The Creative Process Behind *Dialogismos I*: Theoretical and Technical Considerations

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***Abstract* — This paper examines the aesthetic dimension and the technical realization of *Dialogismos I*, a piece for saxophone alto and electronics by the composer Nuno Peixoto de Pinho. The conceptual basis of the work relies on the notion of 'intertextuality' coined by the Bulgarian-French philosopher and literary critic Julia Kristeva, which was somehow transposed to the music domain by J. Peter Burkholder under the concept 'musical borrowing'. The compositional problems raised by applying an intertextual musical thinking as a key driver of the composition were solved using two different approaches. The first approach was the manual selection of elements from several music works with different granularities to devise the overall structure of the work and to create the saxophone score. The second approach was applied to the realization of the electronic part and relied on concatenative sound synthesis as an algorithmic computer assisted composition method and a real-time synthesis technique.**

***Index Terms* — Music, intertextuality, concatenative sound synthesis.**

I. Introduction

This paper details the creative process behind *Dialogismos I*, a piece for alto saxophone and live electronics, which resulted from a collaborative work between the composer Nuno Peixoto de Pinho and the saxophonist and programmer Gilberto Bernardes. Our aim was to create a new composition entirely based on decontextualized dialogic speech between multiple works from various composers. Metaphorically speaking, *Dialogismos I* can be seen as an offspring that share a congenital relation to a collection of parental works. Yet, even if the structural elements of the piece, such as the sound events, the phrases, the sections, and the form derive from works by various composers, the granularity of the samples and the assemblage process ensures an identity to the new work that if far beyond a simple imitation of the "parental" works, or any aesthetic affiliation.

The artistic notion of creativity as an activity that embodies in itself a continual dialogue with existing artworks from other artists, or even the use of creative processes that involve direct or implicit allusions, absorptions and/or transformations of creative work is an important historical concern in creative arts, which the music field entirely embraces [1].

The conceptual cornerstones of *Dialogismos I* are the work of Julia Kristeva, a Bulgarian-French philosopher and literary critic, particularly her concept of 'intertextuality' [2] coined in late-1960s, and the work of the music theorist J. Peter Burkholder, whose essays on Charles Ives introduce the seminal concept of 'musical borrowing'. *Dialogismos I* builds upon a major idea stated by Burkholder that can be synthesized in one of his 'borrowing' techniques, i.e. *modeling*. According to Burkholder, modeling follows a compositional paradigm in which a work or section is drawn from "an existing piece assuming its structure, incorporating part of its melodic material, imitating its form or procedures, or using it as a model in some other way." [3]. Our work expands previous approaches towards a formalization of intertextual music strategies through the use of computer software to automate most tasks of the process.

This paper is organized as follows: in the incoming section, we discuss previous works that follow compositional strategies similar to *Dialogismos I*. Section 3 clarifies the theoretical assumptions that support the work, i.e. the idea of 'dialogic' processes between different authors and works, and their technical realization. Section 4 examines the compositional methods of writing the instrumental (saxophone) score and enlightens the contributions of each 'borrowed' composer to our work. Section 5 details the electronic music realization. In detail, section 5 A introduces earGram, an application for concatenative sound synthesis (CSS) that is at the core of the production and performance of the electronic part. Section 5 B reports the first phase of the work that comprises the generation of raw audio material by algorithmic computer-assisted composition strategies in earGram and the later edition and processing of the resulting media, which was done in a commercial audio workstation. Section 5 C details the real-time audio processing techniques employed in the live performance.

II. Previous Work

The use of existing musical material to formulate new compositions or improvisations remotes to ancient times and cannot be detailed here because it is beyond the scope of this paper. The technique is as old as polyphony and has been greatly explored since then, not only by composers and improvisers who make references to their previous works, but also by composers that base parts of their works on material from others. When a composer integrates music material from others in his compositions, he usually refers to his contemporaries and stays within his stylistic affiliations [1].

