

# Timbral & Textural Evolution as Determinant Factors of Auditory Streaming Segregation in Christian Lauba's "Stan"

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## ABSTRACT

Formal musical analysis does not typically involve the listener's cognition of the macro/micro structural levels of a composition. Auditory scene analysis provides a fundamental understanding of the way a listener perceives combined sounds and organizes them as separate elements of the musical texture. The aim of this paper is to show how a number of cognitive factors (auditory streaming principles) can provide an insight into the macro/microstructure of Christian Lauba's "Stan" for baritone saxophone and pre-recorded synthesizer. "Stan", Lauba's 11th saxophone concert-study, is a "Study in virtuosity without rubato for well-tempered and well-quantized instruments" and an homage to Stan Getz, the renowned jazz musician. In this piece, timbral and textural parameters, as well as their overlapping and interaction during the evolution of the composition, attain importance and constitute the main generators of auditory streams. The present study reveals the auditory streaming processes -based on the principles of Toneness, Temporal Continuity, Minimum Masking, Tonal Fusion, Pitch Proximity, Pitch Co-modulation, Onset Synchrony, Limited Density and Timbral Differentiation- that project the division of the piece into three parts (A-B-C) and explains the unfolding of the composition's musical texture and the relation of the piece's structure to its title. Pc set analysis is also applied in order to enlighten important processes at the microstructural level. The study shows how two distinct methodologies can complement each other for the benefit of music analysis. The acknowledgment of both cognitive and theoretical results expands our understanding of musical structure and broadens our knowledge about the listener's experience.

## I. INTRODUCTION

During the 90's a collaboration commenced between Christian Lauba and J. M. Londeix's saxophone class in Bordeaux. The direct result of this was the publication of Lauba's "Nine Studies for Saxophones" in four volumes by Alphonse Leduc. A number of reasons, mainly relating to the use of saxophone's extended sound production techniques, led to the acknowledgement of this work as seminal and highly referential in modern saxophone's repertoire. "Stan", Lauba's 11<sup>th</sup> concert-study, composed in 2001, is a "study in virtuosity without rubato for well-tempered and well-quantized instruments". Also, "Stan" is an homage to Stan Getz (1927-1991), the renowned jazz saxophone player. The piece is written for baritone saxophone and piano or pre-recorded synthesizer. The publication includes a compact disk (CD) with twelve pre-recorded synthesizer versions of the keyboard part (*Yamaha DX7 / Sound n° 5: Full Times*).

"Stan"'s first section ("A" in the following analysis) is a representative sample of Lauba's *post-minimal/meccanico* style. A number of Lauba's saxophone concert-studies (Balafon, Sanza, Jungle, Tatz, Xyl-Balafon II, Worksong, Mashai, etc.) share this basic schema and basically fall, entirely or sectionally, in this category. In this style, a bundle

of post-minimal characteristics<sup>1</sup> are combined with a mechanistic approach, as derived from Ligeti's *pattern-meccanico* compositional style (see also Cambouropoulos & Tsougras, 2009; Clendinning, 1993; Hicks, 1993): "Net-structure" is another term used instead. "A "net-structure" ... is a continuous web of finely-woven lines or repeated patterns in a constant, interactive process of transformation of one or more parameters, such as pitch, rhythm, texture, dynamics, or timbre" (Roig-Francoli, 1995, p. 243). Besides the terminological ambiguity introduced by Ligeti, Clendinning and Hicks about the usage of the above terms (*pattern-meccanico* vs *net-structure*), we will follow Roig-Francoli's clarification/classification (1995, p. 244). So, "net-structure" will describe the pattern-generated processes, while "meccanico" will stand for the pitch-repetitive, mechanical style.

Meccanico processes are based on "naive musical ideas" and the textural contradiction between sections of clearness (interval signals) and transitory blurring areas, as described by Ligeti (Cambouropoulos & Tsougras, 2009, p. 122, citing Ligeti et al, 1983). Ligeti carries on by stating "... you hear an interval [signal] that gets gradually blurred and in the ensuing mist another interval [signal] appears,... 'Mistiness' actually means a contrapuntal texture, a micropolyphonic cobweb technique; the perfect interval appears in the texture first as a hint and then gradually becomes the dominant feature" (ibid p. 122). The blurring processes are described by Hicks (1993, p. 174-175), who presents three different intervallic procedures (filling, accretion, shifting) and four types of differentiated intervallic roles (boundary, partition, projection and blur intervals) that generate the construction and blurring of signals. An episode of mistiness may be provoked by various combinations of the aforementioned techniques and thus a "network", meaning a web of functions, is produced where every strand touches others but no strand touches all, since most intervals play multiple roles yet no

<sup>1</sup> Gann (2001) lists a number of fundamental parameters that constitute the post-minimal style. All of them are somehow presented in "Stan" and each of them will be revealed during the analysis' unfolding. Specifically, Gann states that postminimalist music tends to be: 1) tonal, mostly consonant (or at least never tensely dissonant), 2) based on a steady pulse, 3) deviated from conventionally musical sounds, although many of the composers use synthesizers, 4) in shorter forms than the minimalist, 15 minutes rather than 75 or 120, 5) texturally varied. Also, concerning "phasing" or "phase shifting", Gann says "... Though not widely used in minimalist works per se, it survived as an important archetype in postminimal music". Finally, he acknowledges a link between post-minimal and serialist music which will be addressed in this paper through pc set theory: "Another way to characterize the postminimalist idiom is negative: it is the exact antipodal opposite of serialism. Like the serialists, the postminimalists have tended to seek a consistent musical language, a cohesive syntax within which to compose. [...] Minimalism inspired them to seek a more audience-friendly music than serialism, but they still conceptualized music in terms familiar to them from 12-tone thought: as a language with rules meant to guarantee internal cohesiveness" (see also Lee, 2010, p.7).

