IN A CONCRETE SPACE. RECONSTRUCTING THE SPATIALIZATION OF IANNIS XENAKIS’ *CONCRET PH* ON A MULTICHANNEL SETUP

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ABSTRACT

Even if lasting less than three minutes, Iannis Xenakis’ *Concret PH* is one of the most influential works in the electroacoustic domain. It was originally created to be diffused in the Philips Pavilion, designed by the same Xenakis for the 1958 World Fair in Brussels. As the Pavilion was dismantled in 1959, the original spatialization design devised from the Pavilion has been lost. The paper presents new findings about the spatialization of *Concret PH*. It discusses them in the light of Xenakis’ aesthetics, and consequently proposes a plausible reconstruction of the spatialization design. Finally, it proposes a real-time, interactive implementation of the reconstructed spatialization, rendered on a 8-channel setup using a VBAP technique.

1. INTRODUCTION

In 1956 Iannis Xenakis was working in the studio of Le Corbusier, when Philips company commissioned the famous architect a pavilion for the 1958 World Fair in Brussels\(^1\). The fair, being the first after the II World War, was a crucial event for the company: in particular, Louis Kalf, artistic director of Philips, considered it an occasion not to be renounced in order to show the world the technological advancements of the Dutch company. Le Corbusier accepted the commission and replied by promising to realize not an exhibit structure but a revolutionary “electronic poem”. Le Corbusier’s conception strictly adhered to the modernist assumption that sees in technology the way in which art can fulfill a palingenesis of humanity: the architect proposed Philips a Wagnerian total artwork of sound and lights, taking place in a space explicitly designed as a container for the show. As a consequence, the project for the Philips Pavilion resulted in a complex work of art, the *Poème électronique*: an 8-minute multimedia work in which architecture, image and sound were deeply intermingled. The show included a black and white film, made of two filmed sequences created from still images, various light effects over the whole space, and electronic music to be delivered onto a multichannel system. While keeping for himself the creation of the visual part of the show, Le Corbusier asked one of the most avantgardist composers of XX-th Century to join the project, Edgar Varèse. In the occasion, Varèse created, as a musical counterpart for the visual component, his *Poème électronique*: originally a 3-track tape music, Varèse’s *Poème* is one of the undisputed masterpiece of electronic music. At that time, Iannis Xenakis was an associate at Le Corbusier’s studio, where he had already developed some of his well-known architectural exploits (e.g. the monastery of La Tourette). Xenakis was responsible for the design of the space. Xenakis turned Le Corbusier’s original idea of a shell-like structure, based on a stomach-shaped plant, into a self-carrying, concrete shell, higher than 20 meters. More, the Pavilion’s shape was generated by Xenakis as rule-based surfaces, namely hyperbolic paraboloids: the resulting shape was a tridimensional architectural object made of continuous curved lines. By implicit admission of Xenakis, the ruled surfaces of the Pavilion (see Figure 1) bear a structural relation to the striking opus 1 of the composer/architect, *Metastaseis* (1953/54) [2]. In this work, Xenakis started from a theoretical problem, that of defining a continuous transition between two discrete states (Xenakis, cited in [3], also [4], p. 32). The solution was based on devising a system of string glissandos with different speeds and ranges (“sonic spaces of continuous evolution”, [5], p. 10). While designing the pavilion, his “inspiration was pin-pointed by the experiment with *Metastaseis*”, so that there is a “causal chain of ideas” connecting the two works. Thus, in the Philips Pavilion...

