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Bioethical Art
Genome Sense Construction Through Artistic Interactions.

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The incorporation of new technologies, both of communication and of information, while immersing subjects in the new social informational paradigm, has provoked a radical transformation in the identification, creation and reception of art in all its varied forms. Beyond all these new characteristics of art there is one really important from a bioethical point of view: the collective construction of art. In a similar way to contemporary art, ethics (and bioethics) is also the result of collective work. Art is one of the most important foci of reception of new scientific developments. The possibilities that life technosciences offer us have focused the attention of numerous artists. Civil society has an active position in the creation of knowledge and sense. At the same time, bio-artists develop a special place in the social construction of those new meanings: they are something similar to a catalyst. They offer a space for an open debate about biotechnologies. With their open works, these artists enable civil society to participate in their art creations, in a collective activity. This is watchdog art, with strong bioethical aims and in an open-style, requires the participation of civil society, not just as spectators but as true creators.

> *Every art and every inquiry, and similarly every action and pursuit, is thought to aim at some good; and for this reason the good has rightly been declared to be that at which all things aim.*[1]

Ethical Background of Art

More than two thousand years ago, a superb philosopher wrote those lines trying to define the aim of life. Aristotle, disagreeing completely with his teacher Plato,[2] conceded a great value to the Arts (especially, poetry and tragedy) because of their ability to provide new ways of thinking. Good art is constructive and is also a perfect way to educate people. This is my starting point.

A great number of intellectuals also exist who have thought about the characteristics of art throughout the history of humanity and its theoretical - conceptual foundations,[3] but it was the artistic movements of the beginning of the previous century which were the point of inflexion in the rethinking of artistic activity. One of the authors with great capacity to analyze new art, Arthur Danto,[4] together with other authors,[5] have offered a new theoretical framework for the conception of the art of the new millennium. The notions of 'work of art', 'artist' or 'spectator' have been completely transformed by means of new attitudes about artistic creation.

The incorporation of new technologies, both of communication and of information, while immersing subjects in the new social informational paradigm,[6] has provoked a radical transformation in the identification, creation and reception of art in all its varied forms. New technologies have allowed the easy reproducibility of art at the same time as they have provoked a transformation in art itself.[7] But one of the most significant characteristics has been that of the existence of the collective creation[8] of the work of art in electronic environments like open source projects. The artist has certain ideas, and designs the mechanisms by means of which the spectators (now co-artists) develop the work completely.

Galleries and museums lose their territoriality as the art, in many cases, develops on mobile telephones, portable computers, electronic agendas or other personal devices. Even if you debate the form, content or values (if they exist) of new work, they have transmuted and escaped the classic categories of analysis.[9]

Ethics as a Collective Sense Construction.

Beyond all these new characteristics of art there is one really important from a bioethical point of view: the collective construction of art. In a similar way to contemporary art, ethics (and bioethics) is also the result of collective work.

A large part of bioethical controversies are the consequence of the limitations of our language and concepts to the ones that are referred to when explaining the new reality that biotechnologies offer us. And the problem does not reside only in the language: biotechnologies oblige us to think about the world in a totally different way, because they offer us a lot of possibilities for the manipulation of reality that were previously unknown. Because of this, we find frequent metaphorical uses in speeches related to biotechnologies.[10]

In the same way that at the beginning of the twentieth century, concepts such as 'causality', 'space' or 'time" had to be radically redefined after the advances of quantum physics and of the Einsteinian relativist model, nowadays, it seems to me that we are facing a similar paradigm change. The notions of 'individual', 'natural', 'family', 'human being',[11] 'life'[12] or 'normal', to cite some cases, have been radically changed under the impetus of biotechnologies and some of them have even affected our societies from a legal perspective.