single role is played by all (Cambouropoulos & Tsougras, 2009, p. 123). In the majority of Lauba's *meccanico* concert-study cases, the saxophone participates via contiguous circular breathing technique in order to achieve this gradually unfolding isochronous pitch succession that creates the ever-evolving musical continuum. This strenuous activity/state motivates an emotional trance-like experience for everyone involved within this communal framework (audience-performers) (see Becker 2004, p. 1). As Becker writes, this framework is more apt to trancing experiences than a meditative state practised in solitude, which would likely resemble the performer's preparatory period. The term "*trance music*" is also presented as equivalent to *minimalism* in Williams (1997, p. 310). Even though we are dealing with diverse forms and functions of trancing, there is a basic connecting concept in all of them: "*Trancers' core consciousness includes the fact that trancers are aware of the changing events around them, of themselves in relation to those events*" (Becker 2004, p. 141).<sup>2</sup> This "thinking-ahead" attitude constitutes the fundamental link in this procedure, even if we are dealing with one or two performers, in order to achieve the needed well-balanced unity.

Normally, a composition with this title, attributed to Stan Getz (known as "*The Sound*" because of his warm and lyrical saxophone timbre), would probably lead an "experienced listener" to mental representations of terms like "Jazz Music", "Tenor Saxophone", "Bossa Nova", etc. This complex system of probabilities, as L. Meyer remarked (cited in Temperley, 2007, p. 1) is related to the arousal of expectations upon which musical meaning is built.<sup>3</sup> The compositional parameters related to jazz are thus a part of the present study.

We consider that "*Stan*" represents an intriguing quest regarding the concept of concert-studies in general. Specifically, we intend to examine whether the advanced technical skills required – circular breathing, multiphonics, microtones, bisbigliando and trills – truly attribute to the piece's structure, and to list the means by which this is perceptually observed. Since we are examining sound qualities (transformation of timbral-textural features, preservation -or not- of the "*well-tempered*" and "*well-quantized*" instrumental character, etc.) at a cognitive level, theoretical/mathematical analytical tools are not adequate, so auditory streaming principles could provide a valuable analytical approach. Also, we intend to investigate the interrelation between the composition's theoretical/structural plan (revealed via formal music analysis) and its possible cognition (revealed via auditory perception principles), although it is of course unknown whether Lauba composed the piece following a structural or cognitive approach (or both). Analytical results related to rhythm, timbre, texture and style can be combined with cognitive assumptions in order to address certain questions arising from the audition of the piece's performance (a recording of the piece by Richard Ducros - last track of the *Universal Music CD 472 370-2* - was used for the auditioning).<sup>4</sup> So, in this framework, it would

<sup>2</sup> Williams (1997, p. 312, citing Reich, *Writings About Music*, p. 52) presents this fact by explaining the "phase-shifting" procedure. This compositional process is presented in "*Stan*" during the last five seconds of part "A".

<sup>3</sup> Deutsch (1999, p.300) states that besides the four principles (proximity, similarity, good continuation and common fate): "*As a fifth principle, we tend to form groupings so as to perceive configurations that are familiar to us*".

<sup>4</sup> See also <http://www.youtube.com/watch?v=TZIEsN3g-jQ>

be interesting and rewarding to combine a cognitively based analytical procedure (auditory scene analysis principles) with theoretically based ones (pc set analysis, voice-leading analysis, etc.), as the acknowledgment of both cognitive and theoretical results could expand our understanding of musical structure and broaden our knowledge about the listener's experience.

## II. RELATED WORK

Lauba's saxophone studies have not yet been analyzed in a systematic way, and this accounts for the lack of related work about "*Stan*". Ku's dissertation, entitled *Four Recitals and an Essay: Christian Lauba and his Saxophone Etudes From a Historical Perspective* (Ku, 2009), explores - as implied by the title - the first twelve concert studies through a combination of their performance and relevant historical research (recitals/thesis). Even though this historically oriented essay does not contain any analytical insights, a number of briefly presented structural clues are introduced. Yet, concerning "*Stan*", these flashes are enlightening more technical parameters (i.e. multiphonics) than basic structural aspects (Ku, 2009, p. 78-79).

A number of other sources have inspired the initial thoughts and provided the background required for this paper's completion. The expansion of the auditory streaming theory, as initially defined by Al. Bregman,<sup>5</sup> involves - among others - the connection between the results supported by the research on auditory streaming and the common practice voice-leading techniques, as Huron has indicated (Huron, 2001; Temperley, 2007, p. 182-184). In Huron's paper, six core and four auxiliary auditory principles are derived – and consequently treated as axioms – from a number of, commonly appreciated throughout the years, voice-leading tactics. In this paper we will evaluate our auditory stream assumptions via *Toneness, Temporal Continuity, Minimum Masking, Tonal Fusion, Pitch Proximity, Pitch Co-Modulation, Onset Synchrony, Limited Density* and *Timbral Differentiation* principles. E. Cambouropoulos and C. Tsougras have already proposed some of the above auditory principles in their paper about Ligeti's *Continuum* (Cambouropoulos & Tsougras, 2009). Ligeti's *meccanico* style, net-structure compositional process and blurring of signals are all presented and discussed there, through auditory-theoretical analysis, thus providing a background for understanding various textural aspects in Lauba's composing methods as well.

## III. PERCEPTION OF AUDITORY STREAMS IN LAUBA'S "*STAN*"

### A. Macrostructure

Our main purpose is to reveal the basic linear<sup>6</sup> motion that

<sup>5</sup> Al. Bregman's website (<http://webpages.mcgill.ca/staff/Group2/abregm1/web/index.htm>); Snyder, 2000, p.46, Note 7.

