TRIPLE SYNTHESIS

by

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Abstract

This thesis investigates the result of merging three musical approaches (jazz fusion, breakbeat/IDM and Electronic Dance Music) and their respective methodologies as applied to music composition. It is presented in a progressive manner. Chapters two to four identify and discuss each of the three styles separately in terms of the research undertaken in the preparation of this thesis. Chapter 2 discusses, through a close examination of selected compositions and recordings, both Weather Report and Herbie Hancock as representing source material for research and compositional study in terms of melody, harmony and orchestration from the 1970s jazz-fusion genre. Chapter 3 examines breakbeat and Intelligent Dance Music (IDM) drum rhythm programming through both technique and musical application. Chapter 4 presents an examination of selected contemporary Electronic Dance Music (EDM) techniques and discusses their importance in current electronic music styles. Chapters 5, 6 and 7 each present an original composition based on the application and synthesis of the styles and techniques explored in the previous three chapters, with each composition defined by proportions of influence from each of the three styles as in the Venn diagram shown in the introduction. Since the musical context of the original compositions is software oriented, diagrams and computer screenshots are used in addition to conventional score notation in order to highlight details of musical examples and techniques. The final chapter discusses the conclusions made through the thesis research and result of this “synthesis” style of composition.

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Introduction

1.1 Thesis Outline

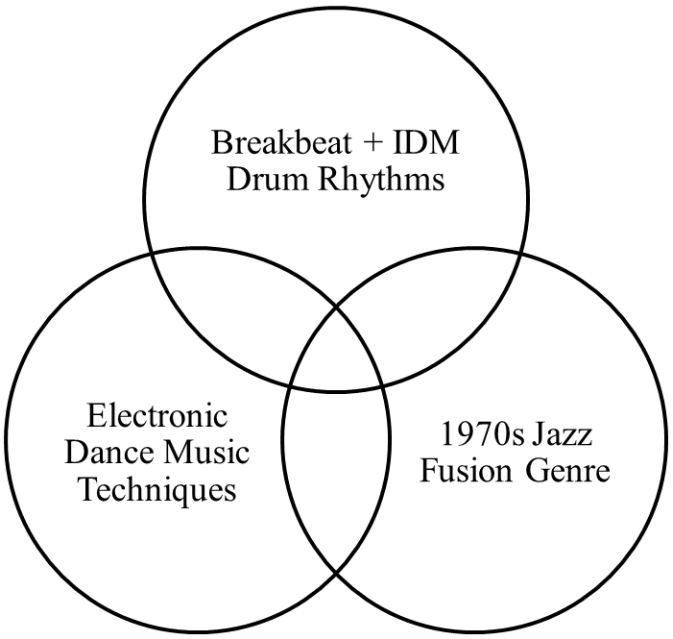
One definition of synthesis is "the combining of the constituent elements of separate material or abstract entities into a single or unified entity."[1] In the case of combining disparate styles of musical techniques, there is an established history of composers drawing on influences outside of their main genre in order to create a new musical style. This thesis pursues the synthesis of three main spheres of musical genres; the rhythms of breakbeat and IDM (Intelligent Dance Music) style drum programming, the harmonic and melodic and musical styles of 1970s fusion groups Herbie Hancock's Head Hunters & Weather Report, and contemporary EDM (Electronic Dance Music) music production techniques. In traditional acoustic music composition and orchestration, the composer's intentions are conveyed through the use of melody, recurring motifs, thematic development, and so forth. Varying timbres in orchestration produce various musical effects which are conveyed to the listener. In EDM, these same principles are present but are instead represented through the implementation of electronic instruments, effects, sampling, rhythmic motifs, etc. Certain forms of acoustic 20th century music correspond to an analogue in contemporary EDM, such as minimal = minimal tech, etc. While electronic dance music is usually created with a focus on the literal "dance club" aspect, specific sub-genres focus on longer form compositions meant for listeners. An underground worldwide movement of this so-called "Intelligent Dance Music" or "IDM" developed in the mid 1990s, best represented by the sub-genres "drum'n'bass," "broken beat" and "nu-jazz" explored the merging of jazz and electronica, predominantly created by electronica producers that focused on adding jazz sounds and samples to their electronica-centric productions. While some of these artists had a background in some music theory and jazz vocabulary, most of the harmony and melodies are pedestrian from a trained composer's perspective. As far as conventional instrument-based ensembles, the implementation of electronics and contemporary recording techniques by jazz artists is not new, as evident in both Weather Report and the

[1] Dictionary.com, 2013. http://dictionary.reference.com/browse/synthesis?s=t

Hancock's recordings. This thesis however seeks to engage more substantial 20th century post-tonal compositional influences as filtered through these selected jazz fusion composers.

The process of music composition can be described as a series of decision-makings as the composer germinates, develops and completes a piece of music. One challenge that arises for a composer lies in choosing the scope of material to be utilized. To assist in this part of the pre-compositional planning, visual assistance will be utilized in the form of a proportional three-sphere Venn diagram, where each sphere represents one of the three areas. In this way, a different weighting will be given to each influence with a corresponding difference in emphasis, the intersection of which will create the end result (see Figure 1).

Figure 1: A Venn diagram representation of musical "Synthesis"



Each of these three styles will first be examined in detail in order to establish a proficiency in the relevant techniques and sonorities of their respective genres, which will lend an underlying authenticity to the resulting set of original music compositions.

2 Jazz Fusion Composers

2.1 Overview and Rationale

One of the three sources of content for the original compositions is selected work of 1970s jazz fusion artists. While the key component of the "fusion" genre generally signifies a mixing of influences that may include jazz, classical, world music, rhythm & blues (R & B) and pop music, as well as a mixture of electric and acoustic instruments, synthesizers and electronic effects, the jazz-fusion term itself is problematic since it can represent a wide swath of flavours from undemanding pop-jazz to uber-technical jazz-rock. For the purposes of this thesis therefore, a selective approach was chosen to seek out the most compositionally substantial and prominent jazz-fusion practitioners whose musical content would also be compatible with the other two electronic music-based components. In fact, jazz-fusion artists share an impetus to extract and re-contextualize musical vocabulary with modern electronic musicians and producers, as noted by Kevin Fellezs in his book *Birds of Fire - Jazz, Rock, Funk and the Creation of Fusion:*

> Today's samplers, DJs, and mixmasters create sonic fusions as increasingly commonplace enactments of no-longer-imaginary soundscapes, articulating the ironic, fluid nature of postmodern identity by routinely manipulating everything from advertising jingles to traditional Balkan fold music in remixes, mashups, and sampled loops. This brave new audio world has been shaped, in part, by the creative work of (Tony) Williams, (John) McLaughlin, (Joni) Mitchell, (Herbie) Hancock, and their cohorts in bands such as Return to Forever, Weather Report, and Nucleus…[2]

Although a list of 1970s jazz-fusion groups could also include Return to Forever, Mahavishnu Orchestra, Tony Williams' Lifetime, and Jeff Beck, both Weather Report and Herbie Hancock (both solo and with the Mwandishi and Head Hunters ensembles) share the following characteristics: a strong background in classical tonal and post-tonal music; a pedigree as members of authentic post-bebop jazz ensembles (Zawinul with Cannonball Adderley and Miles

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[2] Fellezs, Kevin. *Birds of Fire - Jazz, Rock, Funk and the Creation of Fusion.* (London: Duke University Press, 2011), 11.

Davis, Hancock with Miles Davis); recognized success in R &B – style "soul jazz"; the use of funk rhythms and "world music" percussion as a component of their music; and the prevalence of synthesizers and electronic effects used in their recordings. While the "jazz-rock" term has been regarded by journalists and authors as synonymous with "jazz-fusion" and applied to a wide group of artists including Weather Report, Herbie Hancock and George Benson, a distinction is being made in this thesis to separate "jazz-rock" as possessing a more rock guitar-centric aesthetic as heard in the music of Mahavishnu Orchestra, Jeff Beck and Tony Williams' Lifetime.

2.2 Weather Report

Weather Report's three main composers chosen for this analysis are keyboardist Josef Zawinul, saxophonist Wayne Shorter, and bassist Jaco Pastorius. Their compositional styles represent a confluence of shared influences, including bebop jazz, 20th century post-tonal compositional techniques as well as rhythm and blues. World music rhythms and textures, synthesizers and electronic effects also play an important role in Weather Report's wide musical scope. The concept behind the group's approach was to draw on these various musical languages and orchestration methods and re-contextualize them into a "fusion" of new musical expressions. For the purpose of this thesis, four specific areas will be examined: melodic techniques, chord progressions and voicings, orchestration and use of compositional forms.

2.3 Compositional Characteristics

In the case of Josef Zawinul, a strong background in classical piano performance as well as standard jazz repertoire and composition informed both his piano technique and musical sensibilities. An extensive tenure with saxophonist Cannonball Adderley also resulted in a Grammy award and Billboard pop chart recognition for his Wurlitzer electric piano-driven jazz-soul composition "Mercy Mercy Mercy*"* (1966). However, with Miles Davis and later with Weather Report, Zawinul's compositions demonstrated both classical and world/folk influences. The world music influence can be heard in several compositions' melodic content, including "Black Market*"* (*Black Market*, 1976). The main opening melodic theme (See Figure 2) and its simple Bb pentatonic scale singsong sonority emphasizes intervallic leaps by 4th and 5th

intervals, while the synthesizer's sound quality and rapid vibrato resembles a middle Eastern or African flute. In "Black Market," the Bb pentatonic quality of this melodic excerpt is also echoed by the Bb-G-F notes of the introductory bass vamp (see Figure 3).

Figure 2: "Black Market" melodic theme excerpt

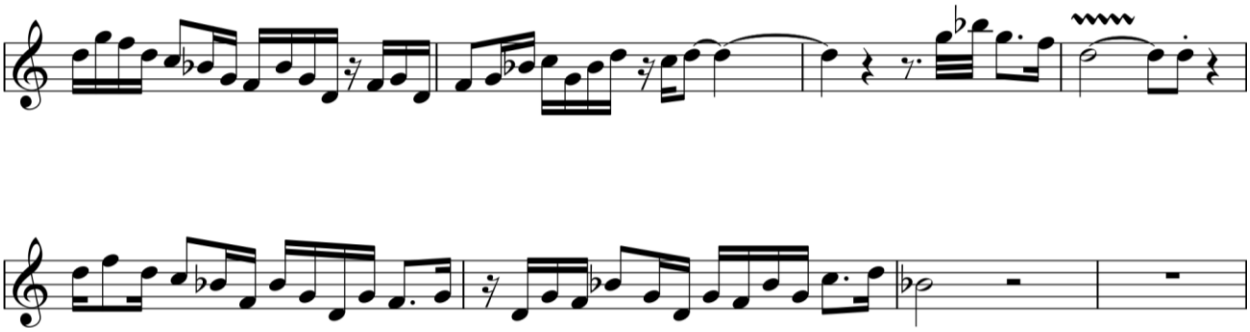
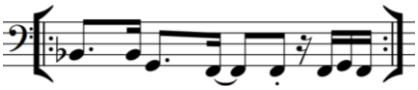
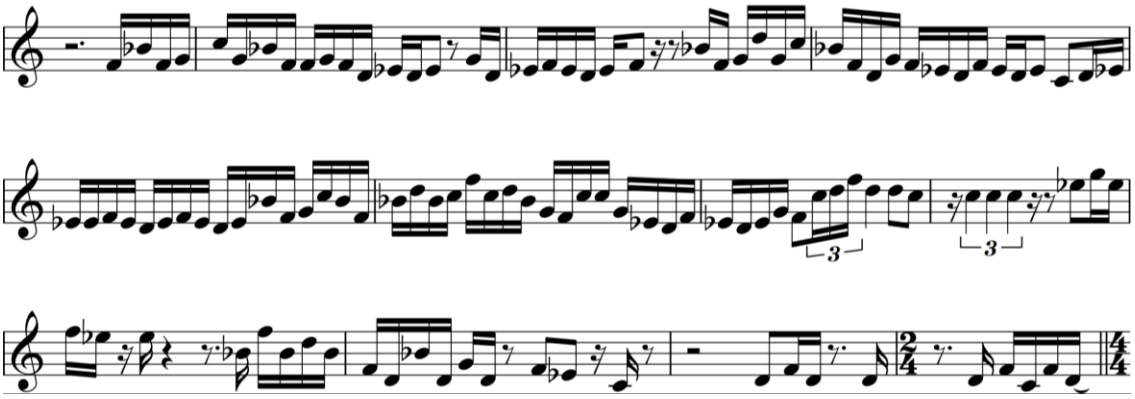


Figure 3: "Black Market" opening bass vamp



The Zawinul composition "Volcano for Hire" (*Weather Report*, 1982) shares this use of pentatonic scales, but in a different way. The song opens with an aggressive drum and percussion rhythm, leading into a short wide-interval unison phrase and an open-sounding vamp improvisation over a C7 sonority. After this introduction, the bass drops out and a unison piano/synthesizer/tenor saxophone melody (see Figure 4) takes place over 12 bars, consisting of short fragmented modal phrases drawn from what is essentially a C minor pentatonic scale with an added 2nd passing note at certain points, a device that could be referred to as "pentatonic-plus-another-note." With the exception of eight Eb pitch occurrences, this melody shares an enharmonic relationship with the Bb pentatonic scale melody from "Black Market," including an emphasis of 4th and 5th intervallic leaps, but differing in its suggestion of a C minor or F13 suspended quality as well as its instrumentation.

Figure 4: "Volcano for Hire" - melodic theme example



Another notable characteristic of Weather Report's music is that of various harmonic techniques such as those drawn from 20th century post-tonal music including non-functional chord progressions, symmetrical and non-symmetrical root movements, triads over alternate root notes, and chord movement over pedal notes. Although these key group members possessed a pedigree in jazz and bebop harmonic languages, Wayne Shorter in particular had earlier made a conscious decision to depart from traditional jazz chord progressions and voice-leading, referring specifically to the composition "Nefertiti"[3] which he recorded with Miles Davis in 1967 (*Nefertiti*, 1967). In spite of this, several Weather Report compositions contain chord progressions that reflect traditional bebop jazz chord progression and root movement. Examples include "Palladium" (*Heavy Weather*, 1977) with its II-V-I coda and the extended IImi7-V7-I-VImi7 bridge and solo section from "Black Market." On these compositions however, the jazz style chord progressions are reframed from an acoustic jazz ensemble setting into a new context that includes electric bass, synthesizer, percussion, and modern drum rhythms.

"Man in the Green Shirt," a Zawinul composition from *Tale Spinnin'* (1975) contains a selection of harmonic techniques: a modally harmonized melody, conventional tonal- centred

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[3] Shorter, Wayne. *Artist Transcriptions: Tenor & Soprano Saxophone Transcriptions.* (Van Nuys, California: Alfred Publishing, 2000)

chord progression over an extended number of bars, extended suspended chord pedal, and non-tonal chord progression. The piece opens with a simple Bb Rhodes keyboard figure (Figure 5) whose extracted melody uses only three melodic notes, Bb-C-D, and is harmonized underneath by modal Bb6, Bb^{add}9 and Bb6/9 chords (Figure 6).

Figure 5: "Man in the Green Shirt" - opening keyboard figure's extracted melody

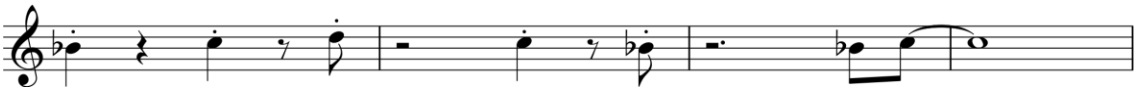
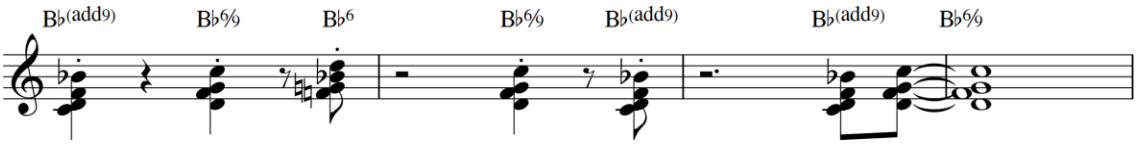


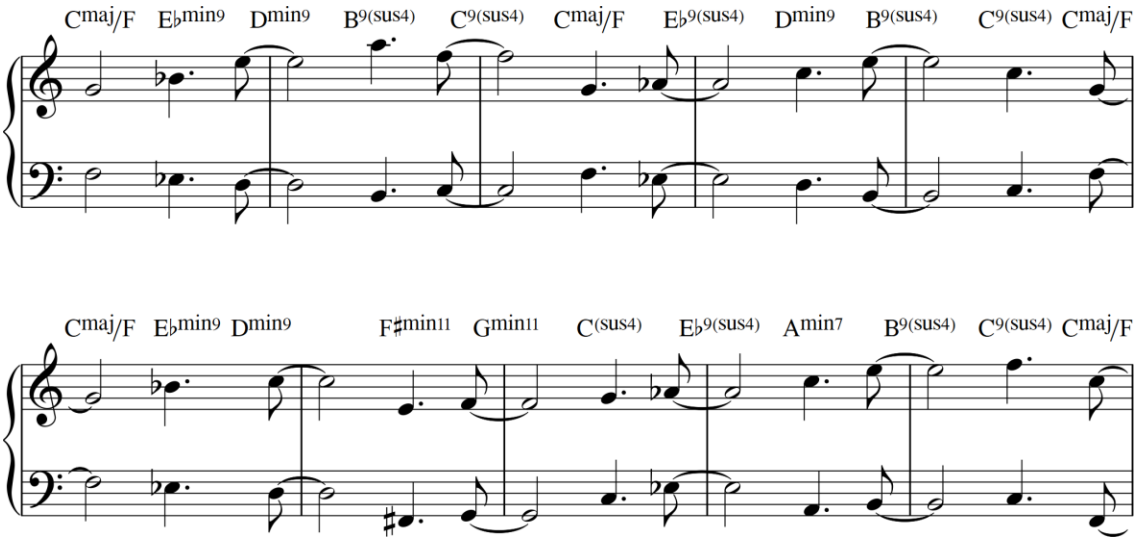
Figure 6: "Man in the Green Shirt" - opening keyboard figure with modal harmonization



The soprano saxophone and synthesizer theme which follows is drawn from a Bb major diatonic melody moving from Bb6/9 to C minor over a Bb pedal in primarily 8th note phrases, over a frenetic 16th note Bb bass and drum vamp. A layer of interspersed Fender Rhodes comping adds both rhythmic interest and a funk-oriented character through the use of a wah-wah pedal effect. The passage then moves through G minor and C minor chord changes before a twice-repeated C minor to F7sus "II – V" cadence back to the Bb major theme restatement. After this restatement, the phrase continues over relative G minor and Eb minor chords before modulating by a descending scale-wise step to a surprising E7sus chord extended vamp and solo section in half time. However, after this vamp reaches a peak, a bridge section resolves into a new theme consisting of a simple melody harmonized by an unusual chord progression that cycles through a 10 bar phrase. This section begins with an F major 9th chord voiced as a C triad over F, then descends scale-wise to Ebmi9 and then Dmi9, the before leaving this pattern and approaching an implied V chord, C7sus, from a B7sus half step below. This regularly occurring movement from C7sus to F major suggests an F major tonal center for this section. However, the revolving root movement obscures this tonal center and instead favours a series of minor and suspended chord

qualities voiced as either triads or close clusters, over root movements which use brief quasi-scalar moves to approach successive chords by half steps, whole steps, or minor 3rds from above or below, as well as one tritone movement from Eb to A. The keyboard voicings are dictated by a simple leading keyboard melody (Figure 7).

Figure 7: "Man in the Green Shirt" – 10 bar bridge chord/melody excerpt



After several repeats which include soprano saxophone fills, the piece then moves back to the opening Bb major theme and tonal chord progression for a brief reprise, before exiting to a coda which ends on the surprise E7sus chord.

Non-conventional chord progressions are also evident in two pieces by bassist/composer Jaco Pastorius from Weather Report's album *Heavy Weather*. "Teen Town" and "Havona" both demonstrate knowledge of symmetrical chromatic median root movement in their chord progressions.

The first chord cycle in "Teen Town" is based around a C root, and first outlines a set of four chords which cycle through a progression from C13 down a minor third to A13, then moves down a major third to F13, which then repeats the minor third movement down to D13. An opening synthesizer/saxophone theme is first played twice over this progression, following a 13th to 5th chord tone melody on each chord, followed by a more convoluted 16th note electric

bass/bass synthesizer melody over the same sequence of chords. After a restatement of this entire sequence, a brief B13 chord a minor third down the last D13 sets up a secondary dominant "V to I" modulation from B13 to E, where the entire four chord sequence is restated in a transposed form, as in E13 – Db13 – A13 – F#13. Again, a simple melody is first stated, this time by the bass and bass synthesizer and outlining the root notes, followed by a more intricate electric bass/bass synthesizer melody.

Similarly, "Havona" features a chord sequence that includes chromatic mediant relationships, in this case descending major third root movement which is repeated a half step below, as in Emaj7b5 to Cmaj7 followed by Bmaj7b5 to Gmaj7. This is followed by a chromatic mediant movement down a minor third back to an E root where the sequence cycles through again, the only alteration consisting of a suggested "Tierce de Picardie"[4] movement from Emi11 to Emaj7b5 in the first two measures. The last Gmaj7 chord in the sequence then moves up by major 3rd interval to hover over a seven measure B7sus tonality with an A7sus to B7sus figure, which repeats three times before ending with a unison Cmaj7#11 arpeggio, then moving up a major third to Emajb5 and the beginning of the four chord sequence again.

Another notably modern sonority in "Havona" is evident in the parallel suspended chord voicings used in the introduction (Figure 9) and ending, which first harmonizes a descending E mixolydian b6 scale from the lowered 7th degree implied by the first two notes, then switching to a diatonic E major scale for the rest of the phrase. This interpretation of the sequence as containing E-related material foreshadows the E tonal root center which begins the four note chord sequence at the A section (see Figure 8).

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[4] The "Tierce de Picardie" or Picardy third is a harmonic movement that refers to a tonic major chord that concludes a minor or modal passage of music. In this case, the harmonic device is used in a brief suggestion of this technique since it occurs over the course of just two bars.

Figure 8: "Havona" – extracted introduction melody

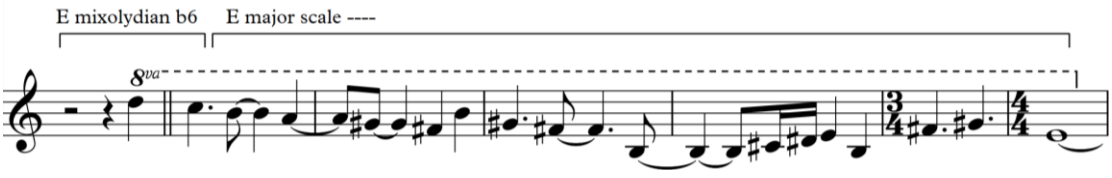
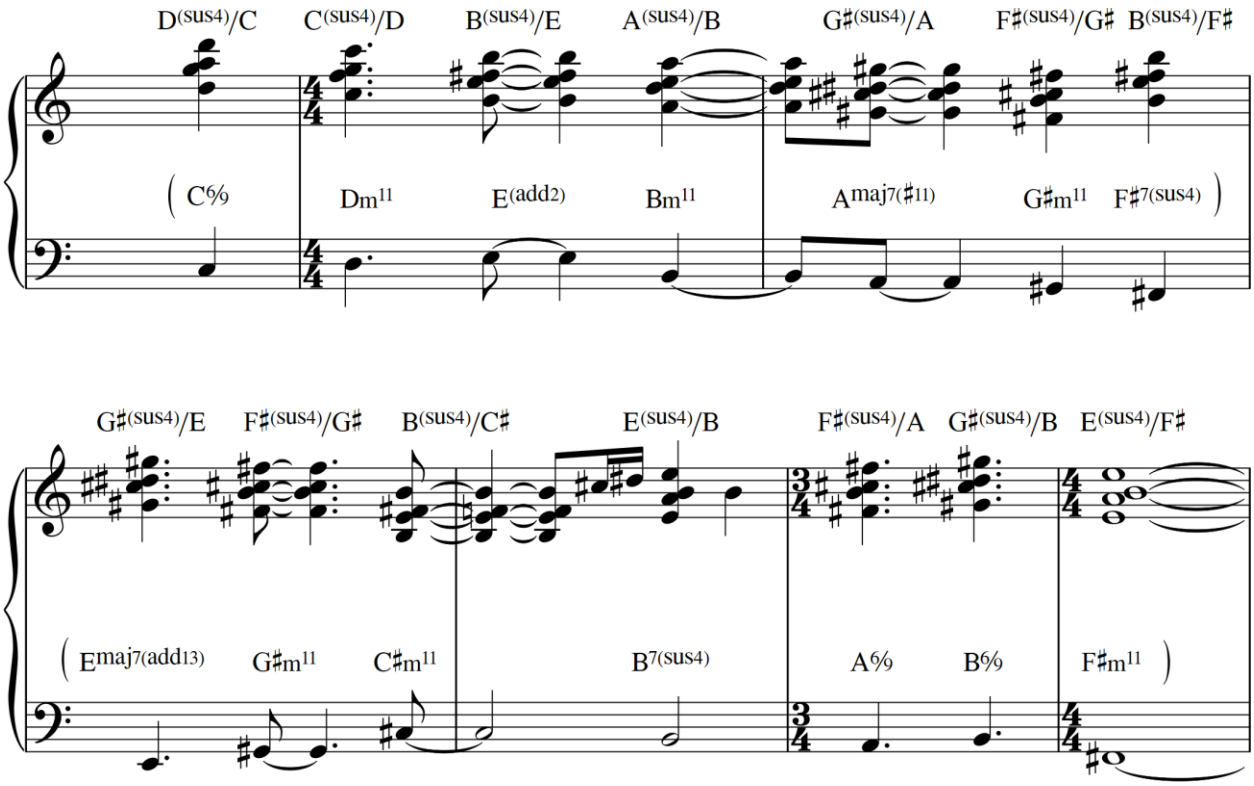


Figure 9: "Havona" - complete intro harmonization

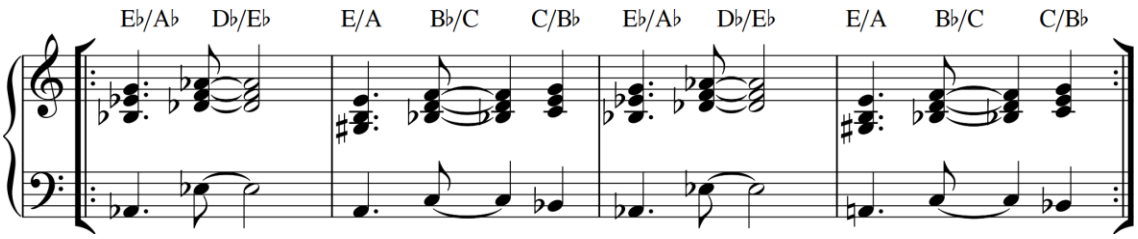


In harmonizing this intro melody, the top voice is doubled in the bottom of each suspended voicing, reflecting 4th intervals in major 2nds. Similarly, an alternate series of bass roots echoes this scheme as it also reflects the E mixolydian b6 scale note for the first two notes, C and D, followed by diatonic E movements. This same suspended voicing is also used for an A7sus to B7sus chord motif later in the piece, connecting this sonority through the composition. However, the opening root sequence provides both contrapuntal movement and a shifting change in each chord quality "of the moment," suggesting minor 11th, suspended, and 6/9 sonorities. For

example, the concluding F# root under an E suspended voicing produces an F# minor 11 sonority. This application of parallel structured voicings over alternate bass notes produces a non-tertiary sonority, where upper structure chord tones such as the 9th, 11th, 13th are emphasized, but without a complete supporting harmonic voicing structure. Although the resulting so-called "slash chords" can be analyzed with conventional chord symbols, the texture suggests that the voicings themselves are integral to the piece. The transcription depicted in Figure 9 illustrates the parallel suspended voicing slash chords and root movement, with a conventional chord symbol of the moment indicated above each bass note. Conventional chord symbols are indicated in brackets to illustrate the lack of specific texture that would result in omitting the detailed voicings in the score.

