valued for their speed, flexibility, control, stamina and power" (Ibid.). In other words, musical talent has often been equated to performance technique and proficiency—aspects that are tied to natural physical attributes and conditioning. However, arpeggiators (among other tools of performance technology) separate this intimate relationship between the physical attributes of the musician and the ability to create music from their instruments. For example, my own electronic music is rarely composed using any musical notation. Instead, my creative process primarily involves composing *with* the instruments directly as opposed to *for* an instrumentalist to interpret. In this way, physical ability is not responsible for creative expression. The action of performance in my electronic music is a labor of production and composition at the same time: if I cannot get the (organization and qualities of) sounds that I desire out of the instruments, then they will not exist in the composition. More importantly, I

[64] One would be hard pressed to question the talents of Herbie Hancock, Jan Hammer and Jean Michelle Jarre among countless proficient musicians who use tools for programming and automation in music.

often purposely choose to utilize an instrument (or a feature of an instrument such as the arpeggiator) that either has the ability to execute something that I cannot physically play, or has an innate characteristic that I want to exploit expressively and creatively. Automation via an arpeggiator or sequencer undermines the notion that musical talent is intrinsically linked to physical proficiency—"an ideology of human agency, individualism, and personal autonomy" (Ibid., 46) that has existed for centuries, towards prioritizing creativity. Creativity, as expressed through music, has found a tool in which artistic expression can bypass the artist's physical ability to perform it. This opens up seemingly endless possibilities of musical expression for trained and untrained musicians alike.

3.3.2. Weaving Temporal Structure as Musical Structure

Furthermore, if we take a closer look at the role that arpeggiators and sequencers play in the creative process, something interesting is revealed: inspiration, the spark of the human creativity, is in fact facilitated by the machine when we position some basic interconnected tenets, such as:

- The arpeggiator is a *performance* device—a tool for generating rhythmic patterns in "real time"
- Rhythm is the "central organizing structure of music… it organizes musical patterns in time. Rhythm is indispensable to music. Whereas rhythm can exist without melody or harmony, melody and harmony cannot exist without rhythm" (Michael H. Thaut, Pietro T. Trimarchie, and Parsons 2014, 429). Music, in accordance to Edgard Varèse, is organized sound (Goldman 1961). That is to say that music is only that in which we (subjectively) perceive to be music via the recognition of a grouping or organization of sonic material. How we organize

sound and perceive this organization is via rhythm—a task that an arpeggiator is designed to do.

The arpeggiator becomes a tool for inspiration and composition because of how it automatically generates a rhythmic phrase in real time by organizing (or reorganizing) sounds in succession, thus creating a musical element that enables improvisational interplay. When we hear a rhythmic phrase being played by the arpeggiator, our brain judges the temporal interval between each of the successively occurring musical units in the phrase (i.e., the duration of time elapsing between beats) and calculates, perceives or deciphers the meter, beat unit and tempo of the phrase from those interval durations almost instantly. This succession of sounds emanating from the arpeggiator creates the essential temporal fabric from which the structure of music can be created and perceived. Accents (more pronounced versus less pronounced units of sound within the phrase) can be identified within the phrase as well, which also aides in meter recognition.[65] All of these factors contribute to what we know as rhythm—the organizing structure of music.[66] By stringing a sequence of sonic units (such as notes) in succession, the arpeggiator defines (or reinforces an existing) musical structure in the temporal realm: a virtual rhythmic grid is established by the notes (and the spaces between them) in the arpeggiated phrase in real time. The specific positioning of the generated and sequential notes in that pattern (further) define the rhythmic meter, beat unit and tempo, while simultaneously outputting the notes as a musical phrase—giving instant movement to static chords, and life to musical ideas as an organized grouping of sounds. In other words, the arpeggiator has the ability to transform a single note, or chord, into a performed musical phrase, and in doing so, musical structure emerges (or is reinforced) *during* the performance of that pattern.

[65] Non-musicians also have the ability to perceive these listed elements of rhythm, albeit without using formal language to label them.
[66] For more on rhythmic perception, see (Michael H. Thaut, Pietro T. Trimarchie, and Parsons 2014).

The musical structure consisting of a pre-programmed rhythm manifests itself as a musical object, which then informs creative decisions pertaining to musical development by the performer in real time. This is not unlike the interaction that occurs in most jam sessions among musicians of music styles that incorporate improvisation.

When it comes to music that features improvisation, interplay between real-time expression and preexisting musical elements is a well-established custom of improvisation in general (Sawyer 2000).[67] The arpeggiated pattern defines and reinforces preexisting musical elements (such as key, tempo and meter). In electronic music, the arpeggiator not only adds a layer of musical content to a performance or composition, it also adds movement and energy to ideas, affording the creation of fundamental structure that can act as the foundation for improvisation and composition. This is more than just a machine rearranging notes for a musician lacking imagination: this is the epitome of an inspirational aide.

For musicians who utilize intuition as part of their compositional process such as myself, creativity and productivity can be accelerated with the use of the arpeggiator. For example, in 2004, while exploring one of my synthesizers, I came across an arpeggiating preset designed to sound similar to a guitarist performing a "chicken pickin'" technique (albeit with a very synthesized timbre quality) called "Picking_HS."[68] When I sustained an E♭ for four bars, the synthesizer's arpeggiator automatically reiterated the note, forming a groove that I liked very much (see Figure 4). To me, this experience of discovering an interesting preset on a synthesizer is sometimes comparable to

[67] A small list of some obvious examples of how improvisation often relies on some form of structural base include: jazz form and "standard" chord progressions; the modes and cycles of Indian classical music; the master drummer who creates the foundation for the African drumming group to improvise over.

[68] A guitar technique where notes are staccato and semi-muted at varying degrees throughout the performance (this specific example is similar to the guitar playing on the intro of Bill Wither's 1977 release on Columbia, "Lovely Day."

the musical discovery that occurs during a piano improvisation when I am allowing intuition to take control of my performance. Of course the difference being that I did not program this rhythm. Instead, the pattern was a factory preset programmed by sound designer Howard Scarr for *Access Virus* (Christoph Kemper 2000).

I quickly recorded sixteen bars of the pattern into my digital audio workstation (Logic Pro) where I could loop these sixteen bars over and over again to act as a musical surface for me to play along with in order to come up with a chord progression that would be consonant with the repeating notes:

[E♭-9 | F\G♭Maj7 | A♭-7 | B♭ Sus]

From there, my partner programmed the drums and percussion (minus the congas, which were performed by a percussionist and recorded live) to fit around the groove that had been generated by my arpeggiator. We then collaborated with a vocalist from New Jersey, named Stephanie Cooke; she wrote the lyrics and melody and phrased them to sit perfectly within our established rhythm and groove, in a manner melodically consonant to my chord progression. I then re-recorded the "Picking_HS" arpeggiator track, sustaining more notes during the sixteen-bar phrase (E♭ and B♭ and C), thereby creating more movement to the pattern and giving subtle variation within the arpeggiator's performance.