<sup>6</sup> Lee (2010, p. iv) states: "*As postminimalist composers combined minimalism with a variety of other influences, linear time became more prominent but did not completely overwhelm the sense of vertical time. Instead, postminimalist music tends to create a hybrid between the two, a conclusion that helps justify and clarify the use of the term postminimalist*" (see also p.111).

arises through an evolving and transforming sonic manifestation of eight different auditory streams.<sup>7</sup> A compound macroscopic version of the whole would suggest that both instruments sound practically as one multi-timbral<sup>8</sup> sound source, since both instruments play in unison for nearly 11 pages (see also Huron, 2001, p. 48; Deutsch, 1999, p. 304). This fact is also enhanced by the permanent sonic blur presented by the keyboard's vibraphone-like sustained tone – this tone occurs as a result of the large value of the envelope's release time of the synthesizer preset –, in combination with the required circular breathing technique used by the saxophone (see also Huron, 2001, p. 12-13). Consequently, both instruments contribute to the generation of the basic - ostensibly ever-evolving and incessant - auditory stream that permeates the composition. Gradually (from page 11 to page 20), the unison texture is increasingly "disturbed", until a structural and textural overturn occurring during the last 1'.21". This turnaround (section "B3") is related to the title of the study, as will be shown later. During that, a small number of other streams appears and vanishes via textural-timbral differentiations, until the initial single multi-timbral instrument is finally split into two discrete instruments/roles, each generating a totally new and perceptually independent auditory stream/function. Textural characteristics and Gestalt laws on the other hand manage to reveal the uninterrupted co-existence and complementation of both instruments until the end, despite the diametrically differentiated auditory streams they generate.

### B. Form and Microstructure

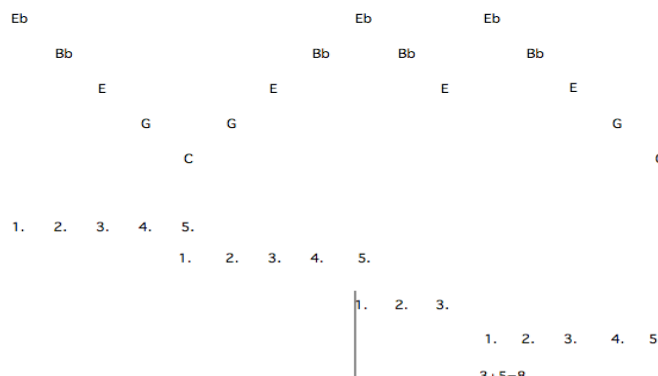
"Stan" consists of three perceptually distinct sections, all sharing the same tempo (see table 1). Section "A" (00'.00" – 04'.17") is a tripartite ternary structure: initial idea ("A1a"/"A1b") – evolution ("A2") – return ("A1a"/"A1b"). Section "B" (04'.17" – 06'.50") restates the initial idea ("B1a"/"B1b"), elaborates it ("B2") and evolves differently ("B3"/"B4"). Section "C" (06'.50" – 07'.50") departs from the main *meccanico* idea and leads to a static conclusion of the piece.

**Table 1. Segmentation in Ch. Lauba's "Stan".**

<b>A</b>	<b>00'.00" – 04'.17" / pages 1-11 / 42 staves</b>
A1a	00'.00" – 00'.13"
A1b	00'.13" – 03'.07"
A2	03'.07" – 04'.01"
A1a'	04'.01" – 04'.05"
A1b'	04'.05" – 04'.17"
<b>B</b>	<b>04'.17" – 06'.50" / pages 11-21 / 38 staves</b>
B1a	04'.17" – 04'.24"
B1b	04'.24" – 05'.37"
B2	05'.37" – 06'.29"
B3	06'.29" – 06'.42"
B4	06'.42" – 06'.50"
<b>C</b>	<b>06'.50" – 07'.50" / pages 21-22 / 7 staves</b>

Section "A", featuring Lauba's *post-minimal/meccanico* style, presents a randomly repeated polychordal five-note

arpeggiation pattern which incurs "A1a" for the first thirteen seconds (see fig. 1).



**Figure 1. Ch. Lauba's "Stan" basic circular arpeggiation pattern including only the first two variant repetitions (00'.00" – 00'.03")**

This whole first section ("A"), according to a number of perceptual principles like *Temporal Continuity*, *Onset Synchrony* and *Tonal Fusion* (see also following chapter about auditory principles), could be perceived as one auditory stream, since both instruments perform in unison contiguous eighth-notes for eleven pages. Still, the monophonic texture can be separated to three distinct streams (this is also indicated at the score by the separation of the first two streams in different piano staves by the composer himself).

The first stream (green band in fig. 2) is initially formulated by the multiple iteration and commutation of the first three pitches (Eb, Bb, E) in section "A1a". The integration of these sonorities into one stream is based on the principles of *Temporal Continuity*, *Minimum Masking*, *Tonal Fusion*, *Pitch Co-modulation* and *Onset Synchrony*. This stream is by far the longest one (sections "A1a" to "B2") and almost everything else in section "A" and part of "B" is presented, filtered and explained in relation to this. A small number of different rhythmic note values between the instruments is presented in this stream and even though this would differentiate our estimations in other circumstances, we cannot acknowledge them cognitively, due to the long release time of the synthesizer preset. These mere notational deviations though, will gradually grow in significance and during "B" they will lead to different textural types (free contrapuntal, fragmented, pointillistic) inside the same stream. Also, at the end of the *post-minimal/meccanico* section, an optional phase-shifting technique characterizes the saxophone's last fifteen eighth-notes (the sax part includes the instruction *ad lib* only for these 15 notes). This archetypic residue of minimalism (see Gann, 2001) occurs during the final five seconds (04'.13" – 04'.17") of section "A", where Lauba uses for the last time the initial five-note pattern. Richard Ducros interprets the passage without making use of the phasing approach, thus avoiding the creation of one brief but quite perceivable different type of auditory stream (see also Deutsch, 1999, p. 305), due to the onset differences (*Synchronous Note Principle*).

The second stream (brown band in fig. 2) consists of the remaining pitches of the initial pattern (C-G). This stream, bearing less structural significance than the first, acts as an auditory counterpoint below the basic one. All auditory

<sup>7</sup> It is worth pointing out that Lauba insists on a type of controlled virtuosic musical interpretation without rubato, that emphasizes precision in every possible interpretative parameter. So, the requirement of "well-tempered" and "well-quantized instruments" promotes the unfolding of the auditory structural plan in a clear and understandable way.