The use of slash chords is also evident in other Weather Report compositions. These sonorities contribute to the modern, post-tonal type of chord progressions. One example occurs in the intro and coda of Shorter's "Harlequin*"* (*Heavy Weather,* 1977) which uses triads over alternate bass roots to suggest major 7th and suspended sonorities which omit the 3 and 5 chord tones, creating an open sounding version of conventional chord symbols (Figure 10). For example, the Eb/Ab and E/A chords equal major 7ths with omitted third, the Db/C and Bb/C suspended 9th with omitted 5th, and the C/Bb a major 6/9 #11 with omitted 3rd. As in the introduction chords in "Havona," these voicings form a component of the composition's substance, since common-use tertiary voicings would fail to express a transparent texture.

Figure 10: "Harlequin*"* – introduction and coda chord sequence



While Weather Report's compositions draw on the various melodic and harmonic techniques discussed such as jazz, bebop, twentieth-century and world music, another element in the group's overall sound is the orchestration and sound design used in their recordings. This includes a blend of standard acoustic instruments (piano, drum set, tenor and soprano saxophones) with electric fretless bass, Rhodes electric piano, frequently with added phaser[5] or wah-wah effects, plus synthesizers, vocoder, world percussion instruments and ambient effects. Instrumental considerations include varying combinations of the melodic role, including electric bass playing solo melody or doubled with saxophone, synthesizer bass doubling the electric bass, synthesizer alone playing the melody, saxophone alone playing the melody, et cetera. Zawinul's use of synthesizers has been noted as a marked decision to create an expressively personal sound. According to Zawinul,

> In many ways the synthesizer is the most natural instrument…I can make any shape, any attack – a fast vibrato or a slow one. I can change pitch to a quartertone, change the octaves to have any kind of notes [6]

Zawinul's arsenal of synthesizers, beginning with the Arp 2600 and moving to Oberheim 4 and 8 voice, Sequential Circuits Prophet-5, Arp Quadra and later, Korg Prophecy keyboards, were used to variously voice melodies, provide lush orchestral string pads, bass lines, and sound design. When playing melodic passages, the reed-like timbres produced by Zawinul's detailed synthesizer programming made use of real-time controlled vibrato.

The use of effects also plays a prominent role in adding texture to Weather Report's recordings. Along with the much-used phaser effect on the Rhodes heard on "A Remark You Made" (*Heavy Weather*, 1977) and "Scarlet Woman" (*Mysterious Traveller*, 1974), another prominent sound associated with Zawinul is the Korg VC-10 vocoder, a voice-driven electronic

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[5] A phaser is an effect based on the mixing of an audio signal with a frequency-affected version of the same signal. The change in modulation of the frequency shifts of the processed signal over time produces a trippy effect as it sweeps through a time-based oscillation. A wah-wah effect, usually used in the form of a guitar pedal, is produced by processing an audio signal through a modulated range of frequencies, producing a human voice-like "wah" tone.

[6] Silvert, Conrad. "Zawinul - Wayfaring Genius Pt. II." (Downbeat, June 1978)

device heard on the song "8:30"(*8:30*, 1979). [7] Zawinul's "NYC: Crazy about Jazz" (*Weather Report*,1982), a three-part suite opens with a synthesized soundscape evoking the sounds of New York City traffic, car horns and street ambience. In the use of studio and tape effects, "Black Market" prominently opens with sounds of marketplace-like vocal chatterings, allegedly sampled from percussionist Alex Acuna's home tape recording. [8]

The use of percussion instruments to provide both rhythmic and textural layers is also a prominent feature of the group, which is heard prominently on "Madagascar" (*Night Passage,* 1980). On "Madagascar," the introductory kalimba and forlorn horn sounds provide a haunting landscape of texture as hinted by a connection to the song title's African place name, with hand percussion and metallic percussive accents adding an exotic tone to Part I of the song. The use of electric bass as a melodic instrument either doubled or as a solo voice is frequently in evidence during the era when bassist Jaco Pastorius was a member of the group, notably providing a compositional focus for Zawinul's slow, lyrical "A Remark You Made" (*Heavy Weather*, 1977) melody. The fretless bass as melodic voice became a staple of the group's sound, as well as Jaco's signature artificial harmonic plucking technique which allowed him to play an 8va melody on the group's hit song "Birdland" (*Heavy Weather,* 1977) and his own "Three Views of a Secret" (*Night Passage,* 1980).

Despite Weather Report's categorization as a "jazz" group, the types of forms used in its compositions do not generally follow the AABA, blues or verse-chorus-verse forms popularized by jazz groups in the preceding decades from the 1920s to the early 1960s. Weather Report's songs instead largely develop through each song's own organic structure, as differs from standard jazz format, where an AABA form is stated and then the band members improvise solos over the

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[7] The vocoder, an early synthesizer device developed by Homer Dudley in the late 1930s, was an electronic keyboard device capable of first decoding human speech through an analyzing circuit, and then re-constituting the vocal resonances electronically through a number of bandpass frequency channels and then through an envelope filter and voltage-controlled amplifier. An earlier version, the vodor, was not a voice decoder and created speech-like sounds from an electronic tone source.
Source: Bode, Harald – "History of Electronic Sound Modification" Journal of Audio Engineering., October 1984.

[8] Glasser, Brian. *In A Silent Way: A Portrait of Joe Zawinul* (London, UK: Sanctuary Publishing, 2001), 179. Alex Acuna claims that "The song "Black Market," at the start there's the sound of people talking, like a market. Joe copied that from a tape of mine…That's a tape that I made in my house with my family, live. I was listening to music and I was recording music, and my family and children were in the background – that's their voices."

same form, restating the melody again as a conclusion. This was a conscious direction by Zawinul and Shorter, as they had "changing ideas about song structure,"[9] as Zawinul stated:

> Wayne was coming at it independently from me, but he had that same kind of openness, with no limits. I was tired of standard jazz form – you know, the AABB and the changes - sax, trumpet, bass solo, then drums, then back to the melody.[10]

With this in mind, an examination of the various forms across the compositions reveals a wide range of structure. This connects to other movements against traditional forms in post-1940s electronic music such as Karlheinz Stockhausen's "moment form," a term he first used in 1960 when discussing his composition "Kontakte" for prerecorded tape, piano and percussion, and essentially refers to an "approach that treats every portion of a piece as an end in itself, without any intentional relationship to what precedes or follows it."[11] Various Weather Report compositions present material that occurs only once and is not referred to later in the piece, while others may refer briefly to an earlier theme.

Compositional devices used in Weather Report's repertoire includes passages marked by a brief unison phrase as in "Volcano for Hire," through-composition as in "Night Passage" (*Night Passage*, 1980), thematic restatement by chord progression as in the four-chord sequence in "Teen Town" which is treated to a transposed reiteration, and thematically structured pieces, as in "A Remark You Made" and "Harlequin," which re-use material during the piece while avoiding standard ternary form.

A common structure for some of the group's most well-known compositions consists of a forward-moving progression through a series of passages before reaching a final rousing "shout chorus" coda, a feature heard in "Birdland" and "Volcano for Hire." In "Volcano for Hire," the song enters its final phase using a repetitive diatonically modal melody which uses primarily five diatonic notes from the Db major scale, as in Db-F-Ab-Bb-C, omitting the ninth and including the 4th (Gb) only once (see Figure 11). In contrast to the 4th and 5th intervals emphasized in

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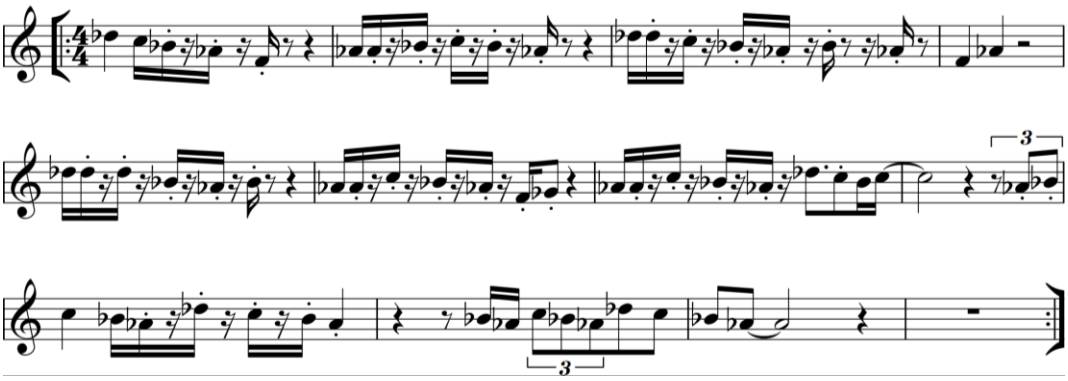
[9] Glasser, *In A Silent Way,* 132.
[10] Glasser, *In A Silent Way,* 132.
[11] Kostka, Stefan. *Materials and Techniques of Twentieth-Century Music* (Englewood Cliffs, New Jersey: Prentice Hall),154.

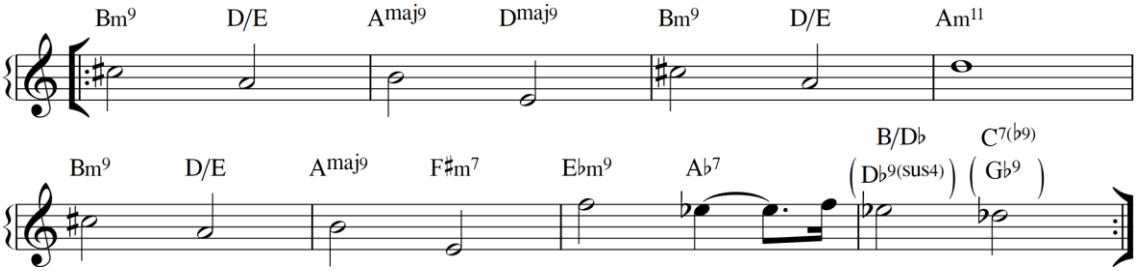
"Black Market" and the earlier "Volcano for Hire*"* theme, the short phrases heard in this passage use movements in by scale steps or by 3rds, using the tonic, major 7th and fifth as resting points.

Figure 11: Weather Report – the "Volcano for Hire" shout chorus melodic theme



A final shout chorus is also evident in the eight bar repeating coda of Shorter's "Palladium" which uses a diatonic A major melody until a two bar turnaround, which moves as upper chord tones through ii-V-I-IV, ii-V-I-vi and II-V root progressions, creating minor 9th, minor 11th, suspended and altered chord sonorities (Figure 12).

Figure 12: "Palladium" – coda shout chorus



Of note is the interpolated II-V sequence in the second last measure which begins on a an Ebmi9 chord a tritone away from the A major key center and cycles through a iii-Vi – ii-V sequence (Ebmi9 – Ab7 – Db9sus – Gb7/C7b9) back to Bmi9 ii chord, and the tritone substitution dominant altered C7 chord in the final bar which resolves by moving down a half

step to the opening Bmi9 chord, reflecting the traditional bebop chord sequences Shorter used in the early 1960s but is recontextualized here with slash chords, synthesizers, electric bass, and layers of percussion.

2.4 Herbie Hancock

Pianist and composer/arranger Herbie Hancock, an important member of the Miles Davis Quintet and a band leader in his own right, released a series of acoustic jazz albums that ranged from soul-jazz, harmonically impressionistic post-bop acoustic ensembles, to jazz-fusion and techno-jazz music. An acoustic piano classical prodigy debuting with the Chicago Symphony at age 11 on Mozart's piano concerto No. 26 in D Major, Hancock's study of 20th century classical piano repertoire including Debussy and Ravel was later folded into his post-bop compositions , notably on the albums *Empyrean Isles* (1964) and *Speak Like a Child* (1968). The "fractured functional harmony" [12] evident in the rich harmonic chord structures and non-standard progressions on these recordings served as a launchpad for his sophisticated solo improvisations, as Hancock *Speak Like a Child's* liner notes state that he was attempting to emphasize "sounds [timbres] rather than definite chordal patterns."[13]

Hancock's interest in so-called "soul jazz" is found on earlier pieces such as "Watermelon Man" and "Empty Pockets," and demonstrated an interest in more groove-oriented and earthy harmony and rhythm. The earthy, groove oriented and blues-progression based "Watermelon Man", a hit for Mongo Santamaria and recorded by at least 200 artists, draws a significant early connection to Zawinul's background in "soul jazz" with "Mercy Mercy Mercy," a Billboard #11 hit for his bandleader Cannonball Adderley in 1967. The Fender Rhodes electric piano would become the focus of his funk-influenced style of jazz-fusion, signalling a move to more electric-based ensembles soon after his introduction to the instrument by Miles Davis during the 1968 *Miles in the Sky* album sessions. The instrument immediately appealed to Hancock for its

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[12] Gluck, Bob. *You'll Know When You Get There: Herbie Hancock and the Mwandishi Band* (Chicago, IL: University of Chicago Press, 2012), 41.
[13] Hancock, Herbie, Liner Notes, *Speak Like a Child* (Blue Note BST 84279, 1968)

ensemble blending and sound qualities, as he recalled about the session, *"*It was much, much fuller and it had a blending quality that the acoustic piano doesn't have. The Fender Rhodes piano blends so well with other instruments. And I could hear myself much, much better. Plus the vibrato effect – I liked that right away.*"*[14]

The album *Fat Albert Rotunda* (1969) marked this new direction from Hancock's acoustic jazz efforts in its jazz-funk aesthetic, followed by the more experimental *Mwandishi* (1971) which layered Rhodes electric piano, electronic and studio effects and electric bass, as well as a small brass and woodwind trio over early 1970s funk rhythms. The followup album *Crossings* (1972) added a large modular Moog III synthesizer, vocal choirs and percussion to its extended pieces which made use of non-standard jazz forms, instead using brief interludes to bridge the main thematic sections. *Head Hunters* (1973) continued in the use of electric instruments, synthesizers, effects and funk rhythms, but marked a determined direction in a more stripped-down and funk-oriented, less impressionistic direction, and provided Hancock with commercial success in the form of the hit song "Chameleon," which was inspired by the octave-and-flattened seventh style funk bass vamp in Sly and the Family Stone's "Thank You (Falettinme Be Mice Elf Agin)".

Hancock's next album *Thrust* (1974) exhibited a more sophisticated jazz-fusion style, most notably in "Actual Proof," which made use of Hancock's rich non-functional chord progressions and included an odd-time signature turnaround, while adding a new trademark sound in a Hohner D6 Clavinet with wah-wah pedal funk comping. A highly sophisticated style of free-style syncopated funk drumming by Mike Clarke was used on this performance to great effect. However, disagreement between drummer Mike Clarke and Hancock's producer David Rubinson over the former's complex drumming style would foreshadow movement to a more commercial direction in Hancock's later albums *Man-Child* (1975) and *Mr. Hands* (1980). These later albums

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[14] Fellezs, *Birds of Fire,* 190. As stated by Fellezs in the end notes to "Birds of Fire" on p. 260, "This quote is taken from a recording Hancock produced when he was the spokesman for Fender Rhodes electric pianos. The recording was part of a multipage advertistement entitled "Herbie Hancock Demonstrates the Rhodes Sound" that included a plastic flexidisc insert. Readers of the November 8, 1973, issue of Down Beat could find the ad and disc on pages 25-28, which, coincidentally, featured a cover announcing "Jazz Rock."

saw the small group dynamics and group improvisation replaced by the use of session musicians, overdubbed string and percussion elements and layered electric guitar. However, these recordings retain aspects of Hancock's jazz elements, for example "Sun Touch" (*Man-Child*, 1975) which uses a recurring augmented bass and guitar unison figure, extended Fender Rhodes solo over modulating key centers, and the use of triads with alternate root notes ("slash chords").

2.5 Compositional Characteristics

While the later 1970s Hancock recordings and live *Flood* (1975) double album includes electric guitar, its inclusion does not fall into the jazz-rock style as in the Mahavishnu / Jeff Beck axis but instead supports a funk aesthetic. As in the case of Weather Report, there is a combination of acoustic instruments (piano, flute, trumpet, flugelhorn) with electric piano, electric bass, synthesizers, and electronic effects. Hancock's "Rockit*"* (*Future Shock*, 1983)*,* the highly successful electronic techno single which combined DJ GrandMixer D.ST's turntable scratching and with echoes of his "Chameleon" melody and signature clavinet-style funk comping supports the notion of combining jazz motifs with current rhythms and electronic music techniques. Hancock's connection to electronic music is further reinforced by British group Us3's 1993 hit song "Cantaloop," a loop and rap-vocal updated rework of Hancock' 1964 soul-jazz hit "Canteloupe Island."[15] With this in mind, selected motifs, sonorities and themes will be examined in Hancock's brand of jazz-fusion in detail, including melodic and thematic phrases, non-conventional chord movement, superimposed chordal structures and orchestration.

Melodic themes and phrases used by Hancock encompassed simple unison riffs as in "Chameleon" and "Sly" (*Head Hunters*, 1973), and longer harmonized phrases. Prominent unison riffs are evident in several compositions, in combinations that may include Rhodes, bass, saxophone, or synthesizer as in "Chameleon," "Sly" and "Sun Touch." For example, after the famous opening ARP Odyssey bass synthesizer figure from "Chameleon" which moves chordally from Bbmi to Eb, the main melody of the piece is a unison Bb minor pentatonic funk-style line played by Rhodes, synthesizer and tenor saxophone, joined in tutti fashion in the final

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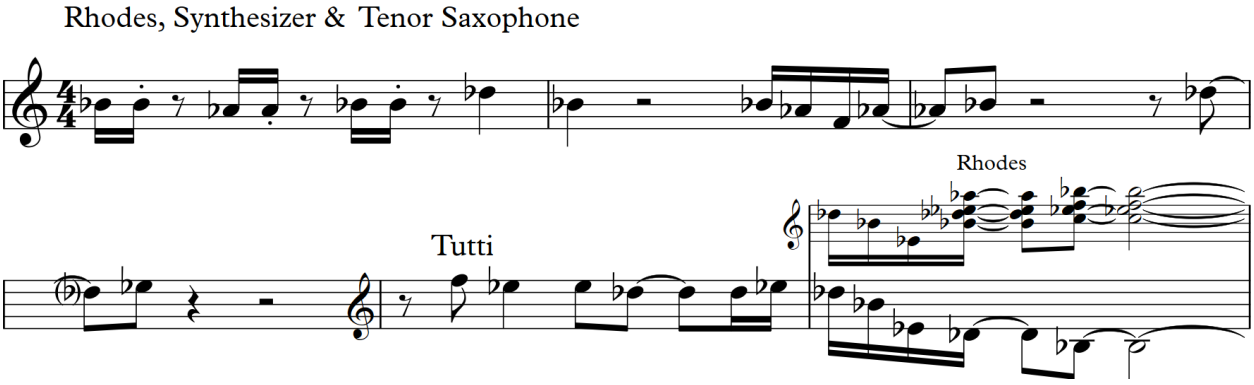
[15] "Jazz in Oxford Music Online." *Oxford Music Online* . 2013. http://www.oxfordmusiconline.com.ezproxy.library.yorku.ca/subscriber/article/grove/music/45011

two measures by electric bass and drums.

Figure 13: "Chameleon" - melodic phrase excerpt



Despite Hancock's later insistence that *Head Hunters* was intended to be a funk album[16], his instinctively jazz-based impulses can be heard even in the most straightforward melodic passages. For example, Figure 13 (above) demonstrates modal Bb minor parallel structure voicings harmonizing the final two notes of the phrase, enhancing a simple diatonic riff. The structure is constructed from a quartal triad with added minor third from the root, as in Bb-Db-Eb-Ab, moving up a tone to C-Eb-F-Bb over the final Bb root note played in tutti.

The use of unison melodic figures harmonized in 4ths or 2nds is also evident in "Sly". The opening E to D figure by soprano saxophone and bass is doubled by an E9(sus4) voiced in as a B quartal triad with added F# by the Rhodes, with a response in the second measure with a bluesy unison bass and Rhodes figure, as illustrated in Figure 14.

Hancock's use of harmonization to reinforce melodic themes is also heard later in "Sly." The melodic theme after the introduction features a rising E minor modal phrase played by the soprano saxophone, over a loping funk bass part in E. As in the introductions, the Rhodes is used to harmonize the melody, in this instance with parallel 4ths and quartal triads below the melody (see Figure 15). A Cma7 voicing over the E bass vamp harmonizes a sustained tonic

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[16] Fellezs, *Birds of Fire*, 210. In a 1985 interview with Bill Flanagan for Musician magazine, Hancock stated that "When I did Headhunters [sic] I was trying to make a funk album, not a jazz album. Not anything having to do with jazz. But as it developed it became what it was."

saxophone note before a short Rhodes E minor fill leads into the answering phrase with similar quartal harmonization, with ending with a more dissonant Gmaj7#5 voicing harmonizing the final B natural melody note, producing an Emi(ma7)^{add}9 sonority.