Recently, the world has become complex and surprising. New biotechnologies have made actions possible which were completely unimaginable just some decades ago, if not, in all the history of humanity. The simple conceptualization of the family as the monogamous heterosexual union that produces its own descendants (though sometimes there are in this context cases of incest or infidelity), has been devastated by new biotech possibilities and, we shouldn't forget that this also demands a, new social conception of human relations. The meanings of 'to be father of', 'to be son of', 'to be mother of' have mutated profoundly. This does not imply for my part an affirmation of nostalgia toward previous values. It simply consists in the verification of a new society and how changes contributed by biotechnologies oblige us to think again about the world and to create solid categories to understand it. For example, the category 'to be a mother of' at the moment implies for a woman some of these possibilities (in function of the available legal framework):

<table>
<tr><th colspan="3">Insemination</th><th rowspan="2">Birth</th></tr>
<tr><th>Kind</th><th colspan="2">Source of Genetic Material</th></tr>
<tr><td rowspan="4">Natural (own ovum)</td><td colspan="2">Legal partner</td><td rowspan="4">Natural</td></tr>
<tr><td colspan="2">Stable but not legal partner</td></tr>
<tr><td colspan="2">Sporadic relationship (in agreement with the sporadic partner/the sporadic partner is not informed about reproductive aim of the sexual interaction)</td></tr>
<tr><td colspan="2">Forced relationship (rape)</td></tr>
<tr><td rowspan="4">Artificial Insemination</td><td rowspan="2">Own ovum</td><td>Partner's semen (legal, stable but not legal)</td><td rowspan="4">Natural, Surrogate mother, Family (sister, mother, cousin,...), Friend</td></tr>
<tr><td>Donor semen (known/anonymous)</td></tr>
<tr><td rowspan="2">Donor ovum (known[13] /anonymous)</td><td>Partner's semen (…)</td></tr>
<tr><td>Donor semen (…)</td></tr>
<tr><td>Adoption (with or without partner)</td><td>¿?</td><td>¿?</td><td>Adoptive mother donor</td></tr>
</table>

The table above implies a redefinition of the meaning of the other terms related to human relationships. Let me continue with our imaginary exercise: a baby is born that has been engendered with semen from an anonymous donor and an ovum facilitated by the sister of the mother, with the resultant embryo having been implanted in the mother's mother. The baby is the legal son of the mother (who has a more or less stable partner with no legal connection or recognition of cohabitation), but it is genetically descended from 50% of its aunt and technically it has developed in the uterus of its grandmother. Besides, all this has been possible thanks to the contribution of a donor of anonymous semen and an excellent team of scientists from diverse fields.

We would be excessively innocent if we affirmed that this is a 'normal' process (in the sense of habitual and perceived as somewhat current) and that at the end, the baby is simply the 'son of its mother'. To confront this new and positive reality, we should not only talk about it, but also design a new language that enables us to understand these human beings (and not to classify or to catalogue). We need a new way to think about human relationships and the meaning of biological concepts.[14] For example, when can we say that an amount of human cells is a human being? In which of the consecutive phases of ovum, zygote, morula, blastula or gastrula, does a human being become a 'true human being'? This is not a 'philosophical mental experiment', but a real problem. The existence of synthetic gametes will enable gay and lesbian couples to have descendants with 50% of their own genetic information.[15]

> *It is, moreover, evident from what has been said, that it is not the function of the artist to relate what has happened, but what may happen,--what is possible according to the law of probability or necessity. The artist and the historian differ not by writing in verse or in prose. The work of Herodotus might be put into verse, and it would still be a species of history, with metre no less than without it. The true difference is that one relates what has happened, the other what may happen. Art, therefore, is a more philosophical and a higher thing than history: for art tends to express the universal, history the particular.*[16]

DNA-ART

The impact of biotechnologies covers multiple aspects of the social sphere. Reflection and worry about their derivations and their results affects extremely unlike social agents: religious groups, patients' associations, political parties and, occupying a special place in this process of analysis, we have the artistic collective.[17]

Art is one of the most important foci of reception of these new scientific developments. The possibilities that life technosciences offer us have focused[18] the attention of numerous artists.