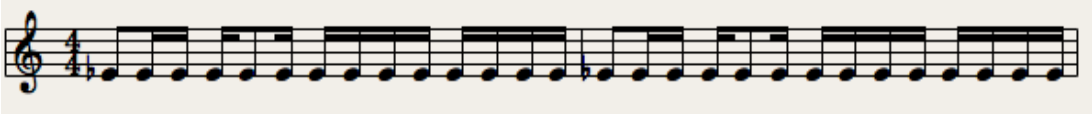

Figure 4. The original "pickin'" pattern that sparked the chord progression for "New Day."

It is interesting to note that the "Picking HS" arpeggiated patch adds to the groove and the overall rhythmic feel but does not feature prominently in the final product: my partner and I chose to keep that stem low in the mix, similar to how a rhythm track featuring a guitarist playing a muted riffs would be mixed on an soul or funk record

(such as Tom Browne's 1980 release "Funkin' for Jamaica" on Arista). Regardless, the fact of the matter is that the groove and rhythmic pattern of that repeating "E-flat" note was the spark that not only influenced my chord progression in terms of note choices, chordal voicings and harmonic movement, but acted as the original frame for me to place a chord progression within, thereby establishing a musical structure and context to compose harmony in an improvisational manner in the song's earliest stages. This in turn influenced decisions of production and melody further down the creative process. And, while I certainly had the ability to create the chord progression without the assistance of the arpeggiator, there is no question that the groove being outputted by the arpeggiator enabled an interaction akin to jamming with a guitar player with exceptional rhythm. Playing along with the phrase being looped over and over allowed me to follow my ear intuitively while employing a cognitive approach to assess my work in progress at the same time that I experimented with different chord progressions and voicings. Essentially, the arpeggiator performed a groove that facilitated the creation of my chord progression: the first layer contributing to a cohesive grouping of musical ideas and objects towards a composed work. In this case, a sustained whole note was transduced into a tangible underlying groove—a musical surface—which allowed me to perceive musical form, structure and frame for reference and equipped me with the ability to foresee further development of the composition.

3.4. Automated Content Contribution of the Apreggiator

The inspiration one can get when interacting with the arpeggiator can be traced to a number of factors: two of the most potent factors for myself, and for electronic music producers who compose in an improvisational manner, are automation and repetition. This section will examine how the arpeggiator uses automation to foster a unique creative perspective for the creation of EDM.

3.4.1. AUTOMATION: PROMOTING LISTENER ORIENTATION

Automation makes the presentation of numerous musical ideas over a rhythmic linear flow of time possible—affording the musician to feel and listen to (i.e., experience) creative ideas tangibly as they are being generated in real time. The automation of the arpeggiator's output enables the artist to step outside of their role as a performer and evaluate the generated pattern while it is ongoing in a manner more in line with being an audience member, than as a performing musician—a perspective Mark Butler observes in EDM and refers to as *listener orientation* (Butler 2014, 193). As stated previously, creative decisions are informed by what the arpeggiator is outputting, while the arpeggiator's output is dependent on the musician's output. This is the nature of interactivity: the performer's actions affect the machine's output, and the machine's actions affect the performer's output (Garnett 2001). The engaged arpeggiator is assigned to generating (i.e., playing or performing) the notes, freeing the musicians to concentrate on being a "listener," a role that allows them to focus on making creative/compositional choices based on what they are hearing and experiencing from the machine, rather than worrying about the exactness of their execution of the music being performed. It is in this way that the "technologies of electronically mediated performance make it possible for the performer to create and experience a musical event at the same time" (Butler 2014, 197-8) in ways that did not exist before electronic music. The arpeggiator is a perfect tool for this because it is an automated response to human action—translating and transforming any input via a keyboard/controller, whether it is a pre-planned concept or exploratory improvisation, into an automated musical contribution—often with surprising results for the artist. In my own experiences with the arpeggiator, these surprises manifest themselves as musical revelations, not unlike the events that I would experience when writing a melody, lyric or chord progression that resonates with me and gives me creative momentum.

This, however, is not a unique phenomenon for myself, nor is it an experience restricted to the production of EDM. Bands, producers, and artists across a wide spectrum of music from pop, to rock, to R&B, and more have made songs and records where a synthesizer's arpeggiator was a source for inspiration, or at least, an impetus for creating a song—some of which resulted in considerable commercial success.

A perfect account of how the arpeggiator can serve simultaneously as performance aide and inspirational tool was given by John Oates of Hall & Oates fame in a 2008 interview:

> I'm not much of a keyboard player, though I use it sometimes to write. For instance, I used the (Roland) JX-8P to write "Out of Touch." In fact, the JX-8P's arpeggiator is how I got the idea for that song. I was playing around with it, and I went, (sings 8th-note bass line) and I said, "There's a song!" Once I had that, I laid it down on a four-track recorder, and laid down some chords on top of it. Literally, that song was written because of the JX-8P (Schirz 2008).

Of note in Oates' statement is that he felt obliged to express his apparent lack of proficiency as a keyboard player, and in the next breath explains how he was "playing around" (an indication of aimless exploration), expressing that he believes the machine, not his musical skill was the main force for the composition. When one listens to the bass line of "Out of Touch" it is clear that Oates was playing (inputting) values of whole, half and quarter notes only.[69] However, the rhythm of the bass line is sounded out in 8th notes, which gives his song propulsion, both rhythmically and inspirationally. In Oates' scenario, the arpeggiator eliminated the problem of technical keyboard proficiency altogether, enabling a direct path to music creation. By "playing around" with the arpeggiator of the JX-8P, his elementary musical performance is instantly transformed into an inspiring bass line. This is an interesting example as it illustrates how the arpeggiator gave musical structure to a basic improvised performance by someone with limited keyboard playing technique in real time.

[69] The performance of the bass line generating keyboard being struck can be witnessed in the song's official video which demonstrates their sustained values verses the output sounded values.