Figure 14: "Sly" - opening excerpt

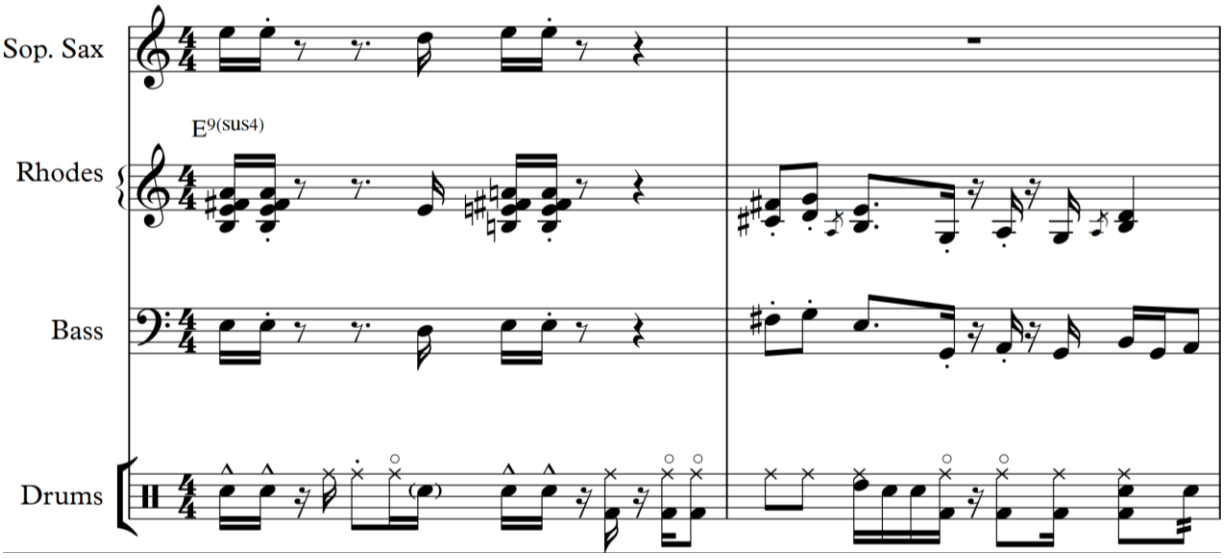
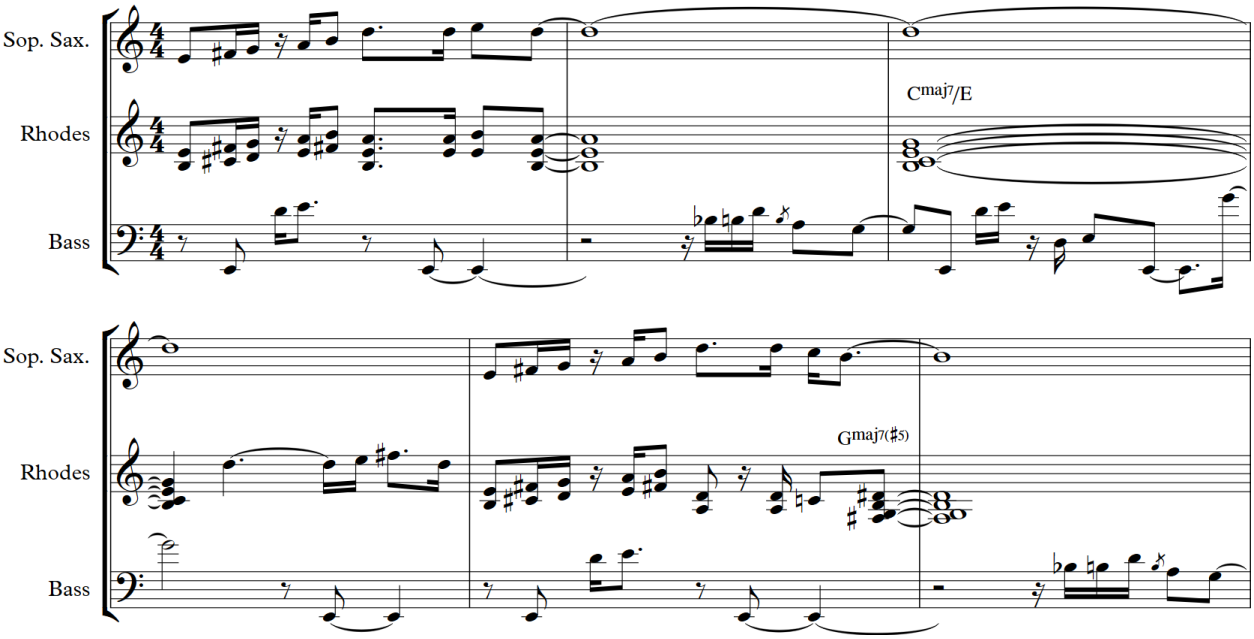
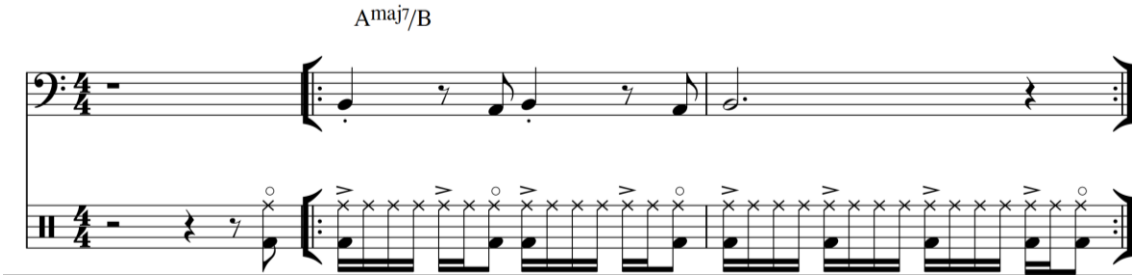


Figure 15: "Sly" - harmonized melody



Hancock's 1975 release *Man-Child,* while continuing the funk-influenced style of jazz-fusion captured on *Head Hunters* and *Thrust*, further emphasized a riff-oriented style, but expanded the instrumentation to include strings, guitar, percussion and guest musicians Wayne Shorter (saxophone) and Stevie Wonder (harmonica). Significantly, Motown studio guitarist Melvin Raglin, or "Wah-wah Watson" is credited as co-composer on four out of the six compositions, and guitar textures and riffs figure prominently in the compositions. However, although a more commercial and more produced production style predominates, the extended funk rhythm section vamps over which are played riff-oriented melodies and keyboard improvisations still retain a sense of sharp harmonic angles that add harmonic interest to the songs. The composition "Sun Touch" exhibits unison figures played between various multi-octave doubling of flute, bass, guitar, bass trombone, muted trumpet bass clarinet. The main Amaj7/B rhythmic theme stated by the bass guitar is used as a motif from which other variations are drawn. The opening "Sun Touch" bass vamp is a simple ostinato that closely matches the kick drum (Figure 16).

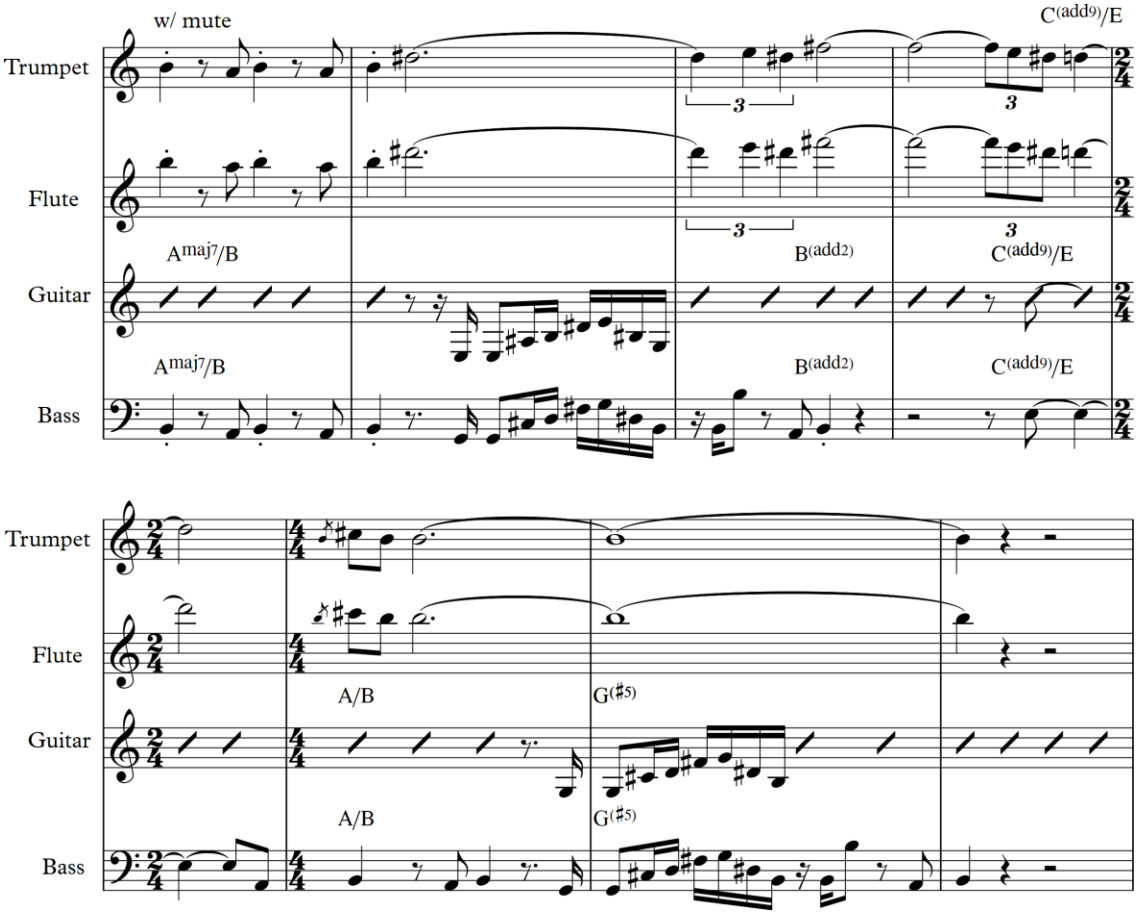
Figure 16: "Sun Touch" - opening bass vamp



"Sun Touch" proceeds to make use of several unison figures in various combinations. After the vamp, flute and muted trumpet enter first doubling the bass figure for one measure before moving to a lyrical phrase in the next five measures. This rising and falling melodic theme uses a simple B major scale to move upwards to first a $B^{add}2$ chord, followed by a chromatic fall down from E to D with an accompanying $C^{add}2$ chord with E in the bass.

Meanwhile, a new 16th note bass figure begins on a G root note, a major third from the B root in the second measure of this section. The unusual syncopated phrase ascends from the G root to the perfect fifth and octave notes D and G approached from a half-step below, then descends through a G augmented triad (see Figure 17). This phrase is joined by rhythm guitar. A restatement of this section is then made, with bass trombone reinforcing the bass and guitar's 16th note syncopated G/G augmented figure.

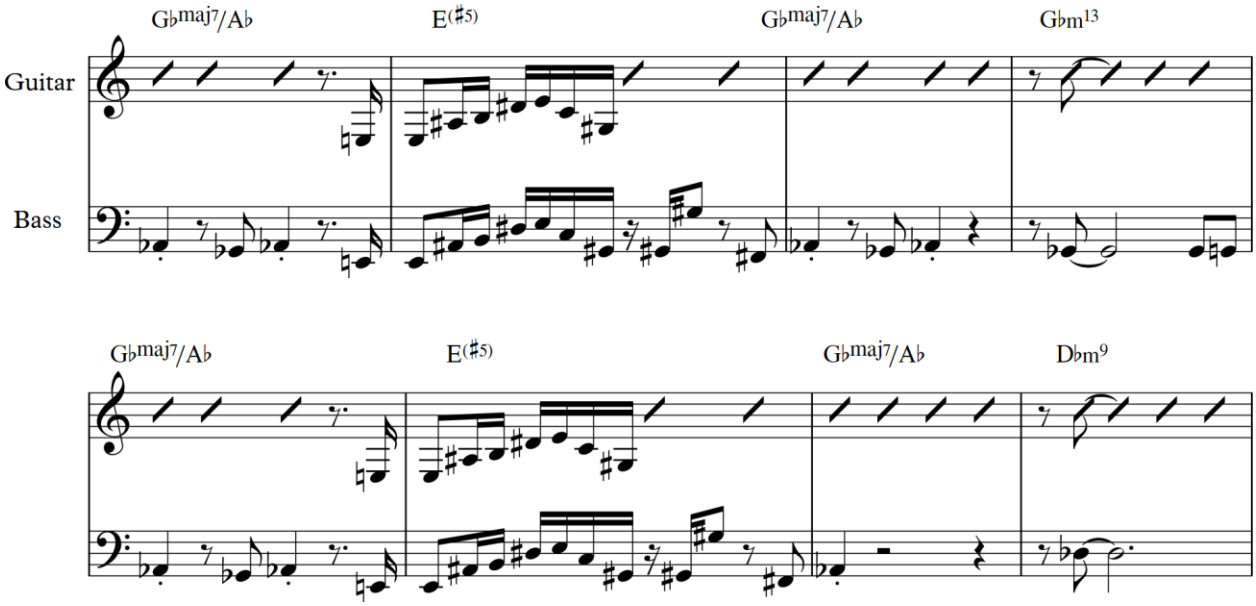
Figure 17: "Sun Touch" – melodic section excerpt



After a brief Emi9 transitional chord, the piece modulates down a minor third to a Gbmaj7/Ab chord and an extended Rhodes solo begins. The bass vamp continues in the new key on an Ab root, the transposed part including the doubled bass/guitar which is now based on an E

root note a major third down from the Ab root key of the passage (Figure 18).

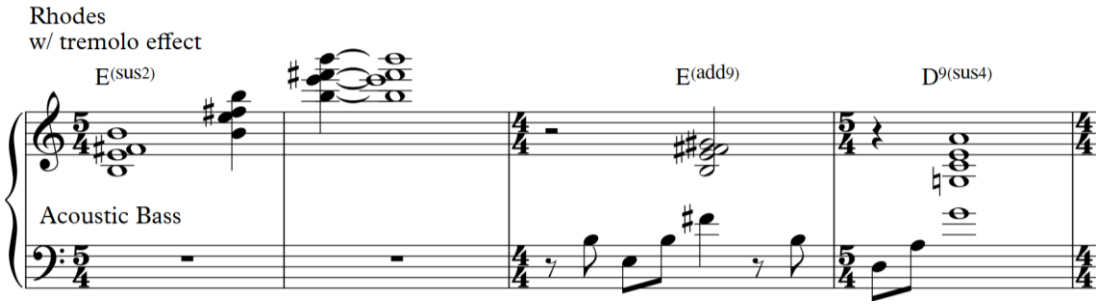
Figure 18: "Sun Touch" – bass & guitar vamp during Rhodes solo



The types of chords and voicings used by Hancock include superimposed triads, parallel structures, pedal notes and slash chords. A favoured voicing technique used by Hancock is 4ths separated by 2nds or 3rds. The composition "You'll Know When You Get There," from *Mwandishi* (1971) exhibits several of these characteristics. Although acoustic bass is used on this piece, a jazz-fusion aesthetic is evident in the effected Rhodes sounds and modern sound production use of reverb and delay effects. The opening Rhodes phrase, with tremolo effect,[17] moves through three octaves of the same Esus2 chord, voiced as two stacked 4th intervals separated by a perfect 5th (see Figure19), recalling similar 4th-based sonorities heard in "Sly" and "Chameleon." In the fourth measure of the piece, the cluster of two 4ths separated by a major 6th suggests a D9(sus4) chord.

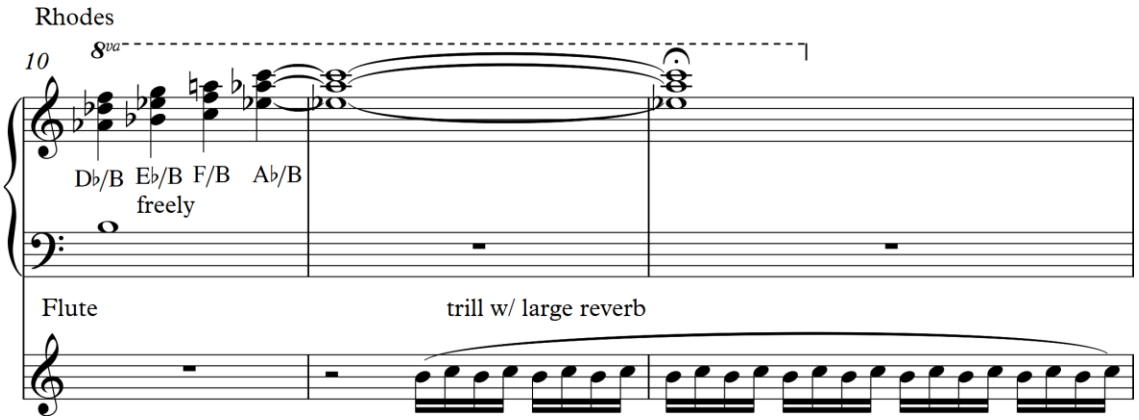
[17] In the context of electronic effects, the tremolo effect is a rapid wavering of the amplitude of an audio signal. The application of tremolo to the Rhodes piano adds a commonly used "watery" effect to the sound.

Figure 19: "You'll Know When You Get There" - Rhodes introduction



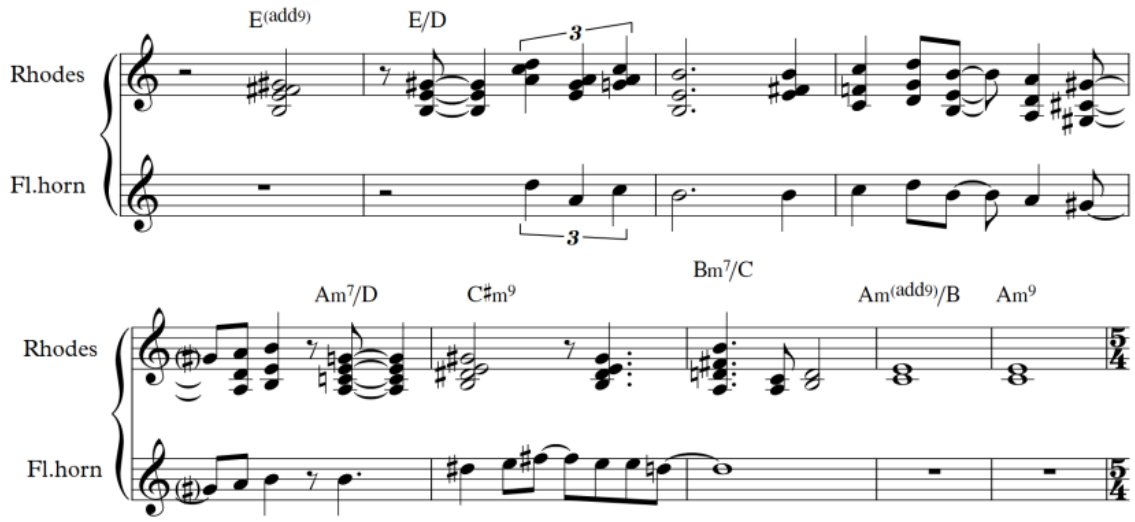
Brief dreamlike interludes in this piece also make use of superimposed triads, pedal notes and slash chords. After the first flute statement of a simple modal E melody, a rubato interlude features the Rhodes moving in a Debussy-like manner through ascending whole-step triads as in Db-Eb-F-Ab over a B root, resting on the final Ab/B chord sounding like a partial B7(b9 13), while the flute trills on a B to C, or tonic to b9 interval, as depicted in Figure 20. A large reverberation effect is added to the flute trill, which along with bells, highlighting the trancelike atmosphere of this passage. The implied V chord of the Ab/B sonority is finally resolved back to an E tonal root after a brief bass solo.

Figure 20: "You'll Know When You Get There" - Rhodes and flute interlude



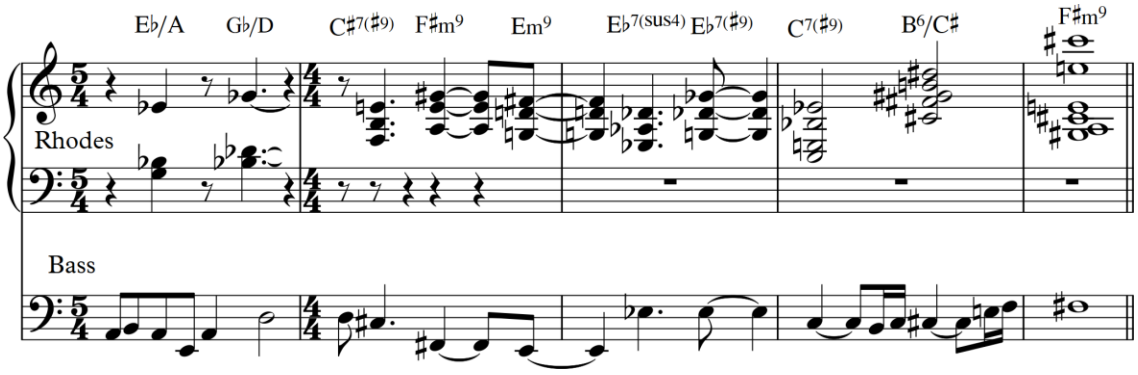
The flute theme is then restated by flugelhorn, this time using the Rhodes harmonization technique recalled in the “Sly” example. In this instance, the restatement is harmonized by three-note voicings in 2nds and parallel 4ths recalling the “Sly” harmonized theme, bookended by slash chords such as E/D, Ami7/D and Bmi7/C and Ami(^{add}9)/B (see Figure 21).

Figure 21: “You'll Know When You Get There” - Flugelhorn melody with Rhodes harmonization



Following this passage, another rubato interlude makes further use of slash chords as well as contrasting three-note and broadly structured voicings. Brief dissonant Eb/A and Gb/D chords occur in a single bar of 5/4, leading into a four measure Rhodes and acoustic bass interlude. A series of half- or whole-step moving chords suggests an F# minor tonal center in cadential C# to F# root movements at the beginning and end of the sequence (see Figure 22).

Figure 22: "You'll Know When You Get There" - Rhodes and bass interlude



However, the mix of root movements and chord voicings obscures this suggestion of functional harmony. For example, the "3rd – 7th – 9th" voicing used in F#mi9 moves down a whole step to Em9, then a half step down to an open-sounding Eb7(sus4) chord which omits the 5th. This chord then shifts to a three-note Eb7#9 chord over the pedal bass note, before moving down a major third to C#7#9. A surprising half step movement up to a B6/C#, functioning as a C#9(sus) chord, then resolves back to F#m9. These unusual root movements, combined with the chord voicings used, evoke a roundabout route towards the F# minor root center. As Hancock stated in a description of his 1963 composition "King Cobra" (*My Point Of View*, 1963), "The chords in most jazz tunes flow in a certain way. I wanted to expand the flow so that it would go in directions beyond the usual."[18]

Chapter two has identified a range of key compositional characteristics from the repertoire of both Weather Report and Herbie Hancock including melodic techniques, chord progressions, voicings, orchestration and song forms. A number of these characteristics are those which will be used in the creation of the original compositions later in this thesis.

[18] Gitler, Ira, Liner Notes, *My Point of View* (Blue Note Records - BST 84126, 1963), quoting comments by Herbie Hancock.

3 Breakbeats and IDM Drum Rhythm Programming

3.1 Breakbeats - Overview

The term "breakbeat" refers to several different but related concepts, depending on the context, but which revolve around certain funk, rhythm & blues and soul recordings recorded primarily in the 1960s and 1970s. Breakbeats from the late 1970s and 1980s also include certain disco recordings. The term arguably falls into three categories. Firstly, the term originally referred to a brief musical interlude or "break" in a particular recorded song which featured the drum set playing a special rhythm, usually a variation of the song's main rhythmic pattern or a special new pattern, while the other instruments remain tacet. Secondly, the "breakbeat" style of drumming often refers to the "broken" or syncopated quality of drum style the drum "break," referring to the rhythmic interplay between the kick drum, hi-hat, snare drum and sometimes the ride cymbal; the snare often using quieter "ghost" notes to offset the main snare hits. And thirdly, breakbeat also refers to a style of electronic music which developed in the U.K. in the early 1990s, which relied on the manipulation of electronically sampled breakbeats from vinyl records to create new pieces of music.[19]

The attraction of breakbeats for sampling and manipulation by DJs and electronic music producers, often decades after their recording, can be attributed to the unique ambience of the original vinyl recording, the compelling feel and rhythmic style of each drummer's performance, and the opportunity to obtain a "clean" drum break where other instruments are tacet, certain breaks also including hand percussion, usually tambourine or congas.

The method of locating and employing these brief rhythmic musical excerpts from vinyl records began in a very rudimentary fashion employed by early hip-hop DJs in New York City in

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[19] An EDM genre also known as "breakbeat" developed in the early 2000s which relied on breakbeats, but differentiated from drum'n'bass and jungle in its slower and less frantic tempos and feel. In this modern iteration of "breakbeat" music, a heavier rhythmic feel is characteristic, the result of layering breakbeats with processed kick, snare and hi-hat midi-programmed patterns. Breakbeat loops are used here to inject feel into the composition, in contrast to the drum-soloing complexity of earlier drum'n'bass and jungle styles.

the 1980s, using only turntables. DJ Kool Herc, a transplanted Jamaican DJ whose Reggae-style sound system block parties needed a boost, found that dancers drew the most inspiration during short drum breaks on funk and disco records. Since the original recording's drum break was usually brief, perhaps 4 to 8 measures, the drum break was extended to a longer duration by switching ("crossfading") back and forth between the identical copies of the same record as they played, using headphones connected to the mixer to maintain rhythmic sync, or "beat matching."

This style of turntable and mixer manipulation of records expanded to include other techniques: the layering of records on top of one another, vinyl scratching (purportedly discovered accidentally by DJ Grand Wizard Theodore much earlier, in the late 1970s), and Grandmaster Flash's more advanced "punch-phasing" method of dropping riffs and stabs from one record over top another. Along with guest rappers ("MCs"), who would freestyle over this extended musical base, a new piece of music would be the result.

In the U.K. however, the underground music scene referred to this use of breakbeats as "rare groove," originating with DJs that would search through obscure record shops, thrift shops, and other sources of vinyl records in order to locate unique or "rare" drum breaks to use in their dance sets, usually held in warehouse raves. As the frenetic energy of these underground events grew in the late 1980s and early 1990s, pioneering DJ-producers such as London's Shut Up And Dance collective, began to increase the speed of the turntable using the device's pitch control, in a new type of music referred to as "hardcore."