In the 1980s *living art* appeared, which explores living beings through art, modifying or altering the human body, creating new beings (such as flowers)[19] or making constructions with organic matter. The Hundertwasser houses with recyclable and organic ceilings were, at the same time, an architectural reference and a new way of approaching the design of human life.

During this period the first forms of art in the laboratory could also be found, such as those created by the French duet Art Orienté Object (AOO),[20] or those of the Australian group of the University of Western Australia, Symbiotica.[21] In the case of the French, Marion Laval-Jeantet and Benoît Mangin, AOO, they sought reflection on life through the ideas of hybridization and poetry. In their project *Cultures de peaux d'artistes*, they allowed the main world producer of artificial skin, an American business, to take biopsies of their

epidermis, in exchange that samples of pigskin were added to themselves, and tattooed with images of animals under threat of extinction. One of its last projects, *Que le panda vive en moi*, they intended to do blood transfusions with animal blood that had been previously treated to be compatible with human blood. The artistic limits that they explore permit better reflection on real complex contemporary phenomena such as xenotransplants. Marta of Menezes, a painter from Lisbon who embraced living art to be able to give solutions to the advances of life sciences, deserves a special mention.[22] Working with the laboratory of evolutionary biology of the University of Leyden, Holland, she produced the work *Nature?*, which consisted of modifying butterflies' wing patterns by means of punctures to the chrysalis at very specific places. We must admit that the selective breeding of animals and plants throughout the history of humanity has been based not only on practical but also on esthetic-morphological aspects. In the year 2002, after carrying out 'paintings of DNA' (Nucleart) in a British laboratory, the painter was transferred to Oxford University to take images of the cerebral activity of a pianist while he interpreted a piece of music, by means of the viewing techniques used by functional magnetic resonance. Living beings are apprehended in new ways. The Slovene painter Polona Tratnik, with her exposition *37º* sought to reflect on the phases of life and the scientific detachment that, supposedly in her opinion, exists regarding this fascinating phenomenon.

In a more technologized context, we consider as an example the case of Stelarc[23] and his conception of a cybernetic corporal art. He analyzes the limits and identity of the human body, when we start to have the possibility to carry out electronic implementations creating new beings, the cyborg, that aspires to surpass the limits of the invalid body. The living being incorporates electronic components, infringing the direct limits of the natural thing and the artificial thing.

Another important case of art in the barrier between the natural and the artificial in a living environment is the artist Orlan, who makes her body a work of art by means of a scalpel. The internationally famous French artist has been in the creative vanguard for decades, although it was her decision in 1990, during her 40th anniversary, to make her own body into a ready-made Duchampian. She defines his art as *Carnal Art*, and she conceives it as direct action by means of cosmetic surgery of her own body. She goes beyond body art, making herself a walking artwork not exempt from dangers. Reflecting on the arbitrariness of the female esthetic canons of diverse epochs, she has submitted herself to multiple esthetic operations offered with public access (by television and Internet) in which she has acquired the characteristics of some icon of traditional art: the nose of a Diana of the school of Fontainebleau (1530-1560), the mouth of the Europe of Boucher (1732-1734), the chin of the Venus of Botticelli (1485), or the forehead of Leonardo (1503).

