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REMATERIALIZED TENDENCIES IN MEDIA ART? FROM SILICON TO CARBON-BASED ART

¿TENDENCIAS REMATERIALIZADORAS EN EL MEDIA ART? DEL SILICIO AL CARBONO EN EL ARTE

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Abstract: The importance of digitality in Media Art theories consolidated the aesthetic of dematerialization, as it shifted the value of materiality in this field. However, the advent of new forms of technological art, such as Bio Art, which uses laboratory technologies in an aesthetic way to manipulate life, demonstrates the crisis of this paradigm and the trend of rematerialization. This paper investigates the role of materiality, even in the more dematerialized realms of Media Art: the digital technologies. We focus on two art forms that combine new technologies and life sciences: Artificial life, which involves the intangible features of Media Art, and Bio Art, which interprets materiality in a radical manner, by choosing life as the raw material for artistic creation.

Key Words: materiality, inmateriality, Digital Art, A-life Art, Bio Art.

Resumen: La importancia de lo digital en las teorías del Media Art consolida la estética de la desmaterialización al alterar el valor de la materialidad en este campo. En cualquier caso la llegada de nuevas formas de arte tecnológico, como el Bio Art, que usa tecnologías de laboratorio para manipular vida de una forma estética, demuestra la crisis de este paradigma y la tendencia a la rematerialización. En este artículo se aborda el papel de la materialidad, incluso en los ámbitos más desmaterializados del Media Art, los de las tecnologías digitales. Nos centraremos en dos formas artísticas que combinan las nuevas tecnologías y las ciencias de la vida: el arte de la Vida Artificial, que presenta características intangibles asociadas al Media Art, y el Bio Art, que presenta la materialidad de una forma radical al elegir la vida como la materia prima de la creación artística.

Palabras clave: materialidad, inmaterialidad, arte digital, A-life Art, Bio Art.

1. Media Art: between A-Life Art and Bio Art

Like any art term, Media Art is problematic, as it encompasses extremely varied forms of expression. Moreover, Media Art tends to be considered apart from mainstream contemporary art. There is no agreement on the boundaries of this art form. It is sometimes understood as a synonym of Electronic Art, meaning the use of electronic and digital technologies for artistic purposes (Giannetti, 2002). It can also refer to the use of new technologies, as a synonym of the expression art and new technologies (Jana & Tribe, 2007). This second definition expands the boundaries of Media Art considerably to include not only computers and communication technologies, but also technological fields such as biology, physics or chemistry. Additionally, Media Art forms are often related to scientific developments, so other terms that are used are Science Art or Sci Art (Da Costa & Philip, 2008; Wilson, 2010) or, in more general terms, a reference to the context of 'art, science and technology' (Alsina, 2007; Wilson, 2002). Beyond the theoretical definitions, differences and uncertainties, there is some agreement on the existence of common ground among the different Media Art fields and works. Consequently, Media Art can be considered to have an identity that is isolated from mainstream contemporary art. What is true is that Media Art has developed an independent system based on exhibitions and festivals (such as Ars Electronica), theoretical production (with a remarkable number of artists working as theorists, such as Roy Ascott, Steve Wilson, the Critical Art Ensemble or Eduardo Kac, to name a few), and platform media (such as the Leonardo journal). In this report we refer to the more inclusive sense of Media Art, to identify the aforementioned common ground and explore explanations and contradictions within this field.

An analysis of the reasons for the impermeability between Media Art and mainstream contemporary art (see Shanken, 2011) is not the purpose of this text. However, we will try to explore how certain criteria, such as newness or the use of technology, can contribute to understanding elements within Media Art and to highlighting its need for flexible boundaries. Thus, we aim to identify relationships among works that are considered Media Art and those that are not, and to support the exchange of analytical methods from one field to the other. This text focuses on the internal contradictions in Media Art that result from bringing together works that are essentially different. Constructive criticism is needed on the rigidity of certain taxonomies applied to the field of art and (new) technologies. The

starting point for the present analysis is that differences in specific works can justify their belonging to separate and simultaneous taxonomies. We promote the flexibility required for media works to be analyzed from different, complementary perspectives.

The question Rematerialized Tendencies in Media Art?, in the title of this text arises from the difficulty of including in this field a form of artistic expression such as Bio Art, which uses life as a raw material to investigate the application of biotechnologies. The issue is that immateriality has been used to explain much of Media Art production, especially that which involves artistic applications of digital technologies. Therefore, there is no easy answer to this question, as it addresses the very nature of Media Art boundaries, which can accommodate heterogeneous sets of works. In a way, the concept of a rematerialized tendency implies that material and immaterial paradigms are opposed or occur in a sequence in the history of Media Art. However, what we propose here is a model of coexistence, in which we claim that materiality has a value, even in those cases where immateriality or dematerialization has been considered a defining feature.

The centrality of information, the raw material in digital works of art, is the main reason for the development of an aesthetic of dematerialization, which has been theorized about in terms of: immateriality (Lyotard, 1985), disappearance (Virilio, 1980) or absence (Weibel, 1997). Information is related to applications such as software design, computer codes and the possibilities of virtual reality and networking. In the aesthetic of dematerialization, information is considered independent from a material substance and can be transformed, reproduced or shared by virtue of its digital nature. The undervaluation of the devices that host these information materials and allow their manipulation and operation (computers and interfaces) underlies this aesthetic paradigm.

