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Toward Alive Art

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Abstract. Electronics is about to change the idea of art and drastically so. We know this is going to happen - we can feel it. Much less clear to most of us are the hows, whens and whys of the change. In this paper, we will attempt to analyze the mechanisms and dynamics of the coming cultural revolution, focusing on the «artistic space» where the revolution is taking place, on the interactions between the artistic act and the space in which the act takes place and on the way in which the act modifies the space and the space the act. We briefly discuss the new category of «electronic artists». We then highlight what we see as the logical process connecting the past, the present and our uncertain future. We examine the relationship between art and previous technologies, pointing to the evolutionary, as well as the revolutionary impact of new means of expression. Against this background we propose a definition for what we call «Alive Art», going on to develop a tentative profile of the performers (the «Alivers»). In the last section, we describe two examples of Alive Artworks, pointing out the central role of what we call the "Alive Art Effect" in which we can perceive relative independence of creation from the artist and thus it may seem that unique creative role of artist is not always immediate and directly induced by his/her activity. We actually, emphasized that artist's activities may result in unpredictable processes more or less free of the artist's will.

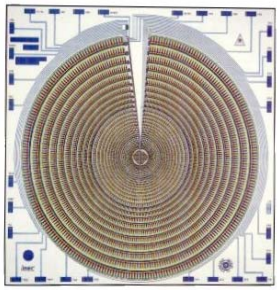

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Fig. 1. IMEC and University of Pennsylvania, University of Genova and University of Pisa *Diagram of Neural Net Microchip* MOMA, Gift of University of Pennsylvania

1 Introduction

In recent decades the so-called western countries have had to face a new fact of life: electronics. No matter whether you prefer virtual or physical reality, regardless of personal likes, dislikes and preferences it is impossible to shut electronics out of our life (or out of the life of society). Moreover, there are so many facets to the electronic cultural revolution that one feels there is no limit to how much we could say about it. If we look more carefully, we will notice that sciences have had always significant impact on arts. There is a lot of evidence for similar cases in ancient Egypt, China and other cultures. Here, however, we will attempt to discuss one particular aspect of the revolution: the impact of the electronic revolution on artistic thought. We will try to do this without moving too far away from art, while at the same time avoiding too detailed an analysis, so as not to get lost. The goal of this paper is to try to depict a new art form which we are going to call «Alive Art». To achieve this objective we will examine the social and human context and the physical space which this new art form inhabits - thereby arriving at a definition of what we mean by electronic art and the «electronic artist». We will try to trace the boundaries of the new art form, the shapes it is likely to take and the way in which it is likely to expand. Finally we will spend a few words on the ways in which such an art movement might affect art itself.

2 The social context of electronics

In this section we will discuss the possible relationship between electronics, as a technology, and art, in the sense of a specific social context. In order to identify the arts whose roots reach down into electronics we will need to understand the terrain we are discussing. For this reason, we will try to analyze the scene on which electronics plays its role.

2.1 Where electronics acts

In our opinion, there are two main spaces where electronics can interact with and perhaps challenge human beings. It is as if electronic machines have two separate identities facing respectively inwards and outwards. There is one side to the machine which exists in the physical world. This is hardware (e.g: a robot). Then there are the machine's «internals», its software (e.g.: a program interface). Despite this distinction, ordinary people's reaction to the words «electronics» and «computer» is to think of a screen on a PC (or electronic device's interface). It follows that this is one of the places where, socially and psychologically speaking, electronics *acts*. In some sense, a PC screen (and electronic device's interface) are similar to the human