<sup>8</sup> About timbre and auditory stream formation, see Mc Adams, 1999, p. 95.

principles mentioned previously would suggest the incorporation of the second stream into the first. The reason for its segregation though from the rest of the polychord is the application of the *Toneness* and *Minimum Masking Principles* and the evoked sonic blur of this specific tonal area. The second stream is abandoned during the last part of sections “A1b” and “A2”, which constitute an exclusively monophonic textural representation of the first stream, and reappears again in the recapitulation-like sections (“A1a”/“A1b”). As the general tonal pitch gradually arises, this stream is bound to eclipse from both instruments, and it does so before the Golden Section of the piece<sup>9</sup> (saxophone) and section “B2” (keyboard). The sonic blur produced by the spectral energy of the second stream's tonal area will systematically be replaced by the resonance of a constantly ascending row of initially syncopated and finally contiguous sixteenth-notes.

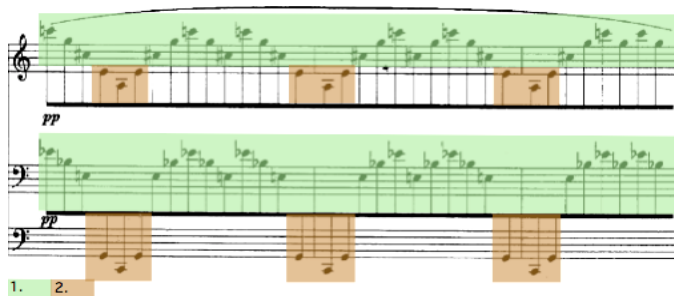


Figure 2. Auditory streams 1 (green band) and 2 (brown band).

The third stream (00'.56" – 02'.04", orange band in fig. 3) occupies the middle-upper part of the score for a number of short flashes during section “A1b” and is combined with the other pre-existing streams in various combinations. The integration in one single stream lies upon *Temporal Continuity*, *Minimum Masking*, *Pitch Proximity*, *Pitch Co-Modulation*, *Synchronous Note*, *Limited Density* and *Timbral Differentiation* principles. This stream could actually be considered as a third (polyphonic) stream/voice<sup>10</sup> in the auditory counterpoint mentioned above. Both textural (chords) and timbral (multiphonics) aspects project the need for segregation. Unfortunately, this third stream is hardly audible in Ducros' recording, perhaps due to the great technical demands it evokes to the saxophone player<sup>11</sup>. In parallel, the keyboard's high resonance reduces the possibility of effectively extracting and listening to the double notes<sup>12</sup> or the varied tonal content of both instruments.

<sup>9</sup> The “Golden Ratio” is applied in a variety of structural levels. The only perceptually audible example though concerns the Golden Section of the whole piece (04'.50") and its significance in the streaming process (see Stream 4). The proportional relation between the first two sections (“A” – “B”) or the initial pattern's ratio  $[5,5,8 (3 + 5) / 5,8 (3 + 5) \dots]$  used from the beginning of the piece (“A1a”) are though not audibly perceivable.

<sup>10</sup> About the relation between the terms: “voice” - “voice-leading” - “auditory streams”, see Cambouropoulos (2008).

<sup>11</sup> There are two main technical difficulties here: first, the rapid changes involved between simple tone production embouchure and multiphonic embouchure and second, the alteration between simple fingering and cross-fingering technique.

<sup>12</sup> On the other hand, when double notes are presented in the second stream (01'.18"), the effect is more audible.

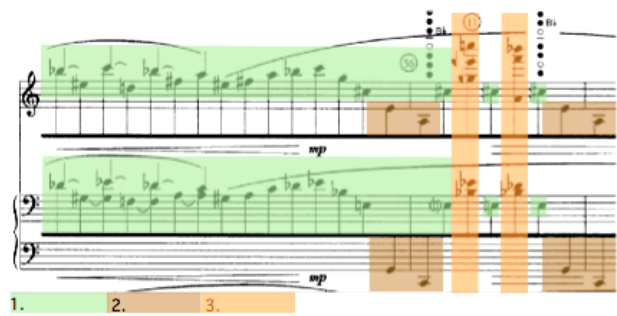


Figure 3. Auditory streams 1, 2 and 3 (orange band)

Three new auditory streams are introduced during section “B”, which starts with the same arpeggiated pattern as in “A”, in a more sixteenth-note syncopated style. The fourth stream (purple band in fig. 4), presented only in the saxophone's part, coexists with the first two streams and becomes more obvious and consistent after the Golden Section and until the first bar of section “B3”. The main generating elements of this stream are *Note duration – Crescendo* (textural aspects, fig. 4a) or *Note duration – Articulation – Bisbigliando/Trill* (textural/timbral aspects, fig. 4b) (see also Snyder, 2000, p.143). Principles such as *Onset Synchrony* (differences in duration and articulation) and *Timbral Differentiation* (timbral trills) can explain why this stream is segregated from the first one and why it affects only the saxophone.



Figure 4. Auditory stream 4 (purple band) among streams 1,2.

The appearance of the fifth stream (magenta band in fig. 5) marks an important textural/structural change in the piece's evolution (section “B3”). The stream is a contiguous “accompaniment” line of upwardly, non-syncopated sixteenth-notes, the culmination of the increase in rhythmic density and tension that started after the completion of the first stream. This abrupt rhythmic/role-changing moment finds the saxophone temporarily occupied with timbral<sup>13</sup> features (bisbigliando). What draws all the attention though is the saxophone's bebop “improvisation” section (sixth stream, yellow band in fig. 5) above the rhythmic accompaniment<sup>14</sup> (fifth stream, magenta band in fig. 5) that follows. The two

<sup>13</sup> About timbre and structural tension see Mc Adams, 1999, p. 96-97, 100.