Within this information-based paradigm, art that has arisen in the biotechnological age brings new challenges to the understanding of Media Art. Bio Art is the most accepted term for this artistic field, although its boundaries have been a focus of debate (see Hauser, 2005). From our point of view, Bio Art refers to works that reflect on biotechnology-related issues using living material (such as cells, organisms, tissues or whole organisms) that are manipulated by laboratory technologies (including genetic engineering, tissue, microorganism and cell cultures). Bio Art focuses on works in which material is conceived in behavioral, technological and ontological terms that do not fit an understanding based

on the immateriality of the art object. The special nature of living work in Bio Art is symptomatic of the above mentioned rematerialized tendency in Media Art, as claimed by Hauser (2005, 2008), Alsina (2011), Jagodzinsky (2012), and, before of them, by Ascott (2000). He coined the term Moist Media to name the integration of digital (dry) and biological (wet) elements. The coexistence in Media Art of such different conceptions of materiality calls for theorizing about a suitable aesthetic for the material nature of these new practices and a review of the importance of materiality in the history of Media Art.

As an interdisciplinary form, Bio Art also reaffirms the relationship between art, science and technology in the biotechnological age, and explores new realities through the historical relationship between art and nature. It is therefore interesting to examine together the two art forms that link new technologies and life sciences: the art of Artificial Life or A-Life Art, and the art of experimental biology or Bio Art. Bio Art and A-Life Art have a common interest in models and theories from biology, but clearly differ in their material nature and in the ontology of their artistic productions. The source of this divergence lies in the use of digital technologies in the case of A-Life Art, and the use of biotechnology in the case of Bio Art. The main difference between the technologies is clearly a material one: silicon-based works in A-Life Art, and carbon-based works in Bio Art. A-Life Art and Bio Art are two different but coexisting conceptions of materiality in the history of Media Art that have been applied to such a sensitive field as the living. The material conditions of the work of art are not neutral as they concentrate on a particular definition of life. Neither are they secondary, as they influence the behavior and effects of the art object.

The answer to the question in the title prompts a critical review of the role that materiality has played in Media Art. First, we will describe the theoretical origins of the aesthetics of dematerialization and the technological reasons why this theory is possible in the context of the digital revolution. Below, we propose a revision of the nature of digital technologies. We assert the importance of materiality, understood in a broad sense, ranging from the need for a material substrate in works of art to the importance of the body in the experience of digital works. Our aim is to recover an integral vision of Media Art. In this approach, discourses of dematerialization are compatible with the material nature of digital works, which forms the basis for their production, presentation and reception. Once this overview of Media Art has been presented and in light of its materiality, we will address the impact

that these models have had on the comprehension of A-Life Art and Bio Art, the two major art forms that have related art, new technologies and life sciences to date.

2. Digitality and immateriality

The exhibition Les immatériaux, held in 1985 at the Georges Pompidou Centre in Paris and curated by the philosopher Jean-François Lyotard, marks a landmark in the theorization of an aesthetic of dematerialization. This exhibition aimed to explain the existence of a postmodernist immaterial condition, as a result of the inrush of developments in the field of technological sciences, electronics and computing. Les immatériaux was not based on art history, but on philosophy. The aim was to transfer some ideas to the format of an exhibition (Rajchman, 2009). As we will see, dematerialization is in some way more an idea than a reality of Media Art. From this point of view, the exhibition established the theoretical foundations of immateriality as the defining trait of postmodernism. From a different perspective, the theorization of the immaterial condition of technology means that Media Art works can be included in the tendency towards artistic dematerialization. This tendency may have begun in the 1960s, as Lucy Lippard (1973) stated with the growing presence of new artistic experiences tagged as conceptual art.

As pointed out by Claudia Giannetti, the dualism used to interpret materiality is the reason for its diminished role in technology: "matter versus logistics in computers, matter versus form in the analysis of an artwork, matter versus spirit in philosophy and theology, matter versus energy in classical physics, matter versus state in modern physics..." (Giannetti, 2002: 89, in Spanish in the original text, own translation). This classification anticipates some of the variations of immateriality (logistics, spirit, energy or state) in the emerging information technologies developed in the last decades of the twentieth century. At the end of the twentieth century, a renewal in the field of art resulted from increasing experiences, such as the fluidity of information, virtuality or telepresence. From a deeper point of view, the dematerialization associated with digital technologies is based on a mechanistic view of the human, in which a reductive parallelism is postulated between mind-software and body-hardware, as stated by Pau Alsina:

> "For many years the computer was associated with the mind in a clear parallel with the classical Cartesian image that conceives human beings as machines. The image of

> the body understood as a clock remains in effect in the assumption of the implicit equivalence of the computer understood as a metaphor for the human brain. This equivalence extends to the association of the body as hardware and the mind as software where the role of the body as a factor that doesn't constitute non-cognitive experiences is rejected" (Alsina, 2011: 152).