Producers of hardcore incorporated breakbeats into their electronic dance-oriented music productions, replicating the DJ method of crossfading between recorded breakbeats, or physically cutting tape-recorded breakbeats into extended sequences. As tempos increased to 130 -140 beats per minute (bpm) using this cumbersome turntable-based method, the new technology of digital samplers such as the Akai S1000 allowed producers to overcome the turntable's limitations by sampling breakbeats digitally.

In the digital environment, the break could be sped up to much higher speeds, sliced into its constituent parts and re-ordered into new rhythmic patterns using midi[20] recording software, where permutations of the drum sample chunks can be triggered in any order that the composer programs. By 1994, the manipulation and rhythmic re-sequencing of the underlying DNA present in sampled breakbeats had become more sophisticated and evolved into a more developed style known as "jungle," with tempos at approximately 150-160 bpm, exemplified in jungle classics such as Goldie's expansive "Timeless" (1994).

As DJ/producers such as LTJ Bukem, Photek and Squarepusher began incorporating jazz and jazz-fusion influences into their breakbeat-based recordings, the increased sophistication and extended pieces of music became known as "drum'n'bass," a less dance-friendly and listener-oriented style of electronic dance music. By the mid to late 1990s, the art of sampling, slicing, and re-sequencing breakbeats and incorporating them into electronic music compositions reached a height, particularly with Squarepusher's *Feed Me Weird Things* (1996) and *Hard Normal Daddy* (1998) where an additional emphasis on jazz-fusion elements and ambient electronic soundscapes combined with frenetically detailed drum programming pushed the drum'n'bass genre firmly away from dancefloor-oriented considerations.

So-called "intelligent" dance music, or IDM, is a blanket term that refers to EDM-based music that is more listener-oriented and contains elements of avant-garde, jazz, or other "musical" content. Composers in this more experimental, "intelligent" style of electronic dance music also included early 1990s practitioners Aphex Twin, Autechre and The Orb. However, the experimental nature of the IDM aesthetic means that its musical specifics and drum beats vary greatly, dependent only on the individual composers' impulses. In the context of IDM music, the repetitive looping of drum patterns ("loops") is less emphasized, as variations in rhythmic pulses provide much of the impetus.[21]

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[20] Midi stands for Musical Instrument Digital Interface, a communication protocol between computers and electronic or virtual musical instruments. Modern DAW software usually includes several types of midi editing and composing tools whose graphic interfaces have specialized functions to facilitate working with the raw midi note data such as score notation, drum-pattern, and keyboard-grid editors.

[21] The static repetition of looped breakbeats is less prevalent in IDM, although hand percussion is sometimes used in this way to provide an anchoring support to the off-kilter rhythmic drum patterns. This layering of tambourine,

Besides drum'n'bass, other EDM genres whose practitioners touch on elements of the "cerebral" IDM approach includes triphop, broken beat[22], and chillout, all of which have different sound characteristics but incorporate some form of sophisticated drum programming using either breakbeat sampling or the approximation of breakbeat-style drum rhythms. In the context of this composition thesis, IDM drum programming will focus on breakbeat-related drum programming. This will be presented in two parts. First, selected key breakbeats themselves will be analyzed in terms of their rhythmic characteristics, origins and usage. Secondly, the method of sampling, slicing and re-programming breakbeats will be explored in a detailed manner, followed by the application of breakbeat transcription in IDM drum programming. This analysis will lay the groundwork for the original compositions' drum rhythm component presented later in this thesis.

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conga and other hand percussion loops with syncopated drum beats is a feature of "broken beat", and its related genre "nu-jazz", a post-drum'n'bass genre of IDM originating in the late 1990s West London music scene. Broken beat, while also drawing on jazz, funk and soul source drum and percussion material, instead exhibits a more funk-oriented afro-futuristic aesthetic in its use of repetitively jerky drum patterns and layered percussion loops at tempos slower than drum'n'bass, generally 120-135 bpm. The broken beat style is exemplified by Afronaught, A/K/A Orin Walters, and his 2001 single "Transcend Me".

[22] The Berlin-based DJ/composer collective known as Jazzanova created a sophisticated IDM-style of broken beat that demonstrates advanced breakbeat sampling and drum programming within a carefully crafted framework of jazz and soul samples, live musicians and vocalists heard most evidently on their 2002 release *In Between*.

3.2 Influential breakbeats

The most popularly sampled and influential breakbeats were recorded between the early 1960s and late 1970s. There is tremendous value in studying the breakbeats themselves in terms of the rhythmic feel and performance details in the drumming style, as well as becoming proficient in the sampling and "slicing" of breakbeats, where the individual parts of the beat are sliced and then mapped across a sampler, each portion triggered by a different corresponding midi note. A list of important breakbeats, in terms of either sampling popularity or artistic significance would arguably include those depicted in Table 1.

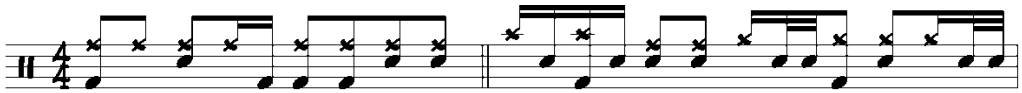
Table 1: Influential breakbeats

Drummer	*Composition*	*Artist*	*Year*
Nat Kendrick	"Soul Food"	James Brown	1963
Clyde Stubblefield	"Funky Drummer"	James Brown	1969
Clive Williams	"Papa Was Too"	Joe Tex	1966
G.C. Coleman	"Amen, Brother"	The Winstons	1969
Bernard Purdie	"Rock Steady"	Aretha Franklin	1971
Andy Newmark	"In Time"	Sly and the Family Stone	1971
Herschel Dwellingham	"125th Street Congress"	Weather Report	1973
Allan Swartzberg	"Funky President"	James Brown	1974
Skip Hadden and Ishmael Wilburn	"Nubian Sundance"	Weather Report	1974
Mike Clarke	"Actual Proof"	Herbie Hancock	1974
Jimmy Bralower	"Do the Do"	Kurtis Blow	1981

The development of this style of drumming in the early to mid 1960s was often featured in "breakbeats," special variations of R&B and funk drum set patterns. The use of "ghost" notes on the snare drum to offset the main parts of the beat function in a way that supplies an inner feel to the overall rhythm. The main drum beats are often displaced from their standard and usual position in RnB grooves. The open hi-hat is also used as a special accent, and the bass drum also

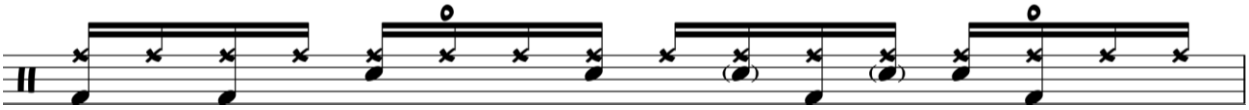
falls on an offset position. For example, the following drum set rhythm (see Figure 23) that is heard on James Brown's 1963 recording of the song "Soul Food, Parts 1 &2" demonstrates an earlier form of this RnB drumming style.

Figure 23: Nat Kendrick - "Soul Food" main drum pattern



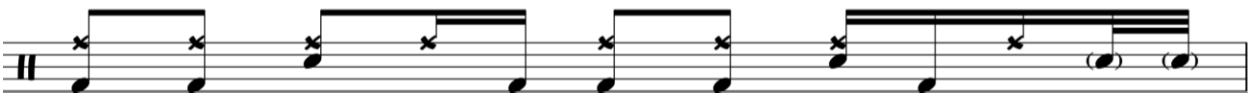
By the time Clyde Stubblefield recorded "Funky Drummer" with James Brown in 1969, the drumming style had evolved to a more sophisticated level, incorporating more 16th notes on the hi hat. As seen in the transcription below (Figure 21), beat three demonstrates interplay between ghosted snare hits and the bass drum, and beat four's second 16th note is accented by a unison bass drum and open hi-hat accent. The beats are played with a slightly swung feel, which blends with the offset syncopations to create a strong impulse of forward motion:

Figure 24: Clyde Stubblefield – "Funky Drummer" main drum pattern



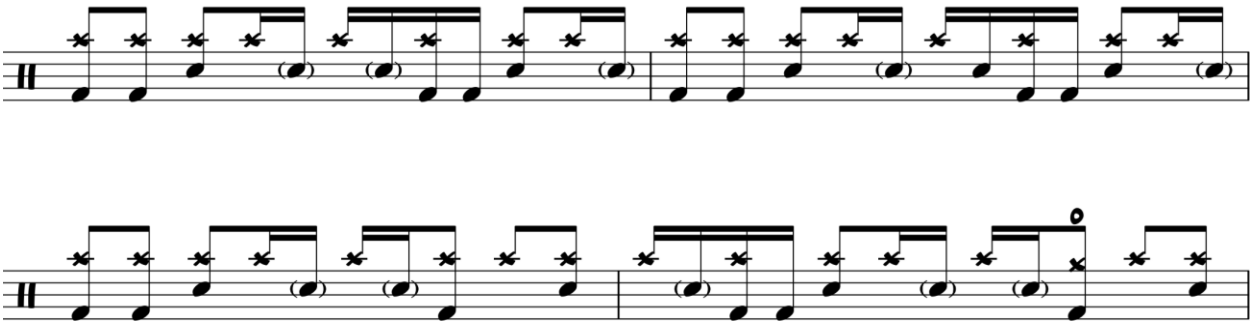
The recording of "Papa Was Too" by Joe Tex in 1966 featured an extended break by drummer Clive Williams. Note the variation introduced in beat four calling attention to the second 16th note, recalling the second 16th note of beat four heard in "Funky Drummer" (Figure 25).

Figure 25: Clive Williams - "Papa Was Too" main drum pattern



The recording "Amen, Brother" by the Winstons in 1969 featured a four bar drum break played by drummer G.C. Williams. This particular breakbeat is famous in having become the source rhythmic material in dozens of songs especially in the drum'n'bass, breakbeat and hip-hop genres.[23] Drum'n'bass artist Tom Jenkinson, working under the artist name Squarepusher, for example, explored the famous "amen break" on compositions such as "Vic Acid" (*Hard Normal Daddy*, 1997), where his advanced micro-manipulations of the edited and re-sequenced break components pushed their rhythmic possibilities to the limit. The original breaks' syncopation and slightly swung 16th note feel was especially prized by drum n bass producers, as it takes on a frantic and forward-moving feel when electronically translated to a higher pitch and speed. As well, the delayed-snare phrasing and kick-snare fills in bars three and four set up a rhythmic tension which creates an anticipation of the next downbeat.

Figure 26: G.C. Williams – "Amen, Brother" - main drum pattern



"Rock Steady," recorded by Aretha Franklin in 1971 and released the following year, demonstrates the evolution of syncopated drum pattern playing, as performed by legendary session drummer Bernard Purdie. The variation evident in bar four follows the format established by the other examples, breaking away from the established basic beat and setting up the next pattern cycle (see Figure 27).

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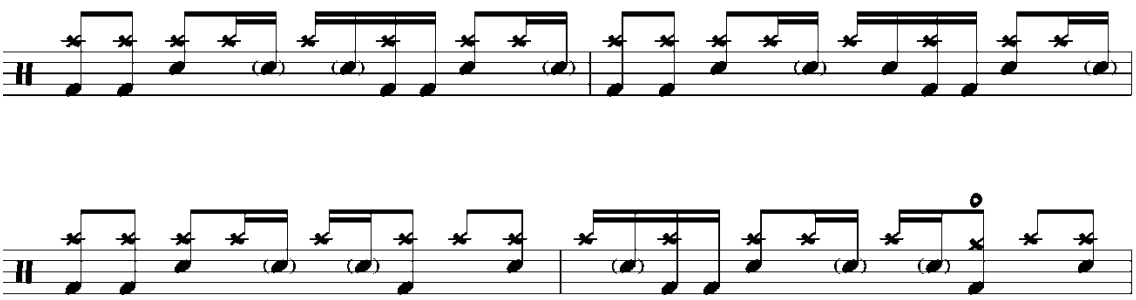
[23] Mainstream use of the widely-sampled Amen break also includes pop artists (David Bowie – "Little Wonder") and television programs (the theme song form the animated television show *Futurama*). The break has also been the subject of the 2011 BBC Radio 1 documentary *The Story of the 'Amen Break'* which was broadcast on March 6, 2011. (Source: www.bbc.co.uk/programmes/b011nyd1)

Figure 27: Bernard Purdie - "Rock Steady" - four bar drum break

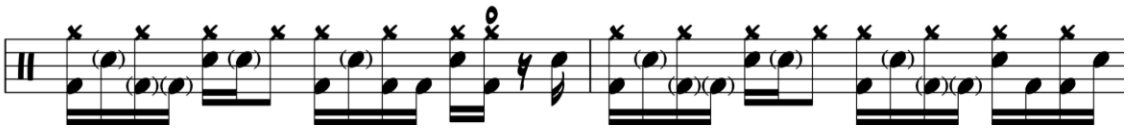


Herschel Dwellingham's drum beat on Weather Report's "125th Street Congress" has been described by Josef Zawinul, the song's composer, as the first "hip-hop beat":

> If you listen to the drum beat on '125th Street Congress' [from Weather Report's 1973 album *Sweetnighter*], that beat is the original hip-hop beat. I played that years before it was recorded. That particular beat has since been used by at least 55 or 60 rap groups, even until now [24]

In *125th Street Congress*, the drum parts' 16th notes are swung heavily and ghosted snare notes prominently influence the groove's "feel" (see Figure 28).

Figure 28: Herschel Dwellingham – "125th Street Congress" - main drum pattern

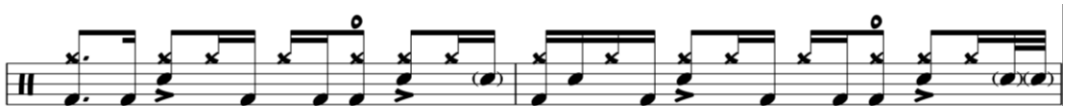


Allan Schwartzberg, a prolific and versatile New York City recording session drummer,

[24] Tingen, Paul. "Joe Zawinul - Jazz Keyboardist." *Sound on Sound*, June 2003.

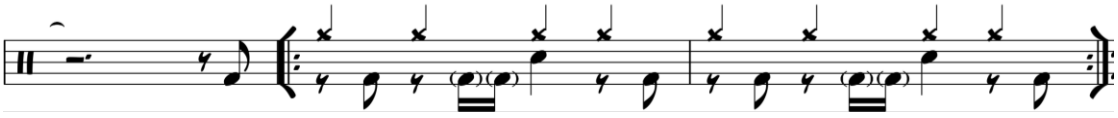
played this swung 16th note beat on James Brown's "Funky President" (*Reality*, 1974):

Figure 29: Allan Schwartzberg – "Funky President" - main drum pattern



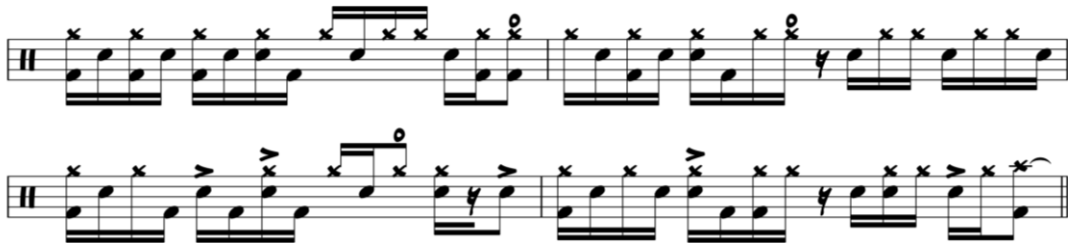
Skip Hadden and Ishmael Wilburn played the following frantic but half-time beat together on the lengthy Weather Report's *"*Nubian Sundance*"* (*Mysterious Traveller,* 1974)*:*

Figure 30: Skip Hadden and Ishmael Wilburn – "Nubian Sundance" - main drum pattern



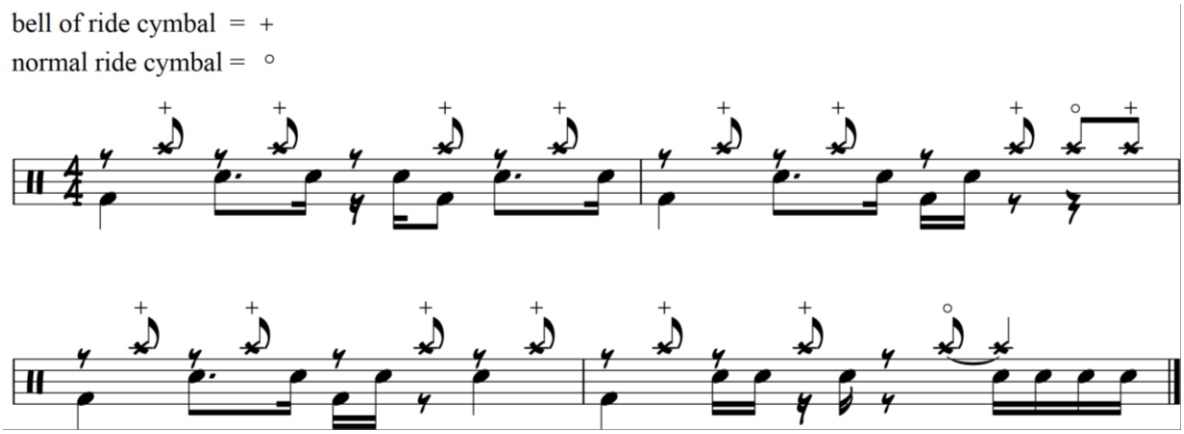
Although not a textbook "clean" breakbeat, as in a completely isolated rhythm part, the complex drum syncopations played by Mike Clarke on Herbie Hancock's recording of the song "Actual Proof" (*Thrust*, 1974) deserves special attention as possibly the apex of breakbeat style drumming complexity, characterized by a lengthy free-form improvisation of 16th note variations and ghost notes between the kick, snare and hi-hat in a jazz-like call and response with Hancock's stunning electric piano solo, as in a main excerpt illustrated in Figure 31.

Figure 31: Mike Clarke – "Actual Proof" - four bar excerpt main drum pattern excerpt



Rapper and producer Kurtis Blow's 1981 rap music hit "Do the Do" (*Deuce*, 1981) closes with an extended fade-out[25] break by drummer Jimmy Bralower (see Figure 32) which was later sampled extensively by artists such as LTJ Bukem ("Horizons", 1996) and Adam F ("Circles", 1997).

Figure 32: Jimmy Bralower – "Do the Do" – closing drum pattern



[25] A fade-out is a gradual decrease in audio volume to the point of silence.

3.3 IDM Drum Rhythm Programming: breakbeat slicing and re-sequencing, groove mapping, and drum programming using sequencing software

In studying breaks and their corresponding use as sampling material, it is evident that there are four main reasons that they are sought after in both their sonic and transcribed form by electronic music producers across a range of genres. First, the sound of real acoustic drum recordings, including the surrounding recording environment ambience and analog recording equipment, as well as the actual sonority of a vinyl record, provides authentic grit to the sound of the sampled beats, which contributes atmosphere to a given composition. Secondly, by "slicing" the breakbeat sample into its component parts, an entirely new drum performance can be re-constructed from the various permutations of the slices in as complex a manner and with sound effects as desired by the producer, but retaining the sonic and groove "dna" of the original performance. Thirdly, the "feel" of the rhythm inherent in the details of the original drum pattern is unique to the highly skilled drummer who performed the original beat, and can be extracted from breakbeats and re-applied to sequenced drum beats. And finally, the analysis and transcription of the drum patterns provides a pedagogy of drum phrasing style that assists the composer in programming beats using midi sequencing software with the detail and complexity that approximates a real human drummer, especially in regard to "ghosted" or subtle notes between the main parts of the beat.

Applying these aspects in a practical way will now be discussed as they translate to their corresponding composition techniques in two broad sections: first, a method for breakbeat slicing and re-sequencing to produce new drum rhythm patterns will be explained. Secondly, a method of extracting the rhythmic feel of a drum break into a "groove map" which can be applied to midi drum programming using a grid-style drum pattern editor will be explained and used in the creation of note-by-note programmed IDM-style drum patterns.

To begin, selected portions of audio containing the breakbeats are recorded into the Cubase digital audio workstation, or DAW. Using digital editing tools, the audio is trimmed to

create a seamlessly repeating "loop" of the selected portion of audio.[26] A helpful feature in Cubase is a beat calculator function, which is used to extract the tempo of the section, which is generally a one, two or four bar passage. The host bpm is then adjusted to match the break's inherent tempo. [27]

At this point, the audio is analyzed using the Cubase sample editor, and each rhythmic component of the passage is designated by vertical lines according to peaks in the waveform, or "hitpoints" as Cubase refers to them. A threshold slider can be used to filter out low peaks such as ghosted notes. Examining the hitpoint position of each of these portions in relation to the overall beats may show where adjustments must be made, to capture each individual drum hit accurately. At this point, the "create slices" function is activated which slices the audio sample at each hitpoint location, then closes the audio editor and replaces the audio sample with a new audio part containing the set of slices on the arrange page. From this, the Cubase audio function "dissolve part" dissolves the slices into individual audio samples which can be mapped onto individual pads of a drum sampler, for re-sequencing. To detail this procedure, the Clive Williams' drum break from "Papa was Too" was sampled and the individual components examined. The tempo of the single measure was calculated at 89.5 bpm. Figure 33 depicts the analysis of the audio sample before slicing.

After editing and adjusting the hitpoints, creating slices and dissolving the audio regions, the individual drum hits can now be loaded into a drum sampler such as Native Instruments' Battery. A corollary procedure also used by breakbeat producers is to slice not only the individual hits by 16th notes, but individual phrases within the beat at the 8th note or quarter note level, in order to capture slightly larger drum phrases which can be used to re-sequence the drum

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[26] The use of seamlessly repeating portions of audio, or "loops", is a common practice in many areas of contemporary popular music, especially electronic dance music. Loops can consist of virtually any source audio material such as drums, percussion, bass, sound effects, keyboards, guitars, vocals, et cetera. The arrangement of these short repetitive motifs into a larger musical framework can become essentially the entire compositional process itself at one extreme, or loops can be used as more of a static, supporting element as needed by the composer.

[27] While adjusting the host tempo to match the drum break is one way to work with loops, the procedure can also work the other way: expanding or compressing the loop's audio length using an audio editing tool common to most digital audio workstations can alter its timing to instead match the host tempo, with or without changing the pitch, a process commonly referred to as "timestretching".

phrases. Figure 34 depicts a second sample window of “Papa Was Too” where four larger phrases are extracted at quarter note divisions.