Between 12th and 15th centuries, composers frequently used pre-existent melodies as a base for new compositions, particularly in motets. These melodies, referred as *Cantus Firmus*, were usually taken from Gregorian chants, i.e. "liturgical music of the Roman Catholic church consisting of unaccompanied melody sung in unison to Latin words," and generally presented in long notes against a more quickly moving texture [4]. Another significant example of music appropriation occurs between 17th and 18th centuries amongst the legacy of the numerous composers that belong to the Bach's family [5]. More recently we can point Charles Ives (1874-1954) and Luciano Berio (1925-2003), as exponents of the technique. Ives uses extensively existing musical material in his compositions, as comprehensively shown in J. Peter Burkholder's PhD thesis [4]. The 3rd movement of Berio's Symphony for 8 singers and orchestra is conceived as mosaic of quotations from various works by the following composers: Bach, Beethoven, Brahms, Mahler, Debussy, Ravel, Strauss, Stravinsky, Schoenberg, Berg, Stockhausen, Boulez and even by early works by Berio himself [6].

The technological advances that allowed the ability to record, manipulate and playback audio by electronic means vastly extended the musical thinking and the composition practice, especially the idea of reutilization of previous existing material as a composition prerogative. The process of creating a sonic result by rearranging pre-existing or pre-recorded material is referred as sampling, audio collage or simply tape music. One of the pioneers of the technique is Pierre Schaeffer. Around the late-1940s Schaeffer started to explore creatively radiophonic techniques with the sound technology available at the time at the home of French Radio in Paris [7]. Besides its artistic contributions, Schaeffer gave a seminal theoretical dimension to the practice, named as musique concrète, which remains active until present times. Later experiments worth mention is micromontage and granular synthesis. These techniques explore sampling methods with very short snippets, usually from 10-100 milliseconds, and allow the generation of textural sounds by recombining short snippets of audio, called grains, into larger acoustic events. Iannis Xenakis coined the term 'grains of sounds' and was the first composer to develop a compositional theory using this taxonomy [8]. By the late-1980s micromontage evolved into automatic strategies of processing and assembling short audio snippets, under the term granular synthesis. The first computer-based granular synthesis implementations were developed and presented almost simultaneously by the composers/researchers Curtis Roads [9] and Barry Truax [10], in USA and Canada respectively. Granular synthesis has been extensively used in computer music since then, by some of the most representative composers of the 20th century, such as Iannis Xenakis, Horacio Vaggione, Curtis Roads, Barry Truax and Paul Lansky to cite just a few. Along the same line of research and grounded on the electronic music techniques mention earlier, i.e. sampling, micromontage and granular synthesis, a novel synthesis technique is presented in the early 2000s that expands automatic audio assemblage by meaningful content analysis and representation of the audio data. We are referring to CSS. The use of concatenative synthesis was introduced in the speech synthesis domain and later redesigned to work with heterogeneous music signals. Briefly, it is a synthesis technique that uses a large collection of descriptor-analyzed sound segments, called units, to assemble a target phrase given a distance measure in the descriptors space. For a detailed description of the historical developments of the technique and its applications domains please refer to [11] and [12] respectively.

III. From Theory to Praxis

The work is based on an aesthetic principle of 'intertextuality' introduced by Julia Kristeva, a Bulgarian French philosopher and literary critic. Kristeva claims that "every text is built as a mosaic of quotes, every text is absorption and transformation of another text" [2]. In music, the intertextual practice is present in many works throughout the music history but only in the 20th century the practice is covered by theorists, particularly in the work of J. Burkholder, under the notion of 'musical borrowing'. Amongst his numerous contributions, in [3] Burkholder presets a table that synthesizes several 'borrowing' techniques devised from the analysis of Charles Ives' works. These techniques represent a valuable source of compositional methods, which will be used here as our main inspirations and terminology.