The theory of dematerialization has also been raised in radical terms, reaching technophile formulations such as that of transhumanism, which postulates a post-organic existence. This disembodied existence is based on renouncing the body and transferring the information stored in the neural networks of the brain to a computer memory. This process is called uploading and is defined by the transhumanist association Humanity+ as follows:

> "Uploading (sometimes called 'downloading', 'mind uploading' or 'brain reconstruction') is the process of transferring an intellect from a biological brain to a computer. One way of doing this might be by first scanning the synaptic structure of a particular brain and then implementing the same computations in an electronic medium. (…) A widely accepted position is that you survive so long as certain information patterns are conserved, such as your memories, values, attitudes, and emotional dispositions, and so long as there is causal continuity so that earlier stages of yourself help determine later stages of yourself. (…) An upload could have a virtual (simulated) body giving the same sensations and the same possibilities for interaction as a non-simulated body" (Humanity+, n.d.).

The literalness of dematerialization in transhumanism is radically utopian, but it is symptomatic of dematerialization theory in the technological imaginary.

Other versions of dematerialization have been proposed in more realistic terms that do not focus on the elimination of physical existence, but on an appreciation of the new dematerialized experiences provided by new technologies. For example, Peter Weibel analyses the subject in terms of an Era of Absence that is the result of developments in telecommunications and particularly virtual reality and telepresence. According to Weibel, these technologies have promoted the reinvention of traditional concepts like space and time, rather than the disappearance of material existence:

> "The immaterial space of telecommunications, dematerialized virtual space of the technological age, is not only a space of absence, a missing space, but also a new space of presence, telepresence, a new space beyond the visible, which has always been there, but could never be seen. The techno-time or techno-space are placed beyond the physical experience, areas that have become experienceable by means of telematic machines, invisible spaces of time" (Weibel, 1997: 110, in Spanish in the original text, own translation).

The development of an aesthetic of dematerialization is based not only on the discursive production of ideas, but also on the development of information technologies and their conceptualization. Digital culture had a major impact in the last decades of the twentieth century, especially in the 1990s, when computer technologies became more affordable both economically and functionally. Digital technology is based on the potential to fit any kind of material into digital information, i.e. a set of combinations of 1s and 0s (binary code) that are interpreted by a computer. Once information has been encoded using this system, opportunities to reproduce, manipulate or move it multiply, pushing materiality into the background. As Christiane Paul, a curator specialized in new Media Art at the Whitney Museum in New York, says, it is the informational nature of digital works that allows their theorization in terms of immateriality:

> "In the digital age, the concept of 'disembodiment' does not only apply to our physical body but also to notions of the object and materiality in general. Information itself to a large extent seems to have lost its 'body', becoming an abstract 'quality' that can make a fluid transition between different states of materiality. While the ultimate 'substance' of information remains arguable, it is safe to say that data are not necessarily attached to specific form of manifestation. Information and data sets are intrinsically virtual, that is, they exist as processes that are not necessarily visible or graspable, such as the transferral and transmission of data via networks" (Paul, 2003: 174-175).

Digital culture allows material to be transformed into information, which provides fresh possibilities for the theorization of immateriality. If we focus, for example, on the reproduction of digital images via a digital camera, there is a break in the continuity between material reality and the digital image (the original and the copy), which in fact

characterized analog media. In digital representation, the referent is transformed into a set of data that are recoded. The aim is to simulate a representation, which is much more of new production (similar in appearance to the referent) than a material reflection of it. That is why digital reproduction is more of a simulation process than a representation: the encoding process converts the digital matter into something essentially different, an algorithmic combination of information that can be understood by the computer. In digital culture, any material can be translated into a computerized code, which seems to diminish the importance of its material specificity:

> "The digital image consists of discrete, modular elements, pixels that are based on algorithms, mathematical formulas. While bits are still essentially threads of lights, they do not by nature require a physical object to 'represent' and are not based on a principle of continuity with a real world" (Paul, 2003: 48).

The discontinuity between materiality and digitality is found not only in the field of image reproduction, but also in the intrinsic potential of digital technology, based on the use of information elements. The Digital Revolution has been made possible by exploring options based on the digital nature of the new media forms. Some of the characteristics of digital media are: large storage capacity and fast data accessibility, data storage combinability and connectivity, capacity to change, convertibility of information through code handling and software design, testing simulations, i.e. the ability to generate effects that are indistinguishable from those produced analogically, and interaction between digital devices and users (Carrillo, 2004: 62-63). All these possibilities are investigated by Digital Art, a generic term which covers all the artistic practices that use digital technology. Digital Art has several sub-disciplines, named after the aspect that is highlighted in each case. Some examples are Software Art which focuses on the development of computer codes; net.art, in which the Internet is the artistic medium; or, Virtual Reality, Interactive Art and the Art of Artificial Life, which we will describe later. Digital Art is not a pure art form but a hybrid one that uses different strategies simultaneously, such as software design and an internet connection.

It is not the aim of this paper to provide a catalogue of works of Digital Art, but to give some examples that may be considered representative of our reasoning. In this regard, a piece by Mark Napier entitled Shredder 1.0 (1998) presents a very clear formulation of the

extent of Software Art. The existence of a term like software art is in itself symptomatic of the attention given to the potential of digital media in terms of immateriality, as the artistic aim is to develop a computer code, rather than to consider technology merely as a tool for the production of traditional works. This artwork, which is accessible via the Internet, consists of a program (Shredder) that recombines information from a source code (a URL that the user can type in). When the URL is introduced, the program rearranges the information received and displays it in a new format as an image. Thus, Napier demonstrates the particular syntax that lies behind the appearance of a web site (i.e. the code) as well as the possibility of recombining information. If the URL is typed into the filter shredder again, a new and different combination arises. This example illustrates some of the possibilities of Digital Art, especially in the field of software design and the capacity to recombine digital information. But what is the role of materiality in such works?