eye; it mirrors the soul of the electronics. Recently, what is more, the PC screen has acquired a new face - people can now perceive electronics in action via the Internet. Materially there has been no change - the social sense has however completely changed. This previously unknown «virtual space» represented by the Internet is or is rapidly becoming an essential aspect of arts, business and economics. Socially speaking, this means that it will become a pervasive aspect of our lives. Art will have to cope with this. The Internet is a real if strange kind of space. Just as humans have always done when they have discovered new continents they will attempt to populate it with all kinds of human artifacts. There are many «ordinary» electronic artifacts which people do not consider to be art and which they do not see as being particularly intelligent or autonomous. These are of enormous importance - it is around such devices that some of the toughest battles will be fought in the future. These however lie outside the scope of this paper. Here we will concentrate on two main themes: autonomous robotics, and neuro-informatics - hybridized in the cyborg concept. Every day society is becoming more closely involved with these two areas of electronics. For the first time since humans began to dream about intelligent machines (e.g.: Frankenstein), we have begun to see them every day on the news[1,2,3,4,18]. People now want wearable computers [5,6], emotional computers [7,8], washable and edible computers! The Cyborg concept [9] inevitably follows behind and is getting more and more popular. To summarize: electronics has two main roles in a human social context. Hardware brings electronics into the physical world; software transports the physical world into electronics. Hardware devices are physical objects in the real world, subject to physical rules; software, on the other hand tends to propose itself as a system, governed by its own rules. These are the physical spaces and the social context where electronics acts, but, what kind of relationship can we create with these spaces?

2.2 How technology influences art (the world)

To ask how electronics influences art, and consequentially the world, might sound like a hard question. The history of human ideas and art might help us in understanding it. For example, when photography spread into human societies art, in general, and painting, in particular, changed abruptly. Painting lost its role as a tool for imitating reality and began to explore new meanings of vision. Then photography began to evolve too - and after initial rejection by conservative critics and artists, it was accepted as a new form of art. This changed the «common sense» view of art and the rituals of perceiving art. Walter Benjamin has explained [10] how photography and, of course, the cinema and music recording, overthrew principles that have been felt indispensable for art: in particular the uniqueness of original works. In the same way, painting was influenced by photography and cinema, investigating and finding new ways of depicting movement as in Cubism and inventing a new vocabulary of the form, as in abstract art. This would suggest that technologies have the power to change the values, even of people who do not use them . Will electronic art influence the world in the some way? What does electronics offer us that photography, cinema and painting cannot? Could it be interactivity? Or «changeability»? We think both factors count; further on in this paper, we will come back to these issues .

2.3 How technology gets feedback (from art and the world)

Feedback is not a one way process. There are ways in which art gets "revenge" on technologies and science. Technology allows human beings to manipulate their habitat. Art gives human meaning to this process. Pythagoras, for example, discovered the relationship between tone and the length of a string but never thought of playing the instrument he had discovered. Composers on the other hand continually re-discover and "explain" the magic of that same instrument. Thus, when art explores the extreme possibilities of technological products it creates requirements for new technology. Will electronics and digital arts follow this same path? Will they be influenced by art movements? We believe this has already happened. We strongly argue that electronic works of art [9,10,11,13,14] would never have been accepted or recognized without the influence of forerunners using traditional techniques as in so-called Contemporary Classical Music (e.g.: Berio or Stockhausen) or in movements such as Futurism. Later on, in this paper we will present evidence of this tendency. First however let us retrace out steps and try to figure out what we mean when we talk about an «electronic artist».

3 What artist?

Western societies usually segregate artists and scientists into two different mental spaces. Today however new electronics-based technologies are giving birth to a new kind of artist who is closer to technological and scientific knowledge - artists who share the approach of a Leonardo Da Vinci, who recognized no separation between art and science. To understand the need for this kind of science-oriented artist we have to look closer at what artists actually do.

3.1 Two different concepts or aspects of the artist

There are many possible definitions of what it means to be an artist. Among these we can identify two main conceptions: the concept of the "immaterial" artist and that of the "material" artist. This makes it possible to distinguish, if not two different kinds of artist, at least two different categories of «artistic act». The former is based on the abstract idea, the concept, which lies behind a work of art; the latter is centered on the phenomenon: the material translation of the concept into the physical world (in a wider sense). To become real art an artifact requires both. Better, the first category of act, artist conception, refers to a mental process, state or, attitude that leads to the production of ideas. It has to do with language and the sense of a work of art. This is what we call "immaterial" art: the way in which it is produced (in this case via linguistic revolution or evolution) is the same for any kind of art. The second kind of art action, on the other hand, is much more closely related to the workings of mind, in the modern sense of a body and brain functioning as a whole. The idea of a "material" artist, in our sense, has much to do with body action (e.g. the movements of dancer using the peripheral part of the nervous system) and with the technology the artist might use. In this context the search for new «tools» is a key part of the artistic

process in which a number of artists play a pioneering role. As the object relationships develop it is expected that scientists and artists develop more complex tools and processes which will result in artifacts. This work is very similar to the work performed by scientists. Let us clarify with two examples.