In my own case, technology that enables me to take on the role of a listener, in fact, enables myself to *experience* the music in the same manner as someone who would hear the music without any personal attachment. I find this to be incredibly useful when making music that has a "functional" aspect to it such as dance music.[70] In EDM, DJs, producers and dancers have a physical and interactive relationship with the music (Butler 2006).[71] Automated content creation via arpeggiators and sequencers can be seen as an enabling facet of this interaction. The ability to interact with the musical work as a producer, composer, dancer, critic, DJ, and listener intermittently *while* the work is still in progress cannot be undervalued. For example, through the automated execution of an arpeggiator or sequencer, I can absorb the music I am hearing as a listener, divorcing myself from the work momentarily in the process. This helps me react as a genuine member of the audience would react to while listening to the music. Creative decisions based on this approach are aimed at complying with the expectations of a patron or DJ of this style of music with regards to form, aesthetics and arrangement.[72] This is in contrast to more traditional approaches to music creation that involve performing passages, whereas I find that I may "lose myself" while in the action of performance or creation, thereby not being the best judge for development, groove, or third-party audience interest. In other words, the chances of my music falling into self-indulgent (see: boring) territory are much greater while in the act of playing. Automation allows me to focus on experiencing the music with less ego, and therefore will have less tolerance for self-indulgent passages, or elements that get in the way of the function of the music (i.e., not having a good groove to dance to). I can seamlessly switch into the role of producer or composer, and add modification or development that keeps me as a listener or audience member interested while the work is in progress.

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[70] EDM's primary function is to be presented in clubs, discotheques and parties to keep people dancing uninterrupted for hours on end (Butler 2006).

[71] Dancers have an immediate physical expressive reaction to the music. DJs present and manipulate pre-existing dance music recordings in real time. Producers create music and manipulate instruments and studio equipment to create dance music in the studio

[72] I would argue that the "feeling" one gets while performing music can contrast significantly from the feeling one gets as a patron of a concert or dance venue.

3.4.2. AUTOMATION: SIMULATED MUSICAL REVELATIONS

When composing traditional/non-electronic music, I tend to refer to these events as musical discoveries because they often do not feel like creations. Instead, they are more akin to an uncovering of a musical object that already exists on a different plane.[73] This sensation is even more heightened when working with an arpeggiator by virtue of the fact that I am not responsible for executing or inventing the pattern. Of course, I do anticipate a response in the form of rhythmic reorganization of the inputted notes I have played, however the specifics of the resulting pattern, in combination with the sonic quality of the pattern, is, for the most part, unknown up until the arpeggiator executes the pattern. When I feel that the arpeggiator's output is agreeable to the musical direction of the work in progress, the result can influence and stimulate my compositional creativity, either as a musical spark, or as something that leads to changing or enhancing of the current direction of the work.

The injection of unplanned content in my compositions is an element of a man-machine input/output feedback loop, which often exists as a stage in my compositional or pre-compositional process. I frequently make a conscious decision for an arpeggiator to contribute to a groove or texture of which the specifics are unknown before deciding on a musical arrangement, key or melody. This will often manifest as a decision to "leave room for an arpeggiator" for aesthetic and utilitarian purposes as an early part of the compositional and production processes. For instance, I may commence the production of a work with the recording of a roughed-in drum track or chord progression. These early steps are often followed by a conscious decision to "add a layer of arpeggiation" without any preconceived notions besides the fact that it will be generated by a synthesizer. The next step would involve finding that it "fits" with what I have already laid down. The only pre-requisite for the

[73] The belief that composers "tap into" a piece of music that exists in some form of "ether" and reveal it by transducing it from one form of energy into something audible is subscribed to by countless artists. See *Talking Jazz* (Sidran 1992) .

arpeggiator would be that it either complements the current state and direction of the work, or gives me new ideas and momentum for the work. This methodology is more stimulating and rewarding when I approach the use of the arpeggiator without expectation, and where the rhythm or specific notes of the pattern are not preconceived in my imagination or "inner ear" at all, because the automated content being generated forces me to react creatively (often in unexpected ways) to what I hear emanating from the machine. This approach was used for the outro of track 14, "Supernova," (starting at 4:50, and then 5:48) and also in the "break" in track 2, "Kultured Suite" (at 4:06**)** as the idea in both works was to initiate a musical departure by "taking the compositions into outer space." I then accept that once I have found agreeable arpeggiators for those sections, the arpeggiators would dictate the direction the music would go in from there by giving me further ideas.

3.4.3. AUTOMATION: DIVORCING THE EGO FROM OWNERSHIP OF MUSICAL PHRASE

One of the more interesting side effects when surrendering an aspect of control over the content creation to the arpeggiator is how I am able to listen to the pattern with heightened objectivity and minimal ego clouding my judgment. Because the original pattern was not created by me, or dependent on my skills, I am essentially relieved from a sense of ownership of that specific content. If I am not responsible for the creation of the arpeggiator's content, then the content can be considered as its own entity: a pre-existing musical object that I am not overly attached to and, as such, is more disposable and modifiable to me. In fact, it is not uncommon for me to alter, re-program or even discard the arpeggiated line altogether after I have added more instruments and layers to the work in progress—a facet of the ongoing creative feedback loop when interacting with the arpeggiator. This can be demonstrated with my work "New Day" (CD track 5), where the arpeggiator provided a structure for me to compose on top of; however, when completed, the arpeggiated line is barely

audible. Other works, such as "Memories (Martino's Life on Earth Remix)" and "Praying For Rain (dub)" feature an arpeggiated preset from one of my hardware synthesizers that I felt obliged to tweak or alter, because the original factory-programmed pattern was such that it only served to give me a core idea. I modified the pattern and also modulated the filters and resonances of the preset so that the pattern would fit within the composition in a manner that suited my taste and the direction of the composition much better. It is practically an unwritten rule that factory-defined presets of synthesizers are expected to be altered. This practice of altering is also applied to arpeggiators as well, either by note choice, pattern, rhythm, or sonic alterations, which helps the producer to define their overall "sound."[74] When these presets involve an aspect of real-time rhythmic performance, a musician's role is easily divorced from the responsibility of performing the pattern. This often has the consequence of instilling a different sense of responsibility in the musician—a responsibility that traditionally falls under role of the producer: shaping the sounds of the work of music. The automated pattern exists on its own (with minimal input from the musician), and is presented to the artist, practically begging to be reshaped and modified by the artist. This is usually applicable when the configuration of the preset is already quite close to working as is. In the case of "Memories (Life on Earth Mix)", I liked the pattern and sonic quality as it came "out the box." However, I believed it would groove better with a subtle edit of the pattern, and with gradual manipulations of the sonic characteristics of the preset. After I recorded four bars of the pattern, I copied and pasted those four bars into 128 bars of that pattern. I then made an exact copy of that track, thereby having two separate layers of the exact same sound and pattern within my DAW. And on one of

[74] With that said, I also often use certain factory defaults from specific instruments as a way of associating my own sound with sounds that are native to famous synthesizers. By doing this, I appropriate an established lexicon of electronic music, which in turn gives context to my style of music. For example, a lot of the sounds on "Supernova" were presets on virtual analog synthesizers meant to emulate recognizable patches on vintage analog synthesizers, such as the Roland 909 drum machine, the Arp2600, and Modular Moog.

the copied layers I recorded myself altering the filters and resonances, panning the effects of that track. I then merged the two tracks together.