3. The other side of digital technologies: their materiality

As seen above, the aesthetic of dematerialization has played an important role in theorization about Digital Art and, by extension, Media Art. The main reason for the association between digitality and immateriality is the informational nature of digital technologies, and their multiple possibilities and ramifications. This issue should not mask the need for data storage devices to operate the codes or interact with digital material, as well as the importance of the body as a platform of experience.

The purpose of this section is to show the other side of Digital Art, but not from a techno-deterministic perspective, which is opposed to dematerialization. Instead, we combine both realities. The discourse of dematerialization takes shape in works of art in which materiality is essential; not only from the perspective of the physical and objectual nature of any digital entity, but also in terms of the reception of the work. Reception in art history can be understood as a form of interactivity from a mental standpoint (there has always been interaction between receptor and work). Interactive digital devices require added physical involvement: the body´s receptor. This is what Erkki Huhtamo analyzed in terms of Tactile Art (Huhtamo, 2007). The claim for materiality in Digital Art focuses on internal (the work itself) and projective (relative to the receiver, who can also be called the user or interactor) dimensions. This claim is essential to understanding new forms of exploring materiality, such as Bio Art. Although Digital Art is not fully covered by a formalistic

explanation, the value of mediality is undeniable, as it is in the basis of key features such as interactivity, information flow or recombination capacity. Paul highlights the importance of this aspect in Digital Art: "it is important to be aware of the formal aspect upon which the art is based. Ultimately, every object – even the virtual one – is about its own materiality, which informs the ways in which it creates meaning" (Paul, 2003: 70).

If we go back to Napier´s work, Shredder 1.0, it is easy to appreciate that beyond a reflection on the recombination of digital data, a material reality affects the entire creative process, from production to reception, namely the need for interfaces (like the computer) to design the software, display the programs and connect a user with the digital material. The fact that we constantly use devices such as computers has made their interface reality almost transparent, and we are prone to forget that the physical reality through which a user experiences digital material is unavoidable. In this section, we stress the role of material devices in explorations of digital technology's artistic possibilities. We analyze two art forms that we will use as a case study: Interactive Art and Virtual Reality. These two fields are closely related, as Virtual Reality is based on the technological possibilities of Interactive Art.

Interactive Art can be defined as part of Digital Art. However, the term can be extended to art forms that are not necessarily technological, but explore relationships between art and audience, as in performance art. From a technological point of view, Interactive Art is defined by the use of interfaces to provide a communicative exchange between the public (the user) and the work (the system). The emphasis of interactivity may be either on its communication and information potential or on the technical devices that enable this apparently dematerialized fluidity of communication between man and machine.

The relationship between human and machine requires an intermediary to make it possible. Alan Turing (1950) and Abraham Moles (1958) noted very early on the need for an intermediary to unify the respective codes of man and machine. The need for a converter of the symbolic code of human language into the binary code used by computers led to the invention of the interface that both merges and separates the interactor and the machine (Zielinski, 1999). Prior to the appearance of the Internet, and even to the development of digital technology, there was a term for the autonomous capacity of technological systems: cybernetics (first coined by Norbert Wiener, 1948). The aim of cybernetics is to create

systems that automatically respond to circumstances, according to predetermined orders. In other words, cybernetics involves systems that can control complex processes, i.e. the main logic of how computers and the Internet work. The advent of the interface, in conjunction with cybernetics, led to the emergence of the interactive model.

One of the most successful applications of the interactive model is Virtual Reality, which can be defined as a built-computer-reality that users can virtually explore. Theorizations of dematerialization are numerous, but most of them have focused on the idea of disembodied experience as a synonym for virtual experience. Sherrie Turkle (1995) sets out one of the most interesting ideas and formulations concerning the dissolution of body and identity into a distributed, ubiquitous presence that is brought about by the implementation of the Internet and the immersion of a subject in virtuality. However, despite the meaning of immateriality as a feature of digital aesthetics, we must not forget the importance of the materials that enable us to operate and access the immaterial world of digitality, as Paul states:

> "On one level, this form of virtual reality constitutes a psychology of disincarnation, since it ultimately promises the possibility of leaving the obsolete body behind, and inhabiting the datascape as a cyborg. From this point of view, virtual reality is the manifestation and continuation of a flight from the body that has its origins in the fifteen-century invention of linear perspective vision. However, the concept of disembodiment radically denies the physicality of our bodies and reality of our interaction with computers, which still very much is a physical process that in many ways forces us to conform to the set-up of a machine (e.g., wear a headset)" (Paul, 2003: 125).

Virtual Reality always needs an interface to make it possible. This technological requirement is not just a technical detail; the body must be actively involved as an interactive agent. Interactivity does not arise metaphorically (as a mental exchange between the work and the receiver), but in material terms: touching becomes the paramount sense of the interactive experience as the work cannot function without it. It is significant that in art-theorized terms of immateriality, touch (rather than sight, as in traditional art) is the relevant sense, thus revealing not only the materiality of the work itself, but the presence of a sensitive body that interacts (physically) with it:

> "No matter how advanced, fast, detailed or life-like these technological reflections might become, they still need our body in order to exist. There is no virtual world without a real person experiencing it; there is no extension of the senses or the actions without real senses and actions to extend. There is, in fact, nothing without the presence of the body. It is through dynamic relationships, through action and the senses, that the notion of reality comes about, and thereby our notion of our own existence" (Petersen, 2006: 97).