The structure and the fragments 'borrowed' from other works are obtained through two different methods, and named after Burkholder's terminology: (1) *collage*, "in which a swirl of quoted and paraphrased tunes is added to a musical structure based on modeling, paraphrase, cumulative setting, or a narrative program"

[3], and (2) *patchwork*, "in which fragments of two or more tunes are stitched together, sometimes elided through paraphrase and sometimes linked by … interpolations" [3]. The first method is uniquely used in the instrumental writing and relies on the paraphrase of short segments from the following list of composers: Johann S. Bach (1685-1750), Arvo Pärt (1935-), Jorge Peixinho (1940-1995), Wolfgang Mitterer (1958-), and Mauricio Sotelo (1961-). The second method, i.e. patchwork, was used solely in the construction of the electronic parts and explores the idea of elided fragments. In other words, the output of the software is a sample that shares musical qualities with at least two other samples that were used as models for a new entity. For example, we can have the rhythm structure of a midi file, the pitch sequence from an audio sample and the timbre of the resulting output derived from a different recording. Thus, the resulting sample represents a new entity with its own identity shaped from elements that otherwise would conflict, and whose software is able to easily relate.

Our major challenge was to create a coherent dialog between divergent composers, especially since the used material comes from different styles and historical moments. To solve this compositional drawback we assigned each of the composers referred in *Dialogismos I* to a different hierarchical level as summarized in figure 1 and described in the incoming paragraphs.

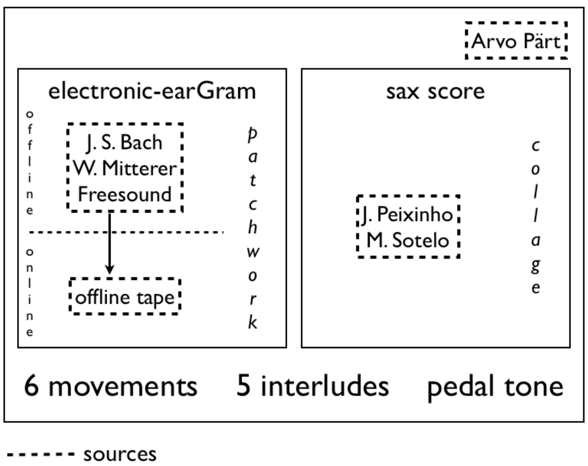

Fig. 1. Relationship amongst 'borrowed' composers, compositional techniques and the macrostructure of the piece.

Dialogismos I has 6 movements interconnected by 5 interludes. The interludes functions as a bridge and establish a connection between its adjacent movements. The electronic part of the movements is fixed and relies on offline compositions methods. The synchronization between electronic and acoustic parts during the movements is done by a relative alignment notated in the saxophone score with reference to units of time, which in this case is one second, or 60 beats per minute (bpm). The interludes have an open structure within certain constrains at the pitch level and its electronic realization relies entirely in real-time procedures. Throughout the piece there is a pedal tone that is generated and interacts in real-time with the saxophone performance.

Für Aline by Arvo Pärt [13] is the building block of the macrostructure of *Dialogismos I*. It not only defines the duration of the movements (macrostructure) and their sections (microstructure), but also constrains the harmonic content of the work. The first six bars of *Für Alina* have a direct correspondence to the six movements of *Dialogismos I*. Both the rhythmic and pitch structures of *Für Alina* determine properties of our work. The same process was applied to the interludes, which appropriate the pitch sequences derived from the bars 7-11 in an inverse path, i.e. from 11-7. Once again, each bar corresponds to a different interlude.

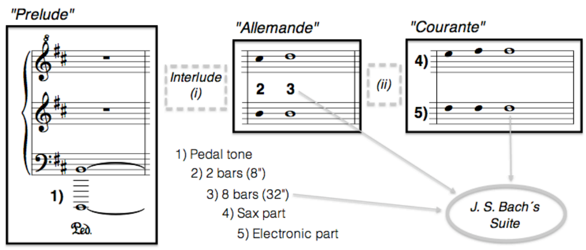

Fig. 2. Scheme representing the material extracted from Arvo Pärt's *Für Aline*, which devised the macrostructure and the microstructure of the first three movements of *Dialogismos I*.

