**Collaborative and Transdisciplinary practices in Cyberart: from Multimedia to Software Art installations**

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**How to synthesize Leonardo?**

The efficiency of collaborative practices related to complex systems in Cyberart dissolves the old rupture and the well-known historical divergences between artists and scientists. The main point of convergence is when all disciplines investigate the same issues, all sciences become one unique science. Interactivity, immersion, autonomy and mobile connections in Cyberart require collaborative practices related to Science of Complexity and its emergent proprieties. Speculative software are written to respond for artistic projects and they place art in the three recent realms of "*engineering art"*, "*engineering culture"* and "*engineering nature"*[1]. These investigation fields respond to the high level of Cyberart's philosophical, technical, biological, social, ethical and emotional implications of scientific discoveries. A variety of disciplines related to the use of computers and networks in genetics, engineering, biotechnology, cognitive sciences, communication, anthropology, computer science, and other areas require sometimes a scripted software when applied in art practices. Writing software is not new in art practices, it has been done since the beginning of computer art, mainly in the development of formalistic aesthetics. However, artists embrace nowadays the design of adequate software by taking algorithmic information content for searching "rules" to be included in the code. Art works in cyberspace search for forms of communication close to the expansion of life in the post-human culture. The focus is the human factor of technologies or the humanization of technologies in the cross-boundaries with creativity and changes in daily life[2]. Howard Rheingold's concentrated efforts discuss the understanding of the procedural specificity of computer programs and the connectiveness to personal and networked computers and mobile relationships.[3] This essay discusses the conceptual framework of collaborative practices in Cyberart and Software Art of collectives working in prominent worldwide labs. It is not our goal to present the long and gradual insertion of computers in art starting in the 1960s, coming to the recent realm of Software Art in the end of the 1990s. The main focus is the collaboration between artists and scientists in a transdisciplinar approach and also a brief background on previous collaborative practices.

The components of the artistic language and communication are in the essence of the code used to adapt and transform the technological apparatus into interventions in cultural activities. Such practices confirm the relevant postulation of Walter Benjamin's historical text from 1934, *The author as producer*. But in our essay, the approach is not only dedicated to political, socialist regeneration of the social context and radical changes in society by artists-activists on the view. Nor do we consider the technical apparatus on the conservative way of the appearance and the beauty of forms. We are engaged in the expansion of human communication and the cyber experience in artworks. Consequently, when the members of collectives are involved in the creation of the code, a transdisciplinary methodology challenges the engineering of 'reality", understanding the transit and melting of real and virtual worlds in daily life. In the end of this essay we analyze several immersive environments, networked circuits, artificial life autonomous responses, and mobile connections in scripted software of art projects. Our special focus are interactive installations which require software development and create physical spaces to be

inhabited. They offer cybrid realities between natural and artificial systems, determining an engineering of the human condition to live expansion of life in Cyberculture.

## Seminal background

Transdisciplinary practices create feedback systems based on Wiener's cybernetics historic writings from 1948, and Von Foerster's second-order cybernetics, from the 1960s.[4] The term Cybernetics in its nature is also transdisciplinar, coming from philosophy, and coined by Plato in Greece to classify "the art of steering". In Cyberculture, the principle of feedback challenges and creates complex human-computer interfaced phenomena in cybrid ecologies, and unpredictable responses come from non-trivial machines cognitive behavior. In this context another contribution is the science of interfaces from physic theories and experiments based mainly on Rossler`s theories[5] concerning the endo/exo-process of communication between people and the artificial worlds. Cyberart also deals with the perspective of overcoming the sphere metaphor, eliminating the distinction between what is inside and outside, following the Goedelian perspective of an interfaced subject, in a world without boundaries in its whole state. Cognitive sciences and relevant ideas of the Chilean philosophers Humberto Maturana and Francisco Varela,[6] from the 1980s, contribute to those analyzes regarding the observer included in the environment and their autopoietic mutual feedback. Artificial intelligence, artificial life and biological computers, biofeedback, networked connections and wireless connections qualify sorts of computer-mediated life that require an adequate design of the apparatus. The "first-person-experience" in interactive art replaces the previous hermeneutic manner in an experimental condition, by extending the hermeneutics by the heuristics resulting from the human involvement with the communication with a system. And the audience is engaged in a communication practice exchanging the cognitive process with the metaphors of artistic discourses. Control and interaction mechanisms, included in the rules of a computer program, and sometimes by software in second interactivity levels, make the public part of the system, by involving them in an engineered reality. Those conditions create opportunities to reinvent the nature of life and the ultimate path of our species in Cyberculture.

Intertwined relationships among body/environment/nets ask for software capacities and reconfigure the human condition. The Brazilian communication theorist André Lemos[7] highlights that cyberculture connections are a social phenomenon which started in the 1970s with the use of the PC, or personal computer, modified by the transformation of the PC into CC, or connected computer (1980-1990s). In the last fifteen years, the author points out the mobile collective computer or CCm using specific wireless equipment (laptops, palms, cellular phones, bluetooth, Wi-Fi, chips, RDIF tags - radio frequency identification, and other mobile interfaces), and the use of ubiquitous, pervasive and sentient computing technologies.

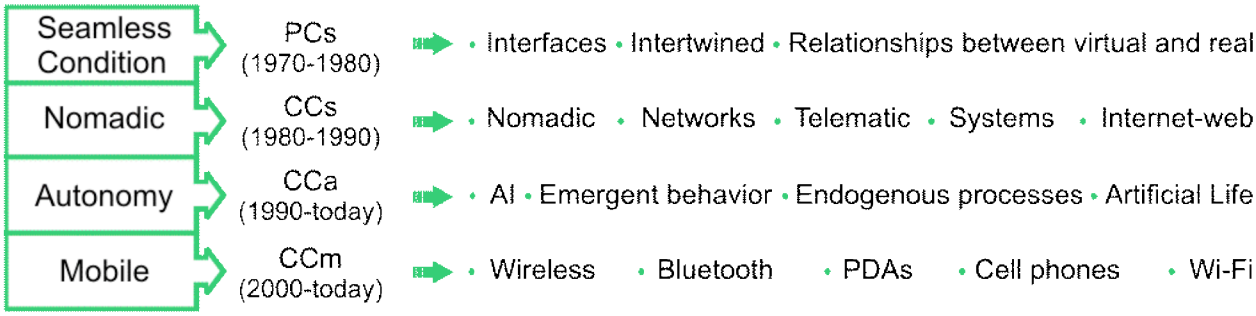


Fig.1

To respond to the complex phenomena of cyberculture, collaborative practices in Cyberart replace Leonardo's wisdom by “collectives”, and transdisciplinarity truly takes place thanks to cross-intelligence of networked expertise of artists and scientists in organic adaptive capacity to regenerate knowledge. A net of disciplines, theories and practices, configure a cluster of investigations in high performance circuits mainly in the human-computer interfaces (HCI) domain to respond to non-linear processes, emergent proprieties and autonomy, telematic systems and social changes.