Figure 33: “Papa Was Too” - hitpoint analysis

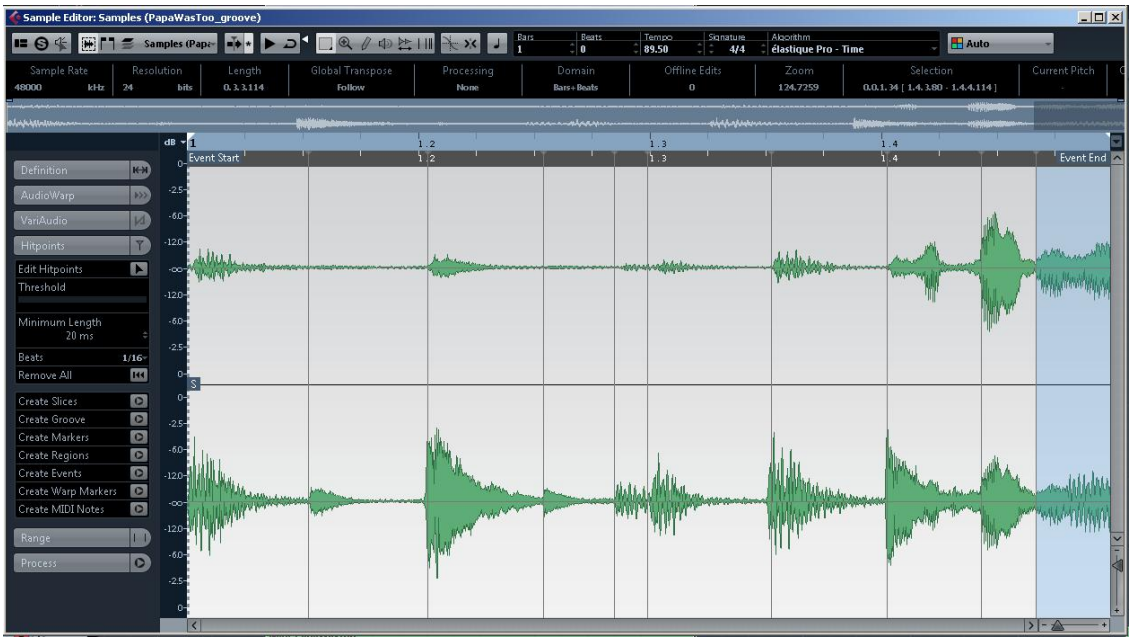
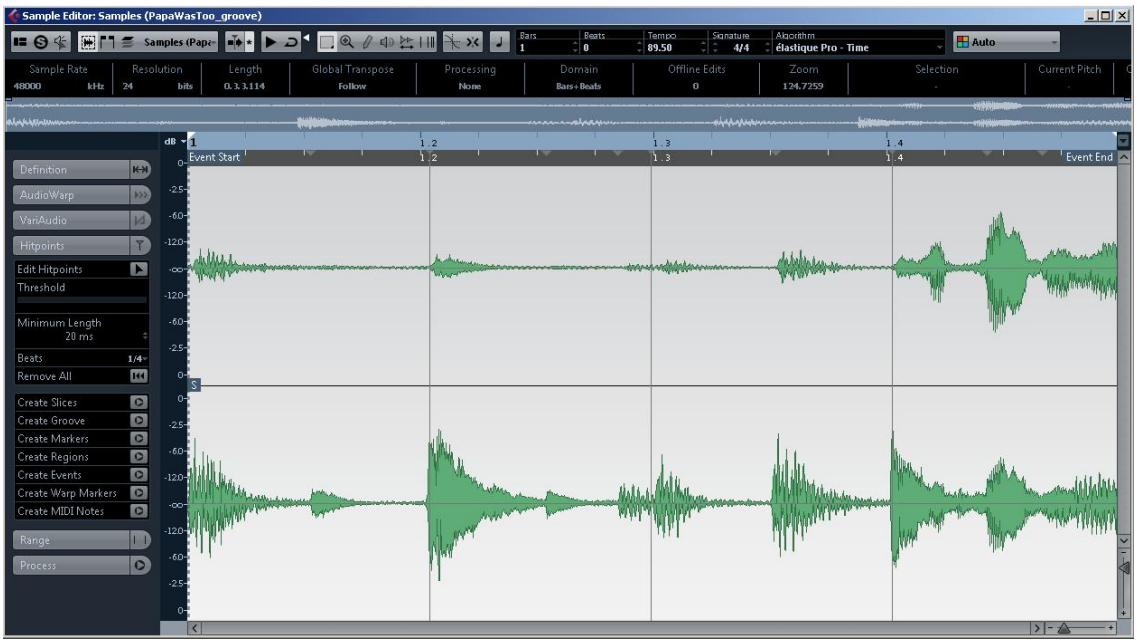


Figure 34: “Papa Was Too” - hitpoint analysis using larger drum phrases



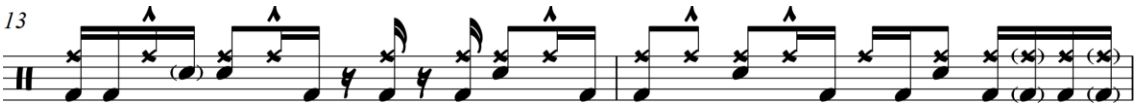
Battery has a matrix of cells across which the samples can be mapped, individually corresponding to specific midi notes. The individual drum hits (kick, hi hat, snare) and larger drum phrase slices can all be loaded into individual cells in Battery, which can then be re-triggered through the Cubase midi sequencer into new rhythmic patterns, each midi note corresponding to a drum hit or slice. At this point new rhythmic patterns can be created through midi programming in the Cubase host application, triggering the individual samples in the drum sampler. Battery also has further sound shaping and editing tools, which can be applied collectively or to individual samples. Figure 35 illustrates such a layout of sliced beats mapped across the first two rows of cells in Battery:

Figure 35: Battery Drum Sampler with mapped drum slices

In programming sequences using these mapped drum slices, a useful midi editor in Cubase called the “key editor” is helpful. The key editor shows a graphic map of a generic

keyboard layout and rhythmic grid, where the composer can simply draw in the parts using a pencil tool. Notes can be lengthened, shortened and time-aligned on the grid in order to both replicate the original break as well as create new drum phrases. Creating new sequences in the key editor allows a composer to compose new rhythmic variations that retain much of the sound quality and feel of the original drum performance. Figure 36 illustrates one such re-sequenced possibility of the "Papa Was Too" drum slices, transcribed into standard notation, which highlight the new variations and complexity.

Figure 36: Drum rhythm variation created using a re-sequencing procedure with the "Papa Was Too" break



The application of breakbeats to IDM drum programming also benefits from the analysis of the drumming style and feel, as opposed to triggering breakbeat slices using an original sample as source audio material. In terms of drumming style, the notes of the source breakbeat can be transcribed and programmed into a Midi sequencer and used to trigger an appropriate multi-channel drum sampler, such as Battery. The types of syncopated patterns, especially between kick, snare and hi-hat are important in capturing the drum style of this genre.

However, this tends to result in a stiff rhythmic feel, as accurate, quantized parts do not benefit from human rhythmic intention. As suggested (about swing rhythms) by Joost Van Praag as early as 1936, "*Swing is a psychic tension that comes from the rhythm's being attracted by the metre."* [28] Ethnomusicologist Charles Keil agrees with Van Praag's assertion regarding swing (or feel, in this case), further describing it as "*the tension generated by a complex relationship between meter and rhythm."*[29]

The actual rhythmic micro-placement of drum hits, as played by a drummer, can be

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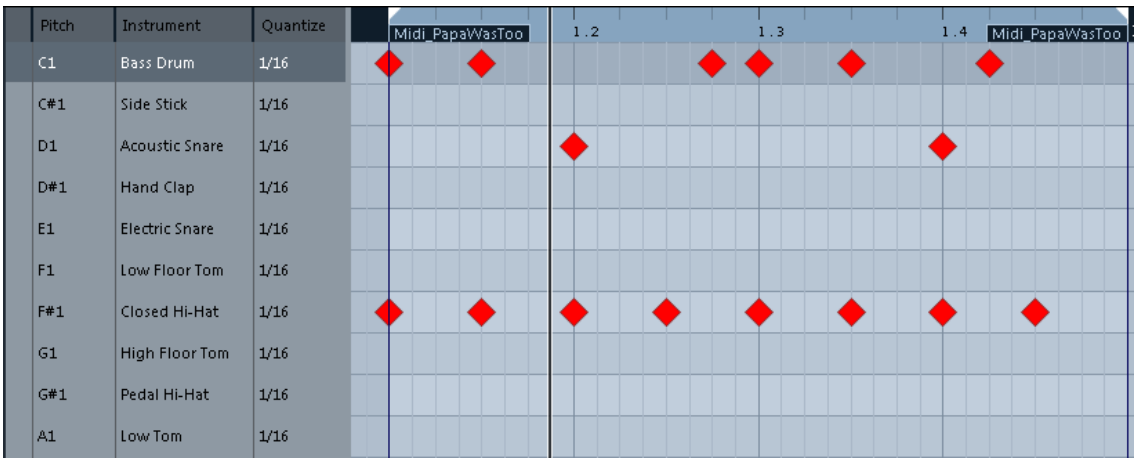
[28] Keil, Charles, "Motion and Feeling through Music: Participation in Grooves.", *Journal of Aesthetics and Art Criticism*, 1966, 58.
[29] Keil, *Journal of Aesthetics and Art Criticis,* 58.

extracted in terms of their micro-relationship to the metric/ rhythmic grid. In this procedure, again using "Papa Was Too" as an example, the audio sample is opened in the Cubase audio editor, and the hitpoints are detected on an approximate 8th note grid as in the first procedure. At this point however, instead of slicing, the groove inherent in the individual drum hit placements is extracted using the "create groove" function, which creates a "groove map" or quantize preset using the rhythmic feel extracted from the detailed placement against the beat of each drum hit. This preset is stored in the Cubase menu of quantize choices and can be applied to a programmed midi part, in particular drum parts.

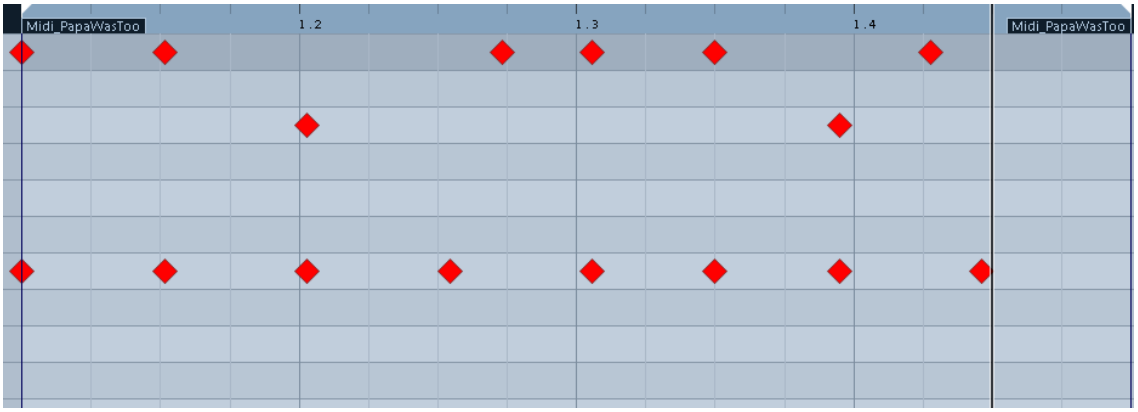
In this way, the feel of the original breakbeat can breathe life into a stiff sounding midi drum pattern. In this type of midi programming, the Cubase "drum editor," a grid-style midi editing tool specializing in drum patterns is useful. Drum patterns are simply entered with a special drumstick tool, and assigned to a sample-mapped drum kit in Battery, using whatever drum sounds are appropriate to the composition. The drum note data-entering process can be made more accurate by enabling a "snap to grid" function, which quantizes the notes automatically on a 16th note grid, for example, to ensure accuracy of the note placement. As an example, the "Papa Was Too" drum figure can be programmed in the drum editor, and assigned to a Battery drum kit with a set of acoustic drum set samples. The grid-style drum part in Figure 37 shows the basic "Papa Was Too" drum pattern with all notes placed precisely on a 16th note grid in the drum editor.

Figure 37: Cubase drum editor with 16th note quantized drum part



Applying the "groove map" quantization preset derived from "Papa Was Too" will shift the notes away from the 16th note grid to the micro-precise placements of the original drum rhythm, replicating the feel of the original performance. Further, Cubase is capable of "iterative" quantization, which shifts notes closer to the quantization map by a predetermined percentage, "feel" in increments by percentage. Figure 38 depicts the magnified view of a 30% iteratively quantized application of the groove map to the same programmed "Papa Was Too" midi drum part.

Figure 38: Cubase drum editor showing closeup view of an iteratively quantized version of the "Papa Was Too" drum pattern

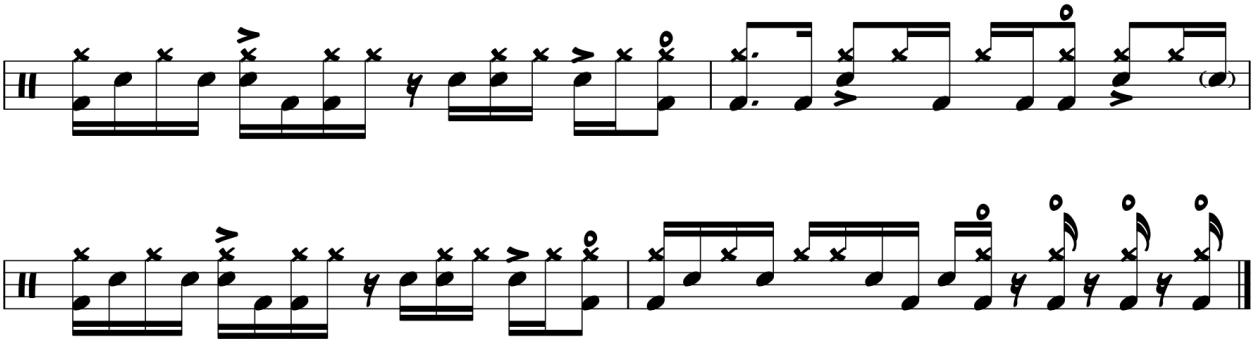


In the iteratively quantized version seen in Figure 37, the individual drum notes have shifted position, replicating some of the organic feel of the original breakbeat. The final step, described next, will proceed to create new midi drum patterns drawn from breakbeat patterns, which will also take advantage of this type of iterative groove map quantization.

The larger IDM aesthetic, of creating electronic dance music that departs from a more formula-based dance music approach, often carries over into the types of drum and percussion patterns used in this genre. The evolving drum patterns and more syncopated, complex rhythms benefit from the study of breakbeats, and the flexibility of using midi programming allows for a more detailed creation of beats beyond the sound sources derived from sampled breaks. This combination of organically complex rhythms triggering mechanized drum samples is a hallmark

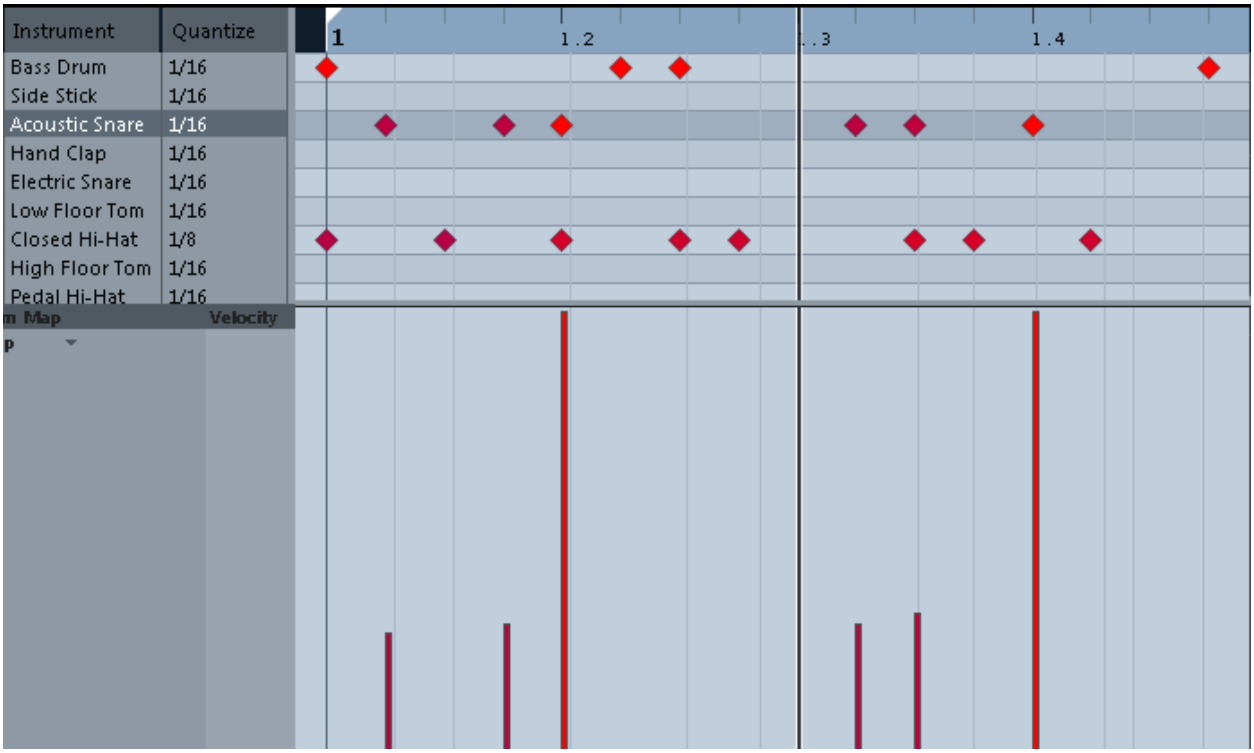
of the IDM paradigm. Consider the newly created four bar drum pattern depicted in Figure 39. Bars one and three establish a pattern similar to Mike Clarke's "Actual Proof" drum part excerpt, specifically the final measure's first two beats. Bar two is drawn from the first bar of figure, Allan Swartzberg's "Funky President" drum excerpt. Finally, bar four is an original drum fill created to add tension that creates an anticipation of the next downbeat.

Figure 39: Original breakbeat-style drum pattern



Using the Cubase drum editor, the sequence was programmed in perfectly quantized 16th notes at a tempo of 130 bpm, then iteratively quantized by 25% using the "Papa Was Too" groove map. However, an issue arises here. The feel of most drum breaks also relies on variations in the individual velocities of drum notes, especially snare drum grace notes, or "ghost notes," which are snare drum notes played at a much lower velocity than the main hits that anchor the groove. Adjusting the individual drum note velocities in the midi sequence solves this issue. By reducing the velocities of un-accented snare hits, and adding variations in the velocities in the hi-hat and kick notes, a more organic feel is emphasized. Figure 40 depicts this concept, as the snare drum notes in bar one of the drum editor sequence highlights the higher velocity on beats two and four, while the ghost notes are reduced by variations in velocity. The iterative quantization also emphasizes the "push" of the snare hits, as they slightly anticipate beats two and four and create a sense of forward motion.

Figure 40: Original breakbeat pattern programmed in grid-style editor



As can be seen from this drum rhythm programming strategy, the gathering of raw breakbeat sample material can be applied both as sonic material, and as a style-based source of midi drum programming technique. Taking this further, a composer can create drum rhythms that take precedence as a driving force in a given composition. In Squarepusher's composition "Cooper's World" (*Hard Normal Daddy*, 1997) for example, the dynamically intricate drum parts reinforce the song's underlying rhythmic accents but introduce continuous variations that shape the compositions' overall texture and shape. While an animated feel is evident in this opus of IDM drum programming, the unnaturally mechanical sonic repetition of the drum samples and glitchy, skittering snare drum fills creates the impression of a futuristically rhythmic landscape.

In the context of composing in the electronic dance music idiom, a composer can take full advantage of these various techniques of drum programming to facilitate the creation of new rhythmic ideas and fully-realized drum parts.

4 Electronic Dance Music Techniques

4.1 Overview

The importance of mixing, sound design, and audio effects to electronic dance music has been evident throughout the modern era of EDM. From early hardware-based solutions with syncronization, noise and maintenance issues and limitations to modern laptop studios with unlimited audio processing and mixing environments, the knowledge and application of audio production techniques plays a prominent role in these genres, since the timbres associated with electronic music contribute to compositional choices. As Rick Snoman notes in his Dance Music Manual, an electronic composer should "examine the various processors and effects that are available. This is because the deliberate abuse of these processors and effects play a vital role in not only the sound design process but also the requisite feel of the music."[30]

While breakbeat and grid-style drum programming has been discussed in an earlier chapter, IDM (intelligent dance music) is itself a sub-genre of the EDM category of music. Electronic dance music's sub-genres are generally divided into trance, house, techno, drum'n'bass, dubstep, et cetera and are classified by general musical characteristics specific to each style. Listeners (and dancers) often distinguish these styles based on the type of drum/percussion rhythm patterns used as well as other musical traits.

The aspect of sound design and sound-shaping tools (whether analog, digital or virtual) and their relationship to EDM here is an important factor, as the difference between "French house" and "diva house,"with similar musical harmonies and melodies, may depend simply on certain settings in one stereo compressor. Composers use these tools as elements of sound design in a way that enables the sonic qualities themselves to hold enough musical interest, in conjunction with the bare written notes and harmony in the underlying piece. In "minimal house music" for instance, simple changes in sonic texture alone over time provide much of the interest, since the percussion and melodies are very simple. As in any genre of music, mixing techniques are used to either blend elements together in a practical sense, or to produce special textures that

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[30] Snoman, Rick, *Dance Music Manual: Tools, Toys and Techniques* (Kidlington, UK: Focal Press, 2008), 31.

contribute to the composer's intended vision of the piece. In the context of this thesis, the intention is to produce characteristic EDM sounds using these techniques that can be used in the original compositions, with a resulting effect of bringing jazz-fusion style music into an electronic music context.

4.2 Effects Routing

The application of effects generally falls into five types, namely: master, insert, send, group ("buss"[31]) and parallel. While virtually any type of effect can be used on any channel, established techniques will be examined in this chapter. The first three most common routings are "insert effects," "send effects" and "master effects," which will be used for the following EDM-genre procedures. An additional chapter describing additional effect routing techniques will follow.

Firstly, the concept of "insert effects" refers simply to audio processors that are directly inserted onto an individual audio or instrument track before it enters the final stereo mix. In analog recording consoles, this is achieved by a direct send and return loop to and from a hardware effect unit on a selected audio channel via audio cables. The digital audio environment offers greater flexibility in this regard, since signal processing effect chains can easily be reconfigured and their parameters adjusted without hardware limitations. Working within a DAW also allows the EDM composer to easily control effect parameters in close detail through automation, which can be used for compositional and arranging techniques that will be examined in the following chapters.

The term "send effects" refers to the transmission of a portion of audio signal sent to a separate dedicated effect channel which has one or more effects inserted. In this case, several instrument and audio channels can send a portion of their signal to a send effect channel, where selected processors are applied to all elements sent to that channel. This has the effect of unifying the timbre or sonic space of those instruments since they are subjected to a common

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[31] In audio mixing terms, a "buss" is a common signal path carrying audio signals to one or more destinations. It facilitates the sub-grouping of channel outputs which can be mixed together and controlled as a group. The term "buss" and "bus" are commonly used interchangeably in this context.

processing effects chain. The term "master effects" refers to the application of signal processing to the final stereo output of the entire composition. Effects applied here contribute to the total impact of the aggregate mix. Standard EQ and compression tools are used here to polish a track, reducing unwanted frequencies, boosting needed frequencies and smoothing out overall volume peaks and valleys. In EDM and in contemporary pop music in general, special "maximize" compressors are used to produce as loud an average volume in the final mix as possible in order to produce the maximum perceived loudness and dynamic punch.

With this background in mind, the following sub-chapters will now undertake an approach to understand signal processing techniques that are common across a range of EDM styles and how they are applied, in such a way as to allow their application in the context of the original compositions that follow.

4.3 Gating Techniques

The piece of audio processing equipment known as a "gate" is also referred to as a "noise gate" which refers to its commonly used function as a noise-reducing audio processor. In simple audio terms, a gate allows an audio signal to pass through to its output until it falls below a certain threshold level, at which point it mutes the audio – this processing action is known as "gating" the audio signal. Companies such as AMS/Neve and Universal Audio produced professional quality gates in the 1960s and 1970s, which were used both in recording studios and in live sound mixing consoles. Live sound mixing in particular made use of the gate to reduce the leakage of unwanted sounds or noise into the onstage microphones.

While the audio hardware originally used for gating techniques is still in use in major recording studios, the development of digital audio plugins that achieve the same functionality has largely taken over from their hardware counterparts. The software versions of contemporary gate effects are capable of much more complex and tempo-synced functions since they are dependent only on the underlying computer processing power and digital audio soundcard, as well as the host software. Universal Audio in particular, while still producing high quality hardware versions of its various preamplifiers, dynamics processors and equalizers, has transformed itself into a producer of sought-after software versions of many of its classic

devices, at a much lower cost.

The gating parameters usually included on a standard gate device, whether an analog or digital version, are outlined in Table 2. A standard gate plugin, in this case from the Cubase DAW, is depicted in Figure 41.

Table 2: Gate audio processing functions

Function	*Description*
Threshold Level	Determines the level of incoming signal that opens the "gate" to allow the signal to pass through and be heard
Attack	Controls the speed at which the gate opens once the threshold has been met
Hold	A supplementary control which allows the gate to stay open for a certain time after the signal has fallen below the threshold
Release	Controls the speed at which the gate closes once the level falls below the threshold
Range	Attenuates the audio signal level when the gate is shut. When set to infinity, the gate is completely closed and allows a zero amount of the audio signal through

Figure 41: A Cubase DAW gate plugin

Standard gates are able to interact with any incoming audio that is directed to its input, and using the controlled parameters, the audio engineer is able to engage several useful functions in regards to the live performance, recording, and studio mixing of music. A typical use of the standard gate by a sound engineer would be to add a gate to a guitar audio channel on a mixing board, where the guitar amplifier is heard through a microphone positioned against the guitar amplifier. Guitar amplifiers often produce audio noise, signal interference, or other low-level buzzes, hums, or static. The gate threshold would be set so that when the guitar is playing an actual passage, the audio from the microphone would be allowed to pass through to the mixer channel, but would be muted once the passage ended so that the extraneous guitar amplifier noises and hums would not be heard. This technique helps to clean up the overall sound mix by muting these erroneous noises.

The various gate parameters (attack, release and hold) would be set according to the individual performance, so that the gating function would not unnaturally cut off notes at the end of a phrase or suddenly open too quickly, creating a clipped opening note. Other typical functions of a standard gate would include muting any sympathetic tones of drumset tom-toms when not actually being played, or a vocalist's microphone during a live performance with an ensemble when they are not singing, preventing extraneous sounds from leaking into the overall mix.

While these functions are certainly useful to an audio engineer for both live performance and recording, a more advanced feature known as a "sidechain input" opens up more creative and musical possibilities that are in common use in electronic dance music. The "sidechain" function allows a separate audio source to act on a gate assigned to a different audio channel. In other words, the gate assigned to channel "A" would have its threshold parameter activated by channel "B" with a corresponding result in channel "A"'s audio output, while "B" is not heard at all on channel "A," instead acting as an invisible actuator of the gate's threshold function. Since the sidechain input can consist of any audio source sent to an appropriate gate, many musical possibilities exist for the creative use of gating techniques, especially when used in modern audio software.

For example, a sustained chordal sound, such as synthesizer string sound, can be given rhythmic qualities by enabling a gate using a sidechain input from a rhythmic source, such as percussion instruments. The chordal "pad" sound would now mimic the rhythmic patterns played by the percussion part, in any degree from sharply accented to more subtle. The trance genre uses a well-known version of this technique known as a "trance gate", achieved by sidechaining a synthesizer pad from a triggered kick drum or other rhythmic percussive element, as heard in The Age Of Love's "The Age of Love" (1992), BT (Brian Transeau)'s "Tripping the Light Fantastic" (1995) and Robert Miles' "Children" (1995).