\(^1\)This work extends the EU-funded VEP Project (http://edu.vrmp.nl/vep/), that has reconstructed the Philips Pavilion and the *Poème électronique* using virtual reality techniques. For a presentation of the project, including previous works, see [1].
Pavilion, “music and architecture found an intimate connection” ([5], p. 10). The internal surfaces of the Pavilion, covered with asbestos, were then literally encrusted with loudspeakers (for a total of 350). Loudspeakers were organized into “sound routes” (allowing sound to travel the space) and “clusters” (groups of contiguous loudspeakers playing together). Their presence converted the Pavilion into a “sounding room” ([6], 210), where, after more than 30 years, Varèse was able to finally listen to his music “literally projected into space” (Varèse, cited in [7]). Apart from the link with Metastaseis, the Philips Pavilion includes a second relevant element in relation to Xenakis’ music. As a composer, Xenakis was allowed by Le Corbusier to create a short piece that should act as an interlude between two performances of the show: the 8 minutes of the Poème électronique were embedded in a cyclic program of 10 minutes, which was supposed to run continuously. The two additional minutes were reserved for an intermission, which would enable one audience to leave the pavilion while the next to enter, the “Interlude sonore.” The Interlude would have then entered Xenakis’ catalogue with the name of “Concret PH”. Because of its quite singular sonic structure (see later), the piece has gained a consistent fame, far beyond the specialists of contemporary and electronic music, and has been hailed as a precursor of “electronica” ([8], see also [9]). While discussing the piece, Harley observes that “the mobile sound trajectories throughout the Philips Pavilion would have no doubt been astonishing” ([10], p. 19). Still its original relation with the space of the Pavilion remains unclear. In the next sections, we first take into account newly available information on the Interlude/Concret PH from unpublished sources; then we discuss issues related to its spatialization in the Philips Pavilion and propose a novel reconstruction from unpublished sources; finally, we describe a simulation of the spatialization implemented on a 8-channel setup, presented publicly on January, 15th, 2010 at the EMF Foundation in New York, in the occasion of the the exhibition “Iannis Xenakis. Composer, Architect, Visionary” at The Drawing Center [11].

### 2. BEFORE CONCRET PH: THE INTERLUDE

In this section we reconstruct the history of the Interlude merging information from already published sources with new data coming from unpublished letters by Louis Kalff (now at the Philips Archive and in the private collection of Peter Wever, co-author of a historical study of the Brussels Expo [12]). The Interlude music was composed by Iannis Xenakis, and resembled his later published work Concret PH, but was not identical to it. The title “Concret PH” did not appear once in the correspondence relating to the design of the pavilion or in the official credits. On the plate near the entrance of the pavilion it was called “Interlude Sonore”, which was also the title under which it was mentioned in the book Poème électronique released by Le Corbusier’s collaborator Jean Petit [13]. An original version of the Interlude Sonore was found back in the archive of the Institute of Sonology in The Netherlands. It consists of three tracks and has a duration of 1’52”. From the instructions Le Corbusier gave to Xenakis for the intermission music on 27 November 1957, one indeed gets the impression that he had little knowledge of the importance of Xenakis as a composer: “I have thought very seriously about your two minutes of music. What is it about? […] it is a sort of carnival hawking, in which it is possible to pack a lot of wit and content that can touch a crowd that by definition is inattentive.” ([6], p. 205). The letter ended with a very firm refusal to Xenakis’ request to leave the office for three weeks to work on his piece in Eindhoven, using the same advanced equipment as Varèse was using for the Poème. Two days later, Le Corbusier sent a diagram of the intermission to Kalff which gave a description of Xenakis’ music, very close to the music as we know it now: “Clouds of intermittent sounds, varying in density and intensity, and moving within the space of the pavilion.”([6], p. 206). On 2 December 1957, Xenakis wrote to Kalff, describing the character of the intermission music as “sober, surprising and of an artistic quality, and at least as good as the rest of the spectacle”. As in the case of Poème électronique, Concret PH was to be delivered inside the Pavilion, where loudspeakers were arranged into sound routes and cluster. Figure 2 shows a diagram of loudspeaker organization, from an original sketch by Xenakis. Sound routes are indicated in the text, clusters are marked with letters A, B, C, D, E, U and J. In order to spatialize sounds, a complex, totally automatic, routing system was devised, based on selectors as used in automatic telephone exchanges, switching on and off the loudspeakers [14] [1]. In the case of Poème électronique, a spatialization score was written. It includes instructions about when to drive a certain track into a certain loudspeaker group. If the group is a cluster, all the composing loudspeakers are activated/disactivated at the same time. If it is a sound route, then a stepping rate is indicated (i.e., the rate at which the sound travels along a route), in stepping impulses per second. In the sound routes, a sound “moves” as it is progressively routed from a speaker to the following one. The score was then translated into signals for controlling the dialers. Signals were recorded on a control tape to be played during the performance, driving the audio system. In a letter to Kalff from 11 March 1958, Xenakis gave a clear description of the material of the Interlude Sonore and the way it was supposed to be spatialized in the pavilion was given: “We recorded the sound of charcoal, and it is very beautiful. Please answer the following questions as soon as possible: a) will I be able to utilise three independent (but synchronised) tracks? b) will I be able to determine simultaneously the speed of movement along the horizontal belt?”. Xenakis then explicitly indicates that each tracks was characterized in his intentions by a specific “sound” and a specific “speed” [15]. He also included a drawing (Figure 3), where sounds were indicated with Roman letters a, b, c and speeds with Greek letters α, β, γ. Kalff answered two days later: “We can […] use only one track to reproduce your composition. The sound of the tape will be spread along the horizontal circle of loudspeakers surrounding the pavilion at a height of 3 to 4 metres. Along this circle, which will have approximately
In order to reconstruct the spatialization of the *Interlude*, possible clues can be found in the sonic structure of the piece, in Xenakis’ spatialization strategies after the Pavilion, and in Xenakis’ aesthetics at the time.