Fig. 2. Sergio Lombardo. Disegno stocastico, 1983. [15]

3.2 Art and human language: the "immaterial" artist.

Art critics identify conceptual arts as these arts in which there is no transformation of matter. This corresponds to an idea of society where the relationship between the things is more important than the things themselves. The aim is to invent expressive codes, processes and systems which will, in turn, produce aesthetic matter. We are talking of artists like Marcel Duchamp's son/daughter. Another example might be Sergio Lombardo [15] with his emphasis on the ways and means of artistic creation. Lombardo's methodology involves sciences like stochastic mathematics and psychology. Moreover, it is important to stress that artists like John Cage have developed theories and concepts behind the idea of stochastic processes and developments by chance. For example John Cage while working with Merce Cunningham a choreographer, said: "I am not interested in expression or relationships as I am supposed to be, I am interested in things which I cannot analyze, which I do not understand". The resulting aesthetic, while a product of these disciplines, is nonetheless unpredictable. Artists like Duchamp and Lombardo can be called artists because of the way they changed the use of symbols, language and ideas respectively in sculpture or painting. It would not matter at all if their works had no aesthetic content - (although we would miss it); the revolution in language is enough. Joel Chadabe composed several pieces using Intelligent Muisic's software called "M" which are the real peices of art published on CD "After Some Songs", a group of improvisational pieces based on well known jazz compositions. Joel Chadabe described how he composed that music with percussionist Jan Williams: " The electronic sounds also function as a kind of interactive accompaniment. In performance, I'm sitting at a computer, manipulating screen controls, while the computer is generating variations on the basic material and controlling a synthesizer.

Jan plays along witt what he hears. At the same time, I'm following what he does. It's as if I'm conducting improvising orchestra which is accompanying an improvising soloist. We're following each other in performance, matching sounds and gestures, letting the music unfold as the result of that mutually influential processes". [27]

3.3 Art and human technique, the "material" artist.

As we said before, part of the artistic approach to the world, besides being related to the physical skill of the artist, is a very scientific one - being closely related to the techniques or technologies the artist uses. In a way, this aspect of the art can be easily abstracted from the language and the meanings art usually brings with it. One example might be Simone Martini, a renaissance artist. His famous "blue" color was the fruit of a deep chemical knowledge of pigments. That blue was at the time a unique aesthetic result which many of his contemporaries tried to reach in vain (and which brought him celebrity). No doubt, it had something to do with painting and the aesthetics of painting. At the same time however it was a purely scientific discovery. The same can be said of Bach that, whose musical work, the Well-Tempered Clavier solved the old problem of instrument tuning with respect to the physical constraints of harmonic scale tonality. Accordingly, Trewor Wishart, who is a contemporary programmer and composer, said: "Our principal metaphor for musical composition must change from one of architecture to one of chemistry. We may imagine a new personality combing the beach of sonic possibilities, not someone who select, rejects, classifies and measures the accepptable, but a chemist who can take any pebble and, by numerical sorcery, separate its constituens, merge the constituens from two quite different pebbles and, in fact, transform black pebbles into gold pebbles". [28]Thus, specific sound which may be characteristic for one musical composition may be made from various sounds in the process of computer sound transformation.

4 Electronic art

So far we have highlighted two kind of art action: one related to ideas, language and meaning (i.e.: "immaterial" art) and one related to physical action by the artist and to art technologies (i.e.: "material" art). We then depicted two specific social spaces where electronics plays a role, the machine (hardware) and the inner workings of the machine (software). So, given all this, what are the implications of electronics and how are artists going to use it? Many of us have the feeling that we are at the beginning of a new techno-cultural revolution which will bring us to new frontiers of knowledge and will change our lives significantly. Electronics is leading the revolution which, it seems, is going to involve every possible category of human artifact, right up to human thoughts, in short, the whole of society. Art will not be external to this process; rather the contrary, it might even have the hard task of somehow, at least partially, guiding it. As the first section argued, when discussing Pythagoras' discoveries, artistic movements, philosophically speaking, «fight» the abnormalities of science and technology by modeling, shaping and finally bending them to the real human needs. Art acts together with religion (when the two can be

separated) as a guardian of the conscience of the human race - as demonstrated by George Orwell. So let us return to art and try to understand the nature of the new frontiers introduced by technology, how art might influence them and how art itself might be influenced by them. Let us try and describe the essential techno-artistic scenario.