In this case, automation gave me the basic building block to inspire the compositional element of a bass line, which, as a producer, I then modified to express the musical direction of my vision for the work.

3.4.4. AUTOMATION: INTERACTIVE TOOL FOR CREATIVE INTER-REACTION

This man-machine input/output loop has been the foundation for whole pieces of music created by many artists of various styles. Original productions I have included in this paper, such as the previously mentioned "Memories (Martino's Life on Earth Remix)" and "Praying for Rain (dub)", are examples of works that were constructed around a core musical phrase (specifically, bass line ostinatos) that an arpeggiator was responsible for generating.[75] The scope of the arpeggiator's responsibility, however, goes beyond note choices and rhythmic phrases. More specifically, the arpeggiator's responsibility lies in how it is employed as a tool for the division of labour concerning music creation. Assigning responsibility to the arpeggiator empowers and expands my artistic expression. For example, if we look at the two afore mentions productions, the arpeggiator-contributed ostinato bass lines comply with parameters that I had already defined, such as tempo and key.[76] From there, once triggered, the arpeggiator went into action, and I went into reaction: reacting as a listener; inserting or discarding new ideas alongside or on top of the automated phrase until settling on something I chose to be complementary. The process is multi-pronged, and not only involves adding voices and layers as a composer and arranger, but also includes modifying the arpeggiated

[75] Technically speaking, the arpeggiated patterns of both of these songs were programmed by the engineers of the Virus B synthesizer. The specific notes of the pattern relied on my input that I change while recording in real time to give slight variation.
[76] The tempo is normally defined within the digital audio workstation/sequencer. The "key" is defined by my playing the chords and notes into the arpeggiator.

pattern as a producer while consciously experiencing the music as an audience member or DJ would—in separate steps/stages or simultaneously. Employing the arpeggiator's ability to generate and contribute content arms the artist with the ability to adopt these numerous roles as part of their compositional process while creating music. The arpeggiator is employed to generate important musical objects (such as the bass lines in the two songs listed above) and, in doing so, establishes itself as more than just an instrument. Rather, it is an element of the composition itself—an element that must be interacted with, forcing the artists to make immediate creative decisions based on what they are hearing the machine create. In other words, the arpeggiator contributes content into a composition and positions itself as more than just an instrument following my commands. As such, it redefines my compositional methodology to include more reactive and interactive processes that can have very interesting results: results that I, or other composers, may not have conjured without the assistance of such a tool.

3.4.5. AUTOMATION: SIMULATION OF LIVE PERFORMANCE

Where previous incarnations of arpeggiators were meant to simulate accompanying musicians, the introduction of automation during the compositional process has the added benefit of simulating the presentation/performance of an electronic dance music production. This automated performance proves to be a valuable tool for pointing out flaws, or for inspiring ideas towards compositional development while at the same time freeing my physical capacity to try out different ideas in a noncommittal manner. My sequencer takes care of syncing, combining and presenting all of the different voices and parts of the work in progress simultaneously.[77] I can then add other musical objects, such as voices, riffs, additional arpeggiators,

[77] Automation in a multitrack sequencer syncs all the layers of a piece of music, such as the rhythm section, chord progression, bass line, melodic riffs, etc.

percussion and more. This division of labour is incredibly efficient from utilitarian point of view, as I would not be able to play all of the parts at the same time. And the fact that this process can occur in real time, as presentation, enables instant reaction on my behalf—allowing me to decide whether new musical ideas that are being added are complementary or not to the work in progress. This is another example of how automation enables me to take on the role of composer, performer, listener and producer. Arpeggiators are an extension of this aesthetics when it comes to EDM.

Furthermore, automation as part of electronic music performance also gives me the ability to simulate a DJs presentation of my work accurately. Understanding the final destination of my EDM will be presented by a DJ as part of a mixed set informs many compositional decisions on an aesthetic level—especially with regards to the timing of introducing new musical content, and the overall development of form within the composition. It is interesting to note that the manner in which a DJ would work with records I have produced (manipulating frequencies or looping sections in real time) is also very much in line with the way in which (my) electronic dance music is created. Many of the musical objects in my compositions are, in fact, objects of process: a process of automation and interaction. A programmed phrase from an arpeggiator is a pre-existing musical object.[78] Excluding the action of note input, the way in which I manipulate and interact with this object is extremely similar to how DJs work with the pre-existing musical objects of records.[79] Records are their own entity, meant to be mixed/blended with other records during a DJ's set. Similarly, an arpeggiator's output is its own entity, meant to work with other layers of a composition. DJs will create loops, add effects and tweak frequencies (via a crossover or equalizer of their DJ rig) over a linear frame of time to enhance, or create tension and release: all of which modifies the sound and arrangement of the records that they are

[78] An obvious example would be a factory defined arpeggiated preset on a synthesizer.
[79] I use the term "records" as an umbrella term for any form of media that a DJ would present, including mp3s, CDs, wavs and more.

playing. These modifications carried out by a performing DJ contribute to establishing a larger scale form that defines the DJ performance as an artistic/musical performance or a product. [80] Automation of pattern performance that arpeggiators are responsible for as an agency of electronic music composition enables me to accurately immerse myself in a frame of mind as though I am the DJ, playing a pre-existing musical object and, just like a DJs with records, I can manipulate filters to cut off certain frequencies, or change the resonance and harmonics of the notes of the pattern, change the loop point of the pattern (by re-triggering the keyboard at different intervals), add echo and delay or reverb—which extends the trajectory of the form of the pattern, from something that is only a bar or two long to something much longer, as described with "Memories." This aesthetics, which extends from the producer's studio to the DJ booth and vice versa in electronic dance music, has its roots in the earliest incarnations of disco, dub and hip hop (Brewster and Broughton 2010) and is demonstrated by the fact that so many EDM producers also DJ. In my own experience, DJing gives me, and other producers, insight as to what makes a successful dance record. The pattern of the arpeggiator is ever-present and, as such, relatively autonomous. Automation of the arpeggiator simulates the performance of the DJ, allowing me to experience the work in progress and judge how successful it is as part of a DJ's performance.