The rhythmic content of Arvo Pärt's score, notably the two different notated headnotes (see figure 2), which we will refer as short and long notes, are responsible for defining the duration of the several sections of each movement of *Dialogismos I*, and therefore its macrostructure and the total length of the piece. The short notes correspond to two bars, and the long notes to 8 bars. The composer arbitrarily chose the duration of each bar to be 4 seconds.

The pitch content of each bar of *Für Alina* has also a seminal influence over the pitch organization in *Dialogismos I*. We split the system of *Für Alina* and assigned the upper part to the saxophone score and the lower part to the electronic part as depicted in figure 2.

The six movements that compose *Dialogismos I* are named after the J. Sebastian Bach's Suites for Unaccompanied Violoncello, which also have a decisive role in the creation of the fixed media parts, notably during the long notes that span over 8 bars (the procedure is represented in the scheme in figure 2 and will be detailed in section 5 B).

IV. SAXOPHONE SCORE

The method used to devise the saxophone score was "cut and paste"/collage. Although it may seem at first a very elementary strategy, the selection and assemblage of material followed a meticulous plan based on a dialogue between the sources towards a natural discourse. The sources in which the saxophone part relies correspond to the two following masterpieces of the repertoire for this instrument: *Argo* by Mauricio Sotelo [14] and *Sax-Blue* by Jorge Peixinho [15]. Variable length sequences of both pieces were used to assemble the saxophone score after a scheme that, once more, relies on Arvo Pärt's *Für Alina*. This last piece constrains the selection of the material similarly to a band-pass filter with a cutoff frequency and bandwidth ratio. Concisely, a manual choice and segmentation of material derived from the scores of Sotelo and Pexinho was done first. The selection criteria was based on reference pitches that were established by the mode used in the Arvo Pärt's composition, i.e. B Aeolian mode, correspondent to the following pitch classes: 11, 1, 2, 4, 6, 7, 9. The composer arbitrarily chose the length of the segment retrieved from the scores, ranging from short cells to musical phrases. Even if the selection mode was uniquely based on pitch, the chosen segments are used in Dialogismos I with the totality of the information that is associated with them in the original scores. In other words, they use the same dynamics, articulation, and other timbre qualities notated in their sources.

The instrument chosen for the piece, i.e. the alto saxophone, is a transposing instrument, which means that the pitch notated in the score is different from the pitch that actually sounds. In the case of the saxophone, for example, a notated "A3" will sound an "F#2". Since we wanted to assemble the score in a literal collage-like method, the sounding result of the saxophone part will not respect the pitch sequences taken from *Für Alina*. This is assumed as a mutation of the original sequence of notes appropriated from the Pärt's score. In sum, the pitch material appropriated from *Für Alina* is respected in terms of notated score and not in terms of sounding result.

V. Electronic Realization

The electronic music realization of *Dialogismos I* relies on different computer music techniques that can be roughly divided in two moments. The first occurred at a preliminary phase of the work and aimed at creating the fixed electronic part for each movement of the piece. This stage encompasses three offline creative strategies: (1) algorithmic computer-assisted composition, (2) audio processing, and (3) audio editing. The second moment followed the realization of the score and the fixed electronic part and covered the live realization of the piece. These two moments will be further discussed in sections 5 B and 5 C respectively, and are commonly referred throughout the paper as offline (first moment) and online or live (second moment) realizations.

One of the central problems for the electronic music realization, which covers both enunciated moments, was the necessity to segment, to rearrange, and to assemble huge amounts of pre-recorded audio to accomplish an initially planned structure conceived by the composer. In order to solve and ease this process we relied on an audio analysis/resynthesis system that combines real-time audio analysis and CSS, also called musical mosaicing [16]. This technique was successfully employed in the production and performance of the piece, and allowed a rapid experimentation of different structures (targets), and corpus that would be impossible when done manually within the time constrains of the writing of the piece. Also, CSS comes as a natural choice to the compositional problem enunciated previously in section 3, since they share fundamental characteristics. The software used for CSS was earGram [17].