As we are still investigating about the 3-track tape (the final version mentioned by Xenakis was 2’30”, while the 3-track tape we found is less than 2 minutes), in the following we take into account (and use for reconstruction) the currently available version by EMF\(^4\), lasting 2’40”, mixed down to mono. In his well-known book *Formalized Music* [5], Xenakis describes \textit{Concreet PH} as an example of “Markovian Stochastic Music” [5]. For the composer, the piece demonstrates that “stochastics is valuable not only in instrumen-
Concret PH is a textural composition, with no specific temporal macroform, a “cloud filled with splinters of sound” ([9], p. 203), resulting in “dry, but sparkling study” ([16], p. 18). The granular sound matter reveals a specific tactile quality [17], that can remind the concrete surfaces of the Pavilion [18]. While there are many references in literature to Concret PH, still the only detailed analysis is the one proposed by Di Scipio [19]. According to Di Scipio the piece is based on a systemic approach to composition, also evident in Analogique A et B [9]. The most relevant aspect of the piece is sound behavior at the micro level, that results from a process of densification, based on the layering of two textures. The “rather simple macroscopic shape” then depends from a single transition from the first to second texture. While Di Scipio’s general remarks are very insightful, his analysis is phenomenologically not so convincing 5. In fact, it is possible to retrieve at least 3 textures (to these, maybe a variation of the second can be added). Figure 4 shows two excerpts from a sonographic representation of Concret PH 6. The piece starts with texture 1, in crescendo: here (Figure 4, top left), the spectrum presents energy spread almost exclusively over 4000 Hz. Even if at 30” some lower impulses can be heard, the second, lower texture enters definitively at 43”: new grains are distinctively lower than previous ones, and they appear on the spectrum as black spots in the range between 2500 and 3500 Herz (Figure 4, top, dotdashed box). The double layering of the textures 1 and 2 is kept stable until 84”. Then, gliding grains, still from texture 2, appear, with an increasing density and relevance. After 2’05”, a third, distinct layer is superimposed: it shows a larger spectrum, both in the low and high frequencies, and it is characterized by a sort of sweeping motion (Figure 4, bottom). The piece ends with texture 3 fading out (2’40”), leaving the texture 1 alone.

Concerning Xenakis’ spatializations after the Philips Pavilion, the composer made a large use of loudspeakers in many other works. The Poème électronique was a model for Xenakis’ experimentation with sound and light systems, the Polytopes 7 [20] and the electroacoustic work Bohor (1968) was for 8 channels. But even if the composer himself has described in depth many of his composition techniques, no detailed info on spatialization strategies in multichannel setup is available, to our knowledge. Still, we know that Xenakis applied to the control of lights and sounds in space the same aesthetic principles and formal procedures he used in his musical composition: as an example, concerning the Polytope de Montréal (1967), he stated that his “total experience with musical composition was used to serve light composition” (Xenakis, cit, in [20], 57). As evident in [2], the composer has always strived to a unified form of thought. Hence the need, in order to define a formal model for the control of the sound speed, to take into account some aspects of Xenakis’ aesthetics.

Concerning the position of Interlude/Concret PH in the Xenakisian corpus, it must be noted that, apart from his seminal work Metastaseis (1953-54) (directly inspiring the Pavilion), Pithoprakta (1955-56)’s inspiring model came from theory of gas molecules, governing the stochastic distribution of sound events [19], [21]. Analogously, Achorripsis (1957-58) can be considered a sonification of probability distributions, following the model of gas diffusion [22] [23]. The same principles are at work in his electroacoustic music. In Diamorphoses (1957) he applied stochastic principles, while Analogiques A et B introduced Markovian Stochastic Music [5] [19], and the notions of Gabor quanta. Speaking about Pithoprakta in 1956, Xenakis underlines the role of the “Gas Parable”, one of the “parables” he used to conceptualize the organization of sound events [2]. In the Gas model, the two main parameters to be considered are pressure and temperature: pressure

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5 It must be noted that the Di Scipio’s analysis was based on a the version of Concret PH from the Nonesuch LP, and made use of scarcely readable sonograms produced in 1984.