An artistic example of Virtual Reality is The Able Skin (1996), which was created by the architect Emilio López-Galiacho, together with Rafael Lozano-Hemmer and Will Bauer. This work consists of a large and interactive virtual wrapping that covers monuments (like the Palladian Villa Rotonda, the Parthenon or the Leaning Tower of Pisa). The layer covering the building acts as a screen on which many kinds of information can be displayed. On the outer side of this skin, images of the real building are projected through a closed-circuit camera, located inside the actual monument. On the inner side, large-scale images are projected, as well as data from information flow generated in the network. Users interact with the equipment by holding two small ultrasonic sensors in their hands, which control a 3D virtual environment, projected on the screen. The two sensors establish the user's perspective in the virtual world. Users' decisions are established primarily through their arms (which trigger the sensors), although when a user´s body approaches the screen, a zoom into the world is activated and, if the word enlace (link) that is projected onto the floor is crossed, another perspective is accessed.

This work illustrates one of the possible forms of the aesthetic of dematerialization (which has to do with the dynamism, fluidity and processuality of the work). However, it also highlights the importance of materiality in terms of the significance of the devices that make the work accessible to the receiver, and the presence of a body as the main agent of interactivity through the senses and intellect:

> "despite the apparent disembodiment associated with computers – commonly perceived as aseptic machines of calculation – and the immateriality of processed data, the body gets a more relevant role. And so we may dare to predict that this renewed relevance of the role of the body and materiality manifests the transition from a conception of a culture centred on the visual to a conception of a culture in a

> haptic slope (...): a shift in the centrality of vision in favour of the internal bodily senses such as touch or self-movement" (Alsina, 2011: 152).

In a work like The Able Skin, not even haptic vision, which was first proposed around 1900 by Adolf Hildebrand and Alois Riegl and defined by Huhtamo (2007: 73) as tactile vision, is enough to explain the project. Interactive works are not made to be contemplated from some distance, like traditional artworks. Instead, they are there to be touched and experienced in close proximity, which implies rethinking the existing relationship between materiality and immateriality in Media Art.

Materiality has played an active and significant role in Media Art, not only in fields such as robotics or bionics, but also in Digital Art. As a result, a suitable analytical model should be established to understand new forms of materiality including Bio Art, a new rematerialized trend, and A-Life Art, which corresponds best to dematerialization discourses.

4. Media Art, materiality and the life sciences

In the following paragraphs, the above materiality-immateriality issues are considered in an analysis of two forms of technological art that take biology as a reference. These are the Art of Artificial Life (A-Life Art) and the art of experimental biology (Bio Art). Today, Bio Art and A-Life Art are active, simultaneous artistic fields (their strategies combine, blurring the boundaries between them). Artificial life as an art form emerged in the late 1980s and was consolidated in the 1990s, while Bio Art, with some important exceptions such as the artists George Gessert, David Kremers or Joe Davis, has developed since the late 1990s.

In this paper, A-Life Art and Bio Art are approached from the perspective of the above discussion. However, we should add another factor, which is the relationship with life and the possibility of manipulating it through technology. The difference in the technologies used in each case (computers in A-Life Art and biotechnology in Bio Art) means that these art forms can be seen as contrasting, especially if we consider the modification experienced by living material (silicon or carbon-based) in each case. Despite these differences, which can be explained as a reflection of the tension between the material and immaterial that characterizes Media Art, there are potential points of similarity between these art forms, in areas such as the conception of life and the impact of information theories on theorizing

about life. The aesthetics and ethics of A-Life Art and Bio Art merge in terms of material and technological traits, which have to be carefully considered.

4.1. The Art of Artificial life: A-Life Art

Artificial life can be defined as the area of scientific research that produces computer simulations of living organisms, i.e. life is reduced to its information logic, reproduced by digital media. The term was coined at a meeting organized by Christopher Langton at the Laboratory of Los Alamos (New Mexico) in 1987. Artificial life arose as a result of developments in two main fields: molecular biology, which allows a syntactic, informational conception of life, reduced to the genetic code, and information technologies, which enable information-based programs to be created.

Regarding molecular biology, the discovery of the structure of DNA by James D. Watson and Francis Crick around the middle of the twentieth century led to the establishment of the genetic code and the development of molecular genetics from the beginning of the 1970s (including recombinant DNA techniques). The genetic model has considerable conceptual implications. It enables life to be conceived as (and reduced to) a set of information units (genes) whose combination determines the final form of living beings. The advent of this new scientific paradigm, and the establishment of a human genetic map (genome sequencing as part of the Human Genome Project), allows a shift from the conception of the body as an anatomical unit to that of a combination of pieces of meaning (López Gómez, 2002: 1-2). This genetic body has been understood as a textual body that can be read through genome sequencing, written via genetic engineering and, of course, rewritten through genetic modification (Aguilar, 2008: 10). The genetic model facilitated the assimilation of the living form to information, paving the way to its reproduction by computers.