**Anchor, pyramid, tree or neural network of knowledge?**

Previous collaboration between artists and scientists in the mechanical and electrical age, in their merely technical contribution in art projects are changed definitely in the shared territory of Cyberart. They call for less instrumental view of technology of multimedia and digital art collaborations that were only the sum of technical tasks coming from teams of people involved in the artistic production. Tools and devices were used to allow predictable responses in participative art manifestations. Nowadays, the science of complexity and emergent proprieties blur the boundaries of isolated disciplines by sharing common investigations to respond to the same concept and context, without any hierarchy, and require reciprocity and collaboration of all experts. To illustrate this point, recently, a surprising call at noon from the Brazilian physicist Alfredo Gontijo de Oliveira, inviting me (Diana Domingues) to give a lecture at the launching of the book *Conhecimento e Transdisciplinaridade II – aspectos metodológicos*[8], (*Knowledge and Transdisciplinarity II: methodological aspects*). It was an opportunity to place our research in a very important group of Brazilian intellectuals from several areas in a collective enterprise at the Instituto de Estudos Avançados Transdisciplinares (Institute of Advanced Transdisciplinary Studies - IEAT) of the Federal University of Minas Gerais (UFMG). I had never met him. I had no idea he had heard of NTAV Research Lab at the University of Caxias do Sul[9] in interactive art in the far south of Brazil. I asked him then why he was inviting me, and he answered that he had been looking for art and communication scientists who are currently working on topics and practices implicit in transdiciplinary approaches. I immediately put in my hectic agenda the irresistible occasion to explore the interconnections of our ideas. It was just like being invited by Santa Fé Institute, in California - founded in 1985, or to be invited by similar advanced centers – public and private ones, such as Max Planck Institut, in Germany, or as those in Stanford, Berkeley and Princeton, the latter having served as a model for the Max Planck Institut. I could not miss the opportunity to breathe such a fertile atmosphere.[10] In Belo Horizonte, surrounded by a huge audience of IEAT scientists from Neurobiology, Physics, Literature, Computer Science, Engineering, Philosophy and other areas, I suddenly found our coincident and shared concepts such as self-organization, feedback, emergent properties, autonomy. Gontijo de Oliveira writes about 20th century Physics perspectives, introduced by Quantum Physics and Einstein’s Theory of Relativity, as well as the ontological rupture with Isaac Newton’s principle, which affirms that the motion of the whole is the sum of the motions of all the parts. The physicist is interested in the principle of complex feedback and emergent properties and not in the fixed states of material. We had also common philosophers such as Morin’s complexity theory, and Prigogine’s dissipate structures principle of the “end of certainty”. The introductory text by Ivan Domingues[11] is categorical when he affirms that transdisciplinarity relinks heuristics to logic. He points out the necessity of projects that unify scientific and artistic practices and defends that it is only the articulation between the poet’s creative intuition and the analytical tools of thinking and discourse, such as logic, mathematics and information technology that makes transdisciplinarity. The prefix "trans" establishes the "secret bridges" between knowledge, the unknown passages of theories, the hidden shared operations in knowledge generation at microbiological levels. Consequently, it is no longer possible to illustrate these relationships with the figures of an

anchor (one discipline only), a pyramid (having a base and a summit), or a tree (having a trunk and branches). Transdisciplinary practices have no *topos* and can only be illustrated with the figure of an artificial neural network with its synaptic circuits, organized in points that can be connected or not. Transdisciplinarity activates the self-organization of each mind and calls for connections of knowledge in its encyclopedic nature.

**Encyclopedic nature of art practices: timeline**

Art, science, technique and technology in all times of human civilization from the Antique, the Middle Ages, the Renaissance until the beginning of Modernity and the digital era based on an encyclopedic nature of knowledge. In the Antique, a unique and concentrated knowledge is exemplified by the synoptic spirit and encyclopedic mind of Plato and Aristotle. Metaphorically, they represent hundreds of books in a library, a huge amount of information. History also highlights eminent artists in monolithic practices, as

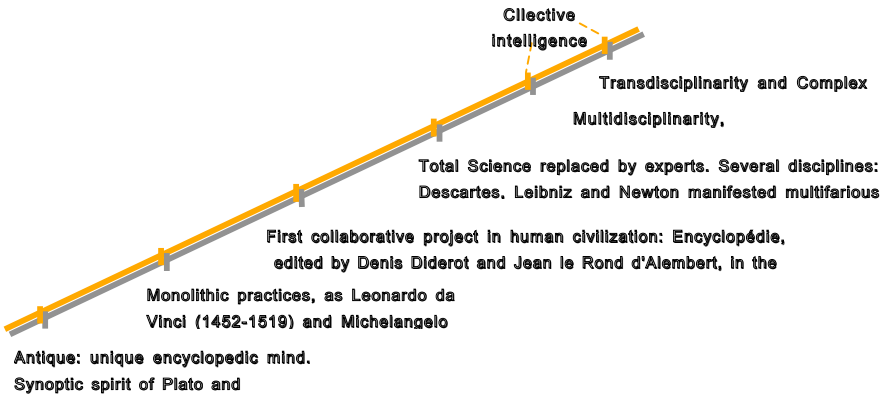


Fig.2

Leonardo da Vinci (1452-1519) and Michelangelo (1475-1564), in Italy, and Albrecht Dürer (1471-1528), in Germany. Later in the Renaissance, we have El Greco (1541-1614), in Spain, and then Rembrandt van Rijn (1606-1669), in the Netherlands. In literature, we have Montaigne (1533-1592), in France, Cervantes (1547-1616), in Spain, and no other than William Shakespeare (1564-1616), in England. The first collaborative project in human civilization is the "Encyclopédie", edited by Denis Diderot and Jean le Rond d'Alembert, in the 18th century, published over the course of more than twenty years (1751-1777). By the time the last volume was published, more than 140 people had contributed to its pages, composed of 32 volumes, with over 70,000 entries. Diderot's goal was to change the common way of thinking through the expansion of knowledge and the development of critical modes of thought, isolated thoughts, published together, in units, referring to each domain. The "Encyclopédie" became the heyday of artists and authors.

The Modern Age brings the division of knowledge in disciplines. The experts who master a variety of disciplines replace the total scientist of the Renaissance. Descartes, Leibniz and Newton manifested multifarious knowledge divided in several disciplines. Exponents of fine arts used the technique of painting to represent scientific laws, physic phenomena, invisible forces, without using technological resources: William Turner, and dynamics, or Nicolas Poussin, and weather. Monique Sicard, in her book *Chercheurs ou Artistes. Entre Art et Science ils rêvent le monde*[12], wrote the text “La chute du mur”, where she discusses the premonitory ideas of artists, and the analogies of scientific forms. She gives examples of Mondrian and molecular biology, Kandinsky and nuclear physics, Julio Verne and the Challenger Mission. We are also aware that

Degas explored the pause of time of photography; Futurists discussed time using chronophotography; the language of film incorporated time to the optical images; Impressionists made a revolution in art representation based on Chevreul's theory of color and the phenomena of optical synthesis; Post-impressionists divided forms in mathematical units which is the source of photomechanical techniques, amplified and automated by digital dots in RGB.