In modern hip-hop and EDM audio production, a common technique involves the use of a kick drum sample supplemented by a low subsonic sine wave layered underneath. In this scenario, a constant sounding low sine wave in the 50-60 hz range is produced on an audio channel using a plugin sound oscillator or tone generator. A sine wave is a preferred choice since it contains less harmonic overtones than a more complex saw or square wave and will blend smoothly. Once a gate is enabled on the "sine kick" channel, its' sidechain function is enabled, triggered by a separate kick drum part. The input, attack, hold and release parameters are adjusted until the kick drum and sine wave sound as one voice, resulting in a kick drum part with a subsonic undertone.

Another contemporary technique using gates is a "microstop" or sudden muting of the entire stereo music mix. Used to create sudden tension as the music drops away, a gate is applied to the entire sound mix as a master effect. At a strategically climactic moment, usually just before a strong chorus of the song, the gate can be enabled through the sidechain by either a kick drum or other unused part, or through the host software's automation. The result is an abruptly dramatic moment of silence before the next section of music crashes in.

4.4 Compression Techniques

The basic functions of the compressor, a dynamic audio processor, traditionally serve to affect the decibel level of incoming sound. A most basic example of compression would be to process the audio of a recorded vocal track in such a way as to reduce peaks in the level so that the entire vocal level throughout the performance would have a more even level, in a sense

"averaging" out the level. This is useful for audio engineers since they can then raise the vocal track in the overall sound mix without worrying about occasional rogue "peak" notes jumping out of the mix. A compressor can similarly be applied to virtually any instrument; bass guitar being another common example of an audio signal that is likely to produce abnormal peaks and may need some taming.

Compressors range from hardware models that function on variations of electro-optical, VCA (voltage controlled amplifier), FET (Field Effect), and valve (tube) circuitry to current software iterations that emulate these functions. Certain famous hardware compressors, such as the Teletronix LA2A, are favoured for the natural effect they produce: "the LA2A's electro-optical feedback design works more slowly and in a non-linear fashion, which nonetheless produces very musical results, preserving the impression of performance dynamics despite quite extreme level management."[32] All compressors whether hardware or software based usually share several standard controls, as depicted in Table 3. Furthermore, the Cubase DAW compressor depicted in Figure 42 illustrates these basic functions.

Figure 42: Cubase DAW compressor plugin

[32] Senior, Mike, "Classic Compressors," *Sound On Sound*, September 2009.

Table 3: Compressor audio processing functions

Compressor Function	*Description*
Threshold	Sets the decibel (db) level at which an incoming audio signal activates the compression function
Attack	Sets the time in milliseconds that it takes for the compressor to begin acting on the incoming audio signal
Ratio	Sets a ratio which determines the reduction in output db of the incoming audio over the threshold. For example, at a ratio of 6:1, where 6 is the amount of db over the threshold and 1 is the output, every 6 db of incoming sound over the threshold would increase the output by only 1 db
Release	Sets the time in milliseconds over which the compressor releases the audio to normal output once the incoming audio has fallen below the threshold
Make-up Gain	Allows the engineer to increase the compressed audio signal in order to make up for any reduction in post-compression level
Knee	Soft Knee settings influence the shape of an activated compression action in a more gentle fashion; Hard Knee settings clamp down on the audio immediately, resulting in a "harder" sounding compression
Metering	Compressors usually include a VU or LED meter which allow the engineer to visually observe both the signal's output level and the level of compression reduction

While this natural-sounding levelling of dynamic peaks in an audio signal is useful in allowing the average volume and loudness of the signal to be increased, allowing a more even blend among audio elements, a compressor can be applied more creatively, achieving special audio textures and genre-defining sounds that will be examined later in this sub-chapter.

Standard audio compression techniques are applied during either the recording or mixing phase of music production. Often, during the recording process itself a subtle compression setting is used in particular for bass guitar and vocal recording which is intended to reduce overt peaks in the audio level. For such an application, a low ratio of compression, perhaps 2:1 or 3:1 is used, with a moderate threshold of compression activation. In this manner, the recorded audio track has a more consistent level for the engineer to work with, but retains all or most of the audio dynamics of the performance. A longer attack setting is helpful in these cases, since the initial sound of the instrument's note will be kept intact, the compressor then smoothing out the signal level immediately following.

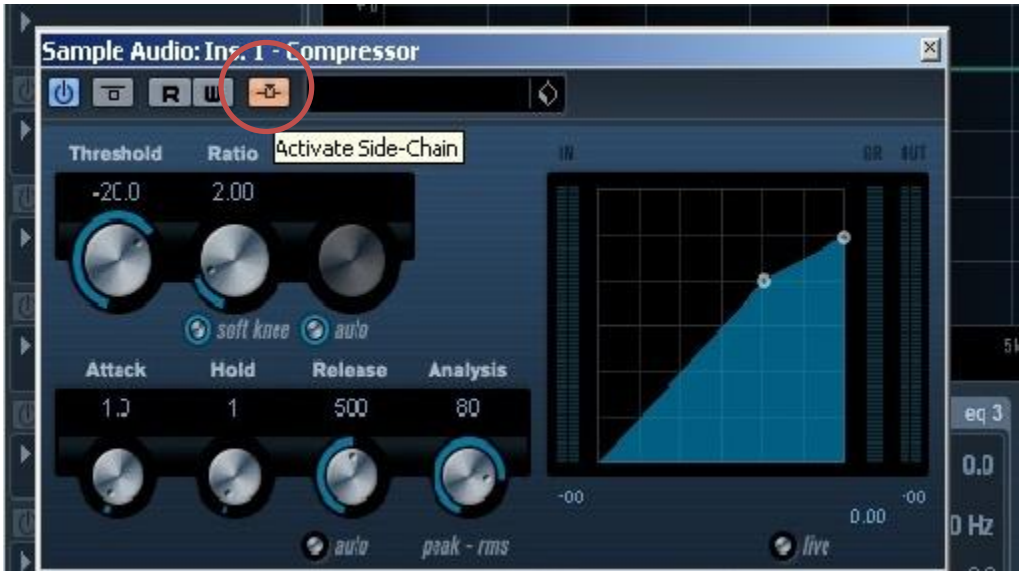
The sound engineer should always rely on their listening skills and will become familiar with various well-known compressors and their capabilities in various applications in order to adjust the compressor's settings appropriate to the style of music. For example, acoustic jazz and classical music generally require natural sounding dynamics, since the discerning listener will likely hear any unnatural compression applied to the performance. As such, the recording phase of audio production is important in determining the level of compression settings, since recorded audio tracks cannot be "uncompressed." During the final mix session however, the engineer has more freedom to influence the sound of both individual instruments and the overall stereo mix. Again, compression settings are selected based on the style of music as well as individual instrument needs. In contrast to acoustic jazz and classical music, various genre of rock and electronic music benefit from more creative and experimental techniques.

One common technique in rock music mixing is to over-compress the overhead microphones of a drum kit. Most modern drum kit microphone setups involve a microphone placed in close proximity to each drum, as well as the hi-hat cymbal. In addition, a matched pair of microphones is commonly placed over the drum kit in order to record the ride and crash

cymbals. Other drum sounds, as well as the reverberant drum sound present in the recording room, will also "bleed" into these microphones. By selecting extreme settings on a stereo compressor assigned to both microphones, such as a high compression ratio as 8:1 or more, and a slow attack of 10 milliseconds or more, the sound recorded by the microphones will swell up dramatically after the initial attack. Since the sound captured this way includes the "room" sound of all the drums, the dramatically "pumping" sound out of the compressor's effect will add weight and impact when mixed with the overall drum mix, supplementing the close-miked drums.

In addition to the creative use of the standard compressor described above to influence a recording's mixdown, the addition of an advanced feature called a "sidechain input" adds more possibilities. This feature allows a separate audio channel to trigger the compressor's threshold function, while allowing the compressor to act on its own assigned audio signal. Figure 43 illustrates a compressor from the Cubase DAW with its sidechain input activated.

Figure 43: Cubase DAW compressor with sidechain input activated



Creative techniques associated with the "sidechain" compressor input are similar to the "sidechain gate" example when a gate is used. However, the compressor is capable of more

organic sounding results. One such technique is central to so-called French house music, a sub-style of the house dance music genre, which uses the kick drum as the input trigger of a stereo compressor which has been applied across all of the music tracks, i.e. the entire stereo mix minus the kick drum itself, which is sent to a separate channel. An efficient technique in the manner is to employ separate stereo busses (a series of stereo sub-channels). While the kick drum is simply sent to one channel, all other tracks are routed to one buss, their direct output to the main stereo output being muted. The compressor is then applied across this bus and a sub-signal is sent from the kick drum to the sidechain input, while a strong compression ratio such as 5:1 is applied, as well as a fast attack.

The result is the impression of the entire track "pumping" after the kick drum's initial attack, which is usually playing on all four quarter notes. Well known practitioners of this technique, French duo Daft Punk's hit dance song "One More Time" (2000) takes this to extremes, the "pumping" effect adding a dramatic swell of music just after each quarter note kick, typifying the "French house" genre.

This technique has been adopted as a key element in other electronic genres, notably progressive house and electro. The composition "Ghosts n Stuff" (2009) by Canadian EDM composer Deadmau5 exhibits a clear example of this effect. The opening organ chord sequence is first heard plainly for eight bars, then in a rhythmically pulsing version at 1:30, where it is combined with bass and lead synthesizer parts and compressed heavily through a sidechain triggered by quarter-note kick drum. Deadmau5 here strategically sets the compressor's hold and release times to swell up at a rhythmic placement that is just short of a metronomically precise 8th note, creating a sense of tension that pushes the musical pulse forward.

4.5 Low Frequency Oscillator Modulation Mapping

The term “low frequency oscillator” or LFO refers to the generation of an electronic signal by an oscillator, usually below the range of 20hz. In an analog or digital synthesizer, one or more oscillators are used to generate audio through various waveforms such as a sine wave. An LFO instead is an auxiliary oscillator that is not itself heard, but whose regular repeating patterns are used to modulate other audio parameters. The result of such modulation is used to add pulse-like motion to the audio signal, with results ranging from subtle to extreme.

As an example, where an acoustic cello player might add expression to a note through vibrato, essentially modulating the pitch, a synthesizer’s LFO could be used to add vibrato to the pitch of one or more oscillators in a similar fashion. In this example, a sine wave LFO would be assigned to modulate the pitch of the target oscillator(s). Additionally, just as audio-generating oscillators have four basic waveforms, as in sine, triangle, squarewave and sawtooth, an LFO often has the same range of options available, depending on the specific synthesizer.

A key concept in the use of LFO modulation is the dual aspect of its application; the LFO’s characteristics in terms of frequency, waveform and amplitude, and the target audio parameter that it is assigned to affect. For example, continuing the above example, a sine wave LFO at a slow rate of speed could be assigned to target the oscillators’ volume, producing a tremolo effect instead of vibrato. A more EDM-specific version of this example would be to use an LFO to target a low pass filter applied to the audio section of the synthesizer, producing a regularly pulsing “underwater” effect. A low pass filter simply filters out a predetermined amount of the higher frequency characteristics of an audio signal.

One of the digital synthesizers most popular among contemporary electronic musicians is Native Instruments’ *Massive,* notable for its digitally modular design and flexible LFO routing options. In the screenshot view of *Massive’s* LFO section demonstrated in Figure 44, the “5 LFO” oscillator (“OSC”) section has been selected with a sine wave waveform (“Curve Select”), slow frequency (“Rate”), and maximum amplitude (“Amp”).

Figure 44: Native Instruments' Massive with LFO5 mapped to Filter 1's lowpass filter

As can be seen in Figure 44, the "5LFO" oscillator has been assigned to the cutoff frequency of a lowpass filter ("Filter 1: Lowpass 4"), and a frequency range cutoff has been selected. The assignment of LFO to the lowpass filter parameter is accomplished simply by dragging the "5LFO" symbol up and into the corresponding box under "Filter 1." The effect is that when notes are played on the synthesizer, the audio oscillators pass through the LFO-effected lowpass filter and the higher timbres present will be filtered out in a pulse-like fashion.

Continuing this process with another layer of modulation, the LFOs characteristics themselves can be triggered by yet another LFO, so that the end result has a greater range of variance. For example, the amplitude ("Amp") of 5LFO could be modulated by a second LFO, perhaps 6LFO so that the amount of low-pass filter modulation also varies from subtle to extreme.

This type of LFO modulation, where a lowpass filter is modulated, is popularly used in the production of contemporary music styles such as dubstep[33]. The result is known as a "wobble bass" for its characteristic throbbing timbre and is one of the staple sounds in contemporary dubstep.

However, dubstep music's LFO often makes use of more added programming details. To accomplish this though, another parameter of the LFO frequency rate is needed; most rate controls have an option to "sync" the frequency to the host audio software's tempo, so that the low-pass filter "wobble" is in sync with the piece of music. As well, such a synchronized rate control will usually have a range of sync rate options, in terms of quarter notes, triplets, sixteenth notes and the like.

Taking this concept further, the host software's automation can be assigned to change the selected rhythmic iteration as desired during the piece of music, so that the distinctive "wobble" sound can be manipulated through triplets, eighth notes, sixteenth notes automatically to produce complex musical phrases over the course of the song.

Figure 45 below shows the host Cubase DAW with an automation channel set to control the rate of "5LFO" in Massive. At measure 1, the automation moves the rate control to8th notes. At beat 1 of measure 2, the rate increases to 16th notes, shifting down to 8th note triplets at beat 3. At measure 3, the rate then shifts down to 8th notes. In this manner, an entire sequence can be customized over the course of the piece of music which imparts an impression of movement that follows the shape of the overall composition. The tempo set at 150 bpm, as shown, is a standard dubstep tempo.

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[33] Dubstep is an EDM genre springing from jungle, drum'n'bass, dub and reggae influences. Early versions of dubstep dating from the early 2000s were characterized by dark echo effect ambiences and analog-sounding drum samples, while more contemporary styles popularized by artists such Rusko, Nero and Skrillex emphasize a more intricate and aggressive electronic style. Characteristic elements in contemporary dubstep are an aggressive half-time drum feel, processed bass synthesizer parts and implied 16th note rhythms, with variations drawn from other EDM genres such as electro and trance.

Figure 45: Cubase DAW automation curve mapped to Massive's LFO5 rate

Figure 46: Massive with LFO5 Sync rate moving to 16th notes at measure 2

Prominent dubstep producers such as Nero and Skrillex use these types of techniques. However, other workarounds are also possible, chiefly the use ofmultiple instances of the synthesizer in the host software, each set to a different LFO rate modulating the filter cutoff. In such a case, longer passages are built through the strategic layering of cross-cut phrases from each virtual synthesizer.

4.6 Equalization and Filtering

Equalization, or EQ, relates to electronic dance music in two fundamental ways. Firstly, in its most practical application it is one of the key tools used to shape the components of a mix into a cohesive vision of the producers' vision through the adjustment of their individual frequency characteristics. This approach is common to any kind of music production. Secondly for a composer, a more experimental approach of using EQ from a sound design point is used as an orchestration and compositional tool.

Basic equalization methods depend on a combination of parameters available in most EQ devices whether analog or digital. An EQ is divided into a frequency range of "bands" along with an accompanying filter shape. The selection of a filter shape and a range is then activated by additional gain and "Q" controls. Gain is simply the amount in decibels of cut or boost to the selected frequency range and Q is the range or slope of bandwidth response surrounding the selected frequency. The most common filter types are described in Table 4.

Table 4: Common filter types

Filter Type	*Description*
Bell filter	Boosts or cuts a bell-shaped frequency profile
High-shelf filter	Boosts a range of high frequencies in a shelf-like shape
Low-shelf filter	Boosts a range of high frequencies in a shelf-like shape
High-pass filter	Removes a range of frequencies below a certain frequency
Low-pass filter	Removes a range of frequencies above a certain frequency

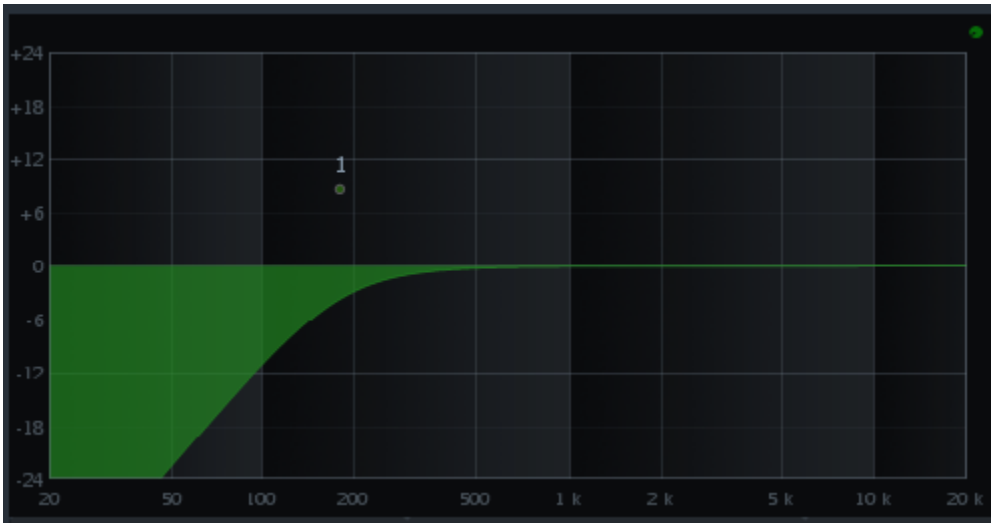
In hardware analog EQ units, the filter types and available frequency ranges usually have relatively fixed parameters. However, digital plugins offer the advantage of more flexibility, and able to use multiple filter shapes and a wide range of Q and gain options. The advantage here is the ability to combine filter types in a single EQ, as in the "radio effect" which uses a high-pass and low-pass filter to allow only midrange "AM radio" frequencies through, as well as the ability to automate changes to EQ settings within the host application to produce musical effects important to the composition.

To demonstrate the use of both a fundamental and compositional-based use of an EQ filter, consider the following two examples using a high-pass filter.

Firstly, in mixing a typical band recording, let us consider that the drum kit's snare drum microphone has a low-mid thud and has also picked up low end rumble from the kick drum. Applying a high-pass filter at a frequency of 400hz at a sharp Q slope will "filter out" these frequencies, leaving only the hi-hat's crisp high mid and high frequencies above that point. This move will benefit the overall mix by allowing the kick drum to dominate the low end of the mix spectrum (other bass elements notwithstanding), while the snare will now sound crisper and the overall mix less muddy. This blending and balancing of sonic elements is common to any style of music.

A second commonly used EDM sound manipulation again involves using a high-pass filter, but applied over the entire drum mix. When the drum mix is heard without EQ filtering, its full weight in the mix is felt. In order to create a sense of suspension, a high-pass filter set at perhaps 500 hz and applied to the full drum mix effectively removes the kick and any low sonic drum energy out of the overall mix, leaving the rest of the elements exposed (see Figure 47). Removing the filter from the drum mix at a strategic moment in the music brings the full impact of the song back as the impact of the full drum sound is heard.

Figure 47: High-pass filter



Adding automated control of the high-pass filter adds another layer of expressiveness to a composer. For example, the 500hz frequency point on our high-pass filtered drum mix can be swept slowly downwards over a number of bars, slowly adding back in the missing low end and increasing the drama the listener's anticipation of the next musical statement as the full weight kicks in. This is analogous to both dynamic markings and performance techniques as in a string section, for example. This type of high-pass or low-pass automated filtering can be applied to almost any element of an EDM piece such as vocal, bass, drum, or synthesizer parts.

Applying a low-pass filter to the entire mix is a well-used DJ technique, where such a filter is applied to point where the mix sounds "underwater" and the notes and chords are obscured. Daft Punk's classic EDM song "Around the World" (1997) opens with a filtered disco version of this murky texture, a low-pass filter placed over the entire mix slowly opening up over the course of a twelve bar introduction before transitioning into a full frequency spectrum groove at the downbeat of bar 13. Alternatively, a high-pass filter applied over an entire mix has the effect of removing the kick and low-end foundation, useful in simulating a breakdown and creating a dramatic impact as the full groove is restored at a strategically timed moment in the music arrangement.

4.7 Delay and Reverb

From vintage tape-based "echo" devices from the 1960s to modern DAW-based plugins, delay effects are highly used in modern music production, whether applied in subtle rhythm-enhancing manners or in obviously blatant ways. The echoed "hello – hello – hello" from Pink Floyd's "Comfortably Numb" (*The Wall,* 1979) is a famous example of using the delay effect to add a forlorn, pulsing texture integral to the composition, as the dotted eighth-note repeats add emphasis to the selected word. This classic Pink Floyd example can be implemented in the digital audio environment by the EDM composer as a valid compositional and arrangement tool, capturing a keyboard chord or instrumental fill out of the mix and sending it through a delay effect, in effect creating a motif out of what can be a very small sonic element.

Deep house and dub styles of music rely heavily on this effect. Famous reggae bass/drum duo Sly and Robbie's 1997 album *Drum and Bass Strip To The Bone* is an example of delay

effects as well as audio manipulation being used to craft entire compositions from sparse instrumental motifs, as album producer Howie B executed. When used on percussive elements, delays can act as a rhythm-enhancer by taking a dry element and increasing its complexity and density, creating an ostinato-like effect. Using time-synced delays can easily be accomplished with modern DAWs can act as a subtle layer of rhythm to help propel a song's inner rhythmic impetus forward. This sense of pushing the rhythm forward in a subtle way is a key element in trance and deep house genres, for example.

These styles of music depend on rhythmic layers to produce a hypnotic effect on the listener/dancer, and the rhythmic interest generated by a delay-effected percussion part or transient synth can provide this. Complex rhythms can be simulated through the use of "ping-pong," stereo or multi-tap delays. A ping-pong delay simply has one delay effect which is automatically panned from left to right over time, usually by an internal LFO, while stereo delays have two independent delays contained in one unit, which can be set to different delay times. The result of applying this type of complex delay is effective, whether used by the composer as an accent in the music or as a shifting ostinato.

Reverb, or "reverberation" simulates reflections of sound waves off surfaces large or small, placing whatever is effected into that space. While past analog methods used by recording studios included acoustic chambers and reflective metal plates to re-create a reflective sound environment, modern reverb plugins known as "convolution" types use highly realistic simulations of the reflective characteristics of actual acoustic spaces that have been digitally sampled and analyzed to add custom-detailed ambience to a recording.

The reverb plugin, as used in a DAW by EDM composers, also has an increased ease of flexibility in audio chain processing, where it can be manipulated further by sidechain compression, for example. "Electro house" music in particular makes use of this type of effect. Adding reverb to an otherwise dry squelchy electro synthesizer melody, for example, produces the distinctive electro "sucking" sound as the reverb sound is suddenly pulled down by the kick drum hits acting on the sidechain compressor, producing a signature sonic timbre as the compressed reverb swells up dramatically between the kick drum hits.

4.8 Sound effects (SFX)

In contemporary EDM, sound effects (SFX) perform a special function. An electronic composer uses SFX in a manner analogous to the supporting instrumental phrases and fills in non-electronic genres of music, providing transitions through major sections of a composition's arrangement and introducing contrasting textures around major melodic phrases. They also provide a specialized texture that influences the composition's atmosphere and cues the listener to the non-organic nature of the electronic music genre. SFX are used variously to anticipate the downbeat of a new passage of music, emphasize a certain downbeat or point in the music, or add a special texture to the music.

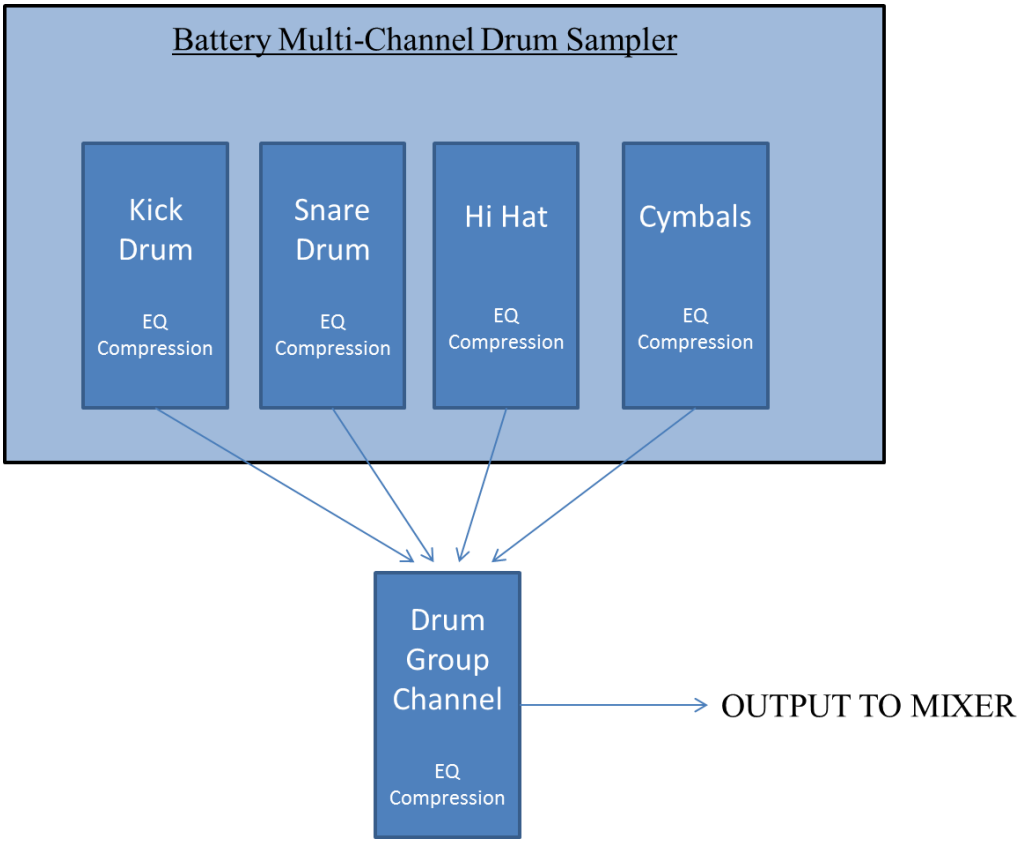
The over-used "reversed cymbal" sound effect, for example, adds a sweeping otherworldly quality that creates tension as the sound grows to its final resolving peak. Sweeps of this type can also be combined with other effects such as gating, compression and EQ filtering to create an exaggerated dimension and increased interactivity with a track. For example, white noise, a type of electronic noise static that theoretically contains a combination of all sound frequencies, can be produced in various white noise-generating synthesizers and is used in contemporary EDM to produce a signature electronica motif. In this effect, a constant white noise sound is passed through a low pass filter that sweeps across a frequency range over one or more bars, while a sidechain-compressor triggered by a kick drum adds rhythmic motion. Panning the sound from side to side across the auditory spectrum as the effect moves forward adds an additional spacial dimension to emphasize the effect.