As mentioned before, the development of digital technologies has promoted the conversion of material to data, and has allowed the creation of programs, codes (software) and virtual simulations on computers. According to Alan Turing, the origin of the use of computers to reproduce living systems is the fact that any predictable system can be reproduced by a machine. This theory has formed the basis of the production of artificial intelligence systems (since the 1950s) and led to the emergence of artificial life in the 1980s, when the

concept of life in information terms just needed suitable technologies to develop simulations. The convergence of biology and informatics is based on the premise that biology can be understood as a mechanical and calculable system and, thus, capable of being reproduced.

The nature of artificial life is ultimately representational. In other words, the aim is to imitate the logic of living systems, to produce simulations of them. The origins of using technological means to imitate life are remote. As noted by Ingeborg Reichle (2009: 146-150), they date back to the eighteenth century, when the first automata were created. Influenced by the mechanistic conception of the human (from René Descartes in the seventeenth century to Julien Offray de La Mettrie in the eighteenth century), the production of the first automata was focused on imitating dynamic and morphological traits (shape and motion). Two centuries later, information technology has made it possible to imitate the internal functioning of life, i.e. the logic of life, rather than the external appearance. Therefore, the historical development of the imitation of life by technological means corresponds more to the traditional definition of nature as natura naturans (meaning nature as an activity, as a power of functioning and creation) than to natura naturata (meaning a passive conception of nature, i.e. nature as products and things). The relationship between art and life has been one of the main topics of aesthetics from ancient times to now, from the theory of mimesis that governed artistic creations during centuries, to the negotiations of boundaries between art and life in the twentieth century.

Artificial life (which is basically a computer-based discipline) suggests a division between the logic of life and that of organic matter, i.e. it separates the laws which govern life from its material reality. Therefore, artificial life can be considered to be perfectly in line with the aesthetics of dematerialization associated with digital technologies. Artificial life intends to shift the material logic of life and transfer it to the logic of computers. It is in such terms that Langton explained the difference between experimental biology, which deals with 'life-as-we-know-it', and artificial life, which deals with 'life-as-it-could-be' (Langton, 1989: 1).

There are two approaches to the ontological consideration of products derived from the implementation of artificial life technologies: the radical position (represented by Langton), which suggests that artificial life is capable of producing entities that are truly alive; and a much weaker position, which considers that artificial life produces simulations of life, but

not life itself. As Edward Shanken states, the radical artificial life position is based on a fallacy, given that the entities are considered to be alive by the mere fact of sharing some qualities that are also found in life 'as-we-know-it' (Shanken, 1998). Some of the characteristics associated with life in its material form are indeed shared by artificial life. For example, artificial life creates digital organisms, which can self-reproduce and react to its environment.

Karl Sims is one of the pioneer artists of A-Life Art. Sims experimented with computer technologies in his first investigations in Locomotion Studies (1987) and Particle Dreams (1988). He later developed pieces such as Evolved Virtual Creatures (1994) and Galapagos (1997), in which he worked to produce virtual entities, subjected to evolution processes. Unlike other computer visualizations, these works rely on the use of software programs that reproduce certain evolutionary principles, such as mechanisms of environmental adaptation, natural selection, reproduction and mutation. He uses algorithms (known as genetic algorithms) that set the standards of behavior of the virtual entities. The work Galapagos (1997), for example, consists of an installation of more than ten screens inhabited by virtual creatures, which are created by a genetic algorithm. The viewer may interact with these creatures by selecting or rejecting them (through an artificial selection process). Selected creatures replicate the logic of living organisms: they reproduce, mutate and generate offspring that share their parents' traits by combining the information that they contain (evolution and inheritance). In addition to the inherited information, a random component is involved in the development process, which tries to reproduce the mechanism of natural selection.

Sims´ virtual creatures share characteristics with organic life (they reproduce, combine their genetic information, mutate due to evolutionary process, etc.). What mainly separates them from natural life is that they are based on silicon (computer) rather than carbon (organic). In addition, the information that regulates them (that is coded in the genetic algorithm) does not come strictly from nature itself, but from the way a biological theory (in Sims´ case, evolutionary theory) interprets nature. Therefore, artificial life tells us more about the computer technology that makes it possible and about the biological theory that is its inspiration than about actual life. That is why artificial life belongs strictly to the field of potential biology (life-as-it-could-be), but not to experimental biology (life-as-we-know-it).

Artists Christa Sommerer and Laurent Mignonneau have extensive experience in this field and have explored the interaction between artificial life and natural life in their work Interactive Plant Growing (1992). This artwork consists of the installation of various natural plants which have sensors fitted in their roots to detect the electrical impulses that occur in the plant when it is touched by a user. By means of a program designed for this purpose, these impulses lead to the configuration of images of virtual plants on a screen located opposite. The aim of this artwork is to explore communication between two concepts of life: biological and digital. Its dependence on interactivity and on the user's actions indicates the importance of the body and materiality, stressing the connections between organic life and vitality in the field of artificial life. However, the boundaries between the living and non-living are respected in this work in which organic and digital life coexist. In artificial life, the natural and artificial are connected, but the boundaries between them are perfectly defined. They are only crossed when the technological intervention does not affect a computing environment, but is applied to life itself and modifies the logic of life through its very materiality.