6 As the piece is structurally made of large-band impulses, the spectrum is very dense and sonograms are not particularly helpful. Here they are used only to show large discontinuities among textures.

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7 More, the shape of the Diatope (1979) bears a striking resemblance with the Philips Pavilion.
Pavilion hardware, i.e. the maximum rate at which the loudspeaker/second was the technical limitation for Philips loudspeaker is.

The available speed range, expressed in activation rate for each layer, a direct relation between the average duration of the impulsive events and the average rate is assumed: the shorter the event, the lower the average rate. In order to calculate the speed parameter to be reconstructed is the sum of the three different speeds (Figure 5). In order to define loudspeaker activation/disactivation and to create the final score, we have to remember that speakers are discrete, so it is necessary to define activation/disactivation events by sampling the speed curve. The process works as follow:

1. at $t_0$ select speed $s$ and activate loudspeaker $l_0$

In our reconstruction, we embrace a conservative approach, assuming as a plausible hypothesis that Xenakis considered initially three tracks, each one with a different texture: tracks, made of molecular sounds, were not only characterized by specific densities and temperatures of sound molecules (one can think in particular of the gliding grains), but, coherently, also by a specific speed of diffusion in the space. As he was not permitted to use three tracks in the space, these were mixed down onto a single track tape, to be delivered in the route I. As we discussed, it seems that, at the end, the access to the “3D dimension” was possible too, but in some sense Xenakis considered it optional, and available sources are not clear about what was effectively implemented in the Pavilion. The use of the 3rd dimension can be obtained by delivering the other tracks on other sound routes, going up and down in the pavilion, or by diffusing them from fixed positions, most probably from the large clusters above the entrance and exit (hence the reference to “stereophonic” placement by Xenakis). This second hypothesis is consistent with [1]. Following the conservative hypothesis, in our reconstruction the spatialization of the Interlude uses a mono track, as it is limited to the horizontal route, in the form of a continuous variation of speed (acceleration/deceleration), with no clusters involved (clusters could be easily added to our design). Also, we assume that the design of the spatialization for other routes could follow the same principle that we are going to discuss. Thus, the final spatialization score would have been made of activation events for route I occurring at variable time intervals (i.e. created by a variable stepping rate).

Taking into account Xenakis’ original idea of having three autonomous tracks, from the analysis of Concret PH, we assume three different textural layers, where each texture is characterized by a specific speed. In the spatialization design, each texture is given a certain speed, that can be thought as the rotation speed of the layer over the looping horizontal route. Hence, the total rotation speed (the actual parameter to be reconstructed) is the sum of the three different speeds (Figure 5). In order to calculate the speed of each layer, a direct relation between the average duration of the impulsive events and the average rate is assumed: the shorter the event, the lower the average rate. The available speed range, expressed in activation rate for loudspeaker is $[0, 10]$, where 0 represents no motion and 10 loudspeaker/second was the technical limitation for Philips Pavilion hardware, i.e. the maximum rate at which the loudspeakers can be activated/disactivated [14]. Each texture’s speed is defined in a certain interval and actually randomly selected by using a Gaussian distribution (Gaussian distributions were extensively used by Xenakis at that time [5]). As the average speed is proportional to textural density, textures 1 and 2 are opposed to 3, much thicker. The first and the second textures have speeds included in the range $[2, 4]$. Texture 3’s speed is in a higher, smaller range, $[3, 4]$. Each texture is given a duration range. During the generation process, a duration is selected in the range, again following a Gaussian distribution. For the duration, speed increases/decreases continuously, as it is calculated by linearly interpolating the starting speed and the next one. In each texture, average duration is proportional to textural density. The duration range in seconds for texture 1 is $[1, 3]$, and $[2, 5]$ for texture 2, as the latter shows a slower pace and the emergence of quasi-pitched grains. Texture 3 is associated the smaller duration range, $[0, 3, 2]$, meaning that speed values are selected at the highest rate. This methodology, based on linear interpolation, is based on the relevance of the visual geometric model of the line in Xenakis’ work: Xenakis always draws lines on paper while composing, and the ruled surfaces of the Philips Pavilion bear a strict relation to the sketches for the score of Metastaseis. Speeds for each texture are represented in Figure 5, with speed expressed in activation impulses per second. In order to define loudspeaker activation/disactivation and to create the final score, we have to remember that speakers are discrete, so it is necessary to define activation/disactivation events by sampling the speed curve. The process works as follow:

1. at $t_0$ select speed $s$ and activate loudspeaker $l_0$
2. calculate the duration \( d \) of the event, i.e. the time interval to the activation of loudspeaker. As \( s \) represents the rate of activation of loudspeaker, if, e.g., \( s = 2 \), then the next loudspeaker will be activated after \( d = \frac{1}{s} = 0.5 \) seconds

3. write an event \( e \) in the score, with loudspeaker index 0 and duration \( d \)

4. wait for \( d \) seconds

At time \( t_0 + d \), a new speed is selected, and so on, until total duration has passed. As the horizontal route wraps around, the process keeps going on until the total time of the piece has passed. The algorithm can be thought as a Sample and Hold applied to the total speed curve (with variable rate depending on sampled speed). Also, if \( s > 10 \), then speed is clipped to \( s = 10 \). The sampled and clipped speed is shown in Figure 5, bottom.

## 4. IMPLEMENTATION

The proposed Concret PH’s spatialization has been implemented in a virtual reality application, that simulates the whole Poème électronique inside the Philips Pavilion. By using VR techniques, the resulting installation let the user experience again the original show, placing her/him into a virtual space created by computer graphics and spatialized audio. The application extends the VEP project [1]. Different versions of the VEP application have been implemented by the VEP project: a single-user, immersive setup with headphones and stereoscopic head-mounted display, a “shared” multi-user version with binaural audio (as in the first version) but using screen projection, a non-interactive six-channel version on a DVD-video. Here we present a new version where the audio component is driven by a VR engine, capable of delivering interactive, real-time audio through a multichannel generic setup (Figure 6). Concerning the Philips Pavilion and the Poème électronique, it relies on the data provided by the VEP project, and integrates the new findings about Interlude/Concret PH discussed before. The general architecture of the real-time versions of the VEP applications features three components: a Computer Graphic Engine, a Control Engine, and an Audio Engine. All the events of the show (concerning the control of audio/video elements of the Poème électronique) are recorded sequentially in a score. The score is a text file where each line specifies an event. The Control Engine parses the score in order to retrieve events. At the same time, it also monitors user interaction (i.e. changes of his/her position). For each event, be it a score- or a user one, it sends the opportune commands to the Video and Audio Engines, via OSC messages. Here we do not discuss in details the architecture (see[1]), and we focus instead on the Audio Engine. It uses Vector-Based Amplitude Panning (VBAP) [24], a triangle based generalization of equal-power panning that has been extensively tested with VR applications [25]: it allows to render an arbitrary source in a virtual space on a ring or half dome of loudspeakers (in both cases, the loudspeakers have all the same distances from the ideal listener). The ring/dome can include an arbitrary number of loudspeakers, placed on arbitrary points of the circumference/sphere. In short, by passing the position data related to a virtual source to a VBAP algorithm, the latter can render the virtual position through a physical multichannel setup. In the virtual Philips Pavilion, the sound sources are the 350 loudspeakers, each with a fixed position on the Pavilion’s walls. Our final setup made use of an 8-loudspeaker ring, with the audience standing around the ideal listener position, in the centre of the ring (Figure 6). In order to pass from a 3D space (in the Pavilion) to a 2D space (the ring), we discarded the height of the loudspeakers (that is, we projected the loudspeaker positions on the horizontal plane). This means that, with respect to Figure 7, loudspeaker \( a \) and \( b \) will have the same position. In relation to space simulation, we used VBAP algorithms to recreate sound localization [26]. In order to render distance cues (intensity, direct/reverberation ratio, spectrum) [27], we used the inverse square law to scale amplitude in relation to distance of the loudspeakers from the listener. We avoided to add reverberation (reverberation data for the Pavilion are available from the VEP Project), as it would then be superimposed to the one of the physical space (that cannot be controlled a priori), and we considered spectral filtering not so relevant in the closed space of the Pavilion. While for localization we discard third dimension of original sources, 3D coordinates are still used to calculate distance. As an example, in Figure 7, source \( b \) will indeed sound from \( a \) position, but at least from \( b \) distance. Differently from [1], in this version the virtual listener can move freely in the Pavilion, and her/his position has to be merged with the source position in order to determine the actual orientation to be