Automation expedites and promotes the creative process by contributing to the musical structure in real time and by dividing the labour of music creation. This allows for immediate reflection and reaction on behalf of the musician, a very powerful help for cultivating and maintaining a creative momentum and inspiration. Through automation, arpeggiators promote an energy that facilitates an improvisational and performance aspect within musical production, with the added benefits of simulating "real world" application and presentation.

[80] A DJ's performance is known as a "set", while the way in which DJs present multiple records in a row during their set is often referred to as a skill called "programming."

4. Conclusion

The arpeggiator proves to be one of the most interesting pieces of music-making technologies available. It inspires creativity, facilitates and enhances performance, adds momentum to harmonically static compositions, and signifies on the musical clichés of the arpeggio, all while being a vehicle for the expression of fundamental African-American musical characteristics.

The sound of the arpeggiator itself connotes imagery of futuristic technology and reinforces underground EDM's historical relationship with interactive programmable musical instruments, redefining the conventional music loop in the process.

The compositions I have submitted with this paper demonstrate various applications of an arpeggiator and how the arpeggiator's sound is so distinct, that it will instantly impact the aesthetics of a musical production, regardless of how central it may feature in a composition.

The arpeggiator's strength lies in its ability to reinforce the *electronic*, *future,* or *tech* aesthetics of music, while adding a groove via repetitions that permit the music to express and reflect socio-cultural realities and fantasies at the same time.

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APPENDIX A: TECHNICAL DEFINITION OF ARPEGGIATOR

A.1 Arpeggiator Basics

In its most basic form, an arpeggiator is a feature found on many synthesizers that, when engaged, automatically plays the individual notes of a sustained chord in a repeating, sequential and rhythmic pattern across a predefined range of octaves where each note of that sustained chord is stepped-through one note at a time, thereby creating an arpeggio.

The arpeggiation can be defined via parameters. For example, when holding a C triad, an arpeggiator will trigger the following output of notes depending on specified parameters typically found on most arpeggiators:

Table 2. Basic arpeggiator parameters.

Parameter	Resulting output
Up	C, E, G, C, E, G, C, E, G, etc.
Down	G, E, C, G, E, C, G, E, C, etc.
Up/Down	C, E, G, E, C, E, G, E, C, etc.
Random	Notes of the chord played randomly, for example: E, C, E, G, G, C, G, C, E etc.

There are features that may appear on some arpeggiators, while not on others, such as:

Table 3. Advanced arpeggiator parameters.

Parameter	Resulting output
Manual	Follows the order in which notes of the chord were triggered
Custom	Predefined by user (often stored as a user preset)
Poly	Does not break the chord into individual notes, instead plays the chord in a repeating rhythmic pattern
Step rate	Sometimes indicated with duration values such as 1/8, 1/16, 1/32. This instructs the arpeggiator what unit of time is used to perform the pattern
Latch/Hold	Enables the arpeggiated sequence to continue even after a keyboardist has stopped sustaining the chord
Swing or Shuffle	A function that changes the rhythmic feel of the pattern by a definable percentage (usually between 10-30%).
Gate or Note Length	This defines the duration of each note in the sequence.

One of the more important parameters of the arpeggiator is the *octave range* setting that instructs the arpeggiator to span the sequence of note values over a defined number of octaves. The following example demonstrates the result of a C triad being

held for two bars with an arpeggiator engaged in a "down" directional mode with a range of two octaves, set to output a pattern consisting of four notes at a 16th note step rate:

C triad input via keyboard controller:

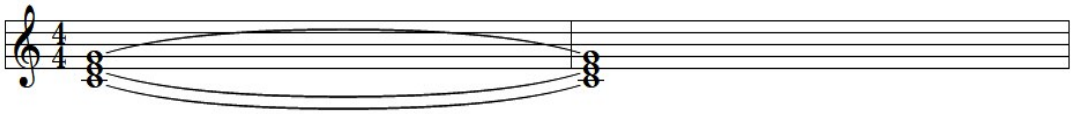

Figure 5. Sustained C triad input.

Resulting output pattern from synthesizer:

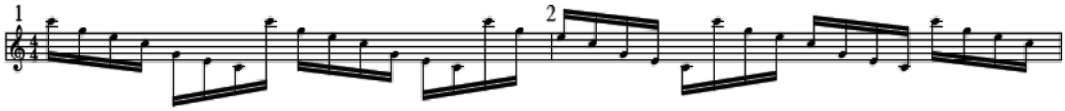

Figure 6. Two octave descending arpeggio repeating for duration of sustained input chord.

A.2 REDEFINING "ARPEGGIATION"

As illustrated, an arpeggiator facilitates the creation of an arpeggio out of a chord. However, in the world of electronic music, the definition of "arpeggiation" has come to include the process, as well as the result, of an automated distribution and (re)organization of manually inputted notes from a synthesizer into a repeating rhythmic pattern, where each note that is played/inputted is assigned to a step of the pattern regardless of how many notes may be actually played. That is to say, an arpeggiator does not only play "arpeggios" in the traditional sense of the word. More accurately, an arpeggiator is simply a "mode" that some synthesizers can enter, which transforms the instrument into an automatic rhythm-pattern-player where every step of the pattern is populated by note values that it receives from triggered or sustained notes (usually via a keyboard). Thus, the arpeggiator is a type of step sequencer: an

instrument capable of various musical applications that will be discussed further in this paper.

Furthermore, looping rhythmic patterns of short synthesized notes has been a facet of electronic music for decades. In fact, the recognizable sound of the arpeggiator predates the invention of the arpeggiator. However, for the efficiency of this paper, the term *arpeggiator* is used, not only to describe specific arpeggiator modules, but also as nomenclature for a feature of electronic music that automatically sequences synthesized tones into a repeating rhythmic pattern.

The following list describes how the recognizable sonic traits of the arpeggiator can be achieved in various ways that do not require an arpeggiator:

- Manually inputting/performing/recording arpeggiating notes from a synthesizer in real time.
- Applying a pronounced delay (tape or digital echo) set to steady temporal values, such as 16^{th} or 8^{th}-note triplets to add a sequence of repeating notes in between notes being played in real time (see Figure 15). On a related note, delay effects are often applied to arpeggiators and sequences to add more rhythmic complexities to the phrase being generated, most famously by Georgio Moroder's sequenced bass line on Donna Summer's "I feel love" (1977).
- Assigning *gates* to sustained notes according to temporal values to create repetition and rhythm (see Figure 16).
- Using a step sequencer (see appendix A.4).
- Putting sample and hold features to use (see appendix A.5).