The Brazilian artist Eduardo Kac[24] goes beyond the artistic conception of living art and proposes a genetically modified art (transgenic art). It consists in utilizing the techniques of genetic engineering to produce beings that permit us to reflect on the limits of these techniques and the decisions about them and their results that the companies should carry out. His most important work has been *Alba*, a rabbit whose genes have been modified to introduce a mutation of the gene of the jellyfish that contains the fluorescent green protein that these produce with the purpose of shining in the dark. Kac presented the *Alba* project at the Digital Festival of Avignon of 1999, and obtained the approval and collaboration of the director of the Festival and the project was developed jointly with three scientists of the INRA. The resultant rabbit emits a greenish brightness under a certain light frequency. The strong social reaction to this work impeded Alba from living in the domestic environment of the artist, just as was initially intended, with it instead remaining in the possession of the INRA[25], a situation that involved a dispute between artist and institution that is still ongoing. On 2003, Kac published a brief book of 28 pages that carried the title *It's not easy being*

green!, in which he reviewed by means of the assembly of images and texts the critical world reception of the green rabbit (he calls him 'GFP Bunny').[26] Curiously, what began as a work of compromised art finished being a commercial product: in June of 2003 Taikong Corporation presented its fluorescent fish, or TK-1, fruit of genetic engineering, as a pet for sale at the price of 17 dollars by unit.[27] The fish contains a jellyfish gene that makes him fluorescent. Art, science and industry: not as separate as at first it seems.

Later, Kac developed a new line of art among living and inert things, creating 'biobots', that is to say, robots that are integrated into living beings. Recently, in 2004, he has developed the project *Move 36*. In my opinion, with this project Eduardo Kac unites sublimely in the same artistic space two of the most important environments of knowledge of the twentieth century: biotechnology and Artificial Intelligence (AI). Kac's work refers to the mythical chess game carried out between the best player in history, Gary Kasparov, and the IBM machine, Deep Blue, in May 1997. According to the Turing Test, a machine would be intelligent if its answers were indistinguishable from those of a human being, but since the origins of computation, there have been many critics that affirmed that a machine would never be intelligent,[28] and they considered chess as one of the human activities that required more machine intelligence for which it was clear that a machine would never be able to play decently against a human being. But in May 1997, Kasparov lost 3,5 to 2,5 against Deep Blue. In the sixth game, concretely in movement 36, Kasparov understood what the machine had earned by carrying out an exceptional and unforeseeable move for a 'simple computer'. It was an exciting encounter: Kasparov conquered in the first game, and Deep Blue counterattacked and got into an imposing position in the second; after the tie, they continued for three more drawn games. But on the ninth day, May 11, 1997, Deep Blue defeated Kasparov, the historic champion, while playing white.[29] Impressed like so many others, Kac conceived an artistic experiment that combined new biotechnologies with a reflection on the historic event of the rational victory of a machine over a human being. In order to do it he used the famous dictum of René Descartes "Cogito ergo sum"[30] and translated the dictum to the binary system[31]. The results is:

01000011011011110110011101101001011101000110111100100000011001010111001001100111011011110010000001110011011101010110111011101101010

Subsequently, he decided to create a system of new correspondences between the four bases(A, C, G, T) and the binary system, assigning to each letter a value: T = 00, C = 01, G = 10, T = 11. Applying this new translation, the Descartes' dictum, once passed to binary code and applying its new correspondence with the bases of life, offered the following code:

CAATCATTCACTCAGCCCCACATTCACCCCAGCACTCATTCCATCCCCCATC

With this artistic procedure, Kac arranged a 'genetic sequence' (or *Cartesian gene*)[32] of 52 bases that symbolized human reason. He then created an installation that was a chess board in which the white squares were hardened white sand (the inert silicon) and black sand (active life). In the position of the 36th movement of the game, Rxe7, Kac planted the plant that had been genetically modified with the insertion of the Cartesian gene, whose leaves, normally smooth, were now rough. The plant is lit with just one spotlight while two silent video projectors send images of two absent chess players on the walls.

In a more aggressive line, we have the Critical Art Ensemble (CAE)[33] that suffered a police pursuit on the part of the American authorities last year due to one of its projects BioTec.[34] CAE is a collective of five artists who stem from different creative environments, and who seek a new artistic language and a critical attitude in front of contemporary society,

combining in their works several different elements (art, radical politics, technology, critical theory). The CAE members denounce the possibility of applying this new know-how to repress human identity and the rights of all beings even more.