A. EarGram

This section briefly introduces earGram [17], a modular application developed by the second author in the Pure Data programing environment for real-time CSS. The software explores music synthesis by generating user-specified audio sequences assembled from a collection of sounds gathered from various audio recordings. Given the space restrictions of the paper, an exhaustive description of the application cannot be completed here, although the reader may refer to [17] for further details.

As stated before, prior to synthesis the software creates a database, called corpus in CSS terminology, by segmenting streams of sound into constituting segments, commonly referred as units, and by characterizing the units by an efficient set of descriptors. The creation of the corpus needs some user guidance to adapt both the segmentation of the audio and the description of the units to a given application or musical context. Units are usually short segments of audio that preferably represent musical entities, such as homogeneous sound events or notes. The current implementation of earGram allows the automatic segmentation of audio according to the following characteristics: (1) note onsets, defined by the presence of different fundamental frequencies or clear peaks on the 2-norm between adjacent normalized spectra (spectral flux), (2) pulse, and (3) uniform size.

Subsequently, a unit selection algorithm is responsible for finding the best matching sequence of units to synthesize a target phrase according to a distance measure defined in the descriptor space. Targets can be specified in symbolic representation (expressed in notes or descriptors), or extracted from audio data (using the same segmentation and analysis methods that were used to create the corpus). The distance measure used is the Euclidian distance, and the selection of units relies on a concatenation cost function between the descriptions of the target and the whole corpus, and the distance to the previously concatenated unit on the non-normalized bark spectra space.

Synthesis is be done by two different algorithms that are responsible for concatenating the selected sequence of units. The first implemented algorithm is a classic phase vocoder, and the second is an interpolating sampler player with Gaussian amplitude envelope and a slight overlap between adjacent units. Both algorithms allow modifications in the length and the frequency of the units.

B. Offline Material

The first phase of the work comprised the production of the fixed media parts (tape) for each movement of the piece and was distributed in the three main tasks: (1) generating material in a computer-assisted composition fashion, (2) processing the resulting samples and (3) selecting and arranging them in time. The first task was done in earGram, and the two following ones were completed in Logic, a commercial audio workstation. The computer-assisted composition stage was meant to ease the creation of a strict plan devised in advance by the composer for each movement of the piece, which was described in section 3.

Some additions and minor modifications had to be done in the earGram framework in order to satisfy the needs of the composer. The first was to implement a new module within the earGram framework, called eargram.series, to assist the creation of raw offline material. The second was a workaround to solve the real-time nature of the software. Due to some Pure Data limitations to operate and render offline audio data, our strategy was to generate the material in real-time and record the outcome of the software.

The composer defined in advance three 'reading modes' for the patchwork method, which were translated to the following three target definitions in eargram.series: (1) the rhythm of a midi file and an imposed sequence of notes (in pitch class) that could be read in straight, reverse, random, and spiral orders; (2) the midi note information (pitch, in pitch classes, amplitude and velocity) from a midi file; and (3) the same as the previous reading mode, with a filter that only allows the processing of notes that are previously specified. The counterpart of the patchwork method was the specification of the corpus used to synthesize the target, which ‘borrow’ the timbre/instrumentation and articulation from the audio source that created the corpus.

For the first reading mode we retrieved the rhythm information from a midi file with a representation of the J. S. Bach Violoncello Suites and a collection of pitches gathered from Arvo Pärt’s *Für Alina*. The second reading mode uses solely the midi files of the Bach’s Violoncello Suites. And finally the third reading uses the same procedure as the second reading mode but only certain notes are allowed to be processes according to a collection of pitches retrieved from Arvo Pärt’s *Für Alina*. The corpus used to synthesize the target was based of several samples from the Freesound Online Database [18], and most of the tracks that comprise the CD *Sopop – Believe It or Not* by Wolgang Mitterer [19].