<sup>14</sup> See “Habituation” (Snyder, 2000, p.24,165).

instruments are now separated not only by their discrete auditory streams, but also by their structural role in a more or less known but differentiated melody & accompaniment stylistic context. All the anticipation that the piece's title may have created is basically resolved in the sixth stream.

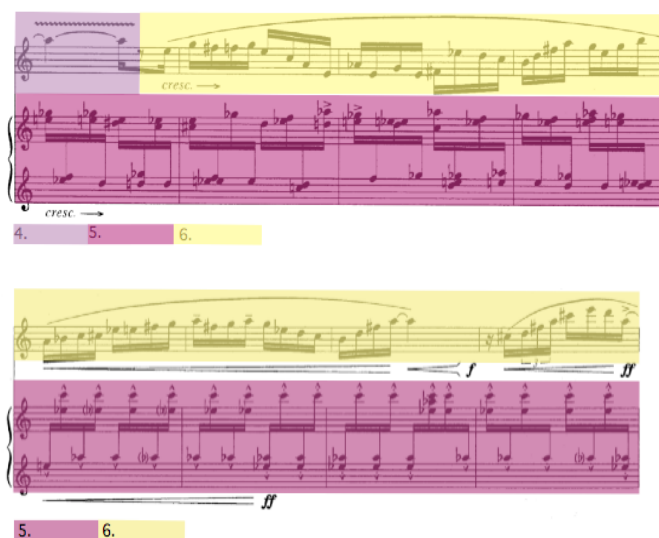


Figure 5. Auditory streams 5 (magenta band) and 6 (yellow band).

Three bars before the saxophone's completion of section "B3", the synthesizer reaches an Ab Major chord, inside the fifth stream (fig. 5b), which will be continued in section "B4" in uninterrupted sixteenth-notes. When the saxophone enters "B4", it does so by trilling the notes "Ab – C". Thus, despite the rhythmic difference, both instruments share once more, even though for a short while, the same (fifth) stream. However, this common shared stream is only temporary, since section "C" confirms the total streaming differentiation by embodying the last two auditory streams. The melody & accompaniment texture is retained, but through role changing: the seventh stream (light blue band in fig. 6) presented by the synthesizer constitutes now the leading voice (mostly vertically sustained<sup>15</sup> chords / *ff-mp*), whereas the eighth stream (saxophone, blue band in fig. 6) reflects the background accompaniment (sustained simple tones and multiphonics / *p-pppp*<sup>16</sup>). We can also observe the auditory induction which takes place between the two streams (see Huron, 2001, p. 11). This represents once more the strong relation between the textural-timbral differentiation and the creation of auditory streams.

<sup>15</sup> See Snyder, 2000, p. 65.

<sup>16</sup> About the rapid changes in loudness see Snyder, 2000, p.34. In fact the whole 3<sup>rd</sup> Ch., *Grouping*, p. 31-46 presents a number of Gestalt laws (i.e. proximity, similarity, continuity, etc.) and their connection to memory organization.

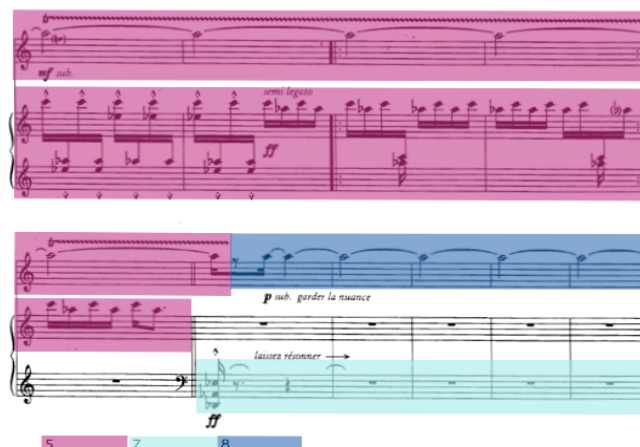


Figure 6. Auditory streams 7 (light blue band) and 8 (blue band).

### 1) Auditory Streaming Principles

- **Toneness Principle.** "Strong auditory images are evoked when tones exhibit a high degree of toneness. A useful measure of toneness is provided by virtual pitch weight. Tones having the highest virtual pitch weights are harmonic complex tones centered in the region between F2 and G5. Tones having inharmonic partials produce competing virtual pitch perceptions, and so evoke more diffuse auditory images" (Huron, 2001, p. 10). Auditory streams 1, 3, 4, 6 and 8 are constricted in this pitch range (F2-G5), whereas streams 2, 5 (keyboard only) and 7 (keyboard only) use tones beyond the pre-described region.
- **Temporal Continuity Principle.** "In order to evoke strong auditory streams, use continuous or recurring rather than brief or intermittent sound sources. Intermittent sounds should be separated by no more than roughly 800 ms of silence in order to ensure the perception of continuity" (ibid p. 12). This principle applies to auditory streams 1, 5, 6 and 8. Streams 2, 3 and 4 on the contrary are organized in sporadic flashes and opposed to the continuity presented by stream 1. Yet, the temporal continuity principle is applied within each groups' inner structure. Stream 7 on the other hand is fundamentally averse to this principle.
- **Minimum Masking Principle.** "In order to minimize auditory masking within some vertical sonority, approximately equivalent amounts of spectral energy should fall in each critical band. For typical complex harmonic tones, this generally means that simultaneously sounding notes should be more widely spaced as the register descends" (ibid p. 18). Minimum masking principle is applicable in all streams as the composition evolves. This can be verified by addressing the relation between parameters such as 'sectional constant pitch rise' and 'sectional rhythmic evolution'. Evidence about that is specifically provided by streams 2 (low tonal range), 5 (high tonal range / keyboard only) and 7 (low tonal range / keyboard only).
- **Tonal Fusion Principle.** "The perceptual independence of concurrent tones is weakened when their pitch relations promote tonal fusion. Intervals that promote tonal fusion include (in decreasing order): unisons, octaves, perfect fifths, ... Where the goal is the perceptual independence of concurrent sounds, intervals ought to be shunned in direct proportion to the degree to which they promote tonal fusion" (ibid p. 18).

fusion” (ibid p. 19). This principle is at work in streams 1, 2 and the upper voice of stream 3 – especially in section “A”, where both instruments play contiguous eighths in unison. From section “B” and onwards this fact is gradually circumvented for streams 1 and 2.