On May 11th, 2004, Steve Kurz, one of the CAE components, called the services of ER to notify that his wife had just suffered a heart attack and that she was dead. When they arrived at his residence-workshop, the police considered it strange that in the workshop there were test tubes and Petri dishes and immediately called the Task Force and the FBI, who arrested the artist on suspicion of being a bioterrorist threat, under the jurisdiction of the USA Patriot Act of October 2001 (Sec. 817. Expansion of the Biological Weapons statute)[35], or H.R. 3162. This law was approved blindly and hurriedly by the American political establishment, which was still confused after the attacks of the 11th of September 2001. Kurtz was then working on the project Free Range Grains with inoffensive biological material (as the bacteria *Serratia marcescens D1*, of authorized use and for sale even for didactic purposes through diverse pages on the Internet)[36] and had a mobile laboratory for DNA extraction with the purpose of analyzing food products to see if they contain genetically modified contamination. He and his companions were accused of bioterrorism and their work materials (computers, house, work plans and some lists for their exposition, cars…) were confiscated. Kurz was called to judgment, being accused of bioterrorism, with a possible penalty of 20 years in prison. For 22 hours he was under arrest by the FBI. The anxiety caused by the dramatic and disturbing turn of events led people near to the CAE to create the CAE Defense Fund, which is trying to show the innocence of Kurz at the same time as criticizing the lack of liberties and unwarranted repression of the State. Diverse American artists have yielded works to sponsor the legal costs of Kurtz´s defense which is currently continuing.[37]

On the other hand we have the surprising British poetess Donna Rawlinson MacLean, who requested at the British Patent Office the concession of a patent for the invention that she called *Myself*. She justifies herself in the following way: "It has taken me thirty years of hard work for me to discover and invent myself, and now I wish to protect my invention from unauthorized exploitation, genetic or otherwise."[38] After delivering the request along with four photos, a copy of her passport and 130 pounds sterling, she was notified in pending request number GB0000180.0, without any problem on the part of the employees of the office. Only a week later, the American artist Marilyn Donahue demanded to have her DNA registered, by certifying her ownership licking a seal and sticking it to an envelope with her own address. At this time a 'program of genetic certification' started, in which everyone has the right to ask for the copyright of their DNA.[39] The starting point of the activity of Donahue was the recent existence of a pharmaceutical corporation, decode,[40] that had a database of the medical information of all the citizens of Iceland. The disinterested contribution of civil society contributed in this way to the enrichment of a private company, though it is certain that the scientific results from the same database served well for the analysis of multiple illnesses. Besides, the artist has a virtual exposition in which her DNA can be observed growing in Petri dishes.[41] The objective is the same in both cases, that of Rawkinson and that of Donahue, to act critically against the abusive and unwarranted patents of human genetic material.

Continuing with the metaphorical use of the DNA, a movement also exists that approaches the reflection on its importance by using music. Jorg Schäffer, a doctor in biochemistry with a qualification in musicology and composition has been developing his artistic works around DNA.[42] With his piano, Schäffer plays his work *Viroids*, 26 brief compositions which are inspired by sequences of DNA. That is genetic music.[43]
The technique is the same one of Kac in *Move 36*: to select a series of the four bases A, C, G, T, and to substitute them for musical notes. As the work would be reduced to only 4 musical

notes, something very limited, through pentatonic music with scales of 5 notes, they have opted to also do the same thing with amino acids. Pieces for piano, clarinet and other genetic instruments have been created from already existing sequences.[44] The Electronic Journal of Biotechnology exposes a detailed chronology of artists-scientists or scientific-artists that carry out "DNA, genetic and microbe music"[45], that all started in 1983, when the molecular biologist and musician Damiv Deamer, of the University of California, Holy Cross, make public that he was seeking musical messages in our genes.

