

**TITLE****Multimodal Architecture of the Ode to Christus Hypercubus****Topic: Music****Author:****Jônatas Manzolli**

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[www.unicamp.br](http://www.unicamp.br)[www.nics.unicamp.br](http://www.nics.unicamp.br)**Abstract**

The article introduces a creative process aided by computer involving music, images, and poetry. The Ode to Salvador Dalí's Christus Hypercubus reported here is a multimodal performance fulfills the sound space with alliterations of sacred music. It consists of images and music that interacts with live musicians and a virtual choir in real time. A diffused acoustic field generated with fragments of sacred music invites the audience to rediscover and recreate meanings for the Catalan's masterpiece. The computer system orchestrates 16 compositions in miniatures called "stanzas of the Ode". The poem "Caminho da Espera" written by the author provides lyrics for excerpts from three sacred works: "Ave Maris Stella" by Perotin (1200-1225), European composer who is believed to be French, "Benedictus" by Portuguese composer Frei Manuel Cardoso (1566-1650) and "Sepulto Domino" by the Brazilian composer Father José Maurício Nunes Garcia (1767-1830). The Ode reconstructs the Medieval Organum as a metaphor of an imaginary echo that still has persisted in the walls of Cathedrals. A constant musical drone accentuates resonances in which memory is expanded into fragmented chants that still linger on the walls and in the arches. The article also elucidates how the development of an interactive real-time animation using seven cropped fragments of Dalí's Christus. The idea is to simulate fourth-dimensional hypercubus using the audio signal to produce 3D transformations. The program extracts pitch and intensity from the audio signal and animates the four cubes in real-time iteratively. Therefore images are generated along the sounds in real time see the visual result in the images below. Finally, using interactive techniques derived from computer-aided real-time composition the Ode attempts to explore human cognition and understand how creativity operates in a multimodal environment. Multimodal generative installations can be seen as a way to create a unified experience where sound, image, and audience are merged in space and evolve coherently in time; to explore both implicit and explicit cues in their individual and collective interaction; to boost interaction with audio-visuals generated during the man-machine interaction, as discussed in [1]. A video synopsis of the Ode can be found in: <https://youtu.be/Ks3X80TZkMs>

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[1] Manzolli, J. "Multimodal Generative Installations and the Creation of New Art form based on Interactive Narratives", Proc. 18th Generative Arts Conference, 2015, pg 32-44.

# **Multimodal Architecture of the Ode to Christus Hypercubus**

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## **Abstract**

The article discusses the creative process of a multimodal performance titled as an Ode to Salvador Dalí's Christus Hypercubus. It is a composition and performance aided by computer involving music, poetry, and images. The performance of the Ode intends to immerse the audience in an imaginary Cathedral and invite them to rediscover and recreate meanings for the Catalan's masterpiece. The article introduces theoretical viewpoints, elucidates the compositional process and finally describes how the computer system controls the performance in real time.

## **1. Introduction**

The creative process described here is anchored on an interdisciplinary research in Art and Science that was already introduced in previous articles [1][2]. They discussed how multimodal generative installations could be seen as a laboratory to develop computer systems for aiding generative composition and to control multimodal performances. Another starting point was to imagine a multimodal architecture inspired by a sound metaphor associated with the reverberating architecture of Cathedrals. Imaginary walls were built with sound and images to invite the audience to immerse in time and space and construct new meanings for the Salvador Dalí's masterpiece Crucifixion (Corpus Hypercubus) (1954) with their own senses.

The theoretical perspective presented here starts upon Salvador Dalí's Mystical Manifesto (1951) [3] followed by a decade-long interaction between Dalí and the mathematician Tomas Banchoff [4]. The compositional and performance environment combines algorithmic techniques such as Markov chains [5], granular processing of pre-recorded and live sounds [6] and an application of an ambisonics diffusion system to simulate a Cathedral reverberant environment in real time [7]. The first section discusses the integration of viewpoints and the conception of the multimodal architecture. Next section elucidates the composition process that is based on collages of sacred music and images, and the third section describes the computer-aided performance environment.

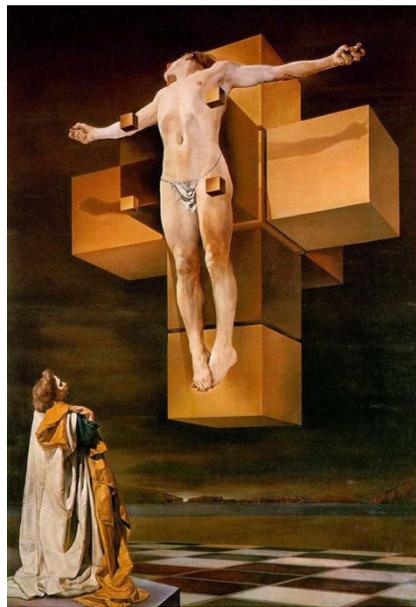
## **2. Integration of View Points**

The composition described here was inspired by Dalí's masterpiece starting upon two observations: what would it be like to represent in music the sensation of observing such a transcend painting? What would it be like to integrate visual and sonic languages in a multimodal performance in order to recreate the dialogue between Art and Science that Dalí developed throughout his artistic career? To combine these motives in a single artwork, I decided to include many musical voices. I have applied collage techniques to recreate the atmosphere of sacred music in line with generative stochastic processes to generate an electroacoustic part and an interactive animation.

### **2.1 Dalí's Mystical Manifesto**

Dalí wrote the *Mystical Manifesto* [3] in 1951, but only in 1954, his mystical concept was fully realized. That new artwork followed also a path of interaction with concepts from modern Science. He painted the fourth dimension using a Tesseract or Hypercube anchored in an unfolded four-dimensional cube in *Crucifixion (Corpus Hypercubus)*, lately named as *Christus Hypercubus* (see figure 1). Salvador Dalí dialogued with Theoretical Physics concepts for many years and some of his remarkable paintings were guided by 20th-century theories. He expressed a dialogue with the Theory of Relativity in his paint “*La persistència de la memòria*” (1931), in Dalí’s words:

[...] ever since the theory of relativity substituted the substratum of the universe for the ether, thus dethroning and reducing time to its relative role, which Heraclitus already assigned it when he said that “time is a child”, and Dalí too when he painted his famous “soft watches” ([3] pg. 365).



*Figure 1:* Dalí’s *Crucifixion (Corpus Hypercubus)* (1954).

Although until his death in 1989, Dalí had explored concepts from Theoretical Physics, it could also be understood as the result of years of interaction with the mathematician Thomas Banchoff of Brown University. Recently, in 2014 Banchoff revealed their collaboration and Dalí’s connection with 20th-century theories such as Relativity and the fourth dimension [4]:

Dalí painted the masterpiece, “*Corpus Hypercubus*” [...] It is rated as one of his most popular and recognizable paintings, right after the *Melted Clocks*. While the deformed clocks are often considered statements about space-time, “*The Crucifixion*”, as it was originally called, makes a statement about four-dimensional space and soon it became known by its geometric name ([4] pg. 2).

Given Dalí's point of view when painted the *Hypercube Christus*, my intention was to recreate Dalí’s statement about four-dimensional space and his dialogue with concepts from Theoretical Physics in a multimodal performance. The creative process aimed to represent all these elements and, therefore, I opted for a creative metaphor in which an imaginary sound navigates the walls of a Cathedral. That sound generates also a digital painting in real time obtained through the application of geometric transformations on eight cropped fragments of the Dalí's *Christus*. The resulting new animated images are projected during the performance such as stained glasses of the imaginary Cathedral (vide figures 4, 5, 6).

## **2.2 Multimodal Architecture**

This article presents also a research on implementation of computational resources for controlling immersive digital processes and to develop computer systems for aiding generative composition and multimodal performances. This study aims to create a unified experience where the performers and the audience are immersed in space while the performance evolves coherent in time [1][2].

The application of multi-modal sensing and effector systems can boost interaction and assist the understanding of the data flow generated during man-machine interplay [8]. We argued that new interactive music technology could function as a laboratory to evaluate man-machine interplay behavior [1]. *Ada: intelligent space* (2002) is also a good example of an installation where visitors had interacted with generative multimodal information performing a soundscape composition based on synthetic emotions [9].

Integrating these previous studies, the architecture of the *Ode* attempts to explore human cognition and understand how creativity operates in a multimodal performance. Although in the creative process of the *Ode* there are composition techniques derived from probability and stochastic process that are described in the next section.

## **3. Composition of the Ode**

Starting upon the multimodal architecture, my intention was to recreate the sensation of a Cathedral in which ancient chants were still reverberating in the walls. Thus, the compositional process recreated a sound environment in which excerpts of ancient music are performed to the listeners. I have decided to work with collages and I rewrote small stretches of sacred music and after integrated them with lyrics of two poems of mine. However, even that the small passages are previously written, the order and the moment they are played during the performed is indeterminate. To concatenate the sequence of the excerpts and indicate when to perform them, I have developed a computer program to integrate the performance and generate video animation in real time (see section 4).

### **3.1 Collage of Music and Text**

The poem "*Caminho da Espera*" (Path of Waiting) (see Table 1) provided most of the lyrics for excerpts extracted from three sacred works: "*Ave Maris Stella*" by Perotin (1200-1225), European composer who is believed to be French, "*Benedictus*" by the Portuguese composer Frei Manuel Cardoso (1566-1650) and "*Sepulto Domino*" by the Brazilian composer Father José Maurício Nunes Garcia (1767-1830). The excerpts were fragmented to build melodic and harmonic collages and later to assign new lyrics. Each small composition, with duration around one minute, were denominated "*Stanzas of the Ode*" and were sixteen in total (see figures 2, 3).

All sixteen stanzas were adjusted around Liturgical Modes. Subsequently, the computer integration in real time produces a multimodal polyphony by superposing fragments with the different Modes. Further, the application of Markov Chain [5] to concatenate the stanzas results in a continuum of sound layers that are processed by Granular Synthesis [6].

With these sound processing applied in real time, an electroacoustic part accentuates resonances to resemble that chants are still lingered on the walls and in the arches of the Cathedral. The stanzas are recombined and superimposed in real time using the granular synthesis technique and each new performance produces unique sound textures. They are used in the composition to

reconstruct the Medieval Organum that is a kind of vocal polyphony composed by preexisting liturgical chant [10].

### **Caminho da Espera**

somente o vazio sobre mim da mesma maneira quando percorri distâncias para te encontrar.	only the emptiness over me the same way as when I travelled distances to meet you.	somente ao longo do caminho deixa-me próximo e distante a tua espera.	only along the way leaves me close and distant waiting for you.
somente estou lá na saída e já transito da entrada para ela.	only here by the exit I am	somente há espaços quando sinto que neles habito.	only there are spaces when I feel that in them you reside.
somente com o espaço sobre mim é que posso cruzá- lo.	and already transit from the entrance to it.	somente agora entendi que sempre estavas lá.	only now do I understand that you always had been there.
somente aqui é que nunca estou mas sempre lá.	only with the space over me can I cross it. only here where I never am but always there.	somente sei do teu olhar sempre olhas para mim são há como fugir da tua presença.	only do I know from your gaze that always looks at me there is no way to escape from your presence.

Table 1: The poem "Caminho da Espera" (Path of Waiting) provided most of the lyrics for excerpts extracted from the three sacred works.

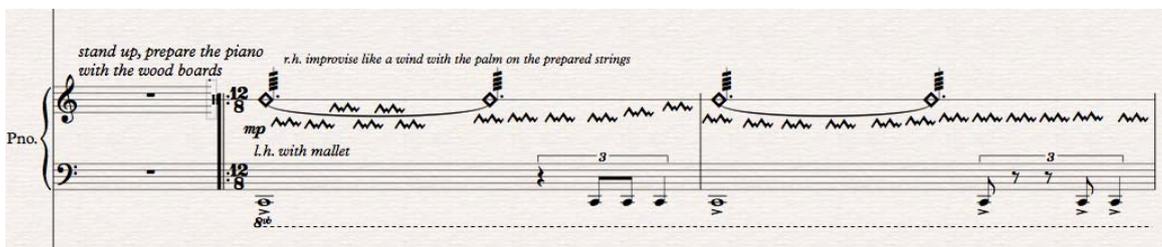


Figure 2: Musical excerpt of the piano part of the Ode.

The image shows a musical score for the XIV stanza of the Ode. It consists of three systems of staves. The first system includes a vocal line with lyrics: "res - so - nân-cias dos ar - cos, pe - dras, ca - te - drais es - qui - nas e ven - to Ah" and "cor - pos, men - tes que a - pro - xi - mam sem - pre mais os sus - sur - ros da gen - te Ah". The tempo is marked as  $\text{♩} = 80$  and the dynamics range from *mf* to *p*. The second and third systems feature vocal lines with the syllable "ah" and "Ah" written below the notes. The score is written in 3/4 time and includes various musical notations such as notes, rests, and dynamic markings.

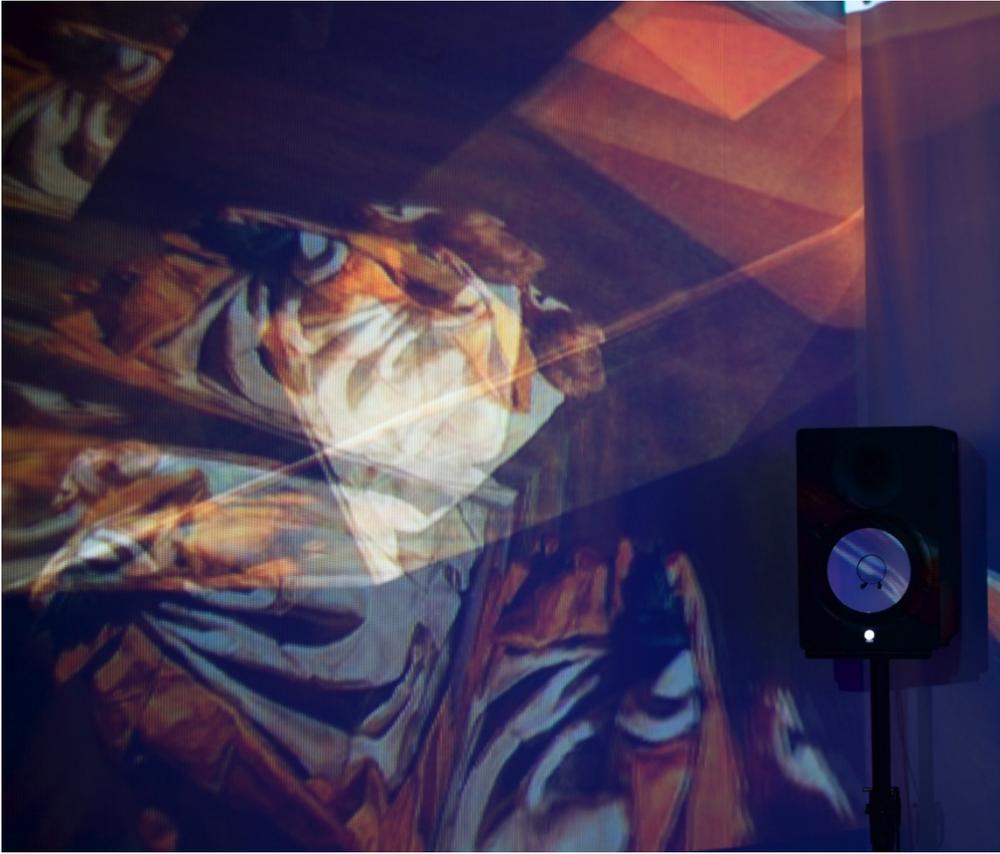
Figure 3: Excerpts of the voice part of the XIV stanza of the Ode.

### 3.2 Animated Visual Collages

The Ode integrates images and sounds, the process for generating visual collages is briefly described here. Using the Pure Data GEM library [11], an interactive real-time animation was developed using cropped fragments of Dali's Christos. I have developed a computer-assisted generative method based on the extraction of spectral information from the audio to control the visual collages of the piece.

Geometric transformations produce complex textures that are obtained by the iterative superimposition and dilatation of two pair of connected cubes displayed in the graphics interface. The idea is to manipulate fourth-dimensional hypercubus resemble stained glasses of the imaginary Cathedral. Using the Pure Data primitive *fiddle~*, the pitch is extracted from the audio as MIDI note values [0 ... 128] and sound intensity [0...100]. Therefore, the computer program detects and extracts these two audio features and iteratively transforms the pairs of connected cubes.

Every time the computer detects a new note, a new image from a set of the eight-cropped fragments, is assigned. The translation and dilatation produced by the sound interaction reproduce new images generating complex visual variations in the graphic projection. The next images (figures 4, 5, 6) present three different moments of the animated visual collages. The images were produced with photos taken by Nato Manzolli using a long exposure in order to extend the persistence of time in the views of the animated collage.



*Figure 4: Photo of the animated collage generated during the performance of the Ode.*



*Figure 5: Photo of the animated collage generated during the performance of the Ode.*



Figure 6: Photo of the animated collage generated during the performance of the Ode.

#### 4. Performance within an Imaginary Cathedral

A program was developed to concatenate and granulate the sixteen stanzas, and control sound diffusion in real time (see performance diagram in figure 7). To order the sequence of the stanzas and indicate when to perform each one, a Markov chain procedure [5] was applied to control their sequence and a negative exponential distribution [12] to control the time between two consecutive stanzas. The performers choose freely to perform or not a stanza indicated by the computer, the number of repetitions is given in the score and every stanza ends with a fermata. The indeterminacy to start the next stanza follows four rules, indicated to the interpreters:

- I – perform a stanza only once;*
- II - the greater the number of reiterations, the greater the silence to start next stanza;*
- III – do not perform two consecutive stanzas with maximum reiteration;*
- IV - start the next stanza after listening to the silence.*

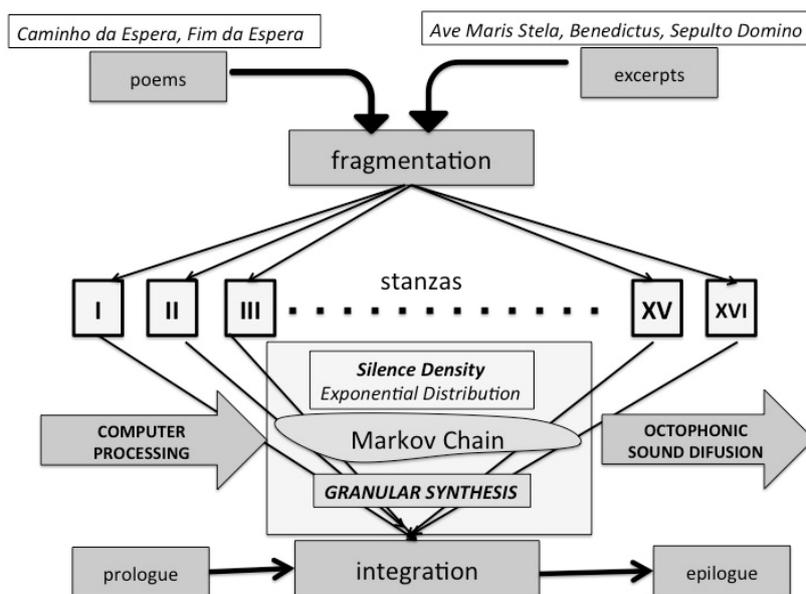


Figure 7: Diagram of the Ode performance. The poem and music excerpts (above), the integration of the stanzas using the Exponential Distribution and Markov Chain (below).

A notion of four-dimensional sound space was built with an electroacoustic diffusion system controlled by the computer (see figure 8). A set of speakers is distributed throughout the installation inviting the listener to immerse into multiple sound layers or dimensions. A "hypercubic sound space" is conceived within the quadriphonic or octophonic sound diffusion controlled by an ambisonics system [7].

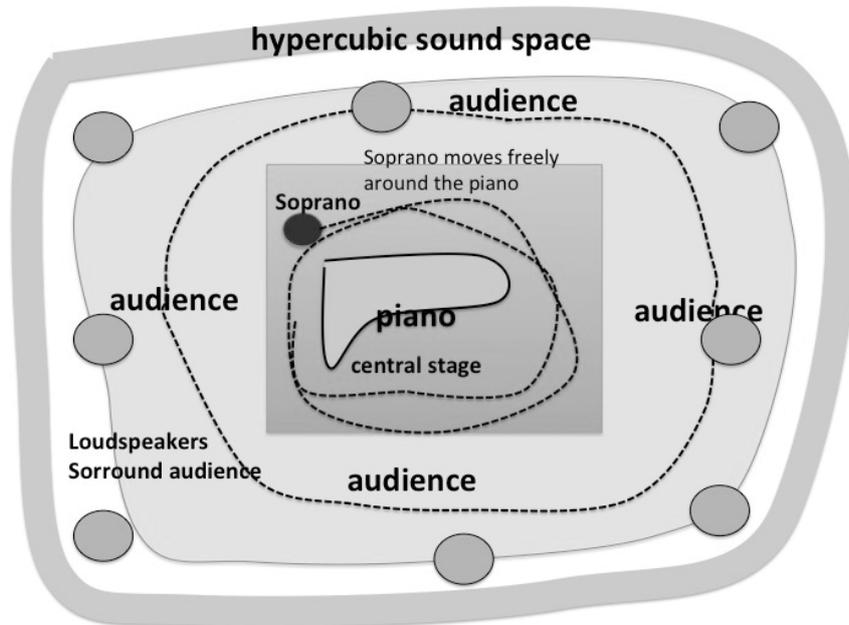
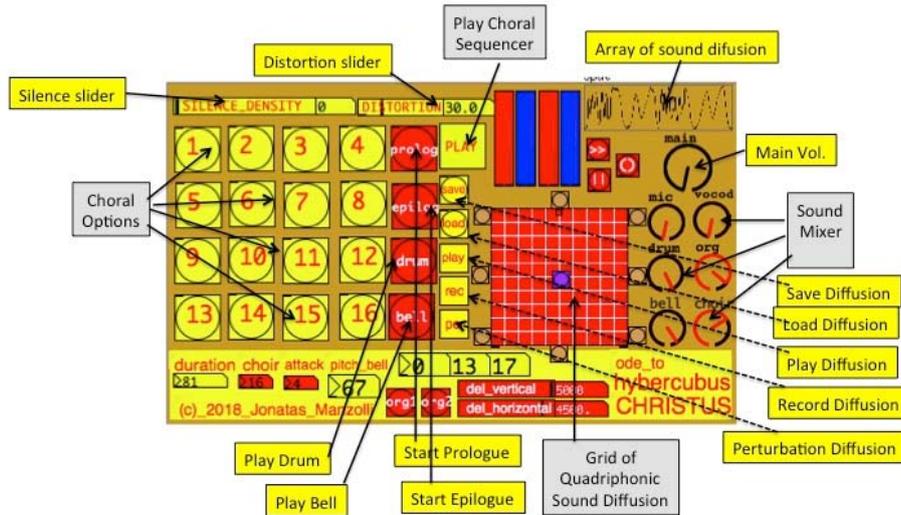


Figure 8: Diagram of the hypercubic sound space with the electroacoustic diffusion surrounding the public.

In order to integrate all composition aspects in real time, a computer program was developed in Pure Data [11]. Figure 9 shows the GUI and highlights the main control parameters: 1) the slider "silence" [0...100] controls the average of waiting time and it is adjusted during rehearsal. At zero level, the sound stream is quite not interrupted while at the 100 level, the flow of sounds becomes very rarefied.



Diffusion: sonic path in a quadriphonic diffusion systems

Figure 9: GUI of the main program implemented in Pure Data. The sliders for the values of silence density, for distortion, the diffusion Grid and buttons for triggering the sixteen stanzas are showed.

The use of the computer-assisted performance provides a wide field for performing the Ode. Those possibilities vary from a performance in a concert hall with musicians interacting only in the acoustic domain until a multimodal assembly in which stanzas are integrated by performers and the audience.



Figure 10: A photo of a performance of the Ode in an electronic studio where it is possible to visualize the man-machine interaction and the real-time animation generated by the computer.

## 5. Conclusion

The research developed around the composition of the Ode is anchored in a series of artworks described as interactive narratives and supported by digital music instruments, virtual soundscapes

and synthetic visualization [1, 2, 8]. It is a study on how virtual spaces, augmented with interactive soundscapes, digitally generated sounds and animations, and interactive video contribute to the understanding of creativity.

The architecture of Ode to Christus Hypercubus integrates music, poetry, and video in a multimodal performance that refers to an imaginary Cathedral. The use of collages from excerpts of sacred music and fragments of the Dalí's Christus produces an environment for the audience to build new relationships with the Catalan's masterpiece. The computational control during the performance allows all the elements of the work to be reconnected and that each performance of the piece is unique.

The multimodal architecture promotes an audio-visual dialogue between performers as well as performers and audience through real-time visualization of events and the sound projection. By developing a computer-based technology for audio-visual interaction and support for storage, analysing and controlling multimodal data, the composition of the Ode advances tools for the performance of contemporary music and interactive installations. The Ode to Christus Hypercubus integrates sound resonances and images to reflect how new knowledge is created through the Art and Science dialogue. The result is a new artwork where the audience is invited to explore multimodal dimensions resignifying their own aesthetic experience.

## **ACKNOWLEDGMENT**

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