- **Pitch Proximity Principle.** “The coherence of an auditory stream is maintained by close pitch proximity in successive tones within the stream. Pitch-based streaming is assured when pitch movement is within van Noorden’s “fission boundary” (normally 2 semitones or less for tones less than 700 ms in duration). When pitch distances are large, it may be possible to maintain the perception of a single stream by reducing the tempo” (ibid p. 24). This principle is effective in the formation of streams 1, 2, 3, 4, 5 and 6. Huron’s last statement concerning tempo and pitch distances is notably represented in streams 1, 2, 3 (contiguous eighths) and 5 (contiguous sixteenths), not by reducing the tempo but by doubling the notes at a given study pulse.
- **Pitch Co-modulation Principle.** “The perceptual union of concurrent tones is encouraged when pitch motions are positively correlated. Perceptual fusion is most enhanced when the correlation is precise with respect to log frequency” (ibid p. 31). The formation of streams 1, 2 and the upper voice of 3 fall in the category of positively-correlated pitch motions that might be collectively referred to as semblant motions (specifically parallel motion in sections “A” and part of “B”).

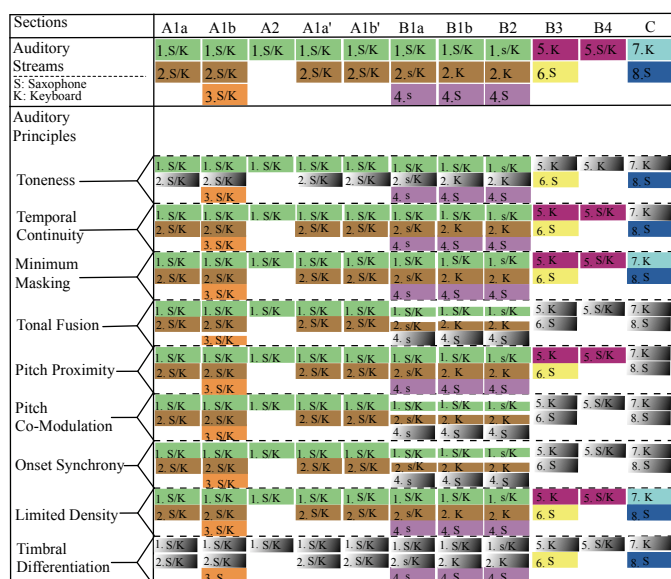


Figure 7. Evolution and interaction of the nine auditory streaming principles applied throughout the piece.

- **Onset Synchrony Principle.** “If a composer intends to write music in which the parts have a high degree of perceptual independence, then synchronous note onsets ought to be avoided. Onsets of nominally distinct sounds should be separated by 100 milliseconds or more” (ibid p. 40). Streams 1, 2 (especially in “A”) and 3 are based in this principle in order to form a multi-timbral instrument. The gradual discharge of this auditory principle is initially presented by the ‘phasing’ section (end of section “A”) in streams 1 and 2. The rest of the streams (4-8) are not

intended compositionally to create such perceptual unity, thus onset synchrony principle is not applied there.

- **Principle of Limited Density.** “If a composer intends to write music in which independent parts are easily distinguished, then the number of concurrent voices or parts ought to be kept to three or fewer” (ibid p. 46). This principle is practically applied to the whole composition.
- **Timbral Differentiation Principle.** “If a composer intends to write music in which the parts have a high degree of perceptual independence, then each part should maintain a unique timbral character” (ibid p. 49). This principle affects only the saxophone part (i.e. streams 3, 4, 6 and 8).

The interaction between the above principles is depicted in Figure 9. Lauba's plan to discreetly and evenly segregate the initial multi-timbral instrument into two differentiated timbres/roles is acknowledged in the way the auditory principles yield the auditory streams. There are two ways of classifying this procedure, as shown in Tables 2a and 2b.

Table 2a. Grouped auditory streaming principles based upon the similarity of auditory streams in use.

<b>1<sup>st</sup> Group</b> (principles with similar streams)	Minimum Masking & Limited Density Principles	Applied in all eight streams throughout the piece
	Tonal Fusion, Pitch Co-Modulation & Onset Synchrony Principles	Applied in three streams
<b>2<sup>nd</sup> Group</b> (principles with differences in one stream)	Temporal Continuity & Pitch Proximity Principles	Applied in seven and six streams respectively
	Toneness & Timbral Differentiation Principles	Applied in five and four streams respectively

Table 2b. Grouped auditory streaming principles based upon the number of auditory streams in use.

Minimum Masking	8 {1, 2, 3, 4, 5, 6, 7, 8}
Limited Density	8 {1, 2, 3, 4, 5, 6, 7, 8}
Temporal Continuity	7 {1, 2, 3, 4, 5, 6, 8}
Pitch Proximity	6 {1, 2, 3, 4, 5, 6}
Toneness	5 {1, 3, 4, 6, 8}
Timbral Differentiation	4 {3, 4, 6, 8}
Tonal Fusion	3 {1, 2, 3}
Pitch Co-Modulation	3 {1, 2, 3}
Onset Synchrony	3 {1, 2, 3}

2) *Signals/Blurring Episodes.* There are five different intervallic signals in “Stan” (see fig. 7). The first one is the initial five-note pattern (pitches C-G-E-Bb-Eb). It is presented four times during section “A” (“A1a”, “A1b” as a flashback 02'.34” – 02'.38”, “A1a”, “A1b” as part of the optional phasing) and once more in the beginning of “B1a”, though syncopated and with many note repetitions. Its intervallic structure includes the intervals: M6, P5, dim5 and P4. This signal is blurred in section “A” through accretion and filling, whereas in section “B1a” shifting is also applied. The second signal (pitches: Bb-C-Eb, inner intervals: M2, m3) appears in the beginning of section “A2”. Shifting, filling and accretion techniques are applied for the blurring, with the use of gradually smaller inner intervals<sup>17</sup> (M2, m2, microtones) leading to the unison, after which the initial signal returns

<sup>17</sup> For more about such processes, see Huron, 2001, p. 22; Deutsch, 1999, p. 304.

