The Double Division of the Living

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I am interested in the idea of the living in relation to artefacts made by man, and in particular to artistic ones. In my opinion, there is a double reflection to be made on the relations between art and the living. Two aspects seem to me to be fundamental, and they emerge from today's papers. It is these I wish to concentrate upon here.

The relationship between art and organic matter is an ancient one. The whole of the history of art has been influenced by the living, by "that which lives". That which lives – animals, plants, other human beings... – for millennia has represented the inspiration and model for artists, the signifying universe in which they existed, which they sought to exorcise, communicate, depict, cali into questiono The whole of the history of art has taken its measure from nature, but an important change took piace with the advent of technology derived from biology and from the disciplines revolving around it.

The first division of the living

The relationship between art and living has two distinct divisions. The first, which we can claim to have known forever, has its roots in organic matter and is founded on carbon compounds. The relationship between art and living has drawn new energy from the development of scientific disciplines such as biology, the sciences deriving from this and the availability of technology and instruments such as biotechnology, genetics etc. A growing number of artists have dedicated themselves to forms of art that use these tools. Alongside the improvement of traditional practices of cross-fertilisation and the selection and hybridisation of plants and animals, new and often controversia I expressive forms have appeared. The first division involves the organic, biotechnology and genetic engineering.

This relationship between art and advanced science has given rise to a series of expressive forms that have been called in various ways: "bioart", "genetic art". "transgenic art"... Even though these definitions are often used indiscriminately, they are actually practices, instruments and results that are very different and which can also be far removed the one from the other.

Nevertheless. a common basis and some points of conjunction do exist. In ordèr to try to give some sort of systematic structure to this multiplicity of approaches a diagram may be useful, which I produced from an idea I gained in a text by George Gessert – the American artist and theorist who since 1985 has worked with plants in the field of genetic art – in a message sent to *Yasmin*. a mailing list on the relations between arts, sciences and technology supported by the UNESCO *DigiArts* programme.

According to Gessert [1]:

> [...] Bioart is art that is alive or has living components. Not all bioart involves biotechnology, or

genetic change. Bioart includes some forms of ecological art and Land Art, for example Alan Sonfist's recreations of the originai biota of Manhattan. Art that represents life (chromosomes, DNA, etc.1 is not bioart.

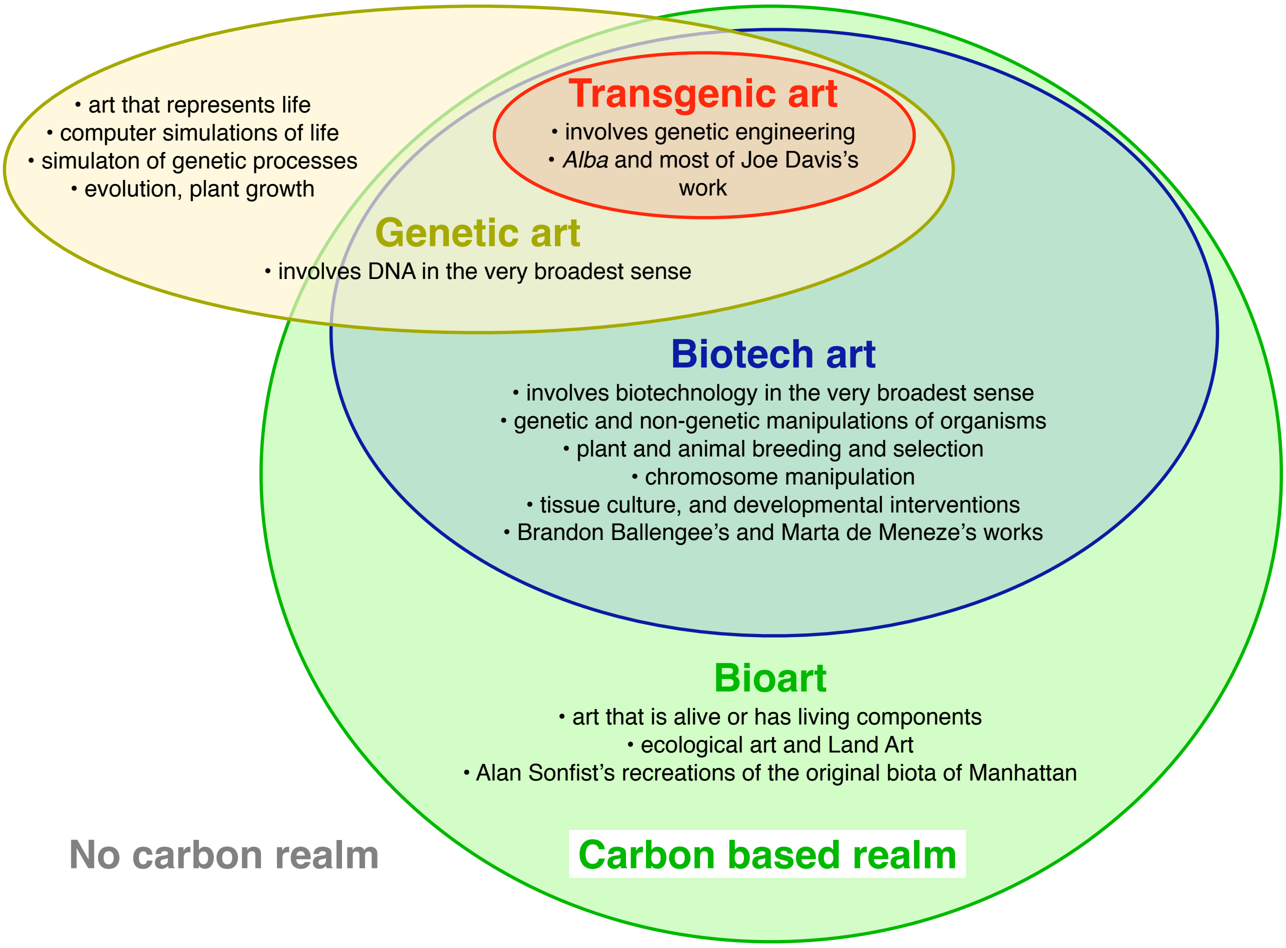
Computer simulations of genetic processes, evolution, plant growth, etc. are simulations of life and not alive, hence not bioart.

Biotech art is bioart that involves biotechnology, in the very broadest sense of that word, to include both genetic and non-genetic manipulations of organisms, including plant and animai breeding, plant and animai selection, chromosome manipulation through colchicine treatments and X-rays, tissue culture, and developmental interventions. Biotech art includes Brandon Ballengee's frogs and Marta de Menezes' chemical interventions in butterfly development. Like bioart, biotech art does not include representations (except perhaps some kinds of documentation), or computer simulations of life.

Genetic art is art that involves DNA in the very broadest sense. This includes some kinds of representational work – eg. Alexis Rockman's paintings of evolution at work, and computer simulations of genetic processes. The term genetic art is potentially confusing, since computer artists also use it in a slightly
different way.

Transgenic art, as I understand the term, is bioart that involves genetic engineering. Examples are *Alba* and most of Joe Davis's work. Marta de Menezes butterflies are not transgenic art.

I felt it could be interesting to show these definitions graphically, so as to visualise them. So I produced the diagram you can see here (no. 1), and sent it to Gessert so he could have a look at it, given that it draws inspiration from a text by him. He replied that the diagram perfectly reflects the relations between expressive forms that are so different. [2]



In its most general sense, the diagram shows two major groupings: the realm of the inorganic (in grey), and the 'carbon-based realm', comprising organic chemistry (in green), that is, chemistry based on carbon compounds. Within the realm of organic

chemistry, of organic matter, the sector in which we have traditionally always situated life on earth, the largest and most general division is that of BioArt, which includes all the others and is totally included within the carbon-based dimension, the dimension of organic matter. BioArt could, according to Gessert, be defined as that art "that is alive or has living components". Not all BioArt concerns biotechnology or genetics. Art that depicts life and computer simulations, are not BioArt. BioArt includes artistic forms such as ecological art and Land Art. The diagram, therefore, also highlights the relation lying at the centre of this congress: the one between Land Art and BioArt. The first subgroup of BioArt is that of Biotech Art. According to Gessert, Biotech Art is the BioArt that involves biotechnology in the broadest meaning of the term: genetic and non-genetic manipulations, plant and animal breeding and selection, chromosome manipulation, tissue culture. For example, the work of the Portuguese artist, Marta de Menezes, who draws motifs on the wings of some species of butterflies, belongs to this category.

The next subgroup is that of genetic art. According to Gessert, genetic art involves DNA, the use of DNA and intervention on DNA in the very broadest sense. This group includes some works by Eduardo Kac, but also works that have nothing to do with the organic world, such as computer simulations of genetic processes (for example, some works by Christa Sommerer and Laurent Mignonneau, about whom Lorenzo Taiuti spoke earlier), forms of painting and depiction, applications of artificial life and works based on software. All of which are based on simulation; they simulate organisms, processes or part of processes, behaviour or scenarios drawn from the living world or referring to it. The interesting thing the diagram reveals is that there is a relationship – dialogue – in this group between the organic and the inorganic dimensions. As we can see, part of this group sticks out from BioArt and thus from the carbon-based realm and enters the realm of the inorganic. It therefore provides an interesting and promising bridge between the organic and the inorganic realms.

And finally, included within BioArt and as a subgroup of Biotech Art and genetic art, we find transgenic art. Perhaps the most famous examples in this sector are *Alba,* the fluorescent rabbit showed by Eduardo Kac, and the works of Joe Davis.

The second division of the living

The second division of the living is far more recent than the first, and since at least the end of the 1980s [3] the field of art is rich in applications. This second division arises from a collection of various disciplines, including 'artificial life' and robotics, these being perhaps the most representative. Artificial life in particular, officially emerging on the occasion of the first international "Artificial Life 1" congress organised by Christopher Langton in 1989 at Los Alamos, [4] develops the idea of studying life – in its organisation of the single, in its social dimension and in its evolution – by simulating its characteristics. [5] Characteristics that constitute living organisms, social characteristics, peculiarities concerning the relationship of the organisms with the environment in which they find themselves, and the evolution of these systems. As with robotics – and completely unlike Artificial Intelligence – artificial life has a bottom-up approach, starting with simple elements to arrive at the configuration of increasingly complex systems. Using information technology, artificial life simulates the processes of life using programs and computer simulations, such as evolutive calculations (evolutive algorithms, genetic algorithms, genetic programming, swarm intelligence, artificial chemistry, models based on cellular agents and automata).

The other interesting dimension is robotics. Robotics is a 'hot' discipline, one undergoing rapid developmenl. The latest issue of *Le Scienze* magazine dedicates some space to this argument but, more generally, the fact that an important scientific periodical should focus so extensively on robotics at all is highly indicative. [6]

Robotics is one of the latest disciplines and we should not regard it in the way it was seen in films of the 1950s and 1960s, in which the robots were electromechanical beings made of metal and electronic circuits. Rather, we should consider them in their current guise as hybridisations with the biological dimension, in terms of bio-robotics, a subject touched upon in the paper given by Louis Bec.

One of the merits of artificial life has been that of extending the idea of life beyond a notion of carbon-based chemistry, rendering the idea of life more general, universal, quite outside an organic dimension. While the knowledge we possess about life is strictly associated with the presence of organic matter, of carbon, artificial life has sought to go beyond this limit or aspect, creating structures that have the characteristics of the living but which do not require organic matter to live.

Therefore, it is no longer the "what is the living made of", the matter that constitutes it (traditionally: carbon compounds), to define the living, but instead the instructions that regulate it. To borrow a computer-based metaphor, it is no longer the hardware that defines the living but the software.

According to Watson and Crick, who discovered DNA, "life is nothing other than a vast range of coordinated chemical reactions; the secret of this coordination is a complex and attractive set of instructions written chemically in our DNA". The organic living we are used to possesses DNA code; the artificial living possesses algorithm code. But while in the first case the code can only be associated with matter and with the organic dimension, in the second case the living can configure itself in various manners: it may be without its own matter and exist merely within a computer, or it may possess a robotic body, or it may be a hybrid with the organic and open up highly interesting sectors and possibilities of application. From this point of view, the non-biological living seems to have a greater freedom, greater possibilities and opportunities.

The two divisions of the living that I have proposed indicate two different avenues, two declinations of the living which – perhaps by maintaining a dialogue between themselves, by interacting or creating hybrids – enrich our knowledge of humanity (and hence also the instruments at the service of art), and suggest new and interesting horizons.

The living

One of the most quoted concepts in today's papers has been that of the 'living'. To conclude, I would like to consider this concept, from which my paper took its starting point and around which it has turned: the living, life. The living has been and is the model of art, but it is also the model of artificial life, of robotics, of a vast range of technical sciences and of an increasing number of artefacts, machines and devices we build and which must be able to 'survive' damage, errors, defects, viruses, and even be able to 'adapt themselves' to changing contexts, to interact with new and unexpected situations. Just as the living is able to do.

The living is the best model for these artefacts because it has demonstrated its efficiency during the course of an evolution that has lasted about four billion years: the best strategy is written in the organisation of the living because the living already has 'experience' of the world. Hence, just as occurred in the history of humanity, and hence that of art, the living itself constitutes the best model for human artefacts. When we must create devices, systems or machines able to function in criticai situations, copying the living may represent the most effective solution.

Biology and the sciences deriving from it have become key disciplines therefore, to the point of presenting themselves as paradigms even outside their specific applications, and thus assuming a significant weight in a cultural setting as well. To give a few examples: [7] in the 1990s, the work of Humberto Maturana and Francisco Varela became fundamental for various sectors of sociology, as did that of Richard

Dawkins for the selfish gene, that of Mauro Ceruti for evolution, that of Luigi Luca Cavalli-Sforza for the relationship between genetics and linguistics and, in more recent years, that of Roberto Marchesini on the concept of "Post-Human". In the field of art, there have been numerous events including, to give just one example, *The Future of Evolution,* marking the 1996 edition of Ars Electronica. [8]

And to remain within the scientific sector, one need only remember how many Nobel Prizes have gone to biology and correlated disciplines in the last twenty years. In the field of technology, it is significant that about a third of the engineers at MIT (Boston) – which we may consider the 'temple of the inorganic' – work on problems of a biological nature to produce devices destined to influence everyday life in the future, because the best model for what will need to 'live' comes from the living itself.

However, we do not truly know what the living is. At a human level, we are fairly sure we can distinguish what is alive (plants, animals) from what is not alive (for example, the chairs we are sitting on). But at a microscopic level, for example, the certainties of these frontiers become less hard and fast, even for scientists. Viruses are enigmas, because they are located at the border between inorganic chemistry and life, and for decades scientists have discussed whether they should be considered alive or not. Today, we know that these ancient entities effect every form of life on earth, and often determine those that will survive. They are responsible for the appearance or disappearance of species and have played – and play – a fundamental role in evolution. Viruses are like pollinators of genes, pollinators of evolution introducing genes into organisms able or not to withstand the changes these cause. Even our genes bear the trace of viruses. In a recent article in *Le Scienze,* Luis Villareal. director of the Center for Virus Research at the University of California in Irvine, maintains that there is a whole range of intermediate positions between that which is alive and that which is not and that "despite the fact that they are not completely alive, viruses can be considered more than simple inert material: they tend towards life". [9] This 'tending towards life', perhaps because it is written by a scientist, is in my opinion extremely interesting, almost fascinating. Is life perhaps also a function of the scale at which it is observed?

Albert Szent-Gyorgyi, the great Hungarian chemist who won the Nobel Prize for medicine in 1937, gave a profoundly inorganic definition of life: "life is nothing other than an electron in search of a place in which to stop". [l0] This contiguity or a mixing between life and the inorganic does not surprise us. After all, about four billion years ago, the organic evolved from the inorganic, [11] the organic and the inorganic are contiguous, osmotic universes. Creativity and art have already climbed over this barrier; as we can see in the diagram I showed you, genetic art throws out a bridge between the organic and the inorganic, crossing the border between the two. But many disciplines of the artificial also follow this route, [12] including nanotechnology, [13] synthetic biology [14] and so on. The double division of the living, therefore, can well appear not so much as a duality but as cognitive and even evolutive strategy.

Notes

1. George Gessert. "Re: [YASMIN-msg] Exhibiting bioart - Yasmin discussion", message sent to the *Yasmin* mailing list, 25 March 2006, <http://www.media.uoa.gr/yasmin/>.
2. Gessert's reply:

From: ggessert@igc.org
Date: 09 January 2007 22:43:23 GMT +01 :00
Re: A question
To: plc@noemalab.org
Dear Pier Luigi Capucci,
The day I received your message I was wondering, how would one graphically represent the

relationships among genetic art, bio art, transgenic art, etc.? Your timing is perfect! As is your graphic. You have it exactly right. I look forward to seeing the Italian edition of *L'Art Biotech* with your excellent graphic.
Best. George.

3. Cf.. for example, Karl Gerbel, Peter Weibel (editors), *Ars EIectronica* 93. *Genetische Kunst – Künstliches Leben/Genetic Art – Artificial Life,* PVS Verleger, Vienna 1993; Karl Gerbel, Peter Weibel (editors), *Ars EIectronica* '94. *Intelligente Ambiente,* PVS Verleger, Vienna 1994, vols. 1-2.
4. Christopher G. Langton (editor), *Artificial Life,* Addison-Wesley, Reading (Massachussets) 1989. In Italy, cf. Domenico Parisi, "Vita artificiale e società umane", in *Sistemi intelligenti,* year VII, no. 3, December 1995.
5. Domenico Parisi, "Mente come cervello", *Le Scienze,* no. 431, July 2004.
6. Another issue of this magazine dedicated to robotics was no. 234, October 2004.
7. Cf., for example, Humberto Maturana, Francisco Varela, *L'albero della conoscenza,* Garzanti, Milan 1992; Richard Dawkins, *Il gene egoista. La parte immortale di ogni essere vivente,* Mondadori, Milan 1995; Mauro Ceruti, *Evoluzione senza fondamenti,* Laterza