Composers can also create customized SFX that contain sonorities and motifs drawn from a track through resampling. For example, a passage of music such as a piano chord with a long reverb tail can be individually sampled, then reversed using standard digital audio editing tools. Placing this sample in a specially timed manner produces a subtle dream-like effect as the piano harmony is first heard in the reversed reverb reflections, then morphs into the full piano sound over the course of the audio sample. Variations on this basic technique include the use of vocals, guitars or other instruments, and can be combined with delays, filtering or other layers of audio processing to increase the complexity of the sound effect.

4.9 Special Routing Procedures

While insert, master and send effects routing has been discussed, two additional techniques applicable to EDM music production will be described in this section. The first refers to "group" or "buss" routing and the second to parallel processing. In this technique, a set of audio channels are sent to a dedicated track for collective processing, before being sent to the master audio output. A clear example of this is used in drum mixing using Native Instruments' Battery multi-channel drum sampler. For this procedure, each part of the drum kit is first processed separately to maximize the sound of kick, snare, hi hat, cymbals, and so on. These channels are then routed to an additional drum group channel for collective processing, compression and EQ before being sent to the master, as illustrated in Figure 48.

Figure 48: Battery drum sampler and DAW multi-channel drum group routing



Taking this group routing concept a step further, consider a set of similarly functioning parts that are sent to a dedicated group buss. For example, the EDM genre "complextro" uses a variety of interweaving synth bass parts, each with individually customized audio characteristics, to create a shifting rhythmic bass texture. Sending all of these bass parts to a "bass synth" group channel allows further processing in a collective fashion, amalgamating their audio characteristics. Applying a kick drum-triggered sidechain compressor to this group channel creates a combined effect that further contributes to a cohesive, pumping timbre.

Parallel effects processing produces a more subliminal effect. For example, the drum group channel contains all of the drum kit sound. For a parallel effect, the drum mix is sent to another send effect that has a highly compressed setting (8:1 or more). On its own, this effect is too extreme pumping and the initial transients are lost, the audio swelling up. However, this effect is slowly added in parallel to the regular drum mix group, adding a subliminal punch to the sound while retaining the full track's impact. This parallel compression technique is also sometimes applied to the master stereo channel, again adding an undertone of weight to the whole mix.

By understanding the fundamental operation of these signal processing effects and their application across a range of characteristic electronic dance music techniques, it is possible to incorporate such effect strategies in a musically effective way that allows the melding of an EDM aesthetic with other musical content such as the jazz-fusion and drum programming components proposed in this thesis.

5 “Solar Neutrino”: Original Composition

5.1 Overview

“Solar Neutrino” is an original composition based on a combination of Weather Report influences, IDM drum programming, and EDM production techniques. In terms of the Venn diagram analogy, stronger weight will be given to the Weather Report compositional characteristics, with supporting techniques from IDM drum programming and EDM production. The piece is comprised of a multi-section arrangement, corresponding to an A B C D E (B variant) F (A variant) form. Both the form and the melodic/harmonic content of the piece reflect the Zawinul/Shorter/Pastorius axis of specific compositional techniques.

This piece uses grid-style IDM drum programming in the Cubase drum editor to trigger Battery, a multi-cell drum sampler, using a style and groove maps drawn from “Nubian Sundance.” Variations in the drum parts are kept to a minimum in order to maintain a mechanical, computer-like style. The instrumentation used consists of Fender Rhodes, synthesizers, soprano saxophone, acoustic piano, synth bass, and programmed drum parts that include extra percussion loops.

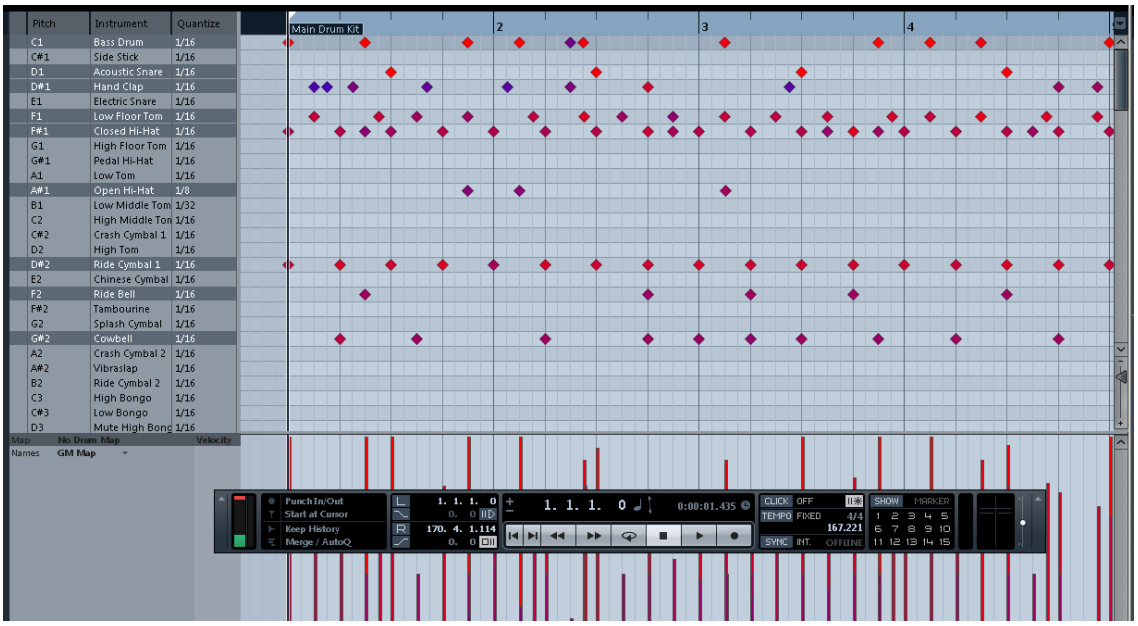
EDM music production techniques are used to add shape and dynamics to the piece, taking the place of traditional instrumental fills and emphasizing an electronic music aesthetic. These focus on the use of rhythmic compression sidechaining, automated filtering effects, LFO-mapped synthesizer and effect parameters, and sound design.

5.2 Analysis

“Solar Neutrino” is based on a layered rhythmic feel similar to “Nubian Sundance.”. An underlying 16^{th} note pushing feel is heard mainly in both the tambourine loops and drum programming accents, particularly ghosted snare notes and interplay between the kick, snare and

hi-hat parts. While the drum and tambourine beats imply a double time feel, the melody and chordal accents are based on a slower 8th note grid. To begin the compositional process, a portion of the "Nubian Sundance" breakbeat was sampled and looped, and a groove map created to recreate the feel in the IDM drum programming used to create the main grid-style drum rhythm (see Figure 49). The breakbeat audio loop when analyzed corresponded to a tempo of 167.221 bpm so this was used for the tempo of the piece. In order to add a contemporary sound to the drum style, a vintage acoustic style drum kit was layered with more modern, synthetic style drum samples in Native Instruments' Battery drum sampler.

Figure 49: "Solar Neutrino" – grid-style drum programming of main drum kit rhythm

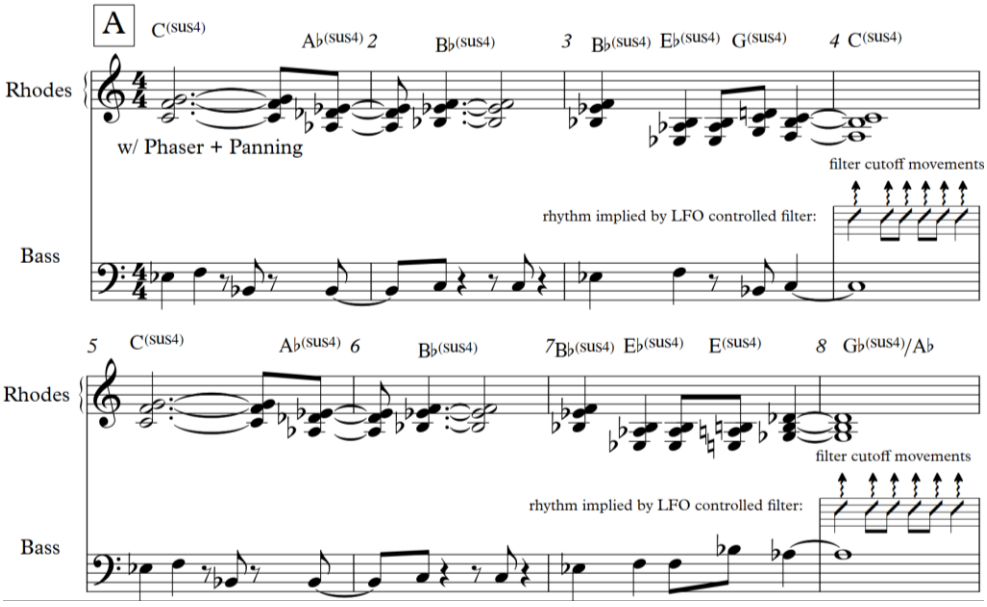


To facilitate mixing options, Battery's kick drum, snare drum, hi-hat and ride cymbal cells are sent to separate stereo audio busses which are processed with individual equalization and compression settings in order to customize the drum mix when all of the other musical elements are added. Then these drum busses are sent to another stereo buss before being sent to the main mix output. As will be seen later, this also allows for the application of effects to the drum mix alone for special EDM effects.

In addition, a hip-hop technique is used to add weight to the kick drum notes, consisting of a 50hz sine tone generator with has a gated sidechain triggered by the kick drum's audio channel. This additional tone also adds a contemporary sound to the drum kit programming to emphasize the electronic nature of the virtual rhythm section instruments. Percussion parts are also a component of the rhythmic landscape in "Nubian Sundance," so conga hand percussion patterns were programmed using a 22% 16th note swing quantization.

The introductory A section is an eighteen measure section based on a dark sounding chordal phrase played with a Rhodes sound. A phaser and automatic panning effect is added to the Rhodes simulate a prominent Zawinul sound. The opening C (sus4) voicing shifts through parallel movements, resting on a Cmi11 in the second and fourth bar of the sequence, and shifting down a major 3rd to an Ab7sus in bar 8 (see Figure 50). This establishes a C root tonality that shifts between minor and suspended sonorities in this part of the composition. The root movement is supplied by two layered bass synth patches, one with an LFO-synced filter that is activated through automation throughout the piece to provide shifting rhythmic movements, and the other a supplementary sine-wave bass sound.

Figure 50: "Solar Neutrino" – introduction excerpt at letter A



A plucked synth patch, with panning filtered delay effects, is used to add C minor accents with portions of this track used as a "resampled" source, processed by reversing the sample and interspersing it as a backwards sound effect during the piece. To set the tone of an EDM aesthetic in the introduction, the full Battery drumkit mix is processed through a drum submix bus which has a highpass filter applied at 734.9 Hz, with a sweepable lowpass filter set at 18.28 kHz , a common EDM effect which holds back the full weight of the drum groove, allowing only the triggered sine kick to provide bottom end weight. An E7sus chord accent on beat four of bar 16 is held over for 3 bars to create a pause before the B section theme begins, with drum fills and pluck synth delay effects accenting the set up to the next section.

At B1 the drum kit filtering is removed through track automation. The tonal key center moves down a fifth to F major with the phasered Rhodes playing diatonic F 6/9 staccato chords in a style recalling the "Man in the Green Shirt" motif, the phrase ending with an Fmi11 chord. A melodic theme voiced by a digitally recreated ARP 2600 virtual synthesizer plugin and soprano saxophone begins at section B9 using primarily diatonic F major scale steps separated by larger 4^{th}, 5^{th} and octave intervals. The ARP synthesizer has been programmed with an LFO triggering a Zawinul-like vibrato, delayed slightly so that it is activated during notes held by more than two beats, creating a more expressive and reactive vibrato. This theme is repeated once, then resolves to a melodically and harmonically slower phrase at B25 to complete this section. The first four chords in this 8 bar section move in two parallel descending minor thirds separated by a whole step, as in Bb-G-F-D, similar to the symmetrical E-C-B-G root movement in the "Havona" analysis. The root movement then moves up a tritone to Ab, before descending a minor third to F and then modulating up a whole step to a resting G suspended chord for two measures.

C1 features a longer, non-repeating melody based on a D minor pentatonic scale played by the soprano sax, acoustic piano and a synthesizer patch closely imitating a Prophet synth sound, over a static G suspended chord tonal center. Occasional major 2nds are added, (see measures 58, 75 and 79) similar to the "pentatonic-plus-one-note" melodic technique used Weather Report's "Volcano for Hire." The drum feel here continues while adding small variations. At bars 80 and 81, a tutti syncopated rhythm ends the section and leads into D.

At letter D, the main drum part is suddenly dropped to tacet while the percussion parts continue. A synth pad with automated filtering doubles the Rhodes phaser-effected chords, created by stacking parallel suspended chord structures in a repeating eight bar phrase by 3rds or 4ths, with a simple ascending melody which occurs over only the first two measures of each phrase. The soprano saxophone plays the melody and improvises fills in the second measure of each phrase. The main drum kit part is reintroduced at bar 99, with just the lowpass filter activated to add a darker build to the second half of this section, then dropping out again at E1 before moving back to the opening material at F1, with the drums again high-pass filtered to create a floating effect. The soprano saxophone improvises over the chord changes and atmospheric pluck pad effects until ending on an E suspended chord at measure 170.

6 "Bernal Sphere": Original Composition

6.1 Overview

For the original composition "Bernal Sphere," an emphasis on breakbeat programming was chosen. Two breakbeats were used that form the rhythmic basis of the piece, which is in four parts. The piece uses influences from Herbie Hancock and Weather Report as will be explained, and EDM components are based primarily in the sound design choices used.

The instrumentation chosen for this piece includes Fender Rhodes, clavinet, synthesizers, soprano saxophone, synth bass, and drum parts that include breakbeat style drums and hand percussion loops.

6.2 Analysis

This piece relies on selected breakbeats that were transcribed from the "influential breakbeats" sub-chapter, then recorded and mixed in the studio to create a live drum feel using analog-simulating software to recreate the sound of vintage drum breaks. Once a basic rhythmic feel was created for each section of the piece, parts were composed for each section of the piece. The first two breakbeats were variations on the "Rock Steady" break and the third on the "Actual Proof" main drum pattern.

Once the drum loops was created, it was added to the initial arrangement and timestretched to 127 bpm to accommodate a suitable tempo. The individual breakbeats were then analyzed in the Cubase sample editor and slices created, extracted and re-mapped across Battery's drum sample cells (see Figure 51). The resulting palette of drum rhythms was then used as a basis for the rhythmic feel and chordal accents in the composition. Once this breakbeat setup was auditioned, the processing and pitch changes resulted in a kick drum with less low end punch.

To remedy this, additional 909-style kick drum samples[34] were added into Battery cells and set to match the midi input channel and velocity-sensitivity of breakbeats, so that each breakbeat kick hit is layered with a deeper sub kick. To balance these layers, the 909 kick samples were low-pass filtered at 178.2 Hz to allow the breakbeats to provide more of the drum part's higher frequencies to provide attack. As well, a high-pass filter frequency at 85.2 was applied to the 909 kick drum audio cells to reduce potentially muddy low end sonic frequencies since this piece features some rapid breakbeat programming (see Figure 51).

Figure 51: "Bernal Sphere" – view of mapped breakbeat slices and layered 909-style kick samples in Battery

[34] The Roland TR-909 Rhythm Composer was a popular drum machine produced in the 1980s which contained both synthetically generated and sampled drum sounds, which could be programmed with rhythms using the built-in sequencer. The drum sounds from this unit have been both sampled directly and re-created for use in contemporary music production in both EDM and hip-hop music. The 909 kick drum sound in particular is known for its deep tone and is often used to add depth to a drum beat through layering with other kick drum sounds or samples.

The introduction consists of the first breakbeat pattern accompanied by a four bar filtered bass synthesizer similar to Hancock's "Chameleon" ARP Odyssey synthesizer bass intro, centered on a syncopated F# minor pattern. The bass line moves from F# down to D# and then D in bars three and four, ending with a syncopated 16th note chromatic phrase from A down to G to set up a half step resolution back to the F# root at the downbeat of the next measure. The bass synth has a compressor sidechained to the breakbeat audio channel, but with a low 3:1 compression ratio and -33.5 db threshold, so the pumping effect is subtle, while allowing the sharp transients of the breakbeats to punch through the mix. Stereo-widened shaker loops are added to provide a steady undercurrent of 16^{th} notes through most of the piece. A virtual sampled clavinet part with an added velocity-sensitive auto wah similar to Hancock's wah-wah Hohner clavinet comping begins at bar 5, with a wide tremolo Rhodes part that is added at bar 9.

The Rhodes left hand part doubles the bass walkdown phrase in the fourth bar of this vamp, which is also accented by the breakbeat programming, corresponding to a kick drum/open hi hat accent. The chords used in the 4 bar pattern consisting of chromatically moving sus2 chords (1-2-5), from Asus2, Absus2 and Gsus2 over the F#, D# and D roots, establishing an F#min11 sonority followed by D#7sus and D7sus chords. From bars 13-16, there is a "drop" as the breakbeats are tacet, allowing the chord pattern, bass and wah clav to take precedence, re-entering at bar 17.

A1 begins with the bass pattern changing to a sparser F# minor pattern while a rhythmic melodic theme begins with short staccato phrases, in a unison voicing by Rhodes Minimoog and soprano saxophone, imitating the texture in "Chameleon." The melodic shape rises from E3 to E4, before descending on a short bluesy conclusion. This four bar phrase is repeated twice, followed by a four bar descending phrase at A9. This phrase begins with a more syncopated rhythm which will set up a tutti iteration by all of the instruments including the breakbeat drum programming. The phrase also uses sustained notes as resting points in its last 3 measures, which will be used to set up a Hancock-like harmonization on its next iteration, which occurs at letter A21.

After a restatement of the melody at A13, the descending rhythmic phrase at A21 which ends on a B melody note is harmonized by a Hancock-like Cmaj7(#5), followed by an F#mi11

chord and then a Bbmaj7(#5) harmonizing the A melody note. The descending phrase is then repeated at A25, this time ending with Cmaj7 and a resolving F#mi11 chord. The eight measure interlude (bars 45 – 52) following the A section features the wah clavinet comping and improvised soprano saxophone fills with added delay and reverb effects providing texture.

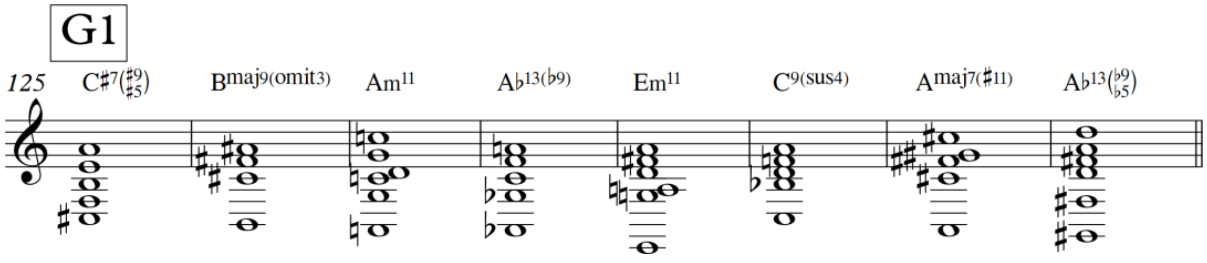
B1 introduces a contrasting section consisting of chord voicings with a symmetrical root movement in ascending minor 3rds, suggesting Abma7 – Bma7 – Dmi11– Fmi11 chord qualities. The first two chords have a major 7th quality and the second two chords have a minor 7th quality, voiced by the Rhodes in superimposed suspended triads. The bass part moves underneath these shifting voicings. The melody here is more legato and is voiced by another Minimoog style of synthesizer sound, but with a more ethereal floating quality doubled by soprano saxophone.

C1 features a Rhodes solo improvisation consisting of sixteen bars of F# minor. D1 and D9 restate the B section chord and melodic material for eight bars each, with the soprano saxophone tacet for the first eight bar iteration of the melody, entering at D9 to provide support.

At E1 a soprano saxophone solo begins over F# minor supported by additional sampled hand percussion loops (congas), clavinet, Rhodes and synth bass, for a 32 bar solo. The soprano sax solo leads into a 16 bar restatement of the B section material at F1 and F9.

At G1 a new section enters where the breakbeat drums begin a programmed "improvisation" over a series of chords revolving around a C# root as a anchoring tonal center, the voicings moving through a shifting motion similar to Hancock's "You'll Know When You Get There." (see Figure 52)

Figure 52: "Bernal Sphere" – Rhodes and gated synth chord sequence at G1



In addition to the Rhodes, a sustained synth pad sound doubles the chords. To add forward motion and an ostinato rhythm to this static texture during the breakbeat solo, a midi gate effect has been added to the synthesizer's audio channel which is triggered on a separate midi track which is not heard directly, which is playing a short rhythm consisting of two 16th notes and an 8th note (see Figure 53). A digital ping-pong delay set to 16th notes is also added to this gated synth part at a low volume to contribute a subtle rhythmic and spacial enhancement. And finally, a lowpass filter is applied to the entire gated synth channel which sweeps upwards from 526 hz to 1.44 kHz in repeating four bar sections, providing a dynamic rise through the programmed drum "solo."

Figure 53: "Bernal Sphere" - Synth pad triggered by Midi gate effect

The drum solo builds to a conclusion through G25 leading into the downbeat of an interlude (bar 157), anticipated by an opening of the gated synthesizer's lowpass filter to 2.04 kHz.

Additionally, the 16th note digital delay's feedback setting is pushed to the maximum level in the second half of bar 156 to create a repeating hypnotic regeneration effect that carries over the next several bars. At the interlude, a drum-tacet interlude version of the intro is restated for eight bars, with the breakbeats re-entering in the fifth bar.

This leads into H1 (a restatement of A13), followed by H9 (a restatement of A21). The final phrase in measure H14 ends on an Eb7#9 chord which sustains over to conclude the piece.

As evident in this composition, breakbeat-style drum programming provides a large portion of the rhythmic impetus and overall dynamic shape.

7 "Tulpa": Original Composition

7.1 Overview

The composition "Tulpa" concentrates on the implementation of electronic dance music techniques to create the substance of the piece. A trance style ostinato synthesizer pattern is used to set the initial mood of the piece, with sound effects, sidechain compression, filtering, and complextro style bass lines weaving through the framework of the arrangement. In terms of drum rhythms, a layered approach is taken. In this case, an underlying half-time dubstep style drum groove at 140 bpm allows IDM-style programmed drum fills to provide superimposed 16th note-based rhythmic variations. The half-time feel of the piece also lends itself to rich Hancock-style chord voicings as well as flute and muted trumpet motifs drawing on textures from his "Sun Touch." The instrumentation for this piece again includes Rhodes, synthesizers, synth bass and drums, while adding flute, muted trumpet and electric bass.

7.2 Analysis

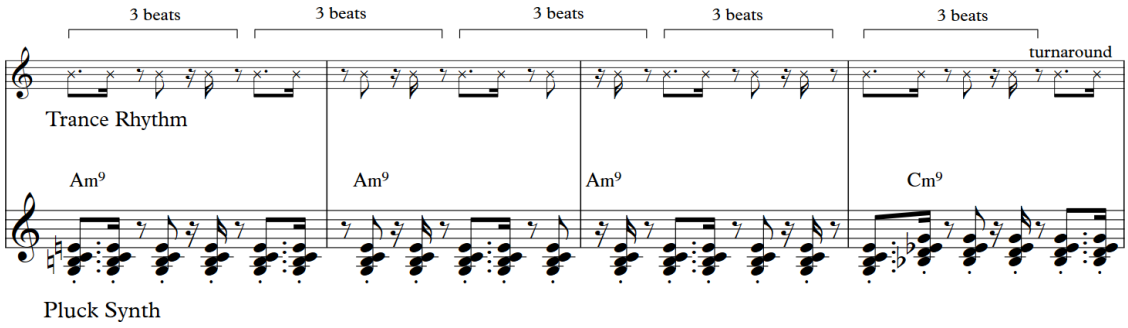
The piece opens with a half-time dubstep feel intro at bpm 140, programmed with a digital style drum beat, and an eight bar trance sequence. The trance sequence uses a "pluck" synth type of patch created in Massive, a muted staccato tone which is characteristic of trance and deep house styles of electronica, and in this context will serve as a harmonically shifting ostinato. A polymeter three-beat rhythm pattern consisting of a series of dotted-8^{th} and 16^{th} notes that is characteristic of trance/deep house and provides a shifting circular effect. The fourth bar of the sequence breaks the pattern by adding a l turnaround dotted-8^{th} /16^{th} to restart the sequence on the downbeat of the next bar. To add depth and additional subtle rhythmic undercurrent, a stereo panning delay synced to 16^{th} notes is added, as well as a reverb effect over the entire audio channel (see Figure 54).

The introduction begins with the dubstep drum pattern, pluck synth, and complextro bass parts. Harmonically, the chords stay on Amin9 for the first three bars, moving up first to Cmi9 at

the end of the fourth bar and Fmi9 at the end of the eighth bar, an idea that reconextualizes Hancock's intro and A section chord progression from his composition "Butterfly" *(Thrust*, 1974*)*. The opening chord sequence in "Butterfly" is anchored by an Fmi9 chord, pivoting first up a minor 3rd to Ami7, then down a major third to Dmi9.

To emphasize a characteristic deep house EDM sound, a muted, "invisible" kick sample has been added on beats 1 and 3 on a separate channel, and is sidechained to a compressor added to the entire pluck synth audio channel. In doing this, the pluck synth direct sound, 16th note delays and reverb swells up during the spaces between the unheard kick hits, re-creating the "deep" property of this style of trance/house music. Additionally, the Massive pluck synth patch itself has a lowpass filter removes most of the high frequencies from the patch, accentuating the muted property, assigned to react to a Macro Control that raises both the cutoff frequency and the attack of the filter reaction simultaneously. Using an automation channel added to the track's midi note sequence in Cubase assigned to this Macro Control, an automation curve is drawn using the Cubase pencil midi editing tool, increasing the brightness and attack of the pluck ostinato to increase the dynamics and reducing it to bring the dynamics down.

Figure 54: "Tulpa" - pluck synth/ trance rhythm intro



At measure 9, a Fender Rhodes with added tremolo effect enters, adding sustained versions of these chords. To introduce an atmospheric EDM sound quality to the composition, a dedicated effects send bus has been set up with an effects chain consisting of delay, chorus, tremolo, and reverb effects, to which portions of the Rhodes part are sent during the piece using

track automation programming, so that a hypnotically atmospheric sound is created from echoes of the chord's harmonics, using a strategy similar to Pink Floyd's "Comfortably Numb" echoed vocal motif. This effect channel has also been assigned a sidechain-activated compressor triggered by a muted kick channel on quarter notes to add rhythm and leave space for the drum and bass tones. A second drum sampler has been added to add a layer of IDM-style drum fills and variations to provide rhythmic interest throughout the piece. At bar 17 there is a four bar break where sound design elements provide an atmospheric break, using a white noise audio sample is sidechained with compression to the muted kick drum on quarter notes, as well as being effected by a low pass filter that opens up over the four bars.

At bar 21, the A section begins. The Rhodes effect buss level is reduced to create contrast with the intro. A sub-bass synth enters, with an automation-controlled LFO filter to add rhythmic interest through the slow tempo. As well, dubstep style wobble bass fills are used throughout the piece in a complextro style layering, where these parts come in and out, but at this slower tempo.

Using the group buss technique described in the EDM chapter, the individual outputs of the three synth bass parts are sent to a group "synth bass" channel, which has a sidechain compressor assigned that is triggered by a send from the Battery kick drum channel. This has the effect of slightly ducking the initial synth bass channel attack, no matter which bass part is playing, so the kick drum hits have more impact, as well as producing the characteristic "pumping" sound as the bass tones expand and contract between kick drum kits. The diagram depicted in Figure 55 outlines the routing architecture.

The tonal center remains focused around the Rhodes Amin9 chord, but moves away to Abmaj7, Gbmaj7, Cmaj7#5 and Bbmaj7#5 chords over similarly shifting LFO synth bass root movements. The melody is played by flute and muted trumpet, as in "Sun Touch," and moves both scale-wise and with intervallic leaps of 4ths and 5ths, approaching the upper chord structures of the chord qualities (see Figure 56).

Figure 55: "Tulpa" - complextro bass and drum channel routing

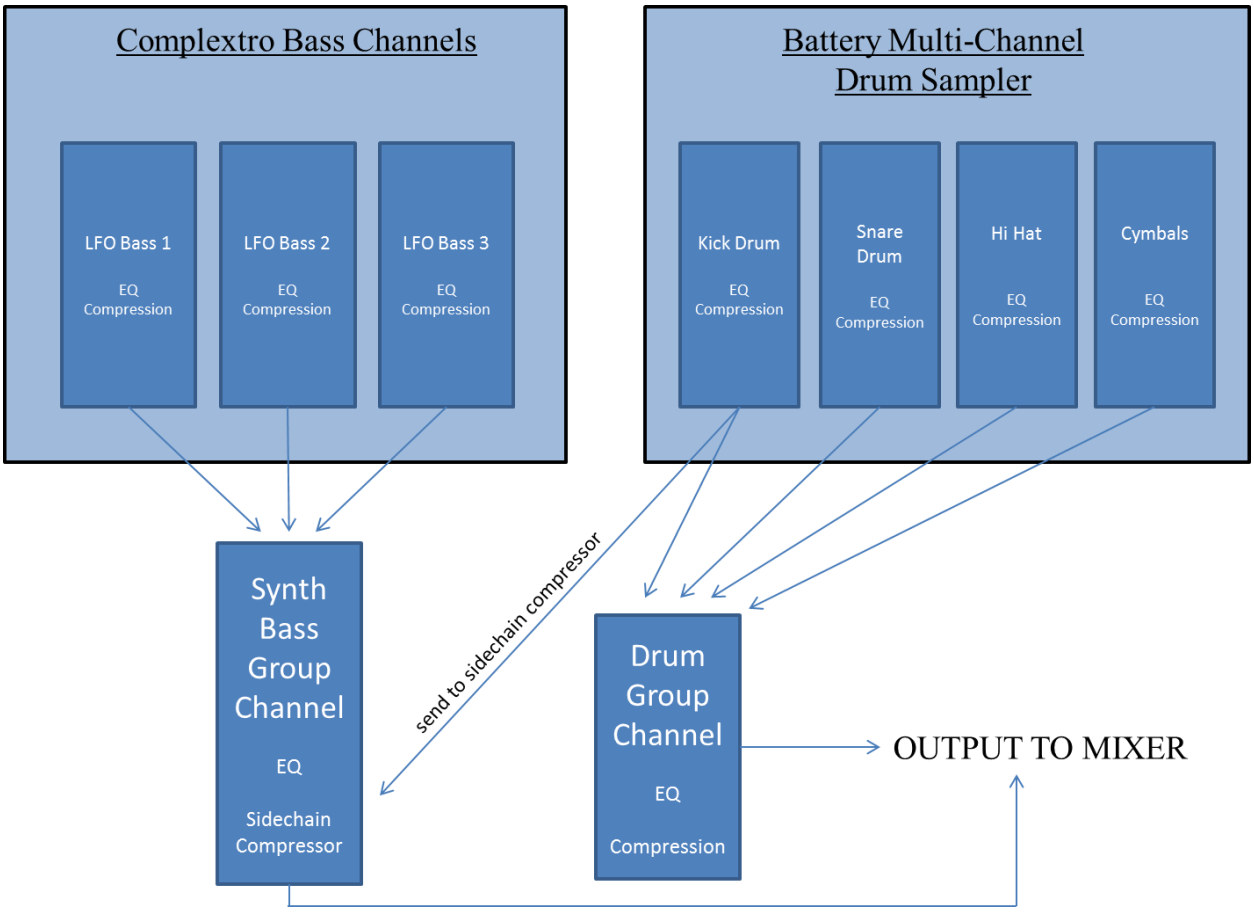
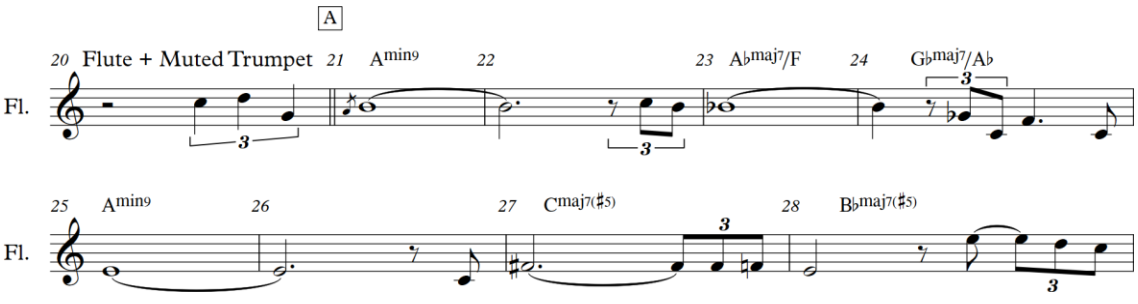


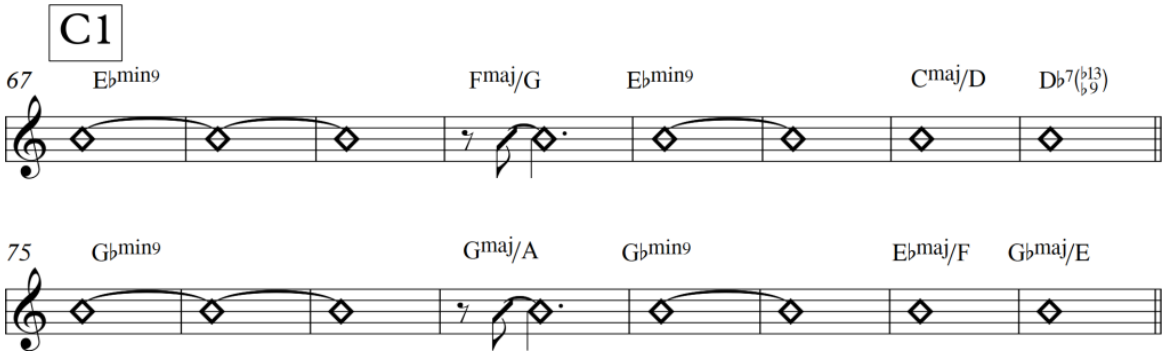
Figure 56: "Tulpa" – letter A section excerpt in lead sheet form



B1 features superimposed chords moving over a slowly descending bass line from G to F to Eb, resolving to the V7 of the opening A root note with a short E7(#11 #5 b9) chord and a tutti motif descending from the augmented 5th of E through the major 3rd, minor 3rd and root, setting up a return to the top of B12. B12 restates the melody from A9, moving into B20 (a restatement of B1). After the altered E7 chord and unison line at B29, the Rhodes sound effects send and drum fill layer leads into C1.

At C1 a modulation takes place, moving from a half step down from E7 altered to Ebmi9. This begins a repeated form that uses chromatic, mediant and V-I to create a circular 16 bar structure, centered around Eb minor and Gb minor tonal centers. To change the texture of the section, a new synth sound is introduced, this time using arpeggios to support the Rhodes-voiced chord changes. The melody here is played by electric bass and synthesizer, with the flute/muted trumpet combination providing answering background figures. While the electric bass melodic element evokes a Weather Report "A Remark You Made" texture, the circular form and use of altered dominants to create tension recalls a Hancock characteristic.

Figure 57: "Tulpa" –chords and root movement at C1



Each eight bar portion of C is similar in root movement and harmonic content but located a minor third apart, in a manner recalling the obscured-functional chord movements in Hancock's "You'll Know When You Get There" Rhodes and bass interlude. To create a slight change in harmonic texture, the altered dominant V chord Db7(b13 b9) in the eighth bar which moves down a fifth to Gb minor, becomes a Gb/E chord or E 6/9 #11 in C16, moving down a half step

back to the opening Eb minor chord. The piece revolves through this sequence four times from C1 to C25, with the secondary drum fill layer increasing in complexity to add dynamic shape. At D1 an eight bar reprise of the introduction takes place with a return to the pluck synth effect, the Rhodes chords becoming tacet and the secondary drum layer decreasing its intensity. E1 and E9 restate the earlier themes from A9 and B1, finally reaching a conclusion by ending on the E7 descending tutti riff.

8 Conclusions

8.1 Summary

This thesis has explored the synthesis of three areas of music: jazz-fusion composing, breakbeats/IDM style drum programming and electronic dance music techniques. Through the technical and aesthetic details compiled through research into each of the three areas, the three original compositions "Solar Neutrino," "Bernal Sphere" and "Tulpa" each represent shifting emphasis on each zone as visualized by a Venn diagram analogy. The total effect of each composition revealed that using this inclusive approach provided a differing range of compositional material required to make each piece cohesive.

The general context framing this thesis is the treatment of jazz-fusion composition in a digital audio based environment, where software-based music techniques play a role in the compositional process. Composing with a computer-based music system bypasses the need to assemble an ensemble of musicians in real time and goes directly to the creation of sounds. Where traditional instruments have been used in the course of the compositions, they are captured in the digital audio domain, where they become part of the electro-acoustic fabric of each piece, waiting for the completion of programming and mixing techniques to be actualized as a piece of music.

Thom Holmes, in "DJ, Dance and Rave Culture" referred to this aspect of electronic music composition in commenting that "electronic music only exists in a state of actualization," [35] reiterating comments by [Russian-born modernist composer] Igor Stravinsky that "it is necessary to distinguish two moments, or rather two states of music: potential music and actual music…It exists as a score, unrealized, and as a performance." [36] Since much of the material in this thesis depends on electronic elements, audio processing and midi programming, documenting the

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[35] Holmes, Thom, "The Origins of Electronic Music." In *DJ, Dance and Rave Culture* (Farmington Hills, MI: Greenhaven Press, 2005), 27.
[36] Holmes, *DJ, Dance and Rave Culture,* 27.

resulting compositions has been presented using conventional notation, audio software screenshots and graphic diagrams. While it would be possible to take the traditional score components of the compositions and arrange them for live musicians in a conventional instrument-based ensemble, the results fall into a genre-specific and well-known format. Similarly, breakbeat/IDM drum programming and EDM music techniques generally fall into categories of established electronica sub-genres.

However, the process of drawing on separate musical sources and techniques to generate a personal style has precedence, as was examined in chapter two. As noted, jazz-fusion practitioners Weather Report and Herbie Hancock used audio effects and synthesizers in the 1970s to add another sonic dimension to a musician-dependent ensemble sound and attempt to create a new sound aesthetic. Taking this movement toward electronic music elements further, Hancock's later techno-hit song "Rockit" proved that an approach taken fully in an electronic music genre by a jazz musician was viable.

The study of selected compositions from Weather Report's three main composers Zawinul, Shorter and Pastorius, as well as Hancock, revealed an intention to leave behind the 1960s post-bop musical aesthetic and create a new type of music both in instrumentation and in the type of musical vocabulary used. All of these artists actively sought out synthesizers and audio processors to transform the sonic characteristics of their compositions and overall sonic aesthetic.

Hancock's hiring of electronic sound engineer and synthesist Patrick Gleeson is a good example. While Gleeson provided synthesizer on Hancock's *Crossings* album to add supplementary electronic textures, the importance of his contributions are evident in Hancock's decision to hire him as a full member of the Mwandishi Sextet, since "Gleeson's gift was the ability to neatly expand on and embed electronic sounds with the existing timbral depth and emphasis of the band."[37]

This incorporation of conventional harmony and melody with electronic sound design and synthesizers therefore sets a motivating precedent for this project. The composition "Bernal

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[37] Gluck, *You'll Know When You Get There*, 127.

Sphere" exhibits this approach by linking Hancock-style chord voicings, unison riffs and wah-clav/tremolo Rhodes sounds with sampled breaks and trance-style gated synth pads.

Weather Report's compositional attributes also had a strong impact on the original compositions. Harmonically, the symmetrical-root chord progressions and types of slash chord voicings used in "Havona" and "Harlequin" were integral to portions of both "Solar Neutrino" and "Bernal Sphere." Melodic style also played a role in these two compositions, in particular the use of the "pentatonic-plus-another-note" Zawinul approach and the use of forms that break out of standard AABA formats. The melodic doubling by ARP-style synthesizer and soprano saxophone, in evidence on "Bernal Sphere," and the electric bass melody doubling on "Tulpa," benefited from these classic Weather Report sounds.

The use of breakbeats in electronic dance music resulted in the development of various styles such as jungle and drum'n'bass, where drum "breaks" from vintage funk, soul and disco vinyl albums are sampled, chopped into slices, processed, and re-sequenced into new compositions. This re-sequencing can be taken to extremes as in the case of Squarepusher's frantic and highly syncopated drum "solos," as well as being used as a contrasting rhythmic layer over simpler drum beats.

The composition "Bernal Sphere" makes use of this type of re-sequencing, but at a slower, funk-friendly tempo allowing the song's melody and harmony to resonate. The expressive timing and note velocity variations contained in a break's DNA serve to enhance the rhythm patterns as they are retained within each drum slice. But further, the specific rhythms used in drum patterns can be enhanced in grid-style drum programming using groove mapping. The composition "Solar Neutrino" makes use of this type of IDM technique, the "Nubian Sundance" drum pattern being used as a rhythmic model in both drumming style and DNA groove mapping feel. In this piece, the main drum rhythms are coming out of the Nubian influence, but new patterns used in various sections of the song were used with the groove map as well. The advantage to this method is that specific rhythmic details not present can be tailored to the piece, including fills, while the feel of the source inspiration is maintained.

A further step in both breakbeat and IDM drum programming involves the sound design aspects. Drum samples can be layered together in a cohesive manner to achieve a certain sonic

characteristic. In "Bernal Sphere," the layering of a deep sub 909-type of kick drum underneath the breakbeat kick sample is used to enhance lower supporting frequencies not present in the sampled break. A similar layering technique was used in "Solar Neutrino" to augment the main kick drum, but using an EDM-styled sidechain-gated sine wave tone generator.

The rise of the digital audio workstation (DAW) has radically changed the way music is recorded and produced. While analog effect devices now reside as virtual plugins in DAWs and can be used in practically any type of music, in the context of EDM the types of techniques implemented become genre-defining musical tools. While technology in electronic dance music has been used to establish various genres from hip-hop to electro, electronic music composers can now access a complete in-the-box facility incorporating audio and midi recording/editing, virtual instruments, countless effects and mixing tools, and other specialized tools such as audio analyzers and tone generators, all within a single host software environment.

In the context of EDM, the use of mixing techniques and audio effects are both composition and orchestration tools in which a composer requires proficiency to achieve genre-specific authenticity. As Rick Snoman states in his Dance Music Manual, *"*Today's dance- and club-based music relies just as heavily on the technology as it does on the musicality; therefore, to be proficient at creating this genre of music it is first necessary to fully comprehend the technology behind its creation.*"*[38]

Because of technical advancements in this in-the-box type of audio computing power, more complex interactivity between a song's elements is possible. The details of these audio "chains" and their interactions affect a composition's direction. For example, the opening trance synth ostinato in "Tulpa" is a combination of variable low-pass filtering, time-based delay effects, reverb and sidechain compression interaction to define the soundscape and mood of the piece's opening. The audio routing needed to produce this result can be displayed as a flowchart style diagram, as illustrated in Figure 58.

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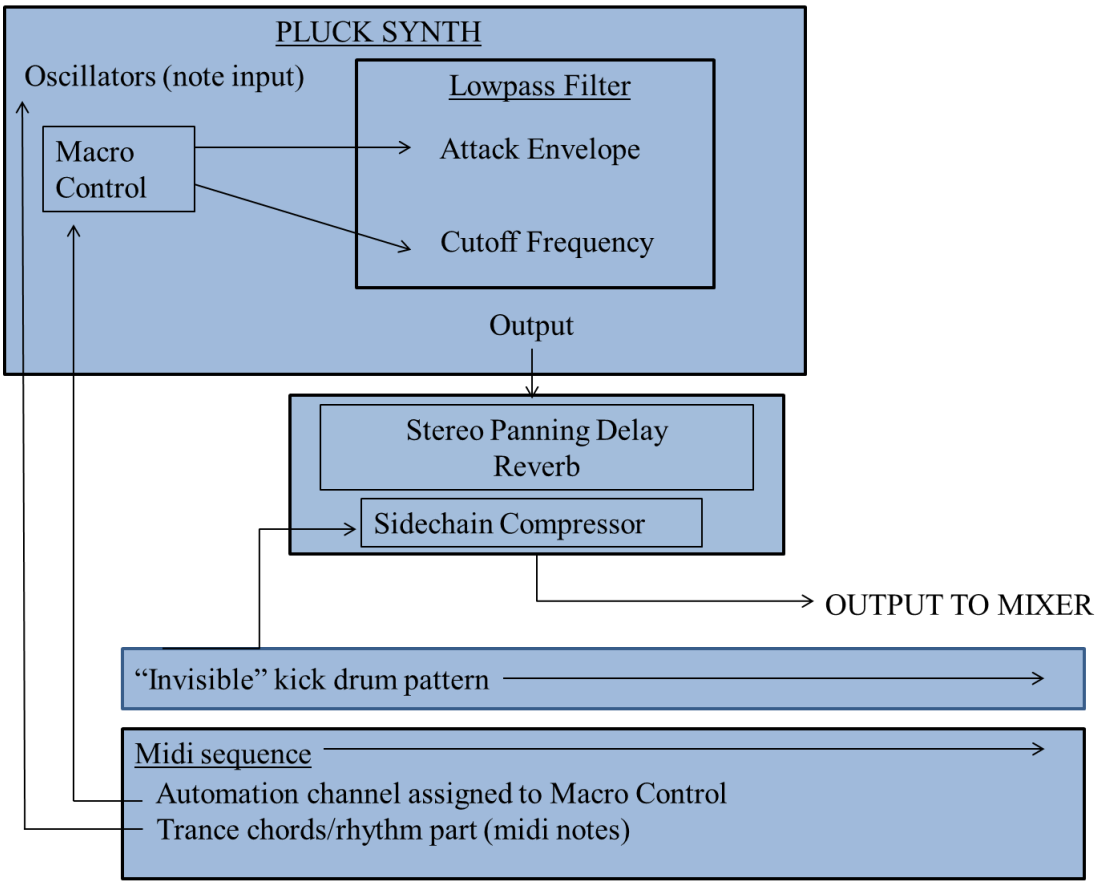
[38] Snoman, *Dance Music Manual*, 3.

Figure 58: "Tulpa" - plucked synth audio routing



The type of interactivity between elements in the DAW environment as described in the preceding pluck synth example was essential to other parts of the compositions in this thesis. In the bass parts to "Tulpa" for example, the sub-grouping of complextro style basslines allowed collective sidechain compression and processing to take place which contributed to the cohesive texture necessary to that aspect of the composition.

8.2 Conclusion

The synthesis of musical styles and techniques explored through the research and original compositions in this thesis proved to be a challenging task, as the aesthetic characteristics in each area encompasses a range of detailed musical approaches including harmonic and melodic analysis, breakbeat and grid-style drum programming, and electronic dance music techniques. Austin and Clark's description of music composition as "putting music together, integrating the materials with skill, planning, and artful originality to satisfy requirements of a particular musical genre" [39] neatly outlines the compositional process undertaken in these pieces, while allowing each composition to develop its own individual mix of genre-based influences.

In a conventional instrumental group, the individual musicians and the recording/mixing engineer hold more responsibility for shaping the cumulative sound, in contrast to the electronic composer. As seen in the EDM components examined in this thesis, digital mixing techniques and knowledge of frequencies, plugins and midi programming influence both the compositional process and the sonic signature of the piece, placing the onus on the composer to become proficient in those techniques. However, from a composer's point of view, this proficiency opens up a spectrum of possibilities for discovering new combinations of sounds through which one's musical ideas can be expressed.

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[39] Austin, Larry, and Tom Clark. *Learning to Compose: Modes, Materials, and Models of Musical Invention* (Dubuque, IA: William C. Brown:1989)

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11 Software

Battery 4. Version 4.1.0. Native Instruments, 2013.

Battery is a drum sampling audio application.

Cubase. Version 7.5. Steinberg Software, 2013.

Cubase is a digital audio workstation and sequencer that incorporates midi, audio, virtual instrument and effect plugins, and digital audio editing tools.

Kontakt 5. Version 5.3.0. Native Instruments, 2011.

Kontakt is a virtual audio sampling application with a large library of available sounds as well as sample editing tools.

Massive. Version 1.4.0. Native Instruments, 2012.

Massive is a virtual synthesizer application.

12 List of supplementary files

12.1 SolarNeutrino_MusicScore_SLucas.PDF

Music score for the original composition “Solar Neutrino” in PDF format.

12.2 BernalSphere_MusicScore_SLucas.PDF

Music score for the original composition “Bernal Sphere” in PDF format.

12.3 Tulpa_MusicScore_SLucas.PDF

Music score for the original composition “Tulpa” in PDF format.