4.1 A new electronic space.

Besides the social space occupied by electronic software and hardware, electronics also occupies a physical space of its own that we will introduce in this paragraph. As suggested above we can distinguish between «material» and «immaterial» art. Where do we find this distinction in electronic art? Although the categories today seem outmoded, the history of ideas and philosophy has identified five main artistic disciplines. These are: painting (we include here all the visual arts such as photography and cinema), dancing, sculpture, music and poetry. As a consequence, you can call yourself an artist if you deal with and excel in at least one of these disciplines. What does this mean? A closer examination shows that in order to be considered an artist you should be able to move in a smart, aesthetic and emotional way in one or more of five different spaces. The painter has always been the one who smoothly steps out across a canvas surface; the sculptor sharply slides into rock, wood and marble while the musician flies in among sound waves, the dancer moves tenderly in body space; finally, the writer jumps surprisingly between words. Each has a well defined, and recognizable role; for each there exists a well defined physical place where skills can be demonstrated and compared - allowing the identification of true artists - expert «walkers» in their own specific space. These are what we called "material" artists. But what has this to do this with electronics? This is a difficult question. It seems to us that electronics and what we call software and hardware have defined a new kind of space where the "old artists", actions would find it hard to fit. The boundaries of this new space are, of course, rather loosely drawn. But the deeper you step into electronic space, the closer you get to identifying what we mean by an electronic artist.

4.2 The "material" electronic artist.

The space in which electronic art takes place is new space, and even though we usually identify it with a PC screen it is, in reality much more than that. It is not a print-out or a «wave file». We can play the violin or a synthesizer and still remain traditional musicians: the space we are moving in is the traditional one for musicians. In the same way, we will soon be able to design an amazing three dimensional file format and print it out on a 3D printer or design a new robot. In both cases we can still consider ourselves sculptors. In the same way, we can work out a poem on a word editor, (perhaps a hypertext editor), without this having anything to do with real electronic art. What we are trying to say is that, electronic art works in a different space. Electronic art (as opposed to the traditional arts, mediated by electronics) can be identified by the physical space it occupies, by the kind of matter it shapes. This is

closer to the underlying electronic logic (if not to the CPU and to specific hardware circuitry). The space defines the way we can move in it, the ways in which we can exert or loose our control. Yes, of course, we act in the space and like any other action in our universe what we do may be in some way audible, touchable, visible and so on. Still, this might not be the focus of the artistic action or the most important thing for the artist - the walker in this new kind of space. Let us take an an example. We sit in front of a PC and start writing a code, say a Java code. We are going to write a genetic algorithm [16,17,19]. Our algorithm takes shape and we write nice functions which give us back amazing results and, maybe, some errors which we don't care about since we are not scientists. (Scientists cannot neglect uncertainty in the same way as artists might and usually do). OK, now we have got billions of nice numbers coming out of our debug console, what shall we do with them? Say that we plot them on a graphical display. What will does that make us? Will we be painters? And what if we plot them onto a sound file? Does that make us musicians? What if we do both? What if we do both simultaneously? Well, we think that it does not matter at all. Insofar as we have a broader sense of art we seek the best possible representation for our numbers - the one which best shakes people's hearts. If, on the contrary, we lack this sense of «material art», we will end up like Pythagoras. In both cases we might presume to call ourselves artists (or scientists). What we would not do is call ourselves musicians or painters. In addition, it is important to emphasize that various genres or media converge and that for example movement trigger sound or visual presentations, that digitized photograph may be transformed into sound etc. Thus, convergence put artists in a position to transcend, transform or sublime not only the basic content but the ways of expression too. By using electronic devices including computers artists have chance to become meta-artists.If you agree with this, you will also agree that we still need a definition of what we mean by an «electronic artist». Before reaching such a definition, let us make one further consideration.