4.2. The art of experimental biology: Bio Art

Bio Art is a generic term that covers a diverse set of artistic practices within the context of art, biology and technology. There is a debate about the inclusion or exclusion in Bio Art of artistic practices in which bio(techno)logy is just a topic, expressed through traditional media such as painting, photography or sculpture, without using media from experimental biology. Jens Hauser has supported the need to distinguish between biotopic (biology as a topic) and biomedia (biology as an artistic medium). He argues that it is absurd to bring together different art forms because they deal with the same subject:

> "Bio-fictional manifestations such as chimera-sculptures, DNA-portraits, chromosome-paintings or mutant depicting digital photo-tricks are no more examples of Bio Art than Claude Monet´s impressionistic paintings could be classified as Water Lily Art or Cathedral Art" (Hauser, 2005).

Indeed, we believe that living material gives a special meaning to Bio Art that cannot be found in a thematic approach to it. The use of living material locates Bio Art in empirical reality. The discourse of modification of life (which is inherent to biotechnology) is offered

to the spectator primarily as an experience of presence. Therefore, we understand the term Bio Art in the sense of biomedia.

Artificial life mirrors life in the form of computer simulations. In contrast, Bio Art brings us face to face with life in all its materiality, a type of life that (as in the field of experimental biology) is subjected to technological interventions in an organic way. A-Life Art meets criteria of representation (or, strictly speaking, simulation), whilst Bio Art does not fit the criteria of representation or the aesthetics of dematerialization. If we return to the importance of materiality in Media Art (both in the work itself and in the experience of the spectator), Bio Art is above all a 'living presence' (Tratnik, 2007). Therefore, its features and behaviour respond better to some reflections based on materiality (and the effects of presence) than to a disembodied aesthetic. The kind of materiality used in Bio Art is essentially different from that of Digital Art. Bio Art deals with life literally, addressing ontological, epistemological and ethical issues. Moreover, biological material promotes changes in the experience of the spectator. The role of body we described regarding Interactive Art, is explored in Bio Art in a qualitatively different way. It is based on the concept of empathy that derives from the fact that the spectator and the artwork share a defining trait: their living materiality. Hauser describes this in terms of co-presence (Hauser, 2008), as far as the art work and the spectator are both living beings sharing the same time and place (that of the exhibition).

The first steps in Bio Art (in the mid 1980s) show the clear influence of information theories. In fact, the roots of Bio Art (similarly to A-Life Art) can be found in computer technologies and in the development of molecular biology, which led to an information conception of the gene (see the previous section). Artists like Joe Davis (in the pioneering work Microvenus, 1986, for example) or Eduardo Kac (in works like Genesis, 1999) explored this issue, in which the idea of the information encoded in a gene sequence is a defining feature. Davis´ Microvenus involves the production of a genetically modified organism (an e-coli bacterium). The bacterium was altered by introducing extra-biological information (a synthetic gene) into its genome. To do this, Davis took a mythical image associated with femininity (hence the use of Venus in the title) and translated it into a DNA sequence by designing a translation code. This code enabled him to reduce the image to a sequence that was compatible with the structure of the DNA – note the parallels with

the digitization process. Once this information had been obtained, Davis designed a synthetic DNA sequence, which he introduced into the genome of the bacterium. Thus, the genome of live bacteria contained the genetic information of this coded image of femininity, but at microscopic scale, hence the name Microvenus.

This pioneering work in the field of Bio Art clearly shows the impact of computer technologies and genetic theories. More specifically, it illustrates the information conception of the gene, and considers the equivalence between genetic code and computer code. The growing importance of genetics (that increased with the development of the Human Genome Project in the 1990s) and the interest of artists who followed Davis in this field led to the proposal that this was a specific art form, called Genetic Art. During the 1990s, we could say that Genetic Art was a synonym of Bio Art (a term that wasn't yet proposed). Although they occurred simultaneously and were both drawn from information theories and molecular biology applied to the understanding of life, Bio Art and A-Life Art resulted in very different artworks. The differences, as noted above, are based on the material associated with life. In Bio Art, this is carbon-based (biological), whereas in A-Life Art it is silicon-based (digital). All other differences follow on from this material distinction, including the use of computer system technologies or biotechnologies, the status of the work as simulated or real, and the interactive nature of works. Revealingly, the 1993 edition of the Ars Electronica festival was dedicated to both these forms of technological art, with the life sciences as a reference. The festival was entitled Genetic Art - Artificial Life, although it was mainly focused on the latter.

The organic nature of living material is therefore crucial to understanding Bio Art. In addition to describing the information conception of genetics, which is the basis of his work, Davis emphasizes the value of a living element, such as a bacterium: "The Microvenus DNA now resides in a bacterium that is a delicate 'living carriage' that cannot ordinarily withstand exposure to air and sunlight. In fact, it was chosen because it could be easily destroyed" (Davis, 1996, 72). The exploration of the characteristics of living material (its fragility, in this case) is a characteristic of all Bio Art. However, Bio Art has now transcended genetic limits (Genetic Art), and involves other technological applications such as cell, tissue and microorganism cultures.

