

Computer Art: glimpses of 40 years of artworks and exhibitions' designs

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Abstract

This essay presents a compelling and innovative approach to 3D morphologies for creating artifacts, exploring the intricate relationship, challenges, and, most importantly, the vast potential for symbiotic and syntropic interactions between humans and semiotic machines in the realm of art. These morphologies, inspired by organic natural phenomena, symbolize life in its infinite variety. In this context, the sensory possibilities inherent in both the virtual and material setups of these artifacts reveal experiments with organic forms characterized by complex surfaces, informed by mathematical concepts leading to the development of a morphological repertoire for computational synthesis. A key feature of this approach is the close interconnection between materials and shapes. When integrated with sensors and actuators, these shapes enable the programming of stochastic dynamic kinetic behaviors for the sculptural artifacts. Sensors capture data about the material world beyond our perceptual field, while sensory algorithms process this data to track and estimate probabilistic quantities. Autonomous agents use different data to modify their behavior, feeding it to algorithms that render visuals in immersive virtual reality environments or to actuators that articulate and respond to external environmental data, creating a captivating experience for observers. These changeable designs foster immersive, poetic, and aesthetic experiences. In my work, I design installation structures using elements derived from parameterized mathematical equations, which I then transform to explore their poetic and aesthetic potential. The 3D artifacts produced apply mathematical concepts and feed the imagination, evoking archetypal meanings and allegorical and metaphorical aspects, amplifying their capacity to mesmerize the senses and instill curiosity about the multidimensional glimpses of the sublime, pointing towards possibilities for poetic and aesthetic configurations.

Keywords: Immersive VR Installations, Artificial Intelligence, Particle Filter Algorithm, Parameterization of 3D shapes

Introduction

This essay presents a compelling and innovative approach to 3D morphologies for creating artifacts, exploring the intricate relationship, challenges, and, most importantly, the vast potential for symbiotic and syntropic interactions between humans

and semiotic machines in the realm of art. "Syntropic" denotes a movement toward greater complexity and organizational life, in contrast to "entropic," which refers to the degradation of energy and matter. Symbiosis refers to the interdependence among organisms that rely on each other for survival or growth; this concept can also apply to human relationships and mutually beneficial technologies.

These morphologies, inspired by organic natural phenomena, draw on the shapes of fungi, plants, animals, and seeds, as well as on processes, symbolizing life in its infinite variety. The investigations for their coming into being reverberate in my life and have prompted an experimental process across Art, Science, Technology, and Nature. A process composed of memorable moments that characterize the compelling adventure in search of knowledge and the discovery of unsuspected poetics in my unknown inner world: an adventure that urges me to explore unknowable frontiers, thereby characterizing the intersemiotic miscegenation between the languages used.

Circumstances, dreams, and synchronicities indicate the paths, intertwining concepts, and elaborating poetic and numerical textures as a fabric formed by chains of cause and effect. A fabric that weaves threads of choices, shifting feelings and vibrations, strengthening paths, discovering and weaving patterns. In them, I find unique people and add them as collaborators. I embraced throughout my life the shamanic and gnostic contexts. In the former, each human being is solely responsible for their actions. One is fiercely impassive and free to detect the emerging signs in the events and things around us. Only we ourselves can interpret them. On this journey, it is possible to access other dimensions, other levels of consciousness, and other universes of meaning, and to express them through art.

From a theoretical point of view, Vilém Flusser's theories on the role of the artist and the philosopher in working with technical images proliferated in Brazil in the 1970s and 80s. For Flusser, technical objects are a black box. He warned philosophers and artists about the importance of whitewashing their content. This warning has characterized all my work in understanding and consciously using these technologies. Mathematics permeates the various phases of research and, through parameterization, enables unlimited ways of doing and redoing, creating new semiotics by assigning new meanings.

In my journeys through life, the cycles of creation, expression, and communication pulsate through semiotic machines, showing an obsessive persistence with experimentation, with new possibilities and stories; in discovering facts hidden in daily routines and plots; in unveiling dreams; in collapsing preconceived stereotypes. These fleeting, breathtaking realities blossom ephemerally and memorably, never repeating themselves, and orchestrate explosive clusters of meanings as perceptive revelations.

Morphological repertoire

Within the context of my computational art research, human-machine symbiosis allows better communication between humans and machines. I should also highlight the relationships among their aesthetic, their poetic, and their functional circumstances. The morphological repertoires I have created during the last 40 years consider basic elements such as:

- the public and the artists with their natural environment and socio-cultural backgrounds, and their own modes of perception;
- the computing devices (semiotic machines) and their software with their specific types of perception.

Given the differing ways in which humans and machines perceive, I address these perceptions as follows: artists engage in sensory experiments with signs, creating communication systems that facilitate the flow of data between humans and artificial life forms. Meanwhile, the public perceives these works and projects their own worldviews onto them.

The artworks presented here are installations and artifacts inspired by nature, some of which move autonomously by computational mechanisms that model numerical relationships. Others are 3D virtual artifacts – with poetic and aesthetic designs – that remain latent until expressed through a computer interface. These concepts merge mathematical uniqueness with artistic expression, resulting in unparalleled and thought-provoking works. The main objective, purpose, and motivation behind my artworks are to explore the aesthetic and poetic potential of these artifacts and to experiment with their materials. Here, "aesthetic" is used in the Greek sense of what affects the senses, while "poetic" refers to their potential for different forms of agency.

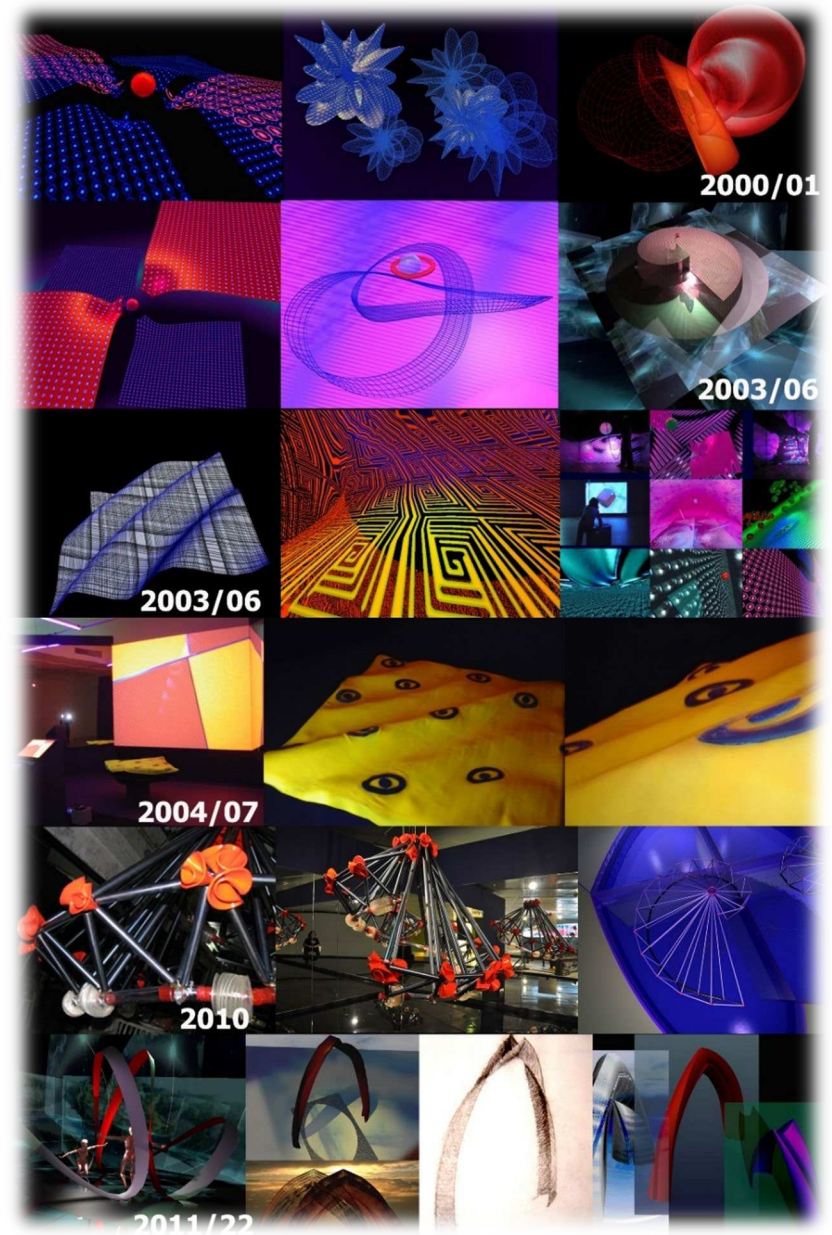
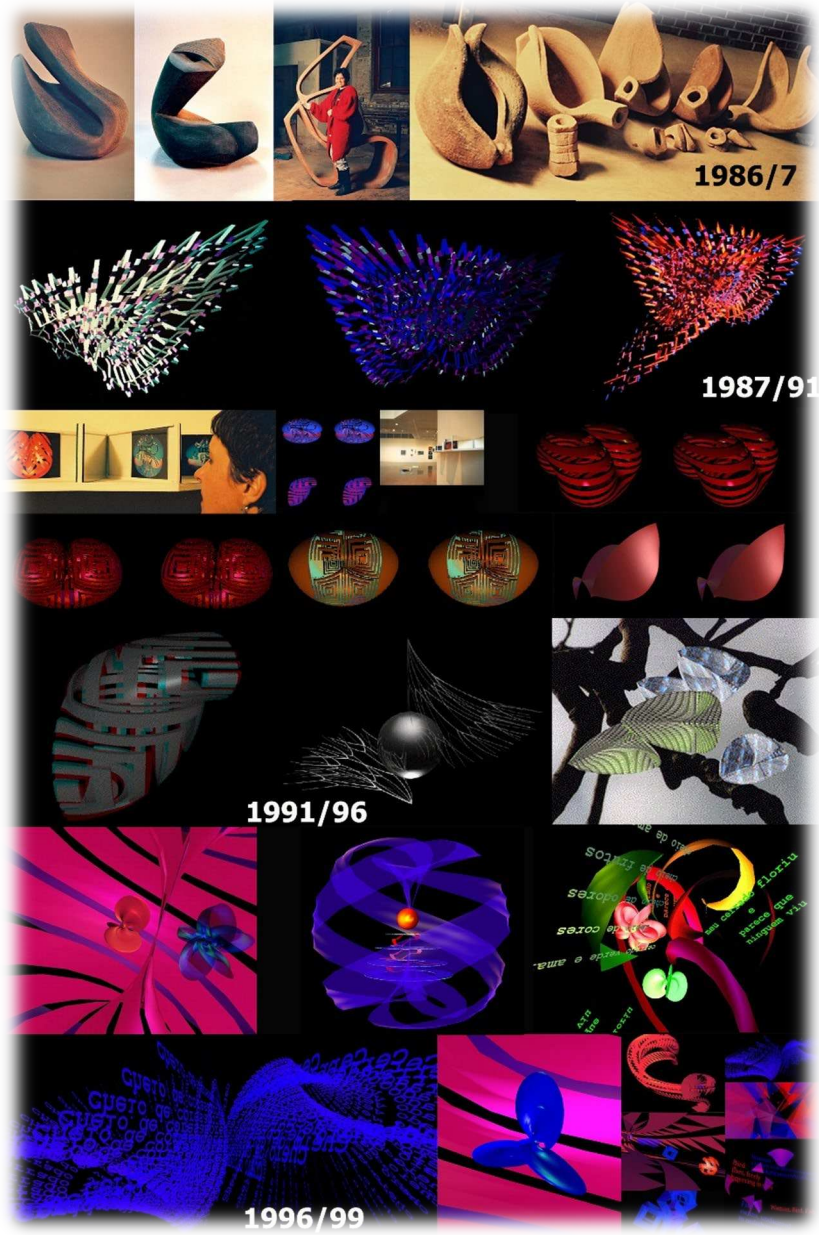
The morphologies I use are complex, representing organic forms with intricate surfaces. I have explored these morphologies in virtual environments and through modern manufacturing techniques, including 3D rapid prototyping, 3D printing, and laser

cutting. An important aspect of this approach is the close interconnection between materials and forms. When enhanced with sensors and actuators, these shapes enable the programming of stochastic, dynamic kinetic behaviors for these sculptural artifacts. In the search for their form's materialization, I drew on scientific and mathematical concepts and theories, which synthesized art, science, nature, and technology. The projects emerge in polysemic poetics through computational simulations, like multiple fragrances mingling in a living fabric of metaphors, allegories, analogies, and correspondences. To the inattentive, these complex processes seem chaotic. Mathematics permeates the various phases of creation and, through parameterization, establishes an unlimited making and remaking, giving rise to series in permanent transformation, creating new semiotics by attributing new meanings to them.

For me, thoughts are things—signs of a different order than that achieved through discursive knowledge. This happens because the sensitive always surprises; it cannot be imprisoned. The sensitive characterizes my journey as an adventure that challenges established axioms and stereotypes, based on the certainty of living in an extraordinary world of fractal, transitory instances, blossoming into a series of unforgettable events.

As an artist, I rescue universes of possibilities, provoking in the other an iconic quality of apprehension of something, leading their consciousness to a state of availability emptied of everything except the pure sensation or emotion resulting from the effect produced, blurring the boundaries between the qualities created and the reactions of the experimenter. As Sartre said: 'in making, one makes oneself'.

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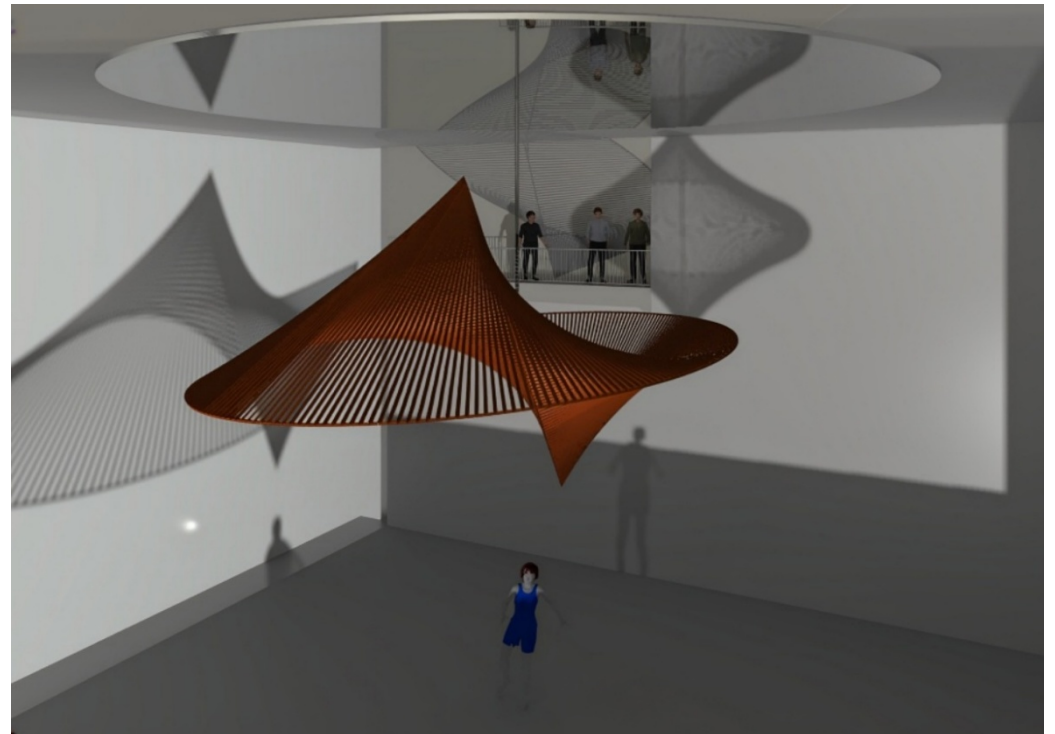
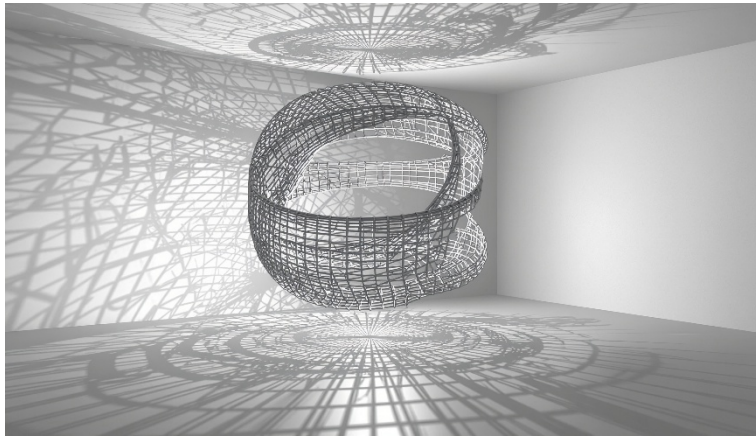


Glimpses at my morphological repertoire: images from the author's collection



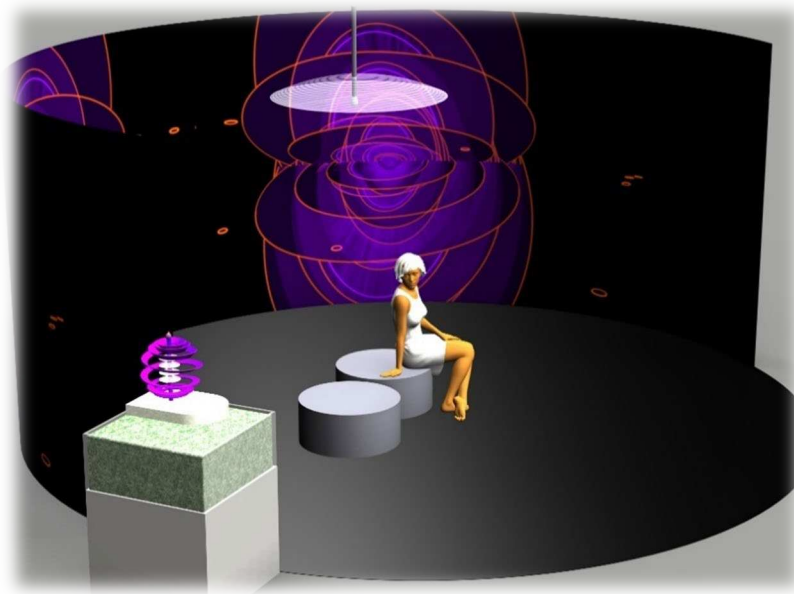
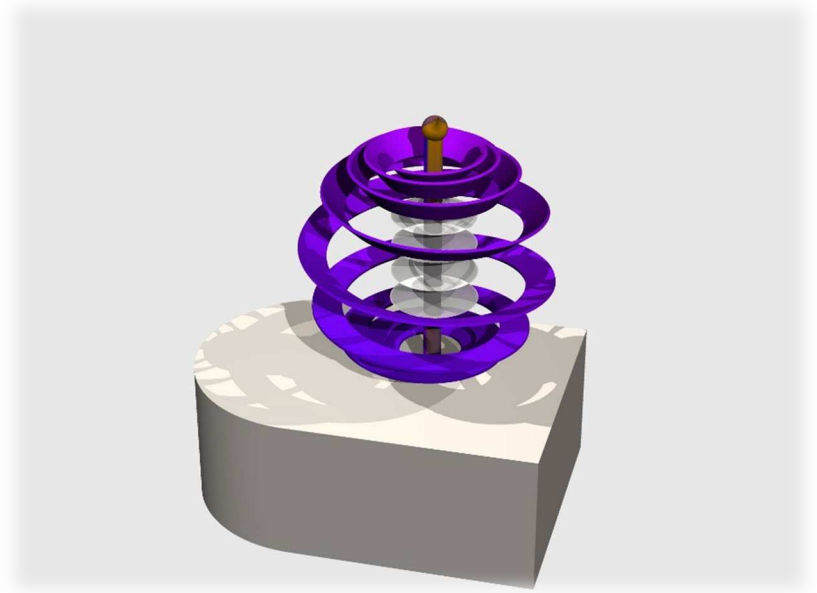
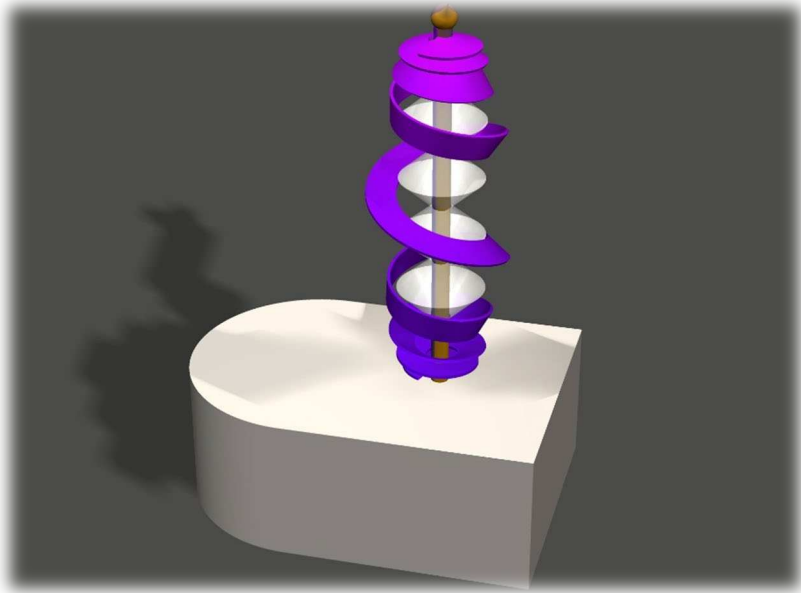
3D parameterized artifacts: images from the author's collection

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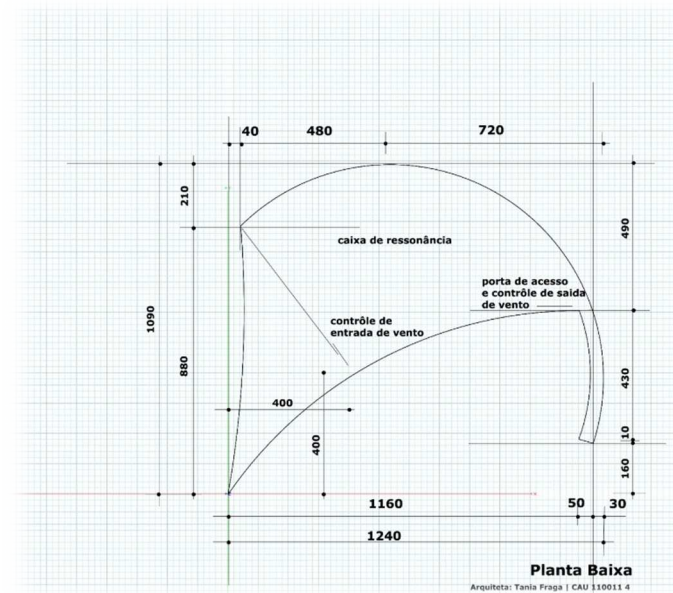
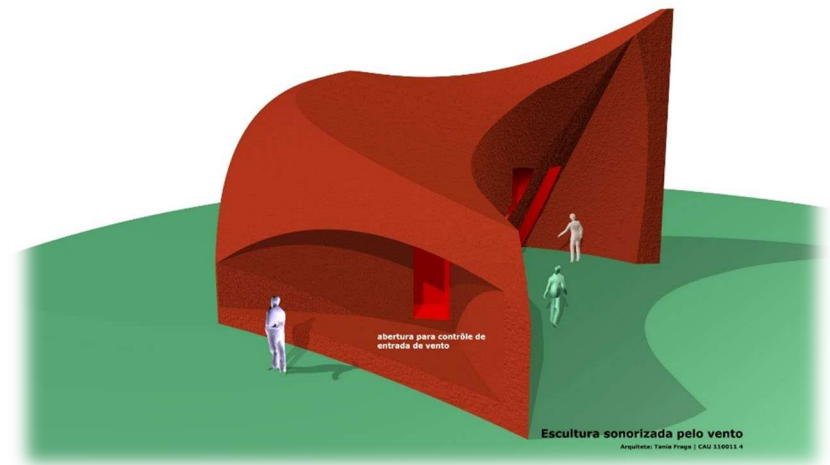


3D parameterized artifacts (works in progress): images from the author's collection

Installation design with sensory artifact (work in progress): images from the author's collection



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Project for architectural sculpture blown by the wind: images from the author's collection

Immersive design for Computational Art exhibitions in Brazil

Computational or Computer Art is an art form in which cognitive, sensory, aesthetic, and poetic experiences are mediated by computers and supported by them. The goal of this type of art is NOT the development of algorithms or research in computer science, but rather the acquisition of a kind of knowledge that enables the creation of multi-sensory environments with poetic and aesthetic characteristics.

Subsequently, I illustrate some immersive expo-graphic experiments for creating, organizing, and producing Computational Art exhibitions, which I have called **meta-installations**. I offer glimpses into these experimental processes through a series of exhibitions spanning 24 years. The method that makes these achievements possible allows me to conceptualize and develop the strategies described here.

The main idea behind a **meta-installation** is that it allows spatial-temporal dialogue among the installations that comprise the exhibition and offers some form of interactivity and immersion. Therefore, they do not constitute separate, independent installations but rather intertwine with one another. The creation, organization, and production of such exhibitions occur at the intersection of computer art, science, and technology. From the artist's point of view, this triad is inseparable and simultaneous. For an exhibition to take place, factors such as the conceptual set that guides it, its purpose, the artworks' explanations on display, the economic possibilities, and the needs or restrictions of the institutions that promote the exhibition, among others, must be characterized.

The design process follows a procedural, successive-approximation method. The artist and curator Wagner Barja, with whom I have had the pleasure of collaborating and reflecting on this practice, conceived the concept of **immersive communication** to analyze the design of such exhibition spaces. We use the metaphor of a stone hitting a calm lake, producing spherical waves that spread successively, reaching a more extensive area each time. For Barja, the act of throwing a stone into the water becomes another metaphor—the anima—which forms the concept of **AnimaVerbiVocoVisuality (AV3)**. Barja has been developing this concept in his PhD as a method of analysis to understand what happens when languages amalgamate and intercommunicate as a hyperlanguage.

The particularities and difficulties I can point out in creating such exhibitions may seem paradoxical. These particularities are related to the complexity of the artworks and, often, to the difficulty of understanding certain scientific concepts that permeate them, challenging the public to appreciate artworks that require them. Therefore, educational personnel are essential at this type of event. Another fact is that this type of exhibition requires its organizers – whether the curator in the traditional sense, the architect or designer who plans it, or the group that will assemble it – to possess technical knowledge that few in Brazil possess. It is also crucial to keep backups of all artworks on additional computers, and to ask the artists to develop a plan B for artworks that require special technical treatment. For example, a video that replaces real-time processing may enable the exhibition to continue in its entirety even if an artwork requires maintenance.

Greater than or equal to 4D is the most important of these exhibitions. Held at the Bank of Brazil Cultural Center in Brasilia, it celebrated the 10th anniversary of the postgraduate program of the Institute of Arts of the University of Brasilia in 2004. It became a guiding principle, serving as a model for future Computational Art exhibitions at this center. The artworks presented in this exhibition represented and integrated pioneers at the arts edge, amalgamating music and sound with the visual and performing arts, with a wide range of scientific areas. The exhibition featured 12 pioneering Brazilian artists and a South American group who have faced unimaginable difficulties in developing their work. The Bank of Brazil Cultural Center (CCBB) was the sponsor.

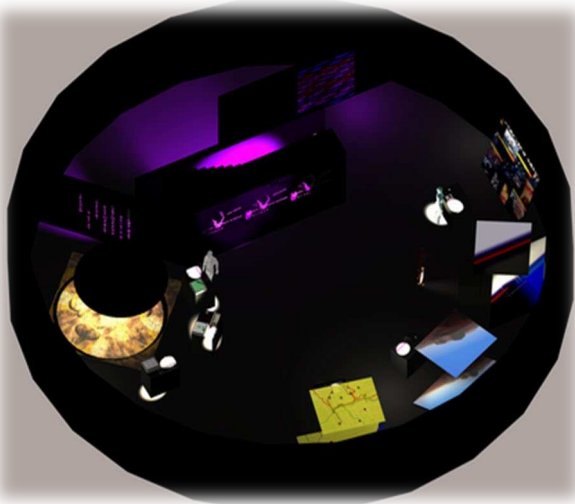
In this exhibition, together with the artist and curator Wagner Barja, we introduced the concept of **meta-installation**, with interactivity and immersion as the focus of almost all the works exhibited. I conceived this exhibition's design as an environment whose structural organization expands the concept of installation, generally employed for contemporary artworks, in which each artist organizes their micro-space individually. This type of organization aimed to reveal the significant aspects, trans-coded into sensations that could be felt and shared. In the resulting space, the public walked through the works of various artists as if immersed in a virtual reality. And I borrowed the concept of **immersive event tunnels** from quantum physics **as metaphors** to organize each installation within the exhibition space-time.

This exhibition offered tactile, gestural, visual, sound, and light combinations as immersive sensory and cognitive experiences. It operated as a metaphor, conveying a deeper, more complex meaning. I simulated the exhibition installations and designed all details, from their assembly and the black-light environment that enabled the reading of the text information, since texts were concise, so visitors could understand what they were seeing in the dark space.

The development of computer languages did not aim for artistic expression. But some artists subvert their codification, enabling the emergence of new artistic modalities. The human sensory apparatus enables aesthetic and poetic experiences, focusing on sensation and perception. When artists create different ways of feeling and perceiving the world, mediated by semiotic devices, they reinvent this 'aisthēsia' (sensorial perception in Greek). Therefore, as said before, the exhibition's design as a meta-installation fostered this type of experience, thereby promoting sensory, perceptual, and immersive aesthetics and poetics.

As mentioned before, we aimed to create spatial-temporal dialogues among the artworks rather than separate sets of independent installations. The meta-installation project not only gave coherence to the exhibition space, enabling the public to enjoy the contents of different installations, ensuring the non-linear nature of possible routes within the meta-installation, and reconfiguring the architectural space of the galleries, redirecting their gaze and modes of perception as they walked through it. This new type of organization aimed to reveal the significant aspects transcoded into sensations that could be felt and shared. In this context, human and artificial intelligence came together, creating a symbiotic and syntropic harmony, a collective intelligence, between the minds of the technology creators, the organizers, the artists, the participants, and the semiotic machines that convey the works.

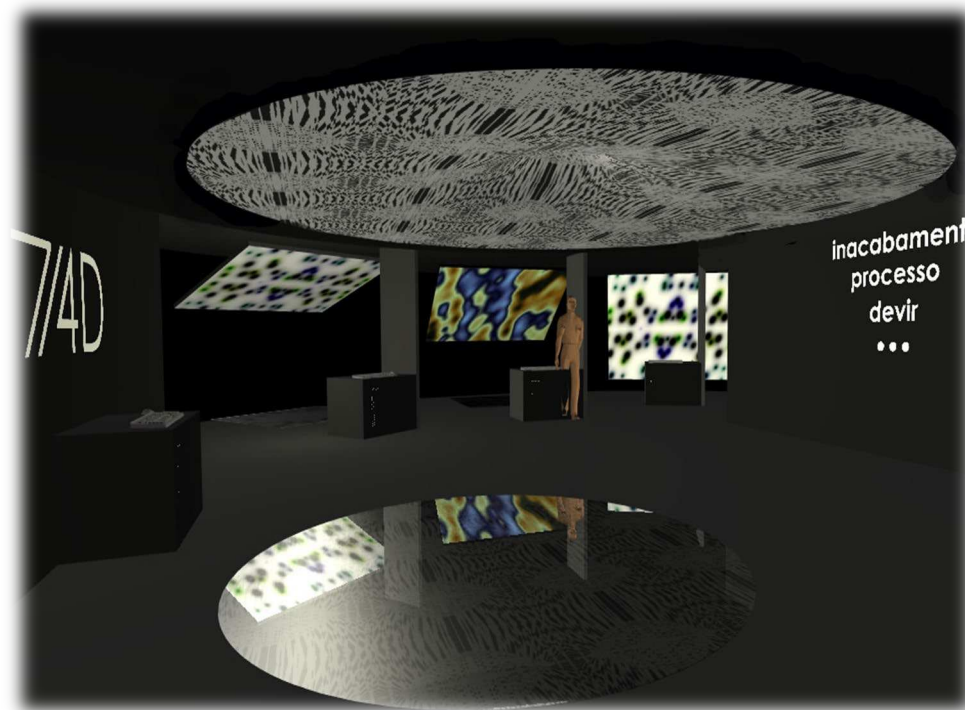
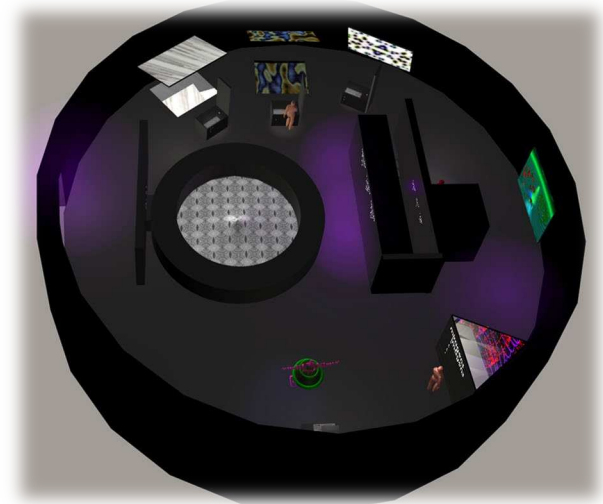
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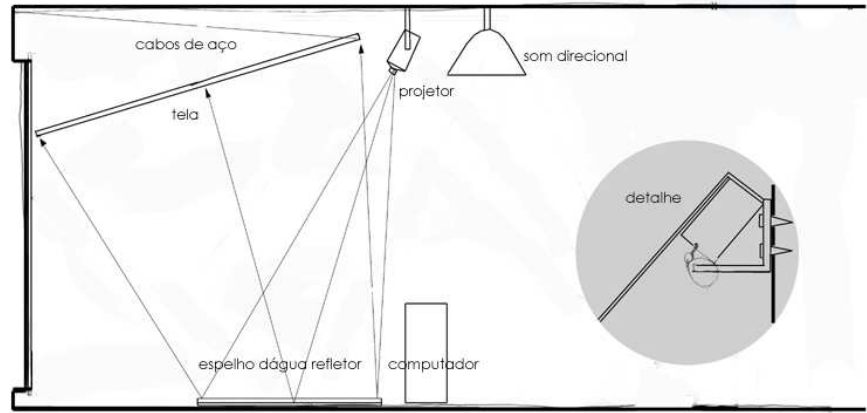


$\geq 4D$

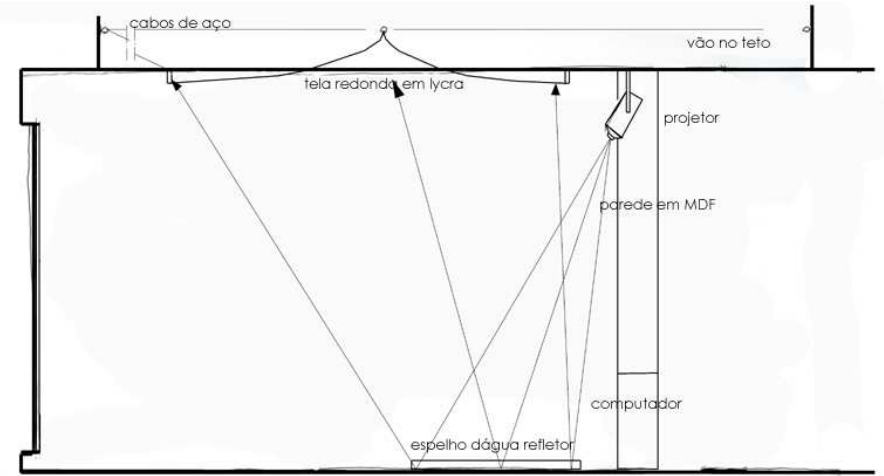
images from the author's collection

3D simulations



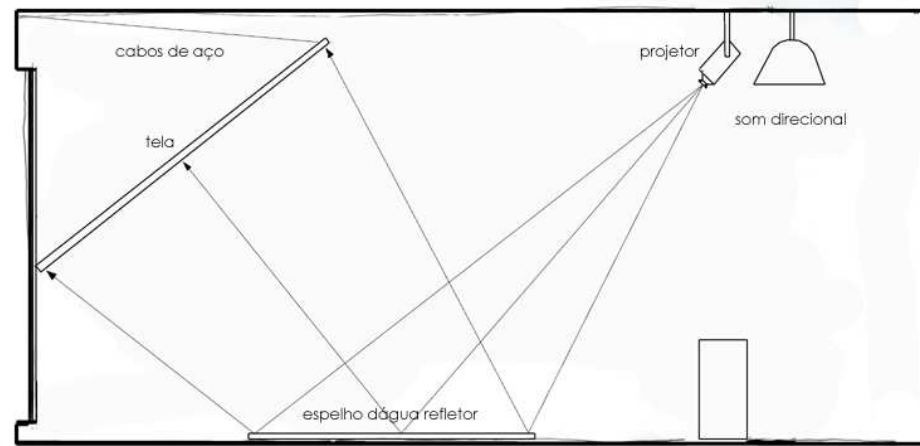


corte transversal da instalação



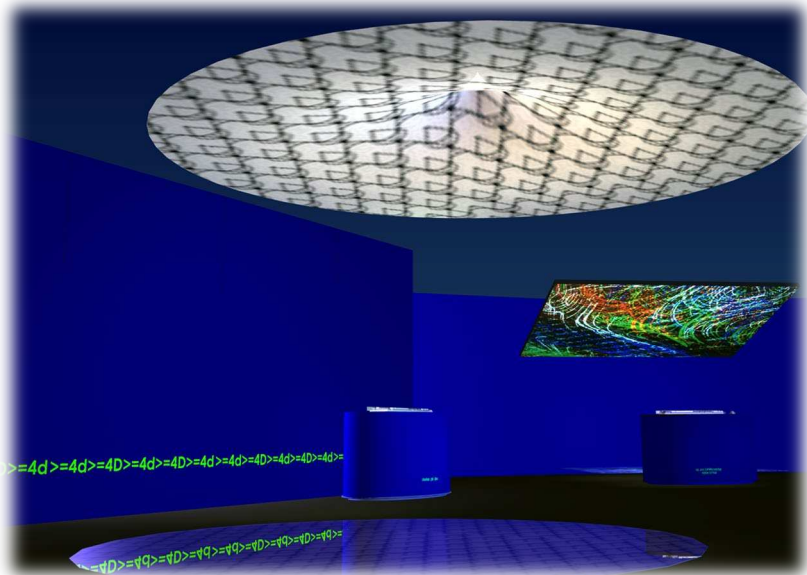
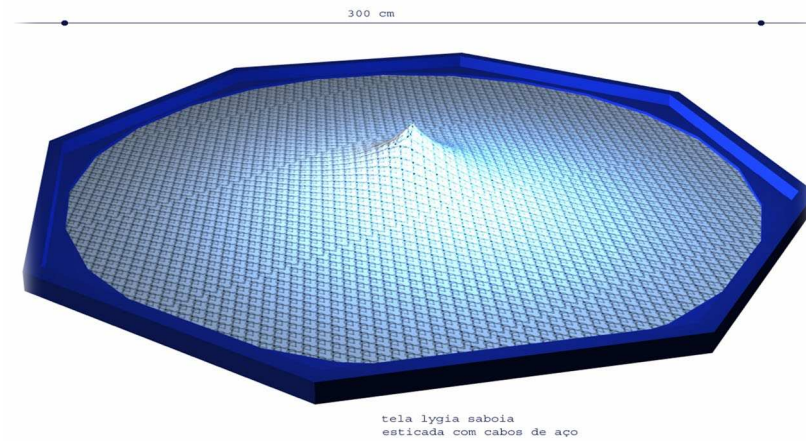
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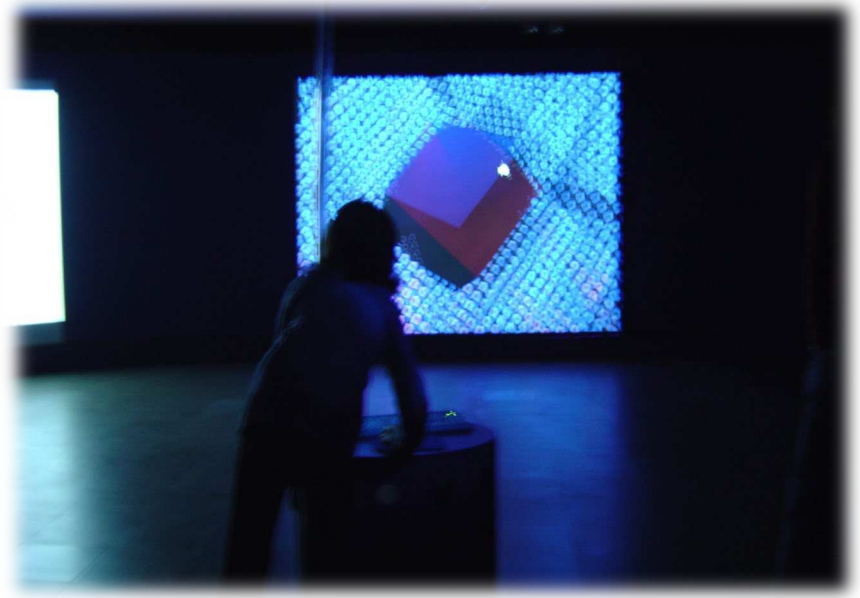
schematic cross-section images of installations



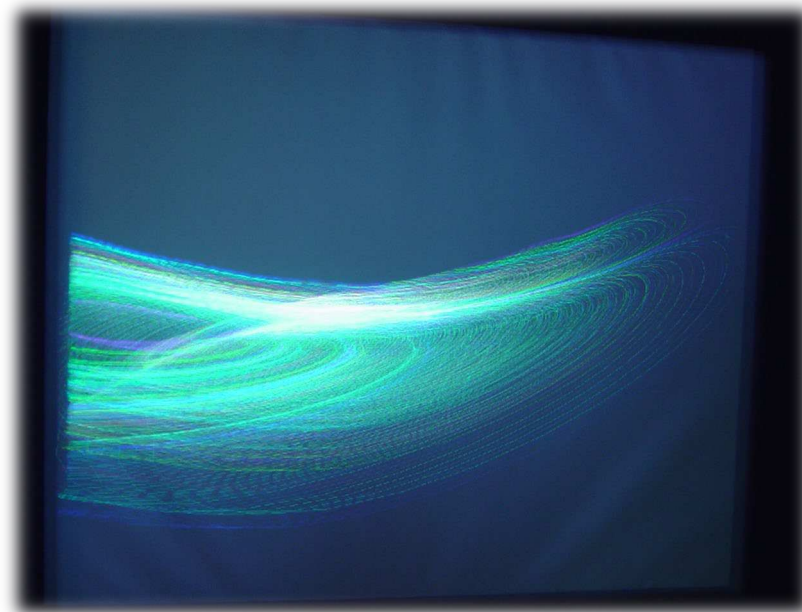
corte transversal da instalação

diagram of the cone-shaped Lycra screen to receive projected images





Suzete Venturelli (microphone interaction), Tania Fraga (mouse interaction), Rejane Cantoni and Daniela Kuthshat (dataglove manipulation)





Performance Images: 1º Brazilian wearable computer by Luisa Paraguai

EmMeio# Exhibitions

Another set of exhibitions, entitled EmMeio#, **advanced the concept of meta-installation** through projects with a similar focus to that of **Greater than or equal to 4D, $\geq 4D$** . They have happened from 2008 to the present day. EmMeio means Inter Medium, but `meio` in Portuguese also means media. This title, therefore, creates a fun play on words.

These exhibitions were conceived and produced with the support of the Institute of Arts of the University of Brasilia, the National Museum of the Republic, both in Brasilia, and Brazilian universities and state research foundations and with Malu Fragoso, Suzete Venturelli, and myself as curators.

I created the designs for these exhibitions as meta-installations. However, since we used to have about 35/50 artists/groups in each one and a minimal budget to carry them out, I added the concept of self-organization to solve the cash flow problems. The design approach for these exhibitions begins with establishing **a series of guidelines and rules** that facilitate self-organization. They allow the artworks to adapt to local conditions and the resources available for their production. Of course, these exhibition guidelines or rules are made available and accepted by the artists in advance, who must agree with this approach. We accept the artists' opinions and suggestions during the exhibition's assembly, provided they comply with local limitations. The artists' collaboration is essential to us, since, as mentioned before, we have been working with very low budgets.

I will point out, **for analysis purposes only**, that there are some activities I consider indispensable for the creation/organization/production process, namely the exhibition's design, which must take place:

- The aesthetic and poetic aspects are important for the set of works and their relationship with artistic practice related to science and technology;
- Next, it is necessary to study the possible spatial-temporal relationships of each work with the others within the conceptual context to value each artwork, interrelating it with the others;
- Subsequently, I prepare the 3D simulation of the space to help the architectural project set up that will allow self-organization to occur during the exhibition assembly;

- The following step is to rework the studies for the exhibition space, incorporating the necessary equipment and available furniture, and arranging them to generate a harmonious and coherent whole. At this stage, we hold conversations with the artists, and the 3D simulation of the space is finalized as a guiding framework because, generally, the complexity of the various variables in action requires changes to the original plan;
- During the next step, the exhibition setup takes place: painting the **walls** and placing the **artworks in the space**;
- Then, changes with the artists responsible for assembling the works are made when necessary. Afterward comes the **electrical technicians`** work. The last stage concerns **the lighting** of the non-self-illuminated sculptural or robotic works, prints, or photos, and the **exhibition texts** and general **identification** of each artwork according to the museum pattern;
- Finally, depending on the characteristics of the artworks, **general guidelines** are given to the artists on safety methods for protecting the works and automation for the daily initiation of them during the exhibition period. Educational personnel are informed about the specificities of each artwork so they can share this information with the public. The educational personnel are also instructed on how to turn the works on and off, and what to do, if necessary, to use the essential backups and Plan B provided.

Malu Fragoso, Suzete Venturelli, and I select the works for the exhibition. In the case of the EmMeio# exhibitions, there are three areas at the museum available:

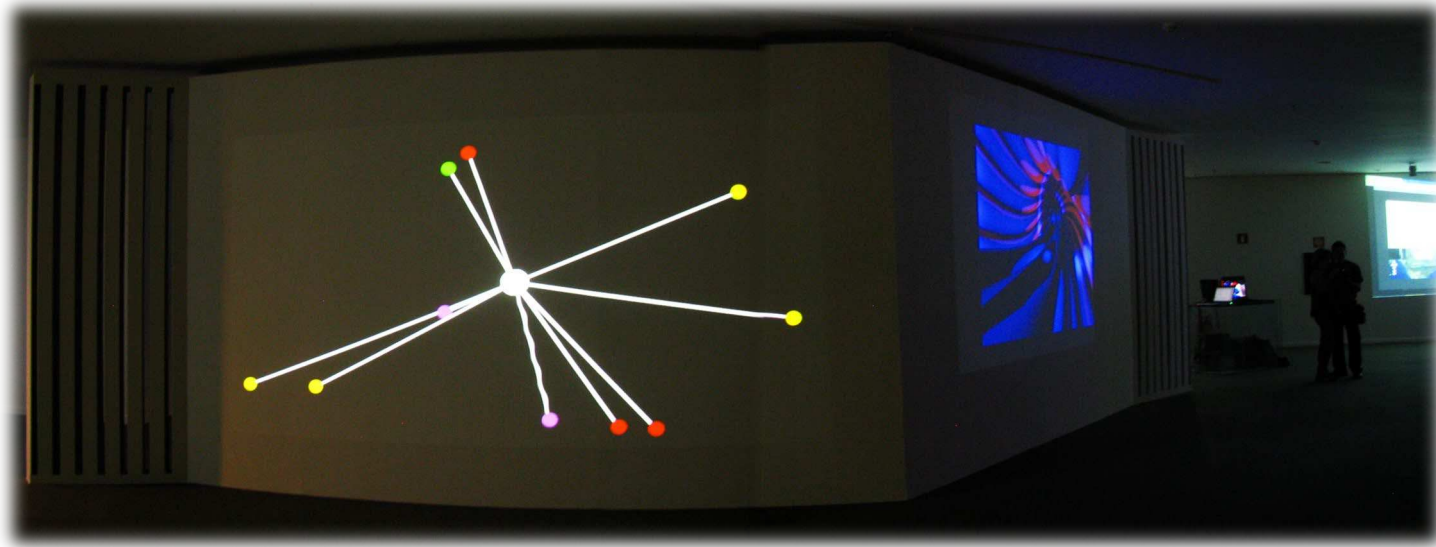
- The **1st floor gallery** for installations of interactive and non-interactive audiovisual artworks, with or without an Internet connection;
- The **museum's dome and outside space**, including its sizeable white dome for nighttime projections and performances, and a mirror lake;
- The **auditorium** is used for lectures, concerts, performances, music, and VJ shows.

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EmMeio# from 2008 until 2025, images from the author's collection

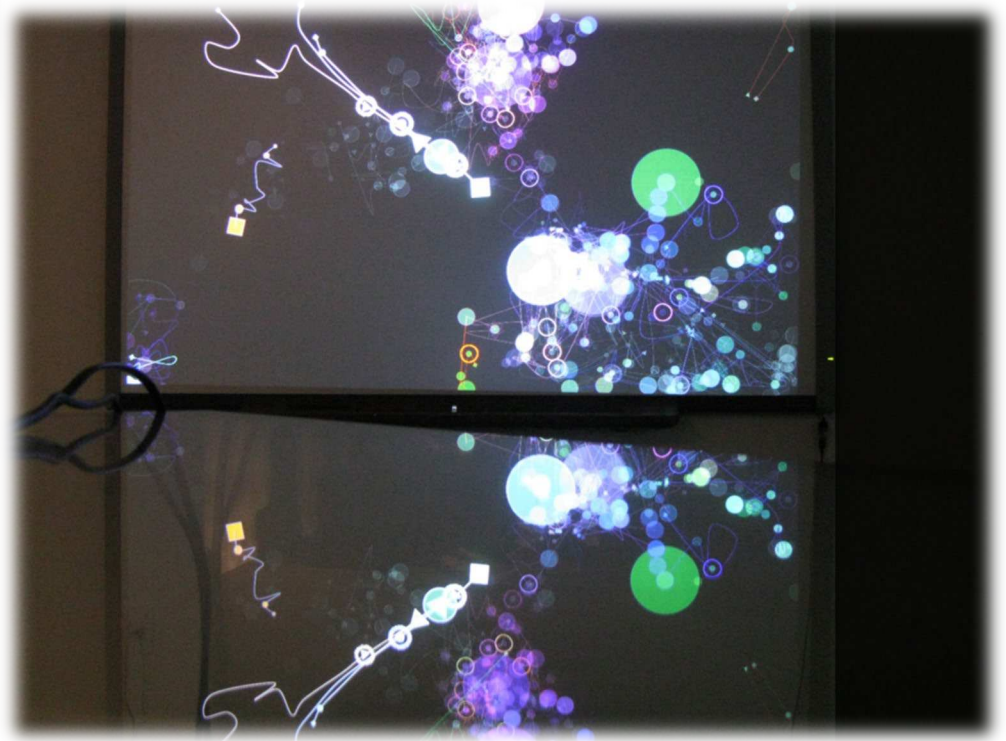
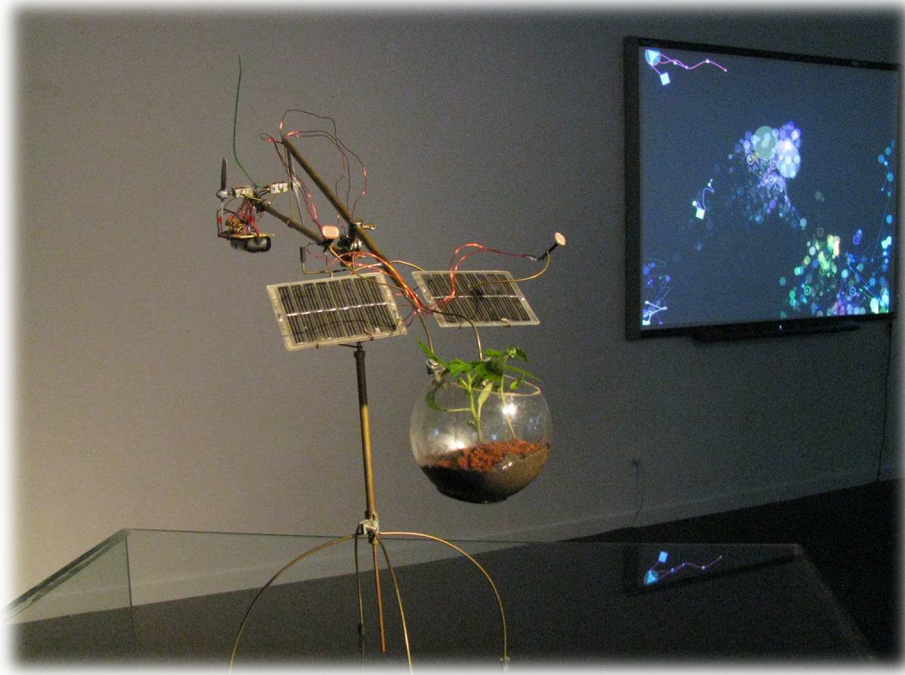
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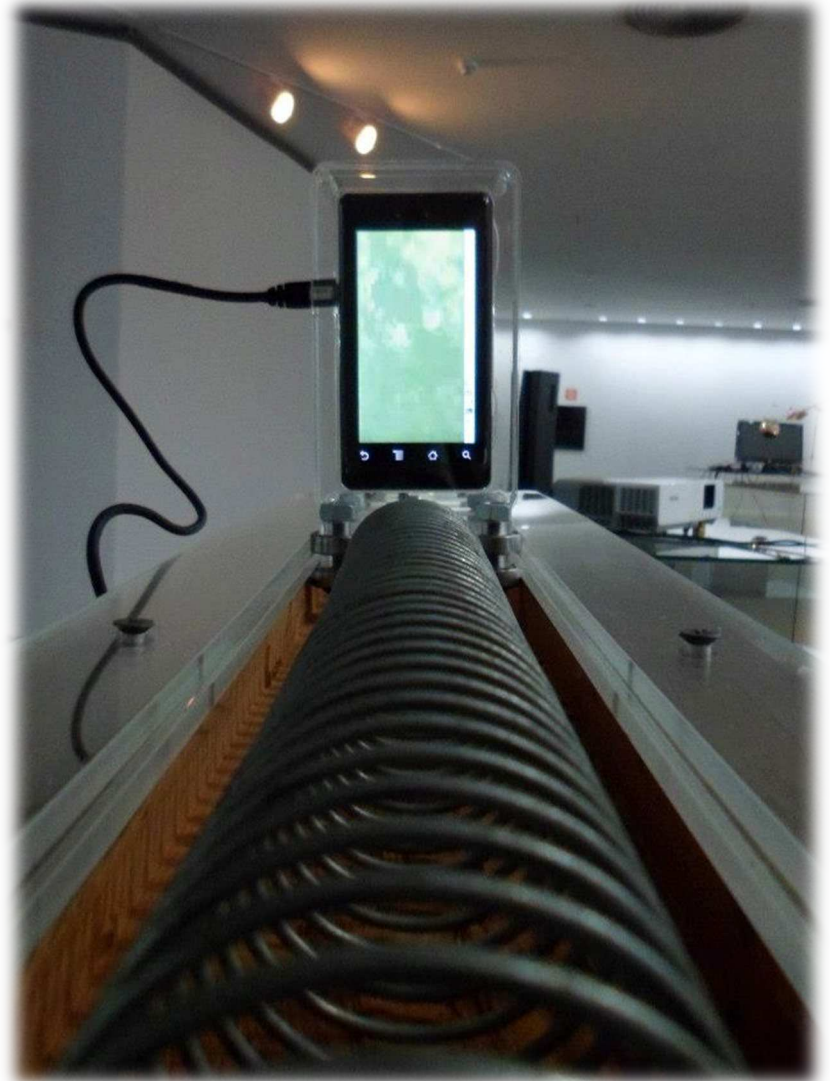
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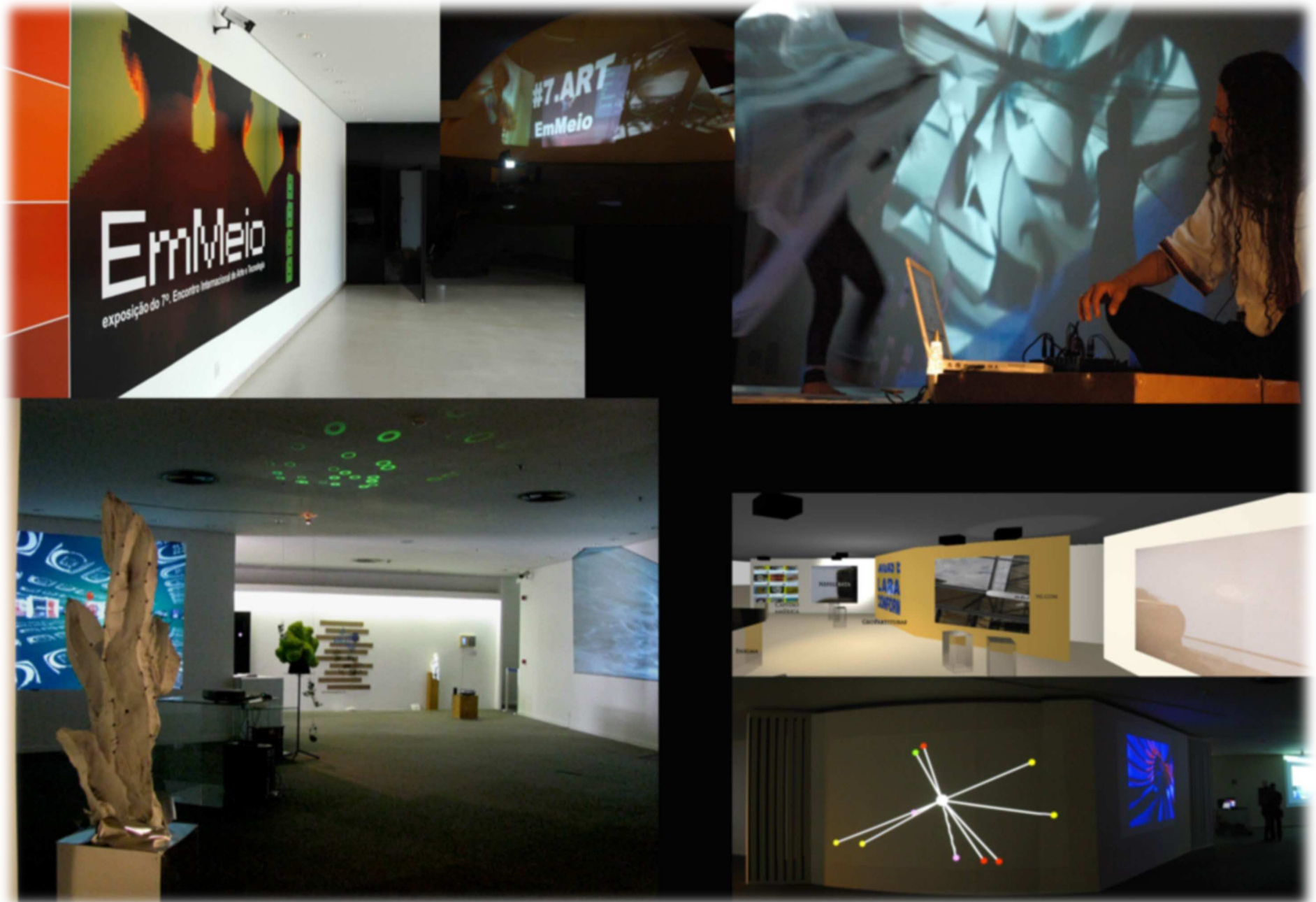


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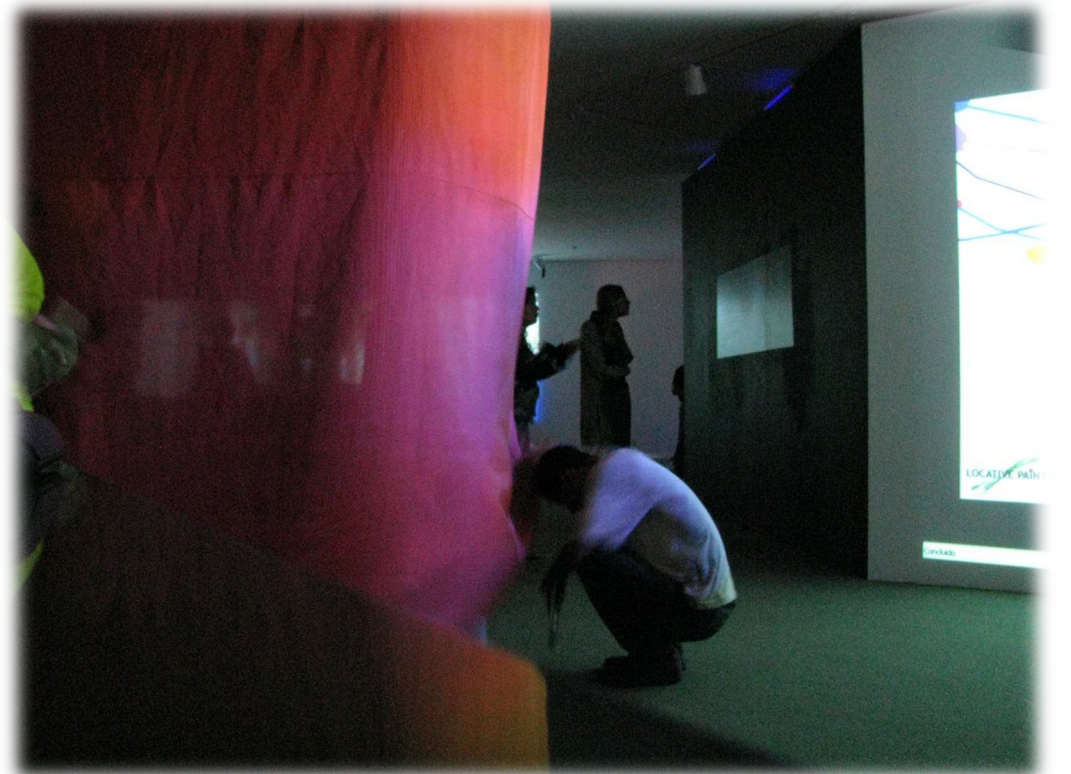
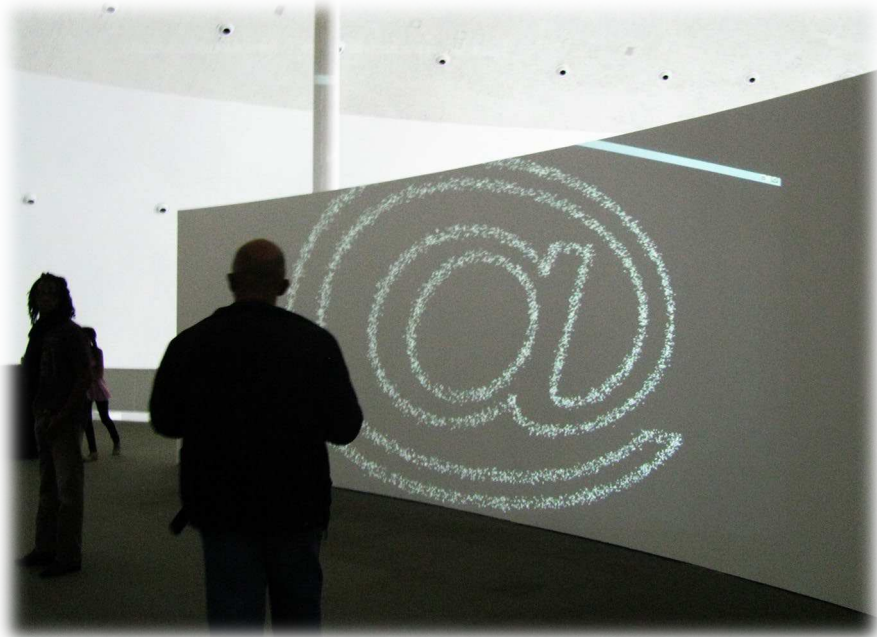


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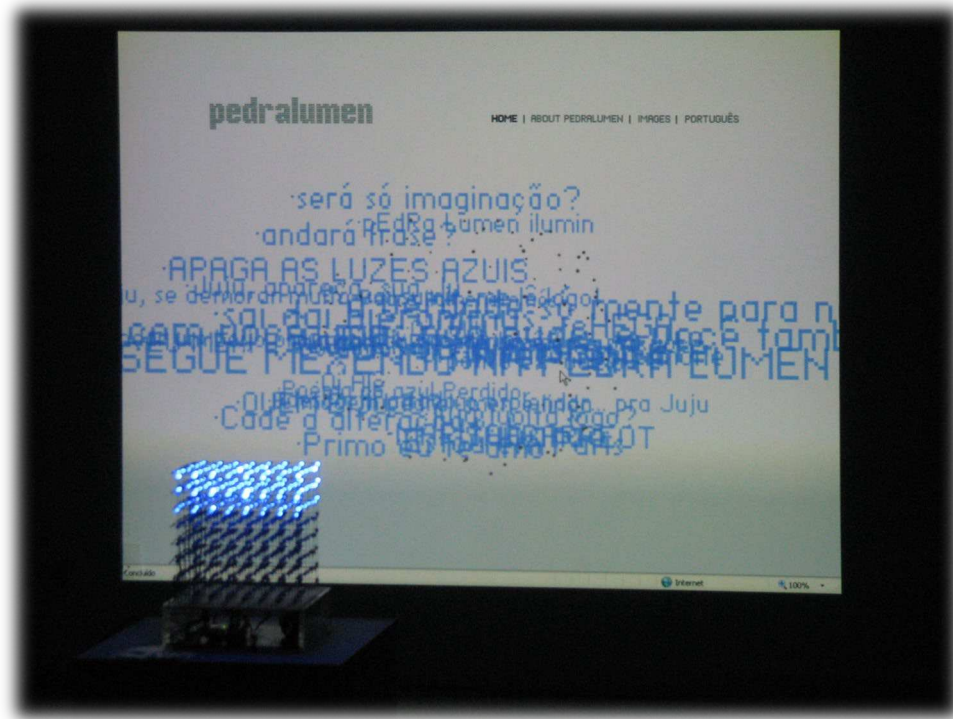


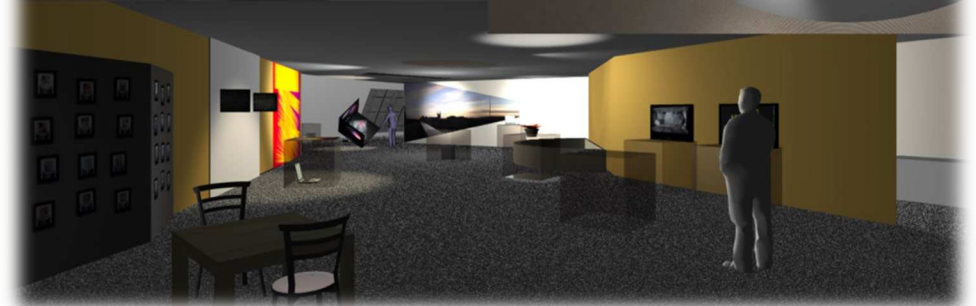
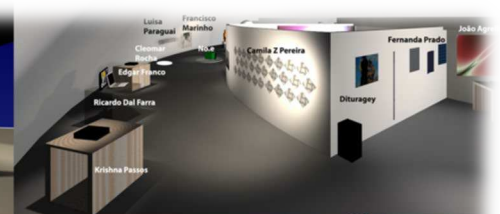
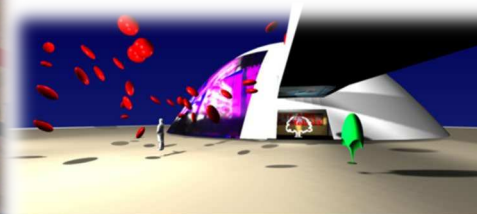


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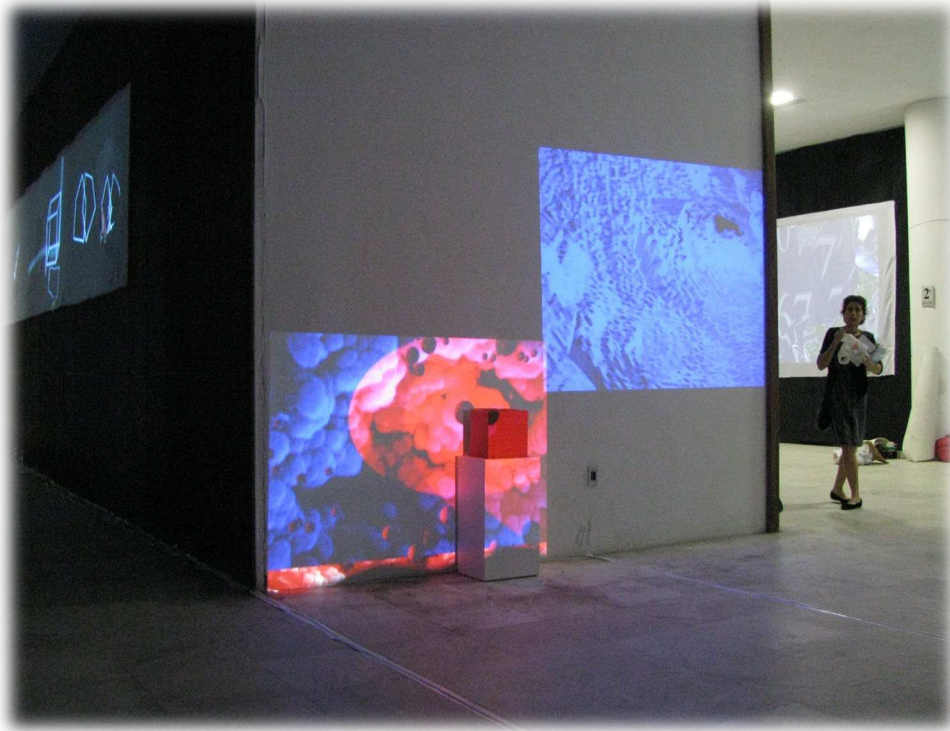
CAC 4 2014, Computer Art Congress 4, at University of Rio de Janeiro Fine Arts School (the oldest Brazilian Art School)

For the setup of the 4th International Congress of Computer Art exhibition, held at the School of Fine Arts of the Federal University of Rio de Janeiro in 2014, I used a similar experimental process, advancing the development of the concept of meta-installation, testing its possibilities in the international context, and verifying its viability. I designed the furniture and several installation formats to address the excess natural light and the open, unsafe space, which makes the artworks vulnerable to theft.

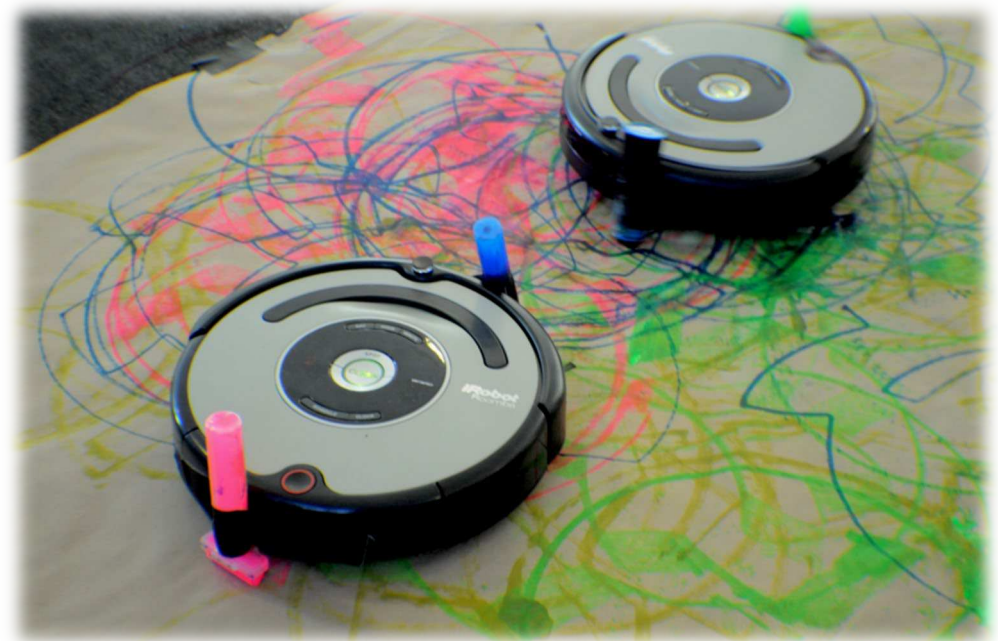
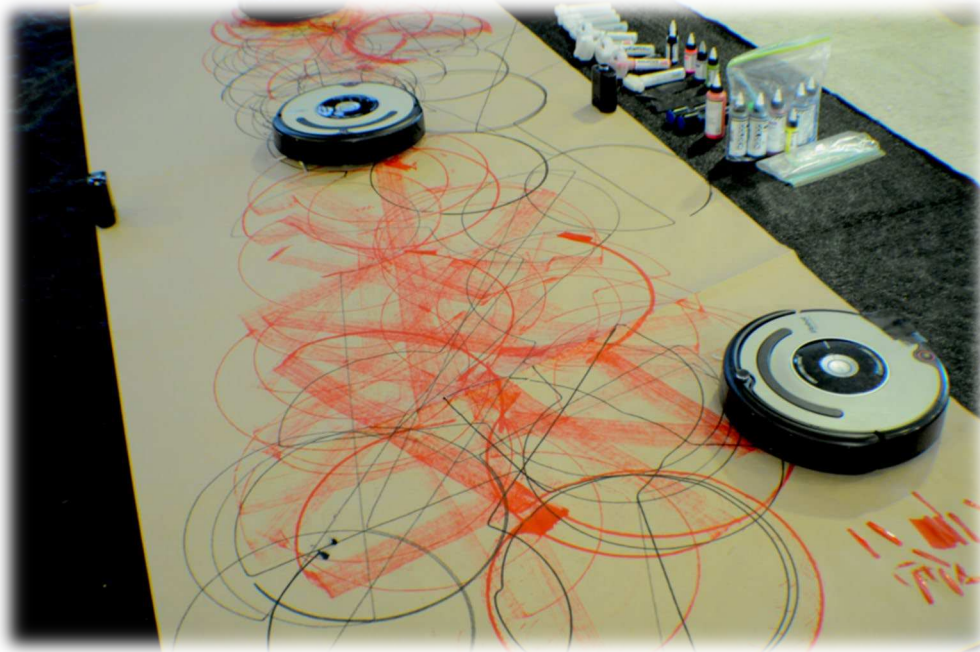
CAC 4 exhibition: images from the author's collection



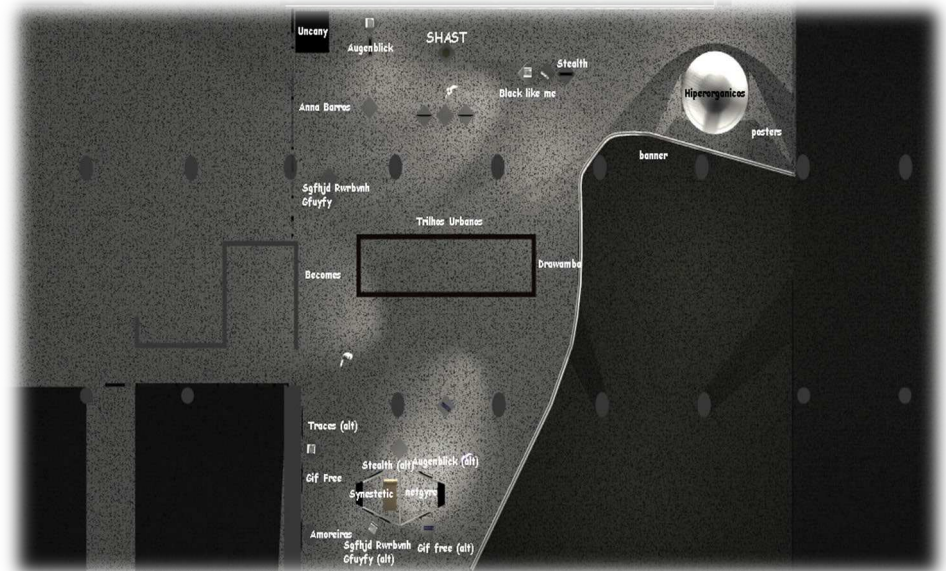
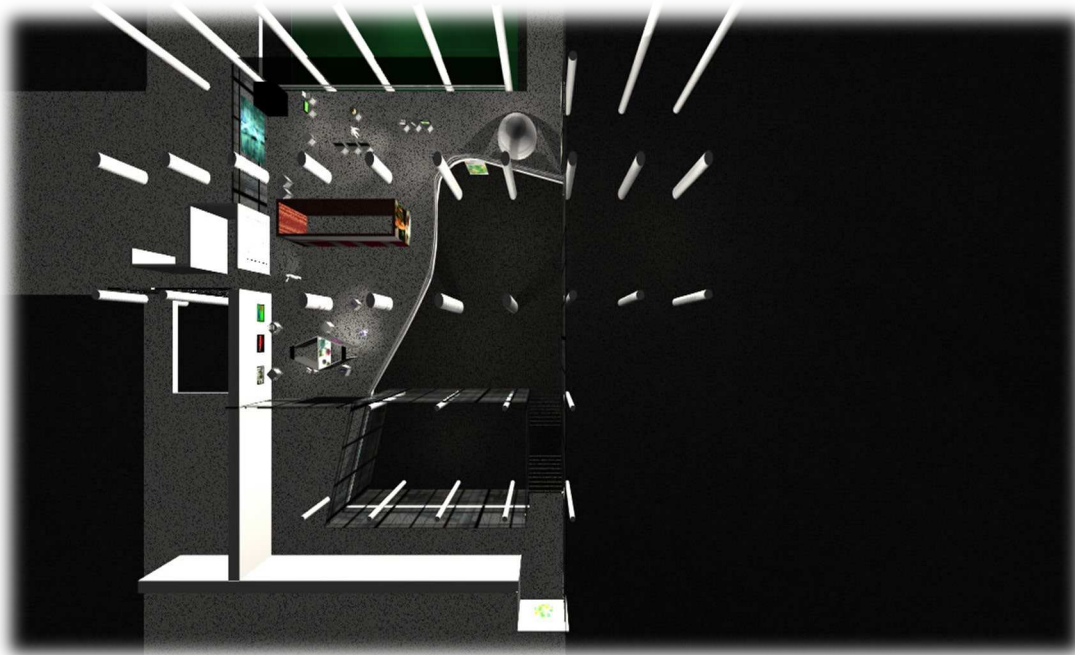
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3D simulations



Reverberations

The experimental nature and processes of these artworks and exhibitions highlight a rich domain full of possibilities for artists. Computer coding, when practiced by artists, differs significantly from other art-making methods. While traditional art often centers on expressive and poetic sensory experiences, Computational Art also engages with mathematical concepts to create poetic expressions that resonate within the human sensory and perceptual domains, along with their associated affective experiences.

More specifically, Interactive and Immersive Computational Art explores emotional and sensory domains that encompass an array of experiences. These experiences are interpreted as signs, expressed through processes, and mediated by semiotic machines. The kaleidoscopic and multidimensional capabilities of these machines allow for successive and varied interpretations of the artwork.

The sensory stimuli generated by these works create a complex network within the affective and perceptual fields, leading to organizations that the artist may not have anticipated. For the public participant, it feels as if there is an opportunity to explore a finite set of possibilities, all while the boundaries remain limitless. Therefore, Computational Art transcends mere Combinatory Art; it transforms sensations, emotions, and expressions into immersive virtual realities.

In conclusion, as Computational Art becomes more established, it is crucial to reflect deeply on its societal implications. With the rise of immersive and interactive technologies, the role of the participant shifts the existing dynamics of relationships, placing public involvement at the forefront of this evolving landscape.

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- Planetarium College – CaiiA STAR
- Ferreira Pena Research Station (Goeldi Museum, CnPQ)
- School of Communication and Arts of the University of São Paulo
- Coordination of Higher Education Personnel (CAPES)
- São Paulo Research Foundation (FAPESP)
- Fine Art School of the Federal University of Rio de Janeiro
- Art Institute of the Federal University of Santa Maria
- São Paulo Institute of Mathematics, Art, and Technology
- São Paulo Paço das Artes
- São Paulo Institute of Art, and Design, IADE
- MetaGalley
- CCBB-DF, CCBB-RJ, CCBB-SP
- CasaCor-SP
- Itaú Cultural Institute
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Researchers, Partners, and Collaborators:

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BCI Implementation: Mauro Picilliani

Partners, Collaborators and Inspiring People:

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Websites with some videos – accessed on: 02/16/2026

<https://youtu.be/o3S5liO51V0>

<https://youtu.be/BWnMc34B1zk>

<https://www.youtube.com/@taniafraga1>

<https://youtu.be/jFRdeLIOOLE>

<https://youtu.be/yaSgHfBDmuk>

<https://youtu.be/7DaH-Sw-5G0>

<https://youtu.be/alHdAh314t0>

https://youtu.be/Df7GKGTum_I

<https://youtu.be/XePCwpSX0Og>

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<https://youtu.be/2v2L86J1JtA>

<https://youtu.be/maxHKiaVvHQ>

<https://www.youtube.com/watch?v=wg86BPGePDs&t=18s>

https://www.youtube.com/watch?v=6egurdgbJvk&list=RD6egurdgbJvk&start_radio=1

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<https://www.youtube.com/watch?v=C4017m3WNtk>

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<https://www.youtube.com/watch?v=Xt8xTLscwpM>

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<https://www.youtube.com/watch?v=iK65j9df2UI>

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<https://www.youtube.com/watch?v=vKbcXIC0bRY>

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<https://www.youtube.com/watch?v=vCPHmtQSgJA>

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<https://www.youtube.com/watch?v=DuSMf-QVwFo>

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<https://www.youtube.com/watch?v=ya4N2AcXyE8&t=38s>

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<https://taniafraga.myportfolio.com/immersive-vr-artworks-1>

<https://taniafraggaias.myportfolio.com/>

<https://taniafraga.wordpress.com/>

Instagram: @taniafraga_atelie

<https://opensea.io/item/matic/0x74578fd3c1effabbce4b2850baaddefe59e00f0e/1>

<https://www.imatech.net.br/index.html>

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[t&src=al&st1=Fraga+%26st2=Tania&sid=6ad110720ed1ae6672d91bc64aca68a0&sot=anl&sdt=anl&sl=153&s=%28AUTHLASTNAME%28Fraga+%29+AND+AUTHFIRST%28Tania%29%29+OR+%28NAMEVARLAST%28Fraga+da+Silva%29+AND+NAMEVARFIRST%28Tania+Regina%29+%29+OR+%28NAMEVARLAST%28Fraga%29+AND+NAMEVARFIRST%28T%29+%29&resultsPerPage=20&offset=1&jtp=false¤tPage=1&previousSelectionCount=0&tooManySelections=false&showFullList=false&authorPreferredName=&cl=t&authorSearchURL=https%3a%2f%2fwww.scopus.com%2fsearch%2fform.uri%3fdisplay%3dauthorLookup%26st1%3dFraga%2b%26st2%3dTania%26origin%3dsearchauthorlookup%26returnTo%3dauthorLookup%26txGid%3da52eff7bba0af2234e2d76ae477f4444&allField=off&allField2=off&selectionPageSearch=anl&authSubject=LFSC&authSubject=HLSC&authSubject=PHSC&authSubject=SOSE&exactAuthorSearch=false&activeFlag=true&showDocument=true&origin=searchauthorfreelookup&cc=10&multSupersededAuth=&zone=AuthorNamesList&tx](https://www.scopus.com/results/authorNamesList.uri?sort=afprfnm-t&src=al&st1=Fraga+%26st2=Tania&sid=6ad110720ed1ae6672d91bc64aca68a0&sot=anl&sdt=anl&sl=153&s=%28AUTHLASTNAME%28Fraga+%29+AND+AUTHFIRST%28Tania%29%29+OR+%28NAMEVARLAST%28Fraga+da+Silva%29+AND+NAMEVARFIRST%28Tania+Regina%29+%29+OR+%28NAMEVARLAST%28Fraga%29+AND+NAMEVARFIRST%28T%29+%29&resultsPerPage=20&offset=1&jtp=false¤tPage=1&previousSelectionCount=0&tooManySelections=false&showFullList=false&authorPreferredName=&cl=t&authorSearchURL=https%3a%2f%2fwww.scopus.com%2fsearch%2fform.uri%3fdisplay%3dauthorLookup%26st1%3dFraga%2b%26st2%3dTania%26origin%3dsearchauthorlookup%26returnTo%3dauthorLookup%26txGid%3da52eff7bba0af2234e2d76ae477f4444&allField=off&allField2=off&selectionPageSearch=anl&authSubject=LFSC&authSubject=HLSC&authSubject=PHSC&authSubject=SOSE&exactAuthorSearch=false&activeFlag=true&showDocument=true&origin=searchauthorfreelookup&cc=10&multSupersededAuth=&zone=AuthorNamesList&tx)

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