4.3 The "immaterial" artist and the uses of electronics.

The sort of process we have just described is not of course the only possible use for electronics. We can bend electronics to our aesthetic and our will without physical contact - without programming or assembling a circuit. We could, for example, hang a computer from the ceiling. This might still be considered art. It is a kind of art that has quite a lot to do with electronics but, is not electronic art and has nothing to do with it. This is a kind of art which does not focus on the object but relates only to the meanings objects, and facts, carry with them. It has nothing to do with science, not directly. This is what we called here "immaterial" art.

5 Alive Art

Electronics and arts have already developed a significant dialog. As a result, the number of artistic movements which make use of electronics, grows day by day,
rather like biological species during the Cambrian period in geology. One of the most evident effects of this "Cambrian explosion" is confusion. This is fair enough. The

growth of electronics affects other arts and produces art itself. This in turns modifies the use of electronics in art and is influenced by it, in a sort of endless loop. Nevertheless, before introducing the concept and definition of «Alive Art», let us first refer to a number of electronic art movements and make a few general considerations.

5.1 Other artistic movements based on electronics

The most famous and widespread electronic art movements are Electronic Art, Digital Art and Computer Art. These "old" definitions, despite their popularity and historical importance, have, in our opinion, lost much of their theoretical significance. This kind of approach to electronic art is too vague for the current situation. What they express is the concept that art has something to do with electronic, digital or computer based materials. It is self evident that we need clearer analytical distinctions. The first thing to be noticed is that, most of the time, there is a quite brutal distinction between artists who use software and those who work with hardware. Considering our analysis of electronics' social context this is not surprising. On the software side we have artists who use various kind of Artificial Life [20] algorithms to paint a PC screen (or its equivalent) or (more rarely) to generate sound. Hardware artists on the other hands create (primarily) cybernetics-based works of art with a minority basing their efforts on pseudo (i.e. non-autonomous) robotics. Among these artists the most productive have been (for solid economic reasons) those engaged in the design of algorithms for sounds and images. There are dozens of proposals of this kind: Artificial Life Art, Genetic Art, Generative Art, Evolving Art, Evolutionary Art, Organic Art, Fractal Art and so on [11,12,13].

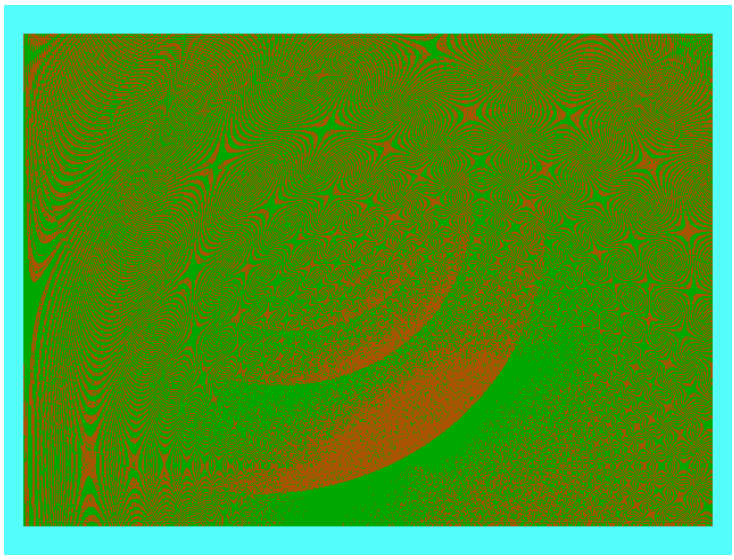

Fig. 3. Vedran Vucic. Green-s, 1999. Produced with the Artificial Painter [13,14].