In its material dimension, Bio Art points to the existence of a rematerialized tendency in Media Art, owing to the fact that the material is not neutral: the vitalism of Bio Art work (Mitchell, 2010) affects its behavior, both temporally and spatially. This tendency is also found in the philosophical and ethical implications of the ontology of Bio Art works which are halfway between natural and artificial, human and animal, technological and biological, and living and nonliving (González, 2011). The importance of materiality in Bio Art should not be understood as a conservative return to the materiality of the artistic object, which is a tempting interpretation if we contrast the assumed fluidity of digital content with the specific material nature of Bio Art works. Instead, we must take into account the characteristics of the specific material used in Bio Art. Life has its own autonomy, a potential of creativity and growth, which can be controlled by technological means, but not always totally as expected. Life is, thus, a procesual material, which affirms its presence, involving contextual traits and strategies, which are mainly performative and similar to non-traditional art works. In this sense, we might say that the roots of Bio Art are in those movements which, from the mid-twentieth century onwards, altered the spatial and temporal conditions of the art object. These include Performance Art, Conceptual Art, Land Art, Body Art, etc. An approach based on art history shows that Bio Art draws, at least, from two sources: an exploration of the processual and transformative features of a work of art (which is also present in Digital Art), and the idea that materiality is a trigger of artistic experience.

One of the clearest examples of the exploration of the effects of presence (and its effects on the spectator) in Bio Art is Transgenic Bacteria Release Machine (designed by the group Critical Art Ensemble in collaboration with Beatriz Da Costa). This consists of a robotic installation produced as part of the GenTerra project (2001-2003). This machine contains ten closed samples of bacteria. Nine of them are unaltered, but one has been genetically modified by introducing human DNA. The spectator can decide whether to press a red button that activates the machine so that it randomly selects and opens one of the samples, like a game of Russian roulette. This artwork investigates fears derived from the coexistence of two living beings in the same space, drawing the attention to the idea of co-presence (Hauser, 2008). Although the exposed bacteria (including the genetically modified one) are harmless, this work helps us to understand the value of interactivity in Bio Art and the experience of the existent continuity of life (between spectator and work) beyond

taxonomical frontiers. In interactions with life, we touch on everything that life implies, such as ethical standards (related to altering life), biological issues (material behaviour and environmental effects), philosophical concepts (such as the negotiation of artificial and natural), and social and ideological aspects (the fears of pests, monsters and chimeras, as explored by Alsina & Rennó, 2012: 179-190) that arise through the dialogue between nature-culture).

Living matter achieves transformational characteristics and promotes new artistic experiences, including the contextual issues of biotechnologies, which cannot be separated from the manipulation of life, in both scientific and artistic practices. Bio Art appropriates biotechnological media in a non-scientific way, that is, with no pragmatic function. In this way it reflects on issues derived from biotechnology, exceeding the disciplinary limits of science: economical concerns as well as epistemological and ontological issues are included in the aesthetic realm of Bio Art. There is also an ethical aspect of the use of life for instrumental purposes (in scientific research, for example). These ethical concerns are explored by bio-artists in an indirect but inevitable way, as a result of the use of non-neutral, living material. However, some artists incorporate a meta-reflection on the materials used, as an artistic contribution to a critical understanding of media in a broad sense.

This is the case of the Tissue Culture & Art group, which produces Bio Art using a different field than genetics: tissue engineering. One of the group's best-known works is The Semi-Living Worry Dolls. In this work, artists borrow the idea of small Guatemalan dolls that children use to dispel their fears. Before falling asleep, children whisper their fears to the dolls and place them under their pillows. The next morning, the problems have vanished. The art group reproduces these dolls in sterile material. They use cell culture techniques to grow a covering of cell material around the doll. Each doll is coated with living material and is sensitive to the surrounding conditions. That is why this work needs to be presented with the help of a bioreactor to maintain the conditions needed to sustain life. Spectators can interact with the dolls by communicating their fears through a microphone and intervening (metaphorically but also physically) in the development of the (living) doll. Artists are promoting both an emotional and physical relationship between the spectator and the biotechnological object, by means of strategies of co-presence. Besides

exploring the materiality of living matter in interactive terms, Tissue Culture & Art highlights the instability of living material (which requires bioreactors to survive) and the responsibilities derived from its scientific or artistic use (they have to be care of the work in order to maintain it alive). In addition, at the end of their exhibitions, artists deal with this issue directly by performing what they call Ritual Killing. The tissue is extracted from its environment and dies, as it comes into contact with uncontrolled conditions. This action reproduces on a small scale the ethical implications of manipulating life in the age of techno-science, which are visualized through artistic experiences rather than scientific ones.

5. Conclusions

The analysis of the materiality of an artwork has been one of the main concerns in the history of art, especially in the formalist school, which was often accused of being reductive. However, an analysis of materiality in Media Art (see López del Rincón, 2011) leads to new insights, which reveal some of the contradictions and limitations of the field of art and new technologies. It also contributes to understanding the diversity of the concepts underlying works of art, some of which are hidden, whilst others are openly visible. The meaning of the (living) material in Bio Art expands the relevance of materiality to new discursive fields. Bio Art consists on reviewing key concepts of Media Art such as interactivity, procesuality or presenciality. However, Bio Art not only challenges issues on Media Art, but also on mainstream contemporary art. The methodological challenge posed by understanding this new art form encourages us to discover links with other art forms within mainstream contemporary art that have already explored the relationship between art and nature through the use of living material. These forms mainly emerged in the 1960s. The new trends at that time were Land Art and Earth Art (in its many facets ranging from the domain of nature to an ecological conception), Fluxus Movement (especially Wolf Vostell), the unclassifiable Joseph Beuys, and some of the forms of Arte Povera (especially Giuseppe Penone). Research on these movements and authors can surely contribute to broadening the understanding the new trends of Media Art in relation to its materiality.

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