Humor has been a valuable source of reflection with respect to investigation in genomics, clearly be seen in the circulation on the Internet of the supposed divine program of human creation, once all the information 'trash' has been eliminated, and continuing with a similar data processing gene = code[46] idea, although this time with a key element of humor. Cartoonists are also a good example of artistic approaches to genomics, with a touch of humor[47].

In literature we find a large quantity of examples of analysis of the new biology as well: *Brave New World* of Aldous Huxley, *The duplicate man* of José Saramago, *AND tomorrow will be the clones* of John Varley. Movies like *Gattacca* or *The Island* continue in this same line.

The Common Construction of Bioethical Sense

Like Art, contemporary societies have changed profoundly. The key to understanding the new social movements and the growing activity of civil society is closely tied to developments in telecommunications and microcomputing. [48] This has created a communication space, a hypertextural agora[49] that has filled the pre-existing social space and given it a new strength. These technological innovations have been rapidly implemented in our companies, provoking changes in social dynamics and human relations. Due to computerized information management what was once a sedentary mass has become a nomadic electronic flow. Websites, chats, weblogs, and e-mail are some of the different kinds of tools that civil society can use for its action or information (both are strongly related) and, because of the intrinsical structure or hypertext documents, they fit well with the cognitive capacities of layperson.[50] Hypermedia have changed our democracies[51] and demand a new comprehension of social management models.

The citizens of the Internet, the *netizens*,[52] might be more independent and they create their own informative content. This leads to greater control of the communicative process, where groups of organized citizens (often protest citizens), can glean information from multiple sources, they translate or simplify this information and communicate it again to other citizens. According to McQuail,[53] companies bring new technologies that generate new forms of understanding and interacting with the world, transforming in turn the same companies. In this process of feedback, civil society is taking control of the communicative process[54] with more and more force. These new technological possibilities are even creating new social dynamics, like the previously quoted electronic political participation, artivism, *flash mobs*, *bookcrossing*, *blogging*[55] or hacktivism.

Related to this idea we find several authors from very different academic fields who are expressing concepts whose final aim is to recognize all or some of these related aspects (1) social processes of knowledge construction, (2) the role of new agents (civil society) in management decision processes, most of them thanks to (3) the presence and general implementation of information technologies and hypermedia, necessary for the current level of coordination and interaction: global brain[56], society of mind[57], connected intelligence[58], intelligent nets[59], collective intelligence[60], distributed cognition[61], civic epistemology[62] and social epistemology.[63]

Civil society has an active position in the creation of knowledge and sense. At the same time, bio-artists develop a special place in the social construction of those new meanings: they are something similar to a catalyst. They offer a space for an open debate about biotechnologies. They also show the latest advances in these technologies and the possible consequences of them. With their works, they develop a non-academic bioethics, an early and fresh vision of new biotechnological trends and its inherent problems. With their open works and simple language, these artists enable civil society to participate in their art creations, in a collective activity. This is *watchdog* art, with strong bioethical aims and in an open-style, requires the participation of civil society, not just as spectators but as true creators. Artists make us think about life, patents, meaning of words, biotech industries or the nature of human beings. They offer us the first step for acquiring profound knowledge and a continuous critical position so that we can talk of 'bioethical art', a new way to create senses for the new possibilities of biotechnologies, with society's contribution.

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REFERENCES

[1] Aristotle. Nicomachean Ethics. Book I, 1.

[2] Plato. The Republic: 604e.

[3]M.P. Battin et al. eds. 1989. Puzzles About Art. New York, St. Martin's; R.G. Collingwood. 1958.. Principles of Art. Oxford. Oxford University Press; J. Fisher. 1993. Reflecting on Art. USA. Mayfield Publishing Company; N. Goodman.1976. Languages of Art. Indianapolis. Hackett Publishing Company Inc; O. Hanfling. 1992. Philosophical Aesthetics. USA.Blackwell; A. Neill. & A. Ridley. 1995a. Arguments about Art. USA. McGraw-Hill; A. Neill. & A. Ridley. 1995b. The Philosophy of Art. USA,.McGraw-Hill.