The common feature of all these movements, is that they are based on algorithms which in some way produce their own rules and which generate their own behavior. In our opinion, the most appropriate descriptions of this work might be Genetic Art (because of the connection to Darwin), Artificial Life Art (because of the connection to Langton and like thinkers) and Generative Art because of the link to the Chomsky. It should be observed that, as far as the authors know, none of these artistic movements have concretely applied their basic concepts to hardware and modeled hardware and software as a unified whole. In other words, most of the time it is the software which operates the artistic transformation while the hardware is "hand crafted" with at most the ability to reiterate some limited "movements". This is crucial. While technically possible there has, in practice, been no revolution in the material structure underlying this kind of art. In hardware-based electronic art things are quite different. There is not room here to go into a detailed analysis. It is nonetheless necessary to make a distinction between early Cybernetics, and later Cybernetics or movements like that of the Kinetic Sculptors. Earlier Cybernetics artists, were from all points of view, the precursors of computer science and life like algorithms. Indeed, Cybernetics, originating prior to the transistor, was successful, right from the beginning, in creating electromechanical analogies to living systems. These artists made direct use of electromagnetic fields in art. Today Cybernetics artists [9], Kinetic Sculptors for example, are quite different. Not only do they give a bigger role to computer based technologies and a lesser one to electromagnetic fields; they also make heavy use of technicians, computer scientists and engineers in their artistic production. In other words, they are moving far away from the original type, and philosophy, of the artist and opening to a conception of artwork as work by a team. Philosophically speaking, this drastically changes the artist's attitude; the use of human material becomes, of necessity, part of the act itself - a fine challenge. Politically speaking this might be a constraint. Materials, which include other humans, are very expensive. For this reason many of these works of art are financed by companies. Inevitably, it turns out that the artist looses his or her freedom. A good example of a similar tendency is the cinema where the artistic component is weakened by the need to generate profit. This is a danger which we should keep clear in our mind and which leads us to additional considerations. As we said earlier the situation is a little confused and the overall scenario is so dynamic that more time is needed before the relationship between art and electronics becomes fully clear. We can nonetheless attempt to outline this relationship.

5.2 Alive Art

Art history tell us we are following a path which leads towards immateriality. As a consequence, visual artists for example have moved from painting to photography to cinema to computer graphics and from figurative painting, to impressionism to futurism to generative art. It appears as if there is a need for an artistic discipline which underlines the restless aspect of representation (in this case visual representation). We are searching for a meaning of dynamics which is not only

moving and changeable but which can go further. For these reasons it seems to us that we now have the possibility of shaping a new art movement or approach, whose medium is mostly but, not necessarily, electronics. This is *Alive Art*. Alive Art should be a discipline where the dynamical aspect of the work of art is crucial if not essential. The use of the term «Alive» stresses that works of «Alive Art» should be ever changing as well as ever moving. Things which are Alive can die - and they can also react. As a consequence, the characteristic of Alive Artworks, would be perpetual change (which can also lead to extinction or death) and interactivity. There is in this definition a strong drive to define an artwork which is, conceptually speaking, immaterial, abstract, difficult to seize in words. This should be an art movement which has a strong relation with the deepest aspect of life which is not, or not only, change but perpetual change, which is not only action but constant action and reaction which leads not only to changes in life but also, at times to the end of life (i.e.: to vulnerability). If we were asked: "what kind of changes are we talking about?" the obvious answer would be: "In Alive Art, as in life, there should be unpredictable, as well as, predictable changes". That is, in our opinion, the way to go. It is the course of art. We want to emphasize two factors which created common sense in this century. The first one is that we are influenced in a great deal by the mechanistic industrial perception of the world around us and that consequently, we tend to interpret things by using mechnaistic approach. Secondly, our perception of ourselves is determined by the mechanisms created in our early childhood. For that matter, one changed attitude would bear in mind that Alive Art assume that evolutionary transformational processes are natural phenomena in material world around us. Though many psychologists paid a lot of attention to the early childhood developments we think that Cristopher Bollas is closest to our perception of the development of generative developmental processes. In his book The Shadow of the Object [29] he stressed that:" A transformational object is experientially identified by the infant with processes that alter self experience. With the infant's creation of the transitional object, the transformational process is displaced from the mother-environment (where it originated) into countless subjective-objects, so that the transitional phase is heir to the transformational period, as the infant evolves from experience of the process to articulation of the experience. With the transitional object, the infant can play with the illusion of his own omnipotence (lessening the loss of the environment-mother with generative and phasic delusions of self-and-other creation); he can entertain the idea of the object being got rid of, yet surviving his ruthlessness; and he can find in this transitional experience the freedom of metaphor." Such transitional experience may be helped by Alive Art processes and for that opurpose developed devices and various hardware and software.