(section "A1a"). The third signal is the Ab major chord presented in section "B3/B4". This signal comes after the synthesizer's contiguous sixteenth-notes upward motion and it leads to section "B4" through shifting. The last two signals occur both in section "C". The first of them is the synthesizer's sustained chords (evolving through accretion and filling) and the second is the saxophone's pitch C (evolving via shifting procedures to the multiphonics).

Figure 8 shows five intervallic signals in a musical score. Signal 1 is marked 'pp' and 'Saxophone/Baritone'. Signal 2 is marked 'p sub.'. Signal 3 is marked 'p sub.'. Signal 4 is marked 'mf sub.'. Signal 5 is marked 'p sub. garde la nuance' and 'laissez résonner'. The score includes staves for Saxophone/Baritone and Piano/Synthetizer.

Figure 8. The five intervallic signals of the piece.

3) *Pc Sets Results.* The first episode of mistiness in section "A1b" represents, from a mathematical pc set analysis perspective, the gradual union of pc set 5-32 (pcs C, Eb, E, G, Bb, initial five-note pattern/first signal) with its complementary pc set 7-32 (pcs C#, D, F, F#, G#, A, B), in order

to produce the first chromatic twelve-tone aggregate.<sup>18</sup> The same procedure is demonstrated once more in section "B1b". In section "A1b", since pitch class D was not included, an aggregate of only eleven pcs occurs. This process is a very concrete structural and technically difficult (due to the circular breathing usually applied to the saxophone) procedure, that describes Lauba's idiomatic *post-minimal/meccanico* style.

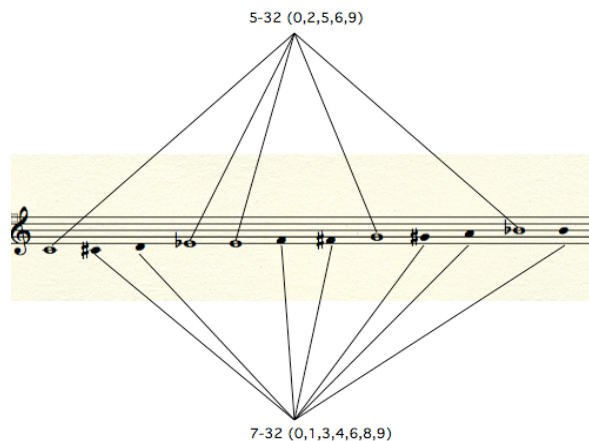


Figure 9. The formation of a chromatic (twelve-tone) aggregate by two complementary pc sets.

Two more important pc sets are 8-28 (pcs C, C#, D#, E, F#, G, A, A#, the octatonic scale) applied in section "B2" and 3-11 (Ab Major chord - third signal) in sections "B3"/"B4". Figure 9 depicts graphically the common pcs of the pc sets used in the piece, revealing their structural coherence and symmetry.

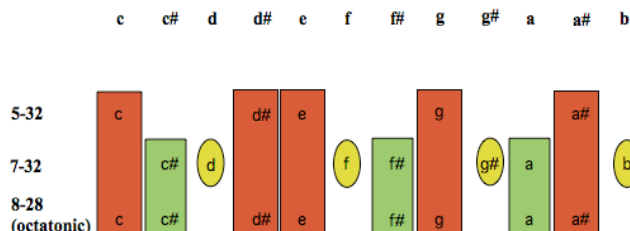


Figure 10. Structural interaction of the three basic pc sets.

4) *Jazz Influences and section "B3".* The composition's jazz character lies initially in the title, the dedication and the instruments in use. All these facts suggest a number of other, openly presented or surreptitiously evolving, parameters throughout the study. First of all, Stan Getz was known for his tenor saxophone sound, without relating somehow to the baritone sax. Yet Wolfe (2009, p.23) presents a faint relation to the baritone. Ku assumes (2009, p. 78) that "The reason Lauba chose the baritone saxophone for this etude instead of the tenor saxophone is that the composer wants to use the different ranges of the two saxophones to intentionally create the discrepancy between his etude and Stan Getz's music, and to avoid the similarities, especially the "improvisation" section in the second half of the piece". We would rather suggest on the other hand, by the cognitive conjectures made so far, that the baritone saxophone is preferred due to its

<sup>18</sup> See footnote 1 (Gann, 2001) about the relation between post-minimalism and post-serialism/atonicity.

timbre and its ability to blend with the vibraphone<sup>19</sup>-like sound more successfully than the tenor. This is critically important especially in the first section (“A”), where the circular breathing and the synthesizer's resonance collaborate to produce one multi-timbral instrument.

From the beginning of the second part (section “B1a”) a flow of jazz initiated schemas appears, that continues up to section “B3”. The first clue is the syncopated sixteenth-notes section (“B1a” – “B2”) with a “*léger et swing sans rubato*” feel. The second jazz schema involves the bisbigliando<sup>20</sup> technique (timbral trill). The third jazz influence is related to the use of the octatonic scale (pc set 8-28) which is typically prominent in jazz harmony. These three features combined produce an environment where bebop “improvisation” and “accompaniment” is anticipated, until it finally takes place in section “B3”. Lauba refers to Stan Getz in this concert-study not in a Bossa-nova<sup>21</sup> environment but in jazz's *lingua franca*, the bebop style. It is worth mentioning that Wolfe in his thesis (2009) argues that Stan Getz is basically a forgotten bebop tenor saxophonist and analyzes Getz's improvisations presenting melodic, rhythmic and harmonic examples in order to prove his argument.