**The predecessor of interactive art**

Collaborative practices of artists, scientists and technical teams involved in creative projects worked on the sum of disciplines in multidisciplinary and interdisciplinary methods. Laboratories in the official circuit of institutions became the meeting place for artists, scientists and technicians, such as the historical example of the Massachusetts Institute of Technology, in 1950s, opening the doors to Art History courses, lectures, and even a museum to call the attention of scientists to cultural themes. Around ten years later, in 1967, Gyorgy Kepes founded the CAVS (Center for Advanced Visual Studies), after had worked with Moholy-Nagy in Chicago, and was influenced by Bauhaus proposals. He investigated light and electricity in art pieces. Walter Gropius, at Harvard, Mies van der Rohe, at the Illinois Institute of Technology, Joseph Albers, at Black Mountain College, are important examples for the mutual influences of art and science. After 1974, Otto Piene was the director of CAVS, and introduced laser, holography magnetism, synthesizers, video and electric and electronic technologies, before the intense use of computer in art practices. Frank Popper,[13] in his landmark publication *Art in the Electronic Age*, includes Otto Piene, Cruz-Diez, Le Parc, Frank Malina, Sotto, De Maria, Turrel, and other artists as the roots for interactive art. They used technical infrastructure of laboratories in the mechanical age to explore laws of physics and mechanics: optical and acoustic effects, the power of wind, air, fire, light, and other natural phenomena, crossing the boundaries between art and Called the EAT "Experiments in Art and Technologies", with the engineer Billy Klüver, a huge organization composed of an equal number of engineers and artists and in 1966. It was a formal entity to "develop an effective collaboration between the artist and the engineer. It provided an environment that encouraged important artistic creations, including collaborations between artists such as Kluver, Andy Warhol, Rauschenberg, John Cage and Jasper Johns. Support was in part provided by Bell Labs. In the 1960s and the 1970s they organized the first international cybernetic inter-media total environment. They presented *Theatre and* Engineering events, developed by 10 artists, working with more than 30 Bell Labs engineers, Kinetic Art participative environments anticipate today's interactive use of space and heuristic audience involvement with the apparatus of computer based installations, managed by complex systems and according to cybernetic models. Among many examples, we emphasize the South American artists Jules Le Parc, who founded in Paris the GRAV (Groupe de Recherche d'Art Visuel) in the 1970s and explored light, magnetism, wind, the audience touch and walk, incorporating mechanical resources of industrial age in order to engage the audience to cause environment changes. Le Parc's intentions were political: his country, Argentina, was undergoing a hard authoritarian moment, and including the audience was an act of freedom. Another strong contribution of Latin American artists are Soto and Palatnik. Many events in Brazil were dedicated to Cinetic Art and the exhibition Cinético-Digital, at Itau Cultural Institute, São Paulo, in August-September 2005, which presented Abraham Palatnik, Waldemar Cordeiro and Julio Plaza, who introduced environmental cinetic art and digital art in contemporary Brazilian artworks.[14]

Interdisciplinary approaches in multimedia artwork by the sum of artistic and technical expertise in studios have replaced old and obsolete ateliers. Teams of technicians use tools and devices for the development of art projects, making a collage of technical languages, but each one always preserving the autonomy of each discipline working in order to solve artworks proposals.

Experts in sound, image, choreography, architecture, electricity, communication, mechanics, optics, design, writing, reaffirms the Newtonian perspective that the whole is the sum of all the parts. The ontology of each media preserves its own constitution, only adding qualities from one to the other multimedia art work, by melting their sintagmas. Incrustation, collision of Eisenstein's montage and Cage's theory of inclusion create interdisciplinary approaches. The prominent artist Rauschenberg, who adopted John Cage's ideas, in 1959, included in his combined paintings several media, by using numerous sound effects, and installed three radios mixed to them. The audience was invited to participate and could tune into radio stations and create an acoustic environment, making this work, possibly, the first predecessor of interactive media art. In multimedia art installations, artists, scientists and technicians collaborated to create multimedia and video installations with displayed images in various sizes, formats, placements and materials, surface of projections or multi-displays, echo cameras, microphones, light sensors, acoustic, visual and tactile circuits, in order to explore the relationship among body/image, sounds, light, texts and architecture. Renowned artists, started to invent tools just as Paik, who invented the synthesizer in collaboration with Shuya Age in the 1960s. Other artists as Eric Siegel, Stephen Back, Vasulka and Vostell, in the 1970s, brought forward the engineering task in artworks for the manipulation process of electronic hardware instruments.

The landmark exhibition *Cybernetic Serendipity*, which was held in 1968 at the Institute of Contemporary Arts in London, organized by Jasia Reichart, is a seminal background of early *artistic* exhibitions of computer art and digital installations. It showed most of the important contributors to the technology art world at the time, and featured exhibits from 325 participants from around the world, including Charles Csuri, Michael Noll, Nam June Paik, Frieder Nake, John Whitney, John Cage and others. There were robots and drawing machines and the first computer sculpture.[15]

**Human controlled space: responsive environments**

Since the beginning of computer-controlled interactive installations, in the 1980s, artists were involved in the engineering of the system to reach different levels of interactivity. Hans-Peter Schwarz's comments concerning the origin of the practices of interactive art is an important reference for our analysis. He highlights the *interdisciplinary curiosity, which allows for the thrilling questioning of the respective discipline which in turns facilitates inquiry on a number of levels without being in favor of one single analytic standard*. He affirms that interactive art attempts to create a synthesis between previously disparate disciplines. The term interactive art refers to the use related to methods of computer-controlled multimedia technologies, and Schwarz emphasizes the *most important element is the provision and design of the interface - the common boundary between the observer and the machinery*.[16] In the archeology of media art and wider aesthetic concern, we can mention Myron Krueger, Jeffrey Shaw, Harold Cohen and David Rokeby, in the earlier 80's, which brought forward the symbiosis of human and computer aesthetic relationship and the embodiment of the visitor in a subjective perspective. They were conditioned to the development of specific software for their artistic works. In the 1990's, a long list of artists worked on the explicit references *to old analogic and mechanical machines as a major aesthetic and structural element of their strategies*[17]. In the beginning of these practices, we may emphasize Edmond Couchot, David Rokeby, Masaki Fujihata, Luc Courchesne, Ken Feingold, Jill Scott, Lynn Hershman, Michael Naimark between other important artists. They announce the collaborative work of artists and scientists and the growing phenomena of Media Labs worldwide in the end of the 1990s and beginning of the 2000s. These labs are dedicated to the design of human-computer interfaces started earlier, in the 1980s, with Nicholas Negroponte, the founder of the Media Laboratory at the MIT.

**Interactive art exhibitions in Brazil**

In the Brazilian Art circuit a historic exhibition took place in 1995 at the international event *Art in the 21th Century: the Humanization of Technologies*[18] that offered interactive art installations as *Very Nervous System*, by the Canadian pioneer artist David Rokeby. The interactive system, created in the earlier 1980s, placed the human body in a powerful involvement of the senses with the system by creating a feedback of sounds originated by gestures in a totally empty physical environment. Eminent artists exhibited video documentaries of their history in interactive arts. Roy Ascott in telematics, Fred Forest and telecommunication projects, as well as a huge amount of synthetic images displayed creative worlds by Kawaguchi, Michel Bret, Hervé Huitric and Monique Nahas, and the Brazilian artists Tania Fraga and Suzete Venturelli. At the same event, artists explored environmental art through computer-based and multimedia installations. We will mention only a few installations of that exhibition: Stephan Baron exhibited *Le jour et la Nuit,* a networked installation using telepresence and the blue of the sky captured in France to change the virtual blue installed in the screen in Brazil. Stelarc did his cyber robotics' historic performance with his thirth hand. Gilbertto Prado installed *M.A. desejo,* and offered hypermedia interactions, Milton Sogabe installed a participative haptic system, *Mãos à obra.* Diana Domingues's installation *In-Viscera* was a participative multimedia environment using medical images of videolaparoscopy, augmented multi-screens, sound amplifications, echo effects, captured through presence sensors.[19]