Despite the importance of the resulting material from earGram, it was solely raw audio samples without a sense of continual flow. Thus, it was felt as a need to post-process the gathered samples in an audio workstation that allowed to manipulate the signal accurately with various audio effects, such as chorus, filters, and spectral processing techniques, and organize the events both horizontally in time, and vertically in layers.

C. Live Realization

The live electronic realization of *Dialogismos I* encompasses the following three purposes: (1) to stochastically generate the interludes between movements, (2) to synthesize a pedal tone present throughout the piece that interacts with the saxophone performance, and (3) to sequence and trigger the several sections of the piece.

The interludes are composed by a predetermined number of phrases that are stochastically generated and synthesized by earGram in real-time. It aims at establishing a bridge between its adjacent movements, and accentuate the connection between them by thus on a database that comprises the two audio tracks that form the fixed electronic media of the adjacent movements. For each interlude, the composer established two sets of descriptors that define the pitch (in pitch class) and amplitudes of a target phrase. However, even if the assigned target is the same, there’s a certain degree of freedom that creates variations on every triggered phrase.

Throughout *Dialogismos I* the live-electronic realization is also responsible for synthesizing a pedal tone that follows the same process used in (offline) computer-assisted composition strategies, and uses once more the earGram application to generate it. The target specification for the pedal tone is a single pitch, B or the pitch class 11, but other constrains were applied on the unit selection algorithm in order to avoid discontinuities between concatenated units. The selection process is the following: first earGram retrieves all the units that have the note B, then, from the gathered collection of units the software selects ten units that minimize the distance on the bark spectrum space to the previous selected unit, and finally, randomly selects one of the units from the previously assembled list.

The live-electronic realization covers also the sequence of the fixed media parts that are triggered by a computer operator during the performance.

VI. Conclusion

Dialogismos I explores the idea of intertextual composition as a creative paradigm. The work was created by a continual dialog between existing pieces from various composers with the help of the software application earGram that allowed the rapid experimentation and creation of raw material that was later sequenced manually. Our approach and major contribution focus on a model that merges two or more sources into a new and single entity, notably by relating specific structural qualities of the sources without overlapping features. In other words, the structural elements of the resulting sample, e.g. the rhythmic structure or the pitch content, is extracted as a skeleton from the sources, and each quality of the resulting sample is only given by one source. The approach described was applied for the creation of both the macrostructure and the microstructure of the piece.

Even if the current software solution was suitable as a computer-assisted composition tool, the software revealed unsatisfactory results when organizing and generating long-term structures in a musical and coherent fashion. Also, the composer felt the need to post-process the output of the software with some audio effects, because we couldn't fine a satisfactory automatic strategy that would cover the composer demands.

Finally, we should address some remarks concerning the music representation that the electronic music realization employed. Most of the representation that the computer had to deal stayed very much at the note level, mainly defined by a collection of three item that covered pitch, duration and intensity. From a computer music perspective the strategies employed seem to limit rather than promote innovation, especially because we are dealing with a synthesis technique, i.e. CSS, that fully embraces audio content processing methods. However, as stated previously, our main goal was to adapt the technique to resolve and ease the composition drawbacks proposed initially, which were partially made in a satisfactory way.

VII. FUTURE WORK

Dialogismos I is meant to be part of a larger cycle of pieces for different instruments, either soloists, or small ensembles, with or without electronics. The collaboration between the authors of the article that started in *Dialogismos I* will be continued in future works of the cycle. It is our aim to proceed the exploration of the aesthetic background that embraces this work, notably by extending and devising intertextural computer music strategies that may assist the composer at work or to be able to generate coherent musical results in real-time.

Different representations and descriptions of the audio content are currently being investigated from a perspective that enables musicians that not familiar with MIR terminology to explore the corpus in a meaningful way. Our preliminary experiments on this topic rely on devising a computational morphological description of the units based on theoretical work by Denis Smalley [20] and Pierre Schaeffer [21].

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