[4] A. Danto. 1981. The Transfiguration of the Commonplace: A Philosophy of Art. Cambridge. Harvard University Press.

[5] M.Barasch. 2000. Theories of Art: From Impressionism to Kandinsky. UK. Routledge; S. Davies. 1991. Definitions of Art. USA. Cornell University Press; B.R. Tilghman. 1984. But Is It Art? Oxford. Blackwell.

[6] M. Castells. 1996. The Rise of the Network Society. Oxford. Blackwell.

[7] W. Benjamin. Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit. Zeitschrift für Sozialforschung. 1936.

[8] D. Casacuberta. 2003. Creación colectiva. En Internet el creador es el público. Barcelona. Gedisa.

[9] N. Wolterstorff. 1980. Art in Action. USA. Eerdmans.

[10] P.E. Griffiths. Genetic Information: A Metaphor in Search of a Theory, Philosophy of Science. 2001; 68 (3): 394-412.

[11] I. Persson. Two claims about Potential Human Beings. Bioethics. 2003; 17(5/6): 503-516.

[12] B. Amani & R.J. Coombe. The Human Genome Diversity Project: The Politics of Patents at the Intersection of Race, Religion and Research Ethics. Law & Policy. 2005; 27(1): 152-188. They make a reference to the case *In Re Howard* 1995:541-542, in which the Appellation Technical Committee decided that DNA was not living, but just a chemical substance, therefore, it could be the object of a patent.

[13] On the 26th of august 2005, a Dutch television show called *the sperm show* started "Ik wil een kind van jou... en verder niets" (I want your son, and nothing else). At: www.talpa.tv.

[14] D. Haraway. 1997. Modest_Witness@ Second_Millennium. FemaleMan©_Meets_Oncomouse™. London. Routledge.
[15] G. Testa & J. Harris.Ethics and Synthetic Gametes", Bioethics. 2005; 19(2): 146-166.
[16] Aristole. Poetics. IX. The italics are of my own: I've translated 'poet' and 'poetry' as 'artist' and 'art'. I think that the original meanings of Aristotle enables us to embrace those translations. Poiesis can be translated as 'to make' or 'to create', that is, the artists activity.
[17] Genomics and contemporary art at a www.gene-sis.net/new_essays.html, Gene(sis): Contemporary Art Explores Human Genomics.
[18] An analysis about relationships between art and science: RTD Info. Magazine for European Research. Special Edition March 2004. Art and Science. www.europa.eu.int/comm/research.
[19] George Gessert is an artist who works in that direction.
[20] http://artorienteobjet.free.fr.
[21] www.tca.uwa.edu.au.
[22] www.martademenezes.com.
[23] http://www.stelarc.va.com.au
[24] http://www.ekac.org.
[25] Institut National de la Recherche Agronomique: http://w3.inra.fr/.
[26] http://www.ekac.org/noteasy.book.html.
[27] http://www.azoo.com.tw/azoo_en/azoohtml/tk1video.php
[28] H.L. Dreyfus. 1972. What computers can't do. Cambridge (MA). The MIT Press; H.L. Dreyfus. 1992. What computers still can't do. Cambridge (MA). The MIT Press.
[29] All chess games between Kasparov and Deep Blue at: http://www.research.ibm.com/deepblue/watch/html/c.shtml.
[30] R. Descartes. 1636.. Discourse on Method. PartIV.
[31] Binary system translator to ASCII or hexadecimal at: http://students.washington.edu/cwei/tools/binary.shtml.
[32] You can ask for synthetic genes at companies like DNA 2.0 Inc: http://www.dnatwopointo.com/commerce/misc/syn.jsp.
[33] http://www.critical-art.net.
[34] They have several projects: Flesh Machine, Society for Reproductive Anachronisms, Cult of New Eve, GenTerra, Contestational Biology and Free Range Grain.
[35] Title 18, Part 1, Chapter 10 Sec. 175: (a).
[36] http://sciencekit.com/category.asp_Q_c_E_435622.
[37] http://www.caedefensefund.org/background.html.
[38] Amani & Coombe. *Op. Cit.* 13, 152.
[39] The DNA Project, http://www.mudhaus.com/marilyn/donahue/6_2.html.
[40] www.decode.com. There is also a civil organization against the privatization of those data, Mannvernd: http://www.mannvernd.is/english.
[41] www.mudhaus.com/marilyn/donahue
[42] www.echtzeithalle.de/kuenstler/schaeffer-j.htm.
[43] K.Hayashi & N. Munakata. Basically Musical, Nature. 1984; 310: 96.
[44] More information at: www.artic.edu/~pgena/NDAmus.html.
[45] www.scielo.cl/fbpe/img/ejb/v7n2/a07/t6.html.
[46] http://www.21stcentury.co.uk/humour/DNA_secrets.asp.
[47] http://cagle.msnbc.com/news/gene/gene10.asp
[48] Castells. *Op. cit.* 7.
[49] N. Klein. 2000. No Logo®. Canada. Random House of canada Limited.
[50] J.F. Rouet. 1996. Hypertext and Cognition. USA. Lawrence Erlbaum Associates, Inc.; G. Landow. Ed. 1994. Hyper/Text/Theory. USA. Johns Hopkins University Press.

[51] R.C. Sunstein. 2001. Republic.com. USA. Princenton University Press.
[52] L. Floridi. Information Ethics: An Environmental Approach to the Digital Divide. Philosophy in the Contemporary World. 2001; Volume 9 (1: Spring-Summer).[Online] [Accessed: October 20th, 2004], Address: http://www.wolfson.ox.ac.uk/~floridi/pdf/ieeadd.pdf .
[53] D. McQuail. 2000. Mass Communication Theory. UK: Sage Publications Ltd.
[54] N. Stevenson. 2002. Understanding Media Cultures. UK. Sage Publications Ltd.
[55] There is an interesting paper about blogs and their activism: R. Kahn. & D. Kellner. New media and internet activism: from the 'Battle of Seattle' to blogging, New media & society. 2004; 6(1): 87-95.
[56] F. Heylighen et al. 1989. Self-Steering and Cognition in Complex Systems: Toward a New Cybernetics . Studies in Cybernetics. Vol 22. USA. Gordon & Breach Science Pub; H. Bloom. 2001. Global Brain: The Evolution of Mass Mind from the Big Bang to the 21st Century Publisher. USA. Wiley & Sons.
[57] M. Minsky. 1986. The Society of Mind. NY. Simon & Schuster Inc.
[58] D. De Kerkhove, Derrick. 1997. Connected Intelligence. Toronto. Somerville House.
[59] A. Barabasi. 2003. Linked: How Everything Is Connected to Everything Else and What It Means. USA. Plume Books.
[60] P. Lévy. 1997. Collective Intelligence. Mankinds Emerging World in Cyberspace. USA. Plenum Publishig Corporation.
[61] E. Hutchins. 1995a. Cognition in the Wild. Cambridge (MA). The MIT Press; E. Hutchins. How a Cockpit remembers Its Speeds. Cognitive Science. 1995b; 19: 265-288.
[62] That idea talks about the cultures and practices of knowledge production and validation that characterize public life and civic institutions in modern democratic societies. S. Jasanoff. ed. 2004a. States of Knowledge: The Co-Production of Science and Social Order, 31(3): 461-467; S. Jasanoff. 2004b. Designs on Nature. Princeton (NJ). Princeton.
[63]S. Fuller. 1988. Social Epistemology. Bloomington (IN). Indiana University Press.