Other interactive art exhibitions, with special reference to those of Itau Cultural, File Festival in Sao Paulo, and since 2005, Telemar Cultural Centre in Rio de Janeiro are part of the Brazilian agenda dedicated exclusively to art and technology. However, one huge example of the acceptance of interactive art in the Contemporary Art circuit is the international mega-event *2nd Biennial of Mercosur*, in Porto Alegre, in 1999, curated by Fabio Magalhães and Leonor Amarantes. They included two segments: Jules Le Parc retrospective, curated by Sheila Leirner, and *Cyberart: Zones of Interactions,* curated by Diana Domingues.[20] The exhibition consisted of a rare opportunity to explore different aesthetic qualities concerning levels of participation and interaction. In the first floor of the Gasômetro building, located by the Guaíba river, in Porto Alegre. Several artworks created by Jules Le Parc offered an experience of participation in environments based on cinematic and physical laws: light, sound, movement, mirrors and cinematic effects and the audience participate by wearing glasses, laying, walking, jumping, touching and other actions by the included observer equipped with mechanical devices. In the ground floor, international guests pointed out the roots of interactive arts. Meanwhile Roy Ascott, Edmond Couchot, Yoichiro Kawaguchi, Fujihata, Christa Sommerer, Laurent Mignonneau and Michel Bret were invited to trace a historical panorama of interactive art. Telematic systems were represented by the collaboration of Roy Ascott and Josep Girbet networked installation *Art-ID/CYB: identities in cyberspace*, which enabled new cybernetic identities by expanding an ongoing investigation into the collaborative and creative potential of the Net as a *universe in which minds can float freely in search of new conceptual spaces of open-ended creative connectivity.* Couchot and Bret exhibited the interactive installation, created at ATI, Paris VIII in a close collaboration, *La Plume et le Pissenlit,* from the 1980s. The blowing makes flowers and an artificial plume go with the wind, depending on the force and the duration of the puff, in a very sensitive performance lived by the external world and synthetic nature. Sommerer an Mignonneau, well-known collaborators, presented *Plants Growing*, 1993, which *deals with the sensitive interaction between five actual plants and five or more human viewers who can, by moving the hands toward the real plants, initiate and control three-dimensional real-time growth of artificial plants.* Masaki Fujihata exhibited *Beyond Pages*, a virtual book that generates a relationship between the real and virtual objects using a digitalization pen. The book's purpose, as the artist says, is to describe *what goes beyond its pages*. Unfortunately, we

could not exhibited Jeffrey Shaw's installations such as *The Golden Calf, Places*, or *Legible City* landmarks for Cyberart. According to Pierre Lévy, the mentioned Fujihata's and Shaw's *places* installations, besides Char Davies'*Osmose,* virtual reality installation, are the four typical artistic works of Cyberculture.[21] Yoichiro Kawaguchi was the only artist who did not offer an interactive computer-controlled environment. However, he was placed in "zones of interaction", the central concept of the curatorship, because of the endogenous interactivity of the algorithms created by his "growth model", which generate an internal organic life of forms. Poetically, Kawaguchi comments that his works remind him of his *childhood dream of a Voyage trough a Planetary Universe*[22].

At the same exhibition, Brazilian artists' interactive systems allowed connections to hypermedia, neural networks, camera circuits, spatial navigation in virtual reality, webperformances. The set of installations confirmed the existence of artist engineers working in collaboration with scientists in Brazil. In environmental art, Suzete Venturelli and the group of the University of Brasilia, UNB, exhibited *Sylleptical Bodies,* a round wall in a virtual reality multi-user environment, in VRML and JAVA. Gilbertto Prado's *9/4Fragments of Blue* offered six touch screen displays placed in the ceiling to interact with sky texts, sounds and images that were reflected on the floor. Kiko Goifmann and Jurandir Müller, with the theme of life inside a prison, used digital media and the interactions to a large projection of the CD ROM "Valetes in slow motion" and connections to the website *Jacks in slow motion*, by VRML navigation. Diana Domingues and the collective *Artecno Group UCS*, *TRANS-E: my body, my blood* (1997-2000) interactive installation simulates a cavern to acquire shamanic powers in third stages of ephemeral identities. The mutations result from the visitors' behavior captured by sensors installed on the floor, transmitting the body signals to the computers, and processed in emergent manner by a neural network in its adaptive behavior and backpropagations. The mysteries of the shaman's life allow an enigmatic experience of trance. The collective Sciarts presented *Entremeios* making interactions among all spaces of the exhibition, by using capture sensors, microcameras managed in multiple co-relationships The collective *Corps Informaticos*, UNB participated with the web performance "*Dobra*", by connecting people in remote spaces using web cams. The other sessions of the of Mercosur Biennial were the Net Art exhibition, *Cyberport,* which explored the physical space as a sort of custom zones, typical of international ports and airports. Corridors lead to terminals that enable planetary communication in two different gates: Mercosur Community and International Community. Innumerous people navigated in the international gate connected to websites of prominent web artists: Victoria Vesna, Stephen Wilson, Sheldon Brown, Ken Goldberg, Seiko Mikami, Sharon Daniel, etoy, Mark Pesce, Kazuhiko Hachiya, Paul Garrin/Andreas Tröger, Bruce Damer, Timothy Leary, Michel Redolfi among others. In the second gate of Mercosul Community Cyberport, other gates presented artists from Argentine, Bolivia, Paraguay, Uruguay, Chile, Colombia and their hypermedia artistic projects in CD ROMs or websites. We mention only a few names as Ivan Marino, Gustavo Romano, Marcelo Mercado, Jorge La Ferla (Argentine), Gonzalo Mezza, Eduardo Elgueta and Chistian Edgar, Oyarzzún Roa (Chile), Jaime Iregi (Colombia) and Brazilian Artists Tania Fraga, Luisa Paraguai, Daniel Sêda, who explored poetically hypermedia net connections.

**Camera circuits installations: the seamless and nomadic condition**

Camera circuits and the inclusion of the observer capturing the viewer body in the specific panoptic vision of optic devices is definitive for the seamless condition of the visitor in the whole system. Duguet's text "Dispositifs"[23] makes special reference to a camera and the viewer's delegation of his/her point of view to the electronic device. The author highlights Dan Graham's multimedia artistic works for the incrustation and participation of the audience, before the use of

camera in computer controlled installations. However, the very seminal reference are Peter Weibel's seminal discussions and relevant artworks in the history of the feedback between perception, consciousness and media impacts with camera circuits. He wrote earlier: *Enclosed in a room, each point in that room is its own prison warder, the perspective is his deadly fate.* His epistemological approaches are in the core of the problem of observing the observer addressed in 1969 and 1972 in *Das Publikum als Exponat and Video Lumina* video installation. At a more abstract level, Weibel refers to Heinz von Foerster and Norbert Wiener's ideas on cybernetics, and to the insights of quantum mechanics. Weibel transfers the idea of "uncertainty" to the level of human perception in everyday life. His installations created an observation chain in which the camera observes the observer, who in turn observes himself/herself on the screen. The observing subject becomes the observed object. These comments are historical and introduce the emblematic contemporary theme of circuits and surveillance that goes from Jeremy Bentham's panoptic architecture of the 18th century until surveillance closed circuits, going through Big Brother reality shows and nowadays web cams generating telepresence[24].