All of these listed differing technologies are utilized and approached in a relatively similar manner of production, but result in a very similar sounding output, thereby creating similar aesthetics in electronic music. So much so that there are many online discussions and debates in synthesizer forums about whether arpeggiators are being

used on certain records or not.[81] Furthermore, advances in digital technology have ushered in virtual synthesizer plug-ins that combine features of step sequencing and gating that are classified as being presets of arpeggiator modules, such as with the Albino virtual synthesizer.

While there are specific mentions of *step sequencers* and *sample and hold* features throughout this paper, the label of *arpeggiator* is used throughout the discussion as nomenclature for the various technologies that create similar sonic events, unless otherwise specified.

A.3 Common examples of Arpeggiation

The arpeggiator can be set to a fixed number of steps (the amount of steps depends on the synthesizer or sequencer: usually between 4 to 16)—where each step in the sequence becomes a placeholder for a note value or a rest. Some synthesizers can also assign more information than just note value to each step of the pattern, including the state of a filter, amplitude or more.

In the following set of examples, a preset (also known as a "patch") has been programmed on an *Access Virus* synthesizer with its arpeggiator engaged and programmed to perform a four-note pattern within one octave in an "up" direction. The rhythmic pattern consists of a sequence of straight 16th notes. In the first example (Figure 7), a solitary D is sustained for two bars. Therefore, only one note (the sustained D) is available to be assigned to each step of the pattern.[82] The resulting output is four 16th notes being populated by the same D per beat. The directional parameter is not applicable in this case as there is only one note available to populate the pattern. The ensuing output is not something that would traditionally be classified as arpeggiation, even if an arpeggiator were responsible for creating the pattern.

[81] See http://www.vintagesynth.com/forum/viewtopic.php?f=1&t=61269

[82] My work "Mars" (track 11) features single-note arpeggiation throughout the arrangement of the piece as an alternative to a bell or hi-hat percussion sound.

However, this can be an effective addition to music production as it can take the role of a percussion instrument (to energize a groove), as well as adding complimentary sonic texture to the production:

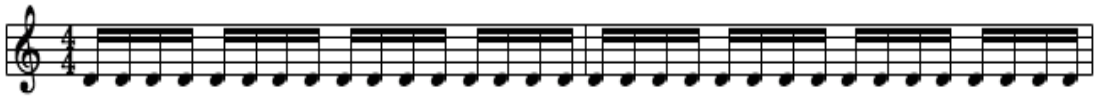

Figure 7. Single-note "arpeggiation."

In this next example, a Dminor7 chord in root position is sustained for two bars of 4/4. Unlike the single note “arpeggio,” the output of this next example is easily recognized as a proper arpeggio. Consisting of a four-note broken chord, the pattern works in perfect symmetry as each of its individual notes is assigned to one of the 1/16th “place holder” units of the four-note sequence. Therefore playing a four-note chord allows the pattern to cycle in such a way that the first note of the pattern lines up with every beat:

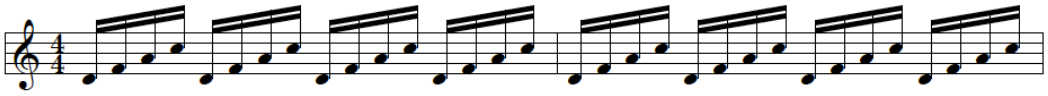

Figure 8. A four-note chord set to an “up” parameter starts the cycle at the lowest note being played, ascending to the highest note and repeats for the duration of the sustained input chord.

Holding a five-note chord such as a Dminor9 for two bars with the same arpeggiated parameters creates an interesting output: each of the five notes of the broken chord will cycle within the same four-note rhythmic and directional cycle in such a manner that the first note of the pattern will appear on a different 16th-note step (in 4/4 time):

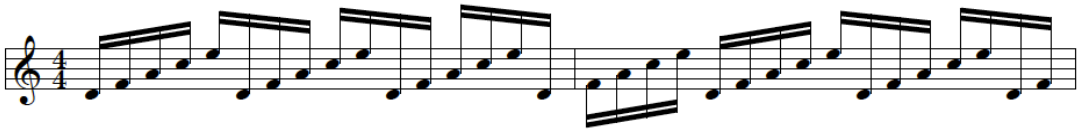

Figure 9. A five-note chord (D minor 9) being broken into a four-step arpeggiator pattern.

Equally interesting is a three-note chord being arpeggiated into a four-step pattern such as a triad:

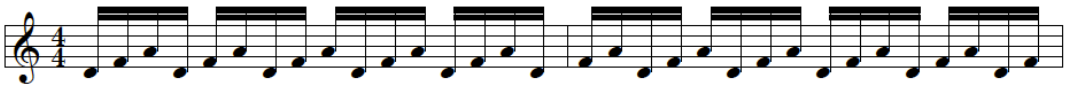

Figure 10. A triad being arpeggiated into a four-step pattern.

Offsetting the cycle by inputting an odd number of notes in an even-numbered time signature is quite common, adding a polyrhythmic dimension to a rather straightforward piece of music. A perfect example of this appears on one of the first records to be classified as "house music" by Frankie Knuckles and Jamie Principle in 1987, titled "Your Love." This seminal Trax Records release is built off a three-note riff being executed by the arpeggiation onboard a synthesizer.

The rhythm and shape of the output has remained exactly the same in all of the examples in this section regardless of the notes being inputted. The only thing that changed in each example is how the inputted notes populate the pattern.

One of the most useful features of the arpeggiator is how the pattern can follow any triggered keys from the keyboard, transposing the same arpeggiated rhythmic pattern in direct relation to the new notes and chords being triggered. The following example, illustrated in Figure 11 and Figure 12, demonstrates how an arpeggiated pattern[83] is transposed and translated to follow key or chord changes, while the rhythm remains the same in each bar:

[83] The arpeggiator preset for this example has a rhythmic output different from the previous examples in Figures 7-10.

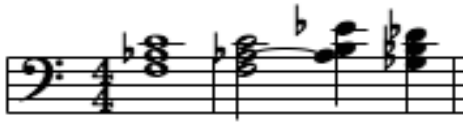

Figure 11. Input of moving chords.

The ensuing outputted arpeggiated pattern follows inputted notes:

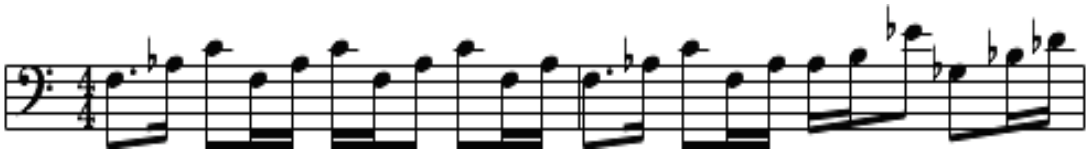

Figure 12. Output of arpeggiated F minor, AAb minor and Eb minor.