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\(^8\) In must also be noted that Concret PH was to be played during the interlude. As a consequence, no visual elements were present while Xenakis’ music was played in the dark Pavilion, thus creating a purely acoustical context for the piece.
rendered. The audio application has been developed using the SuperCollider environment: it features a high-level, object-oriented, interactive language together with a real-time, efficient audio server. With respect to other similar projects (Chuck[28], Impromptu [29]), the SuperCollider language combines features common to other general and audio-specific programming languages (e.g. respectively Smalltalk and Csound), and, at the same time, it allows to generate programmatically complex GUIs. It includes native support to OSC protocol, and VBAP algorithms are available from the BEASTmulch library ⁹. The architecture of the audio application is shown in Figure 8. It receives OSC messages from the Control Engine. The actual setup includes 8 loudspeakers fed by 8-channel audio, with an added subwoofer receiving a mix down of the 8 audio streams. Its main subcomponents are Runner (1), Players (3), Sources (5) and DSP (7). The Runner handles all the communications with the Control Engine. On initialization, it loads the required audio tracks (2): for each track (3 in case of the Poème électronique, 1 for Concret PH), it creates a playback unit (3) and routes it to internal busses (4). It creates sources (5) and controls all the processes related to them. In turn, sources represent sources in the pavilion (i.e. loudspeakers), and encapsulate audio DSP capabilities for both playing back audio and spatialization rendering. There are 350 sources, one for each loudspeaker. Each source outputs 8-channel audio via VBAP algorithm, written on 8 common internal busses (6). These busses are routed to the DSP subcomponent (7), that allows for a global control on the audio streams, so that they can be adjusted in relation to the physical listening space. After being scaled through global amplitude scaling (“volume”), the 8 audio streams are mixed down to be sent to the LFE channel. The sub volume provides independent scaling for the subwoofer signal. In real-time interaction, the Control Engine sends event-related messages to the Runner. There are three types of events: startup, score, user. Startup events require to start/stop the playback units, and are used for syncing the Audio Engine with the Control Engine. Score events are the ones scripted in the score (resulting from reconstructed spatialization), and occurs when a loudspeaker in the Pavilion start or stop receiving audio. In the case that a loudspeaker is started in the virtual pavilion, the Runner calculates the \( \theta/\rho \) parameters (representing position in polar coordinates) by merging the position of the virtual source (passed with the message) and the listener’s one (stored by the Audio Engine). More, \( \text{dist} \) parameter is calculated, representing the distance of the source from the listener in 3D. Then, the related source is activated, and the required track is routed. The source is passed the spatial parameters \((\theta, \rho, \text{dist})\), so that it can properly process the incoming signal (from the routed track), and render audio. The Runner keeps track of active sources in the “active list”, and stores the actual position of the listener. When a loudspeaker is no more active, a stop audio message is sent by the Control Engine: on receiving, the source is paused and removed from the active list. Finally, user events occur when the position of the listener in the virtual space changes, that is when the actual user explores the virtual Pavilion e.g. by means of a joystick. In that case, the listener position is updated, and \( \theta, \rho, \text{dist} \) parameters are recalculated and passed to sources in the active list. In this way, the 8-channel panning and the scaling for each source are recalculated.

5. CONCLUSIONS AND FUTURE WORKS

The reconstruction of the Poème électronique has shown how many and intermingled are the issues emerging from XX-th century artworks that massively involve short-living and ad hoc technological solutions and devices [30]. These issues, concerning philological, technological, aesthetic aspects, clearly emerge in the case of the Interlude Sonore. Our conservative approach has allowed us to re-experience a plausible diffusion of Xenakis’ work in a virtual space, and, in the occasion, to develop an innovative technological solution for a multichannel rendering of the Philips Pavilion. The spatialization proposed at the EMF event has received a very positive feedback from the audience and the specialized press:“the digital manipulation of the original sound material was admirable and effective” [31]. In the future, we plan to analyze in depth, and eventually integrate, the three audio tracks of the Interlude we found. Also, we are still searching for the original spatialization score by Xenakis. Finally, we plan to develop alternate versions of the spatialization including the third dimension.

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⁹http://www.beast.bham.ac.uk/research/mulch.shtml
using the same framework, as VBAP techniques allow to simulate 3D localization.

6. REFERENCES