5.3 The Aliver

As said above Alive Art would be recognizable by perpetual change, interactivity and by the vulnerability of the works of art it produces. But how should we identify the performer of Alive Art, the Aliver? In section one we introduced the social context where electronics moves, while, in section three, we suggested that electronics has introduced a "new" space where the artist can «walk». We went on to emphasize the

risks the artist is taking (i.e.: loss in artistic freedom). These two elements are relevant to understanding the Aliver. The Aliver should move easily in the social contexts and spaces of relevance to electronics. Although we agree that in some recent artworks human material is, more or less necessary, we also believe that the new electronic artist, in this case the Aliver, should, like a sculptor, be as close as possible to the materials he is working with - relying as little as possible on other human beings. This is crucial, not only for the "political" reasons we discussed above but, also because of the relationship the artist builds with the "life" of the object. In brief, the Aliver should be as close to the software as he/she is to the hardware (or whatever material he/she uses. If the Aliver concept is taken to its extreme consequences it is the Aliver who kick starts the life of the work of art (i.e.: an object which changes constantly), to the things, allowing it to reach a point where it (e.g.: a robot) can produce art on its own. At least from an electronic point of view this is not just a vision. It is something which is, at least partially, already happening in robotics (LEGO has already produced the first Robot Musician and Robot Painter [24]). It is what was done by the inventor of Internet. So, the nearer you get to the electronics the closer you are to being a pure Aliver. The techniques one of today's Alivers might use are very different ranging from Artificial Life techniques, such as Genetic Algorithms [16], Neural Networks [21,22] and Cellular Automata, to techniques from electronic engineering such as sensors, motors, chips and lasers, or even biological techniques, such as genetic engineering, microsurgery and neurosurgery. The Aliver might design both the outer and inner body of the work of art itself and of those who interact with it. He/she should be no more outside the technological process than the artist is outside the artistic process. Indeed, to use and deeply know new techniques and technologies is one way, maybe the best way, to give the right emphasis to what society is, to what it is becoming and to the meanings it is carrying along to the third millennium.

5.5 The "Alive Art Effect"

In line with the above definition and with the categories previously discussed (i.e.: the internal and the external aspect of the machine), we can try to imagine two kinds of Alive Artwork. An example of what we called "outward-looking" electronics, that acts in the real world and obeys real world physics, might be a Robot Artist with the ability to evolve and print or modify, time after time, its own body or, at least, its electronic circuitry. This might consist, for example, of a Neural Network controller, which adapts to past interactive experiences with objects, animals and humans. An example of "inward-turned" electronics, could be an Alive Artwork suggested by some expressive phenomena which spontaneously emerged from the Internet. Imagine an interactive Genetic Programming program with the ability to modify itself every time a user uses (or downloads) the software. Both these two artworks would be life-like objects whose creator, the artist, having designed and set in motion their generative principles would control over his/her own work. That would be what we call the "Alive Art Effect".

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Conclusion

In a human social context electronics has an inner and an outer aspect - respectively, the software and the hardware. Moving from this background we have investigated the relationship between art and technology. Technology, or science produces deep changes in art. We have cited, as an example of this, the influence of photography on painting. We then highlighted the current relationship between art and electronics with respect to what we called "immaterial" and "material" art. We emphasized that while the exponential growth of electronics requires science oriented artists, the explosion of technical knowledge also calls for team work. We pointed out the dangers to which this can lead. We summarized the current state of electronic and outlined the characteristics of a new art form -«Alive Art» -characterized by perpetual change, interactivity and vulnerability. We presented examples showing what an Alive Artwork might look like and the way in which the performer of Alive Art might loose his/her artistic authority. While Benjamin, in his time, saw a loss of spatio-temporal unity in art (i.e.: pointing to the problem of the reproducibility of the work of art), electronics seems to undermine the very identity of the artist.

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