Note how the rhythmic pattern remains the same for each bar, and does not restart every time a chord is triggered.[84] The constant inputting and sustaining of notes allows the four-beat pattern to continue fully in each bar.

Some arpeggiators are configured to start the pattern every time a note is triggered. For example, an E minor 9 chord is played on the first beat of the bar, and sustained for four beats using an arpeggiator patch called "Quark," the pattern in Figure 13 will be the result. However, playing and sustaining the same E minor 9 chord for four beats, but triggering it on the last 16th note of a bar, the pattern in Figure 14 is the result. Note how the pattern shifts:

[84] Synthesizers receive tempo information either internally or externally via MIDI. In every transcribed example for this paper, the synthesizer in use receives tempo information via a digital audio workstation via MIDI. Notes are quantized according to the nearest 16th or 8th-note triplet and transcribed accordingly.

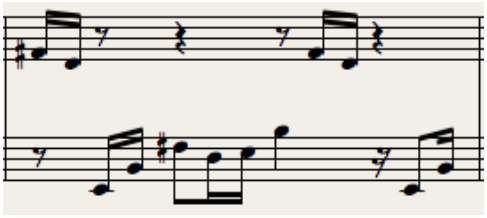

Figure 13. The resulting pattern of an Eminor 9 being triggered and sustained on beat 1 (courtesy of the arpeggiator in "Praying for Rain" (track 4).

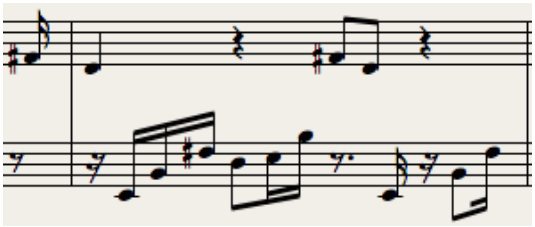

Figure 14. The same arpeggiator and E minor 9 being triggered one 16th note earlier.

Figure 15. In the second bar, a 16th-note delay is added to an 8th-note sequence to create a similar sound of a 16th-note arpeggiator or 16-step sequencer.

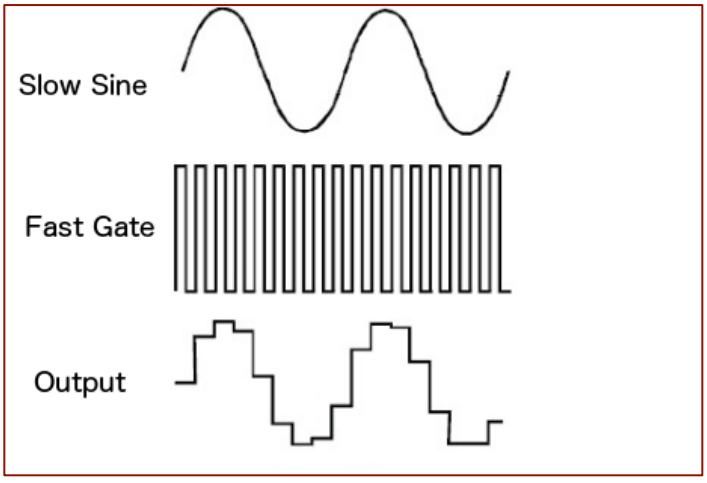

Figure 16. Gate opening and closing to create precise rhythmic phrase out of sustained tone. Source: (McMillen 2015)

A.4 STEP SEQUENCER VS. ARPEGGIATOR

The arpeggiator and step sequencer do very similar things--so much so that it is very difficult to tell the difference between the two by ear alone. However, there is one technical distinction: step sequencers typically respond to only one key on the keyboard at a time, or they will respond to all the keys being played separately. In other words, unlike an arpeggiator that forms its pattern by combining keys being played, the step sequencer's pre-programmed pattern is applied to each note being played separately, thereby transposing that pattern to whichever individual note is being played, or, in the case of more sophisticated step sequencers, will play a separate sequence based on each key being played (Aikin 2006). For example: programming a four-step pattern where each step is set to transpose the inputted note to 0 semitones, 2 semitones, 5 semitone, and -2 semitones. Accordingly, holding a single E note will produce the pattern using the notes E, F#, A and D. However, if you hold a simple E minor triad, the step sequencer will apply a different transposition to each note in the arpeggio as indicated in the following chart:

Table 4. Step sequencer output

Chord Note	Transposition	Output
E	0	E
G	2	A
B	5	Octave E
E	-2	E
G	0	G
B	2	C#

Chord Note	Transposition	Output
E	5	A
G	-2	F
B	0	B
E	2	F#
G	5	C

Source: (Aikin 2006)

Blurring the line between arpeggiators and step sequencers further, some of the more sophisticated arpeggiators have the features described in the following table:

Table 5. Sophisticated arpeggiator features.

Feature	Functionality
Step pitch sequence	Allows each step of the pattern to be transposed up or down a step.
Chord Steps	Some arpeggiators can combine two of the notes being held at the same time into one step.
Gate time	Similar to ADSR[85] of synthesizers. However this has the effect of phrasing when applied to a pattern: Creating a longer release on one of the steps will sound like a tied note; or by keeping the gate closed

[85] Attack, delay, sustain and release.

Feature	Functionality
	on one step will result in a rest being created for that step.
Step time	This permits each step of the pattern to have an assignable duration. This has the potential for creating specific music phrases and riffs.
Velocity modes	Each step of the pattern can have a configured velocity (how hard the note is struck). Depending on the synthesizer, velocity values can then be assigned to control different outputs, such as amplitude, filter cutoff, attack rate, etc.
Controller output	Often associated with older step-sequencers on modular synthesizers (such as the Moog 960), this feature allows steps of the pattern to be routed to voices of the synthesizers rather than the note values. So other data values can be assigned to the arpeggiator, including panning, decay time, etc.
Pattern length	Allows users to define how many steps occur in the arpeggiated pattern

Source: (Aikin 2006)