#### IV. CONCLUSIONS

In this paper we demonstrated how a number of cognitive laws (auditory streaming principles) applied in Lauba's “Stan” can project the musical structure and make it perceptible. Eight auditory streams, that constitute the whole piece, are linked with the data provided by six analytical perspectives (blurring processes, textural evolution, timbral differentiation, jazz influences, pc sets, rhythmic development). We also incorporated a mathematical analytical tool (pc set theory) for the extraction of important compositional information in order to describe the pitch content of Lauba's “*post-minimal/meccanico style*”, as encountered in his concert-study “Stan”. Finally, we proposed a number of musical features connected to the jazz idiom and delineated their correlation and attribution throughout the composition. A summary of the present analysis and a complete overview of its results is depicted in fig. 10 (appendix).

The present paper is mainly theoretical, with no empirical parameters or data examined. Statistical information deriving from experimental procedures though could suggest potential future research concerning the above theoretical assumptions.

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<sup>19</sup> About the historical connection of Stan Getz and vibraphone sound, Yanow writes: “His [Getz's] regular group during this era was a piano-less quartet with vibraphonist Gary Burton”.

<sup>20</sup> Bisbigliando is a type of trill used in a variety of instruments. In aerophones by pressing one or more keys relevant to a specific fingering one can adjust the tuning in mistuned notes or even regions of the instrument. With this technique and in a repetitive trill-like manner, a timbral trill effect is produced. We believe that the practise of bisbigliando as timbral trill started, concerning the saxophone, in improvised jazz music, and then it flourished in contemporary avant-garde tradition as well. However, there are no related references to this concept, thus it should be treated as an assumption.

<sup>21</sup> Lauba wrote *O Prazer* in bossa-nova style in 2007 for tenor sax (R. Ducros) and synthesizer ([http://www.youtube.com/watch?v=H3XjkVtFW\\_w](http://www.youtube.com/watch?v=H3XjkVtFW_w)).



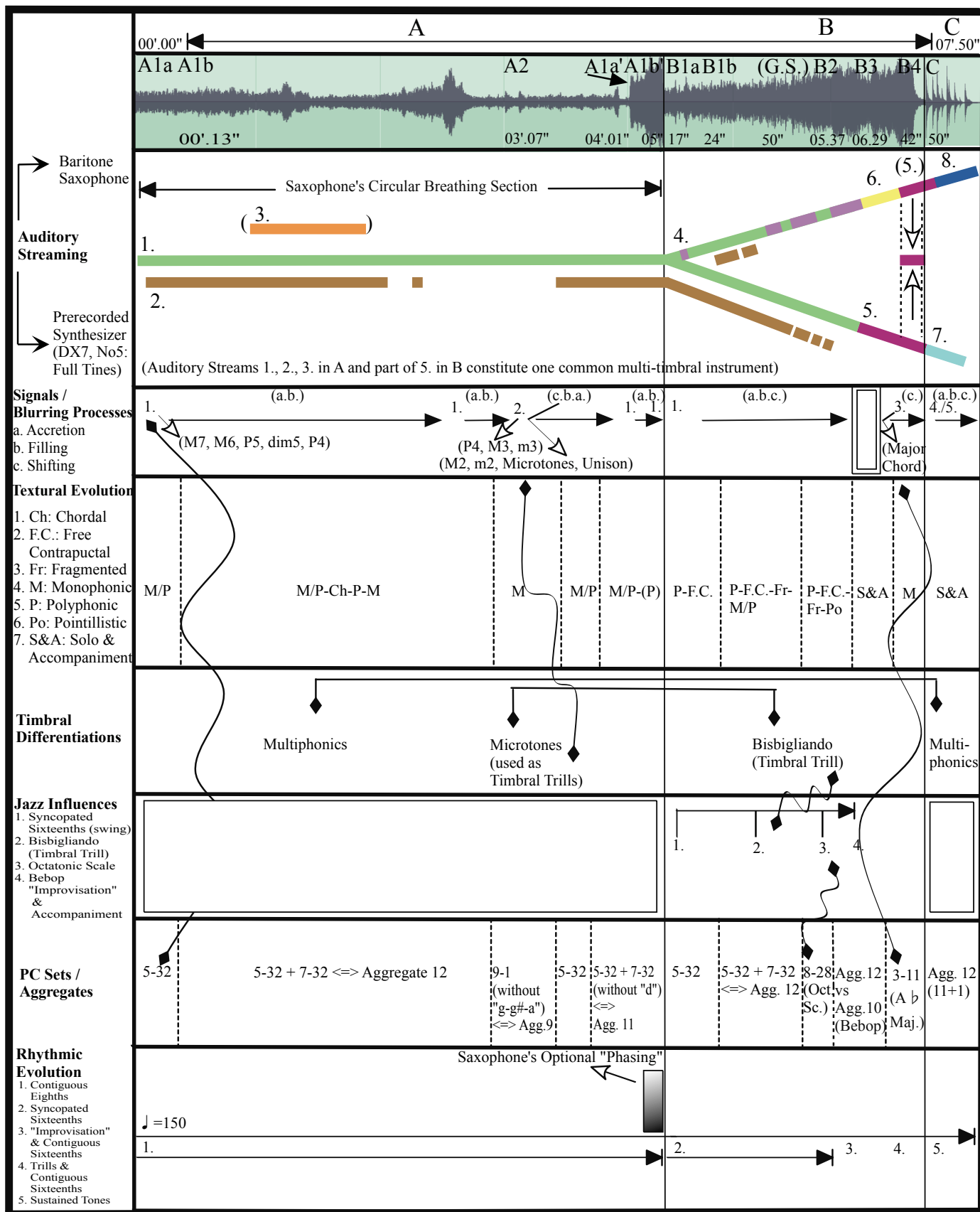


Figure 10. Complete Analysis Diagram of Christian Lauba's "Stan".