Myron Krueger in collab Paul Sermon can be considered the pioneers of cybernetic vision and also of net-based installations, announcing telematic and telerobotic connections. Regarding telematic circuits of cameras, Krueger exploited teleaction in separated locations and proposed the sensation of closeness in virtual worlds. He became the precursor of the seamless condition in global communication as video-conferencing, telepresence and multi-user environments. In his works *Video Place* and *Metaplace,* both from the 1980s, the seamless condition is enhanced by the nomadic condition allowing body actions in virtual reality in separated rooms. Paul Sermon is another pioneer in telepresence with his system mixing the camera vision and chromakey video effects. *Telematic Dreaming* explores the fusion of two separated spaces, by incrustrating people in different double-beds to "sleep" in a virtual projected environment. Ken Goldberg, another artist-engineer who makes his own systems, develops telematic systems and created *Telegarden,* a robotics art work to act in a remote garden. His discussions of a tele-epistemology theory and the philosophical, technical issues of controlling remote spaces propose a telematic vision and action and the reaffirmation of the existence in real places.[25] Camera circuits historical connections are in the huge list of artistic works of Slavko Kacunko's book *Closed Circuit Videoinstallationen*. The author contributes to important aspects of the history of live-videoinstallation[26]. Concerning the brazilian lab NTAV collaborative practices for camera circuits, Kacunko included *A-fetus,* a multimedia installation of the series *TRANS-E - The Body and the Technologies*,[27] which offers a lighted corridor with tomographies, a videocamera, two televisions and a tape of an ultrasound scanning of a womb with a six-month fetus in it. In the end of the tunnel, a circuit of cameras captures the visitor who was born in the physical space, displayed in a huge screen. *INS(H)AK(R)ES* (Fig. 3) is a networked installation in which telepresence and telerobotics resulted from the collaboration with automation engineers and computer science programmers in order to act in a serpentarium in Brazil. Following the engineering art intention, the circuit allows the magic of ritualistic incorporation of a robot/snake and also permits to live with its body in a place with actual serpents. A webcam and a keyboard give images and control the robot, resulting in displacements in the physical remote territory. Ultra red sensors capture robot movements controlled by the arrow keys and activate a mechanical device to give water to the serpents, meanwhile the webcam coupled in the head of the robot makes transmissions of images in a seamless and nomadic condition. Mysteries of life coming to the remote power makes dreams come true and an anthropological ancient desire to gain the animal powers is responded by the seamless body with the serpent. The event reminds of Mesoamerican native rituals[28] and the embodiment of serpent's power to reinvigorate life by a software artwork that reengineers nature.

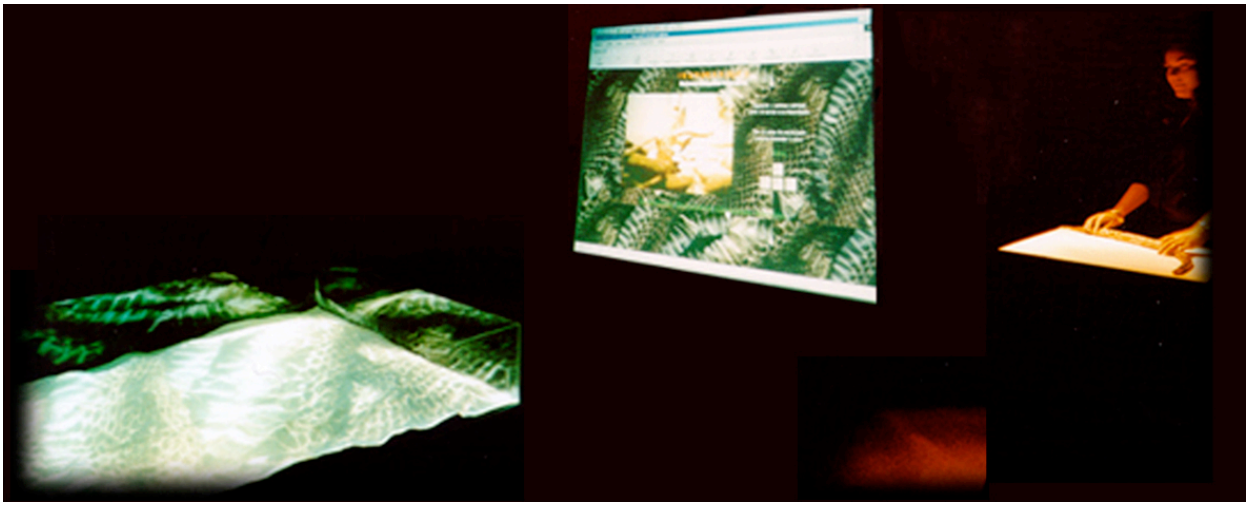

Fig. 3. *INS(H)AK(R)ES* networked installation,.telepresence and telerobotics.


**The immersive and multi-sensorial biofeedback**

Efficient collaboration of artists and scientists earlier as the Architecture Machine Group at MIT, in 1976, founded by ARPA, focused on the spatial experiential nature of data, by anticipating immersive environments. Richard Bolt, under the direction of Negroponte, developed influent research on spatial navigation interfaces, nowadays explored in high levels in virtual reality entertainment and games, caves, architecture application, archeological, historic, tourist, educational, medical studies, and for training in industry, police, e-commerce and other destinations. The system *Spatial Data Management - SDMS* enhances the hyperlinks connection in hypermedia proposed by Vannevar Bush, Ted Nelson, Douglas Engelbart, William Burroughs to spatial navigations. The system offers a multidimensional performance and improves hypermedia associative connections reminding Simonides' effects of Palace memory. Bolt's system investigates navigation in the "information surround", engaged with body data displacements, by inhabiting a virtual world. Scott Fischer is another artist-scientist who worked at the MIT Center for Advanced Studies, and in the 1970s moved to the Aspen Movie Map project, whose system enabled navigation trough an interactive videodisc. He enhanced immersive interfaces as Hellig's *Sensorama*, and Ivan Sutherland's HMD - head-mounted display – in the late 1960s. First at MIT's Draper Lab, in Cambridge, Massachussets, and later at NASA – Ames Research Center in Mountain View, California, in the 1980s. Fischer set out an immersive interface to engage all the senses in a *trompe les sens* with stereoscopic images, enhancing monoscopic vision and adding microphones for sound spatiality.[29] Jaron Lanier created also the dataglove and is also in the beginning of esthetic experiences in multisensory environments by trackers, intuitive biological interfaces for breath, heat, sounds, speech in symbiotic connections,[30] starting biofeedback systems.

In virtual reality, Myron Krueger immersive artworks *Videoplace* and *Metaplaces,* from the beginning of the 1970s, in collaboration with colleagues at the University of Wisconsin, opened a new repertoire for real-time responsive environments by the gestures of the audience. Nowadays caves and networked caves enhance communication inside virtual reality immersive cubes. The history of caves is also the result of collaborative practices between artists and scientists at the Electronic Visualization Laboratory (EVL), University of Illinois, Chicago. Since the 1970s two engineers, Daniel Sandin and Thomas de Fanti, have been investigating computer graphics and imaging, and later, the graduate student Carolina Cruz-Neira worked in the construction of the Cave Automatic Virtual Environment[31]. Technically speaking, a cave is an

immersive cube with multi-display synchronized backprojections where the observer is immersed in a physical relationship with the entire body. Recently, Donna Cox and her colleagues Robert Patterson, Marcus Thiebaux, Stuart Levy and Mathew Hall, at the National Center for Supercomputing Applications, University of Illinois, created immersive networked environments that allows people to incorporate avatars and to live in cosmic spaces. In the networked cave, an electronic glove allows navigation and touch astrophysical phenomena of stars and galaxies, including a set of mythological forms.

In the list of virtual reality and interactive and immersive collaborative practices, Jeffrey Shaw's installations at the ZKM, Zentrum für Kunst und Medientechnologie, in Karlsruhe, Germany, collaborates with Gideon May and Berndt Lintermann. Coming from the cinema and panoramic tradition, Shaw is one of the pioneers for computer controlled environments. *Virtual Projects*, a 1976 installation, presents computer-generated stereo images and an optic interface for the manipulation of geometric objects. In the artistic works *Inventer la Terre* (1986) and in the well-known *The Legible City*, the interactor drives a bicycle and moves around in a virtual three-dimensional landscape with letters taking the place of buildings in Karlsruhe, Manhattan, and Amsterdam. Other labs and important artists for the history of Caves are Monica Fleischmann and Wolfgang Strauss from the Fraunhofer Institutes in Stuttgart, Darmstadt and Sant Augustin, all in Germany[32]. In Caxias do Sul, we opened the UCS CAVE in April 2005 at the *First International Meeting of Art, Science and Technology: Virtual Reality*, with the presence of renowned researchers such as Oliver Grau (Humboldt University, Berlin) and Ramesh Raskar (Mitsubishi Electric Research Laboratories, USA). Two virtual reality applications developed by the NTAV group are already running in the cave: *Aquarium* and *Heartscapes*, both described later in this paper.

Biofeedback investigates mutual behaviors of the body signals and the environment. It involves sensory physiology and cognitive processes that result from the analysis of actions of intertwined body/environment, and their information exchanges. Ted Krueger, at the Human Interface Laboratory at the School of Architecture at the Rensselaer Polytechnic Institute, is involved in *The Synthetic Senses Project* and the redefinition of human perception and cognitive process, dealing with body physiology that acts with immediate physical environment. He affirms that the systematic structuring of the relations between sensory patterns ultimately derived from manufactured sensor technologies and those given by locomotion, proprioception and the internal senses should result in exactly those contingencies leading to the externalization of a percept[33]. Canadian artist Char Davies and her Softimage and Immersence teams developed the landmark in immersive virtual reality landscapes *Osmose* and *Éphemère*, where biofeedback is provided by multi-sensory interfaces and the visitors' breathing triggers mutations of the virtual landscape in which the body is diving. Naoko Tosa, at ATR, developed *Unconscious Flow*, an artificial life installation with interfaces for biofeedback using electrodes to transmit heartbeat signals. Virtual creatures manifest behaviors as individual agents responding to hand movements analyzed by a camera installed on the ceiling. Diana Domingues / NTAV team, in *Heartscapes* offers the immersion in virtual landscape of the heart, mixing visual effects with noises of indigenous rituals, natural environments and allowing responses from virtual objects and navigation in the landscape, by creating the atmosphere of a ritual (Fig. 4.). Mutations of forms in real time are controlled by trackings for movements and the capture of heartbeats allows biofeedback. An electrooculogramm (EOG)[34] interface also enables the visitor to control the immersive virtual reality environment with a mere eye movement. The electric potentials measured and transmitted with the EOG biofeedback with modeled landscape rendering of virtual grounds, landscapes and natural phenomena such as rain and fire, suggest dialogues with the cosmos, metaphorically having shamanic powers.[35]

Fig. 4. *Heartscapes*,.immersion in a simulated.landscape of the heart at the UCS CAVE, controlled by trackings, biofeedback of heartbeats and electrooculogramm (EOG).


**Software art: seamless, nomadic, mobile and autonomous condition**

Software art is a category of artistic and scientific speculation homologated by the art circuit in its relevant role in Cyberart, and received a special central thematic in art festivals and exhibitions in cultural spaces and critical art domains in the end of the 2000s.[36] Mega-events as Biennials offer software art artworks to a wider audience, and oblige contemporary theorists and art historians to interact in cyber environments in an opportunity to enlarge their repertory, and most people do not know that the code is specially written for the artworks. Software art installations bring to the art agenda complex relationships in its heuristic manner and strong experiential nature of audience actions, by activating visceral transit of paradigms of art and science, synchronized to complex levels of human life. In software art, the language of the code and its algorithmic functions requires collaborative practices in laboratories. Artists who are not scientists work in the engineering artistic power of the system going beyond the code in its technical elements. The logic of the script subverts and transfers mathematic paradigms to articulate metaphors implicit in the art language. The objectives are the construction of identity with multi-sensory interfaces and formalization of subjectivity, ubiquity of telematic systems and nomadic condition, wireless connections and mobility, intelligent and self-regenerated responses. We highlight that the scientific elements of the scripted software in its technical sintaxis are not art, because art is not in the code itself but in the downloaded paradigms and the actions allowed by the software information related to creating art content. In her text *Reaction machines: navigating intelligence, diffusing structures*, Sara Diamond asserted at the 13th Brazilian Symposium on Computer Graphics and Image Processing, Sibgrapi 2000: *In particular, artists have been deeply interested in the ways that software and tools provide structures of language and power*.[37] It is really rare to have a written code to explore the interfaced body in a seamless condition by the artist himself/herself. The code requires the work of artists/programmers as the historical examples of David Rokeby, Myron Krueger, Harold Cohen, Marie Hélène Tramus and Michel Bret, Chu-yin Chen, Ken Feingold, Ken Rinaldo, Ken Goldberg, and the capacity to lead isolated practices, but also inserted in transdisciplinary knowledge. Very common in software art projects is the collaboration between artists and scientists historically answered by Jeffrey Shaw, Gideon May, Bernt Lintermann, Edmond Couchot and ATI scientists and artists, Marie Hélène Tramus and Michel Bret, Rafael Lozanno-Hemmer and Will Bauer, Char Davies, Christa Sommerer and Mignonneau, and Tomas Ray. In Brazil, Aluizio Arcela and Suzete Venturelli, and our group in collaboration with Diana Domingues and the NTAV team, with the special contribution of Eliseo Reategui, in the implementation of autonomy condition, and Gustavo

Lazzarotto, Gelson Reinaldo and Maurício Passos, in the implementation of a proprietary library and nomadic, mobile, autonomous artwork systems.

David Rokeby projects focusing in the subjectivity of the code can be presented as an example of the necessity for programming in artworks. In his text *Why I program*, for the catalog of the Electronic Exhibition at SIBGRAPI 2000, he wrote:

*...The writing of a program is a subjective process. Every program carries the programmers_ point of view. The only thing objective about a computer is the rigidity and literality with which it executes that subjective construction. Writing software is expression, an act of representation and communication, and I am very interested in the ways that it conveys message and meaning.*[38]

Rokeby was referring to his historical *Very Nervous System*, 1982, that constructed real-time soundscapes and/or music to be interpreted, and that accompanied physical gestures of people in their perceptual field. And he affirms about other software he was then working on:

*In working on the "Giver of Names" project I perform the role of an artificial intelligence researcher. I contemplate, model and implement vision systems, systems of knowledge representation, systems of language understanding, and subjective language expression. I suppose I am creating a sort of self-portrait. Every stage in the program is in some way an experiment exploring the question of who or what I think I may actually be. It is a fascinating process for me, giving me a very tangible sense of the ways that we come to understand, extend and betray ourselves through models and digital simulations.*

**Collaborative practices and second interactivity: the autonomy of living systems**

Pertinent projects and relevant researches in Software Art call for the role of the artist-engineer to enhance the technological apparatus, by generating speculative software in complex arrangements of life-like behaviors. A team of researchers led by scientists and artists supported by the technological structure of Labs in Institutions make experts of several disciplines, work together in a network of knowledge adapted to the thematic and nature of each project. Transdisciplinarity triggers the emergence of new disciplines and the expansion of boundaries of isolated disciplines by the transit of art, biology and engineering, computer science, communication, cognitive sciences, anthropology, architecture and others, to attempt conceptual and technical issues of complexity theory and nature of life. Ecology-based concepts and experimental researches with software development require levels of heuristic and logic methodological implication in a synaptic transit of common scientific topics that modify the old collage of practices and technical tasks of multimedia art. The conceptual and technical framework challenges the limits and precepts of other interactive artworks to contribute for autonomy and second cybernetic models in terms of common proprieties of emergence and behaviors during the intervention of the visitors. The systems can also include the use of a variety of multi-sensory interfaces by tactile, breath, microbiological or other body signals transmitted by sensors, microscopes, datagloves, radio frequency identification tags, to respond to special artwork aesthetic purposes. The hands or the whole body of visitors are in a seamless connection with the autonomy of the system responses, by generating a hybrid ecology between biological and artificial systems. The results generate biology-inspired synthetic ecosystems with intelligent simulated evolutionary behavior of organisms. In art engineering, the foundation that is necessary for a theory of the artistic production and creativity is totally implicated on the biological simulated features that do not depend on the esthetic judgment only. In this way, Edmond Couchot[39] coined the expression "second interactivity", meaning the enhancement of predictable responses of first interactive feedback, by adding autopoiesis and self-reproduction of

complex feedback to unpredictable responses and cognitive behavior of algorithms with the capacity to recognize, perceive and articulate independent responses as living systems. On the other hand, the philosophical perspective of the observer included in the system, in an exogenous manner, makes exchanges of external information, sent by participants, with internal information, and the endogenous emergent properties through an evolutionary and autonomous code[40]. Second interactivity shakes the ancient Greek models of equilibrium, stability and certainty, by transforming the visitor into an actuator who actualizes information engaged in mutant capacities to evolve into unpredictable and unimaginable responses. That is life created in the post-biological era related to A-Life, and Artificial Intelligence researches enhanced in the aesthetic dimension of living behaviors and emergent properties lived in virtual environments.

Such experimental researches are a fertile field for collaborative practices in the debate of the post-human as a nonbiological entity in artistic and philosophical ideas of consciousness and self-reproduction machines. Concerning the code, each artificial complex system, in its evolution, is an autopoietic source of surprises defined in mathematical terms and the adaptive capacity to regenerate information. Ellen Ullman, a former software engineer, in her article *Programming the post-human*, *computer science redefines life*,[41] emphasizes that the philosophical challenge for computer science in the scientific view of humanity's role is the project of life. This artworks are based in Computer Science landmark investigations of Neumann's cellular automata; Chris Langton[42] and the concepts of "bio-logic" and "life-as-it-could-be"; John H. Conway and his *Game of Life*[43], and the automaton moving patterns to simulate living beings. Other notorious examples of early artificial life researches are Richard Dawkins' biomorphs (1986) and Tom Ray's *Tierra Synthetic Life* (1991) and their models capable of generating forms in cyberspace that replicate many laws observed in living systems. Another seminal contribution is John Holland's genetic algorithms, and in particular his research at the Santa Fe Institute. Many artists work with software art and simulation of life environmental art. Naming just a few, Karl Sims (1991) is at the beginning of interactive art and artificial life with *Panspermia*, which offers a rich set of computer graphic images to the viewers' selection. Artificial evolution is provoked by people, and promotes features of those images in another generation as a self-replicating system from planet to planet, analogous to planet life. Louis Bec, the French artist and zoosystemicist, pioneered this kind of art research in curious biologies and aberrant systems. Among his creations we can find interactions of fish electricity sent to computers and generating artificial life art. Tom Ray's research explores the chance to write a self-replicating program producing a simple organism and its potential evolution that would be subject to a low rate of mutation. When his first systems were running at Los Alamos Lab, he called Chris Langton and told him he had named the system *Tierra or Earth*. He declared: *What you're seeing is the emergence of global patterns from simple rules*.[44] The use of these techniques in art installations by Christa Sommerer and Laurent Mignonneau provide interactions with cybernetic creatures in collaboration with Tom Ray, in 1994, with the application of artificial life algorithms in *A-Volve.* This piece is one of the first systems where users could actually create artificial creatures, interact with them, and watch them evolve. Rebecca Allen and the UCLA team created landscapes and avatars in *The Bush Soul* and *Coexistence*, which use only one software, called *Emergence*. This artwork explores the role of human presence in an immersive virtual world of artificial life, where a person's "soul" is represented as a sphere of pulsing energy. Both works use multi-sensory interfaces including haptic force-feedback and breath sensors. At the ATI LAB (Art et Technologies de l'Image), Université Paris VIII, since the 1980s, Edmond Couchot and Michel Bret's collaborative practices for interactive art created *La plume et le Pissenlit*, previously discussed as the roots of interactive art. In recent exhibitions, they created a field of dandelion seeds (blowballs) which were displaced by the viewer's breath on the screen. Recently, advanced researches for artificial intelligent creatures at ATI augmented the collaboration of Marie Hélène Tramus and Michel

Bret, creating two relevant artworks: *Dance avec moi* and *Funambule*. These artworks enable the seamless and autonomous condition, through the control of virtual bodies and their adaptive back-propagation capacity resulted from neural networks. The movements of virtual bodies when they dance or swing are in correspondence with body's stimuli through the actions in the physical space of installations. It is the body thinking reaffirmed in virtual spaces, which is discussed by Edmond Couchot's theory of second interactivity. Another important artwork is *Quorum Sensing*, by Chu-yin Chen (ATI Paris VIII), which explores interactors' collective consciousness managed by genetic algorithms in a virtual biosphere resulting from the steps of the users, captured by light sensors. Evolutionary forms of the shadows on the floor, in a self-organization behavior, offer creatures' morphology, and simulated biological behaviors are accomplished by an algorithm of cellular automata.

In *Autopoiesis*, Ken Rinaldo creates robotic sculptures in installations consisting of fifteen robotic sound sculptures that interact with the public and modify people's behaviors over time. The behaviors change according to feedback from infrared sensors acting by the presence of the participants in the exhibition and the communication between each individual sculpture. This series of robotic sculptures "talk" with each other through a computer network and audible telephone tones.[45] Another prominent artist, Harold Cohen created over a period of nearly thirty years, together with Raymond Kurzweil, the software for a screensaver in artificial intelligence to continuously originate paintings in other PCs.[46] Ken Feingold makes his own code for the artwork and investigations in a psychoanalytical scientific approach within the context of his own clinical work, and the collaborative process is not only with patients but also with other clinicians, in order to create simulated personalities to his living sculptures. In *Talking heads spout wisdom*, 2004 interactive installations, *In one room, an argument is brewing between a man and a woman. In the next room, 22 voices share their sexual fantasies - in tones as passionless as a computerized telephone message. The final chamber features three characters exploring a mysterious object in front of them as they speculate about the nature of violence. Nothing gets resolved in any of the conversations, but the memory of them is hard to shake*.[47] Stephen Wilson's recent works create bioart installations in which humans play motion games with live protozoa. He declares: *like a scientist studying a species, I tried to focus on what I was seeing and theorized about its causes and implications. I wondered if I could understand them well enough to predict their behavior. In "Follow-me game" visitors were rewarded for careful observation and in "Control-me game" visitors initiated experiments to try to influence protozoa-colored lights position and sound stimulation.*[48] All the artwork described above unveils the mysteries of life and results in mutual exchanges of biological and artificial ecologies, by generating a hybrid cosmos.

**Seamless, nomadic, mobile and autonomous systems in NTAV collaborative practices**

Our collaborative practices at NTAV Lab initially resulted in multimedia installations, and in the 1990s we started to develop interactive art exploring the interface design to offer the seamless condition or a feedback system to allow the communication between human-computer in environmental sensing, and information visualization. Nowadays, we implement systems for installations to offer nomadic condition, by networked connections, mobile connections with wireless technology. We also investigate the simulation of life using artificial intelligence and a-life to explore the adaptive capacity and autonomy of virtual environments, as well as immersion in virtual reality creating interfaces in multi-sensorial levels which resulted in the implementation of the UCS Cave[49]. The cave was constructed by us, adapting low cost devices, and it is the unique cave in Latin America created for artwork destination. Our practices are mainly dedicated to cyber installations exploring hybrid and complex systems that use wireless connections and the mobile condition of visitors mixed to seamless, nomadic and autonomous condition that are

the central topics of the research framework. The transdisciplinary practices are supported by the Brazilian National Science Council of the Minister of Science (CNPq) and the State Research Foundation (Fapergs), two Brazilian agencies concerned with research in art, technology and science. Some projects also received the support of Itaú Cultural. We also earned founds from international prizes as the *2000 UNESCO Prize for Art.*. Our investigation in Software Art writes specific software and creates hardware and speculative software for the aesthetic conceptual framework of interactivity, immersion, mobility, autonomy and seamless responses, resulted from the collaboration of both artistic and conceptual approaches of engineering art. Diana Domingues' role is that of the engineer-artist in collaboration with scientists in artificial intelligence, as in *Terrarium*, a living synthetic ecology in artificial life to create and control serpents' life, rendered in real time and in evolutionary computation. Iconic interfaces activate the creation of snakes, using a DNA code, running a cross-over function, and a multi-local platform causes every machine in the planet to end snakes to the same serpentarium. Iconic interfaces enable to feed the serpents by giving them animals, and time life is thus enlarged. By giving them heat, the speed of displacements is influenced. Serpents' autonomous behaviors make them recognize their territory and thus respect each other. A multilocal nomadic system with wireless connections employs a PDA computer and an internet search engine to evoke the global collective memory, writing sentences in the serpentarium and bringing responses from the words of scientific, anthropological and artistic databases. The artwork manifests the desire of interventions in ecological emergent properties, and enhances human power to interact with invisible forces of the laws of nature, consequently a shamanic condition related to the Mesoamerican imaginary. In *Firmament_PopStars* (2005) a lake ("eye of the earth") is the mirror to a virtual cosmos, where life is designed by the behaviors of stars, thus creating a living organism (Fig. 5). In stereoscopic vision, the stars represent different myths or pop stars, which inhabit the virtual firmament transformed in image, text and sound icons. The collective intelligent behavior of the environment is given by flocking algorithm and activated by the stars proximity and desire for light. Each star is an agent that wishes to live in community. By using a tablet, the visitors can move points of light on the lake. By moving the stars, autonomous shapes enter in the void of the landscape. Internet searches are performed based on a list of words related to the lives of these myths, which come from a database, and then returned in form of sentences written in the dark walls. Mobile SMS connections of cell phones are also available to send messages, and responses, write sentences, by adding narratives about each myth. Another installation with the same thematic but a totally different art history approach is *I'Myth: zapping zone*. Getting into the room of a "brechó"[50], neon silhouettes of myths and objects, and a videoclip that explores the life of myths in the media. Vibrant colors of pop aesthetics and big amount of objects related to the individual myths explore the poetics of excess. Interactions are activated through the selection and presentation to a barcode reader two objects and, like an offerenda, the labeled objects placed in a transparent table/altar, initiate the identification ritual. Emergent states occur in the room: myths' faces are projected on the large screen on the right. Simultaneously, the words of the barcode label characterize the called myths and a search engine on the Internet gives back sentences written on the rotating faces. Cellular phones may be used to send messages to the myths, being answered by sentences written in similar net searches. It's the global memory, in an open system, bringing acts and values related to myths' characters available in the planetary database. On a second screen on the left, three-dimensional rendered objects belonging to the selected myths are displayed in stereoscopy. They appear configuring an ephemeral existence of virtual objects, contrasting with the material ones that populate the room. Interacting with a long list of words in a touch screen, visitors create new individuals stored in the system and used to generate forthcoming populations. Exploiting this idea of evolution, the installation represents each myth by a set of chromosomes, each carrying a set of genes coming from information categorized as adjectives, nouns, verbs and places. A genetic algorithm code with a fitness function is visualized in three monitors, adding between the real and the virtual of

images the abstraction of the written code. In emergent states, inside this memory space, each visitor experiences the transit between the real and the virtual, going through the physical objects in their materiality, to the artificially generated images, the code, the words, the sounds, creating their own relationship with the values of myths. The visitor is part of the whole and his/her interactions generate the zapping mobile zone of the myths' culture (fig. 6). *VR AQUARIUM* is an environment that mixes virtual and augmented reality installed at UCS cave. Telepresence images of fishes living in an aquarium next to the cave are transmitted and combined with simulated 3D scenes. The body enters in the cave populated by real fishes and synthetic animated fishes in relief by stereoscopic glasses that let the synthetic fishes pass through the immersed body of the visitor. The interaction with the virtual fishes uses a body movements tracker, enabling the touch on the synthetic fishes through simple gestures and activating an artificial intelligence program which gives them a collective behavior based on a flocking algorithm. The virtual fishes move together showing a behavior similar to that of the biological world. The interfaces blur the real and the virtual, confirming the magic of interactive technologies.


Fig 5. *Firmament_PopStars* (2005) a virtual cosmos allowing connections by internet and cellular phones, where stars create a living organism communicating with the global memory of myths in the net.



Fig.6. *I'Myth: zapping zone*, mobile and net connections, artificial life allowing dialogues with the collective memory of myths of human culture.

## Final Considerations

To respond to the complex phenomena of cyberculture connections, collaborative practices in Cyberart replace Leonardo's wisdom by "collectives", and transdisciplinarity truly takes place thanks to cross-intelligence of networked expertise of artists and scientists in an adaptive capacity to regenerate knowledge. A net of disciplines, theories and practices, configure a cluster of investigations in high performance circuits mainly in the domain of human-computer interfaces. Interactive technologies can explore the ontological aspects of human communication and the nature of life. Duchamp's premise of art and life is enhanced by interactive art which blurs the limits between real and virtual. Cyber communication reshapes the human condition and intertwined relationships body/environment/nets ask for scripted software, by creating hybrid realities where people experience seamless, nomadic, mobile and intelligent connections. Manifestations in software art expand life to behaviors provoking social changes in society, by reaffirming the artist/engineer role in cultural activities, as proposed by Walter Benjamin. According to McLuhan, artists have a special task to accomplish by being specialists in perceiving sensorial changes. With the new biologic interfaces, such as prostheses put onto or into our bodies, networked connections, we enhance the human and we reinvent life. This is the challenge for the technological art produced at the rise of the 21st century.

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[10] Belo Horizonte is the capital of the state of Minas Gerais, in Southeast Brazil.

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[36] Such as Transmediale (Berlin), Prix Ars Electronica (Linz) and readme (Helsinki) as well in a thematic exhibition hold in the Whitney Museum (New York), curated by Christine Paul. We recommend specific texts related to the theme:
STOCKER, Gerfried & SCHÖPF Christine (eds.) *Code - The Language of Our Time*, *Ars Electronica*, Linz: Hatje Cantz.
COX, Geoff& KRYSA Joasia "Art as Engineering: Techno-art Collectives and Social Change", BROECKMANN, Andreas. "Software art potentials", and HUHTAMO, Erkki, "Cyberarts, codes and coders: contextualizing software art". In: KLUSZCZYÑSKI, Ryszard W. (ed) *Art Inquires. vol.5* Lodzkie Towarzystwo Naukowe, Lodz, Poland, 2004.

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[47] http://www.kenfeingold.com/BH.html , captured in 25th March 2006.

[48] http://userwww.sfsu.edu/~infoarts/links/bioarts.montreal.present/bioartist.research.present8.html , captured in 27th March 2006.

[49] See fig. 4.

[50] Brechó is a second-hand store, usually cramped with clothes and objects.