A.5 Sample and Hold

Simply put, sample and hold (S/H) is an electronic circuit that stores the amplitude of a sampled input waveform, and prolongs that amplitude until the next sampling pulse that is triggered, usually by an oscillator. In other words, the circuit measures the instantaneous value of an input signal, such as voltage and then generates an output signal that corresponds to that instantaneous value, holding that value (ignoring any changes in that input signal) until the circuit is re-triggered, at which point it holds the newly captured value. S/H is used quite often in electronic music and for sound effects in science fiction movies to depict high-power super computers and robots in the movie (see section 1.3). Figure 17 demonstrates how a steady trigger will output a consistent rhythmic pattern consisting of different frequencies based on varying captured values of the input (indicated with red circles):

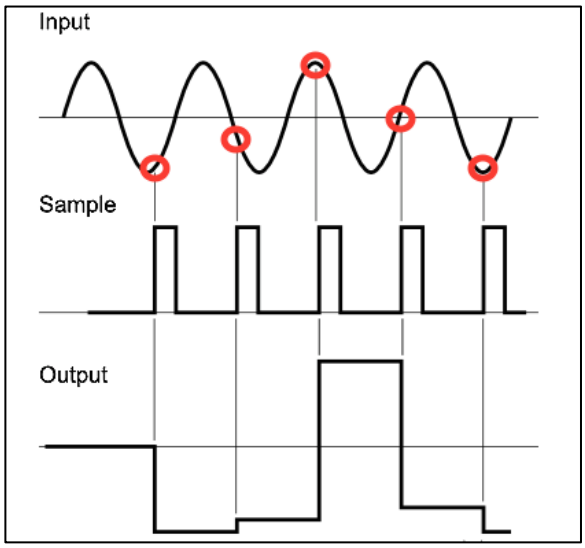

Figure 17. S/H: Input source sampled at regular frequency creating output pattern of varying frequencies. (source: synthesizer.com). Note the similar characteristics to using gate to create the rhythmic pattern.

This feature is very effective for outputting random frequencies by using an input waveform that contains random information, such as white noise as demonstrated in Figure 18:

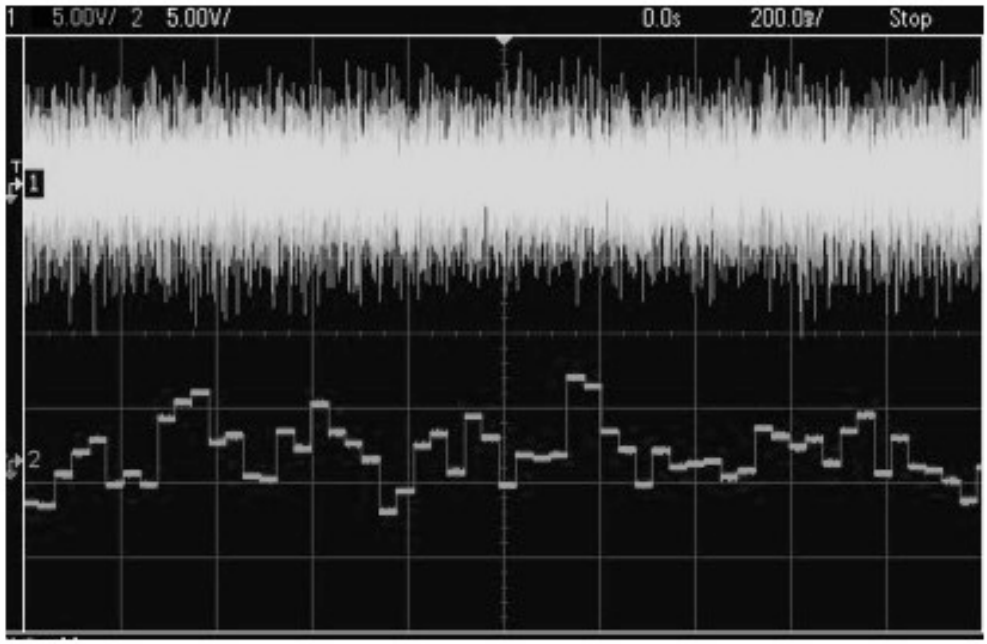

Figure 18. S/H with white noise to create randomized note output. Source (McMillen 2015)

APPENDIX B: Submitted CD Track listing

Table 6: CD Track listing

Track.	Title	Notes
1.	"Tsing Forest."	Layered arpeggiators construct *electro/dance* grooves and combine with cliché "minimalist" orchestral riffs to demonstrate how looping musical phrases are used as building blocks to shape musical form.
2.	"Cultured Girl (Kartino Suite)"	Arpeggiators convey "spacey" aesthetics (at 4:50) and help outline harmony throughout.
3.	Rocco feat. Marcel: "Memories (Martino's Life on Earth Mix)"	The arpeggiator generates a short ostinato that sustains the overall groove and acts as an anchor and building block for *(ac)cumulative* musical form.
4.	"Praying for Rain (dub)"	The arpeggiator from a *Virus B* synthesizer is fundamental in this minimalist arrangement. It conveys techno aesthetics, while representing the notion of *changing same* via subtle alterations to the looping phrase and the stacking of repeating musical objects.
5.	"New Day"	Conventional guitar picking is replaced with an arpeggiator that inspires the chord progression of the composition.
6.	"Vitamin S"	A traditional arpeggio generated by the *Albino* arpeggiator to create instant familiarity for the listener.
7.	"P Jam"	An arpeggiator used as an unnatural texture and groove facilitator over African percussion and conventional house music production.
8.	"Cultured Girl"	The arpeggiator outlines a two-chord progression as well as a four-chord progression simultaneously—aiding the anti-teleological harmonic trajectory of the composition.

9.	Genetix: “Genetix Theme (Eminence Remix)”	An *ES2* virtual synthesizer is arpeggiated to add rhythmic propulsion and harmonic tension--the sound of which sonically conveys SF and techno trope.
10.	“Dark Days (with friends like these…)”	The filter on a single-note arpeggiation is manipulated to alter the rhythmic feel of the pattern to create variation: the result of interacting with the automatically generated pattern (starting at 2:33). The arpeggiator injects techno aesthetics into an Afro-Caribbean influenced house music production.
11.	“Mars”	Conventional house music married with retro SF kitsch—a relationship established by Afro-Futurist musicians. Single-note arpeggiation (starting at 0:48) is used as an alternative to a conventional hi-hat to synthesize traditional percussive elements.
12.	“C.T.S. (Haunted discotheque dub)”	Single-note arpeggiation rhythmically and sonically contributes disco aesthetics to the production.
13.	“Pastiche” (excerpt)	Unnatural synth sounds being arpeggiated inject a mechanistic/funky aesthetic over a chord progression that is more typical of modern jazz.
14.	“Supernova”	The arpeggiator facilitates EDM’s *combinatory form* while contributing SF and techno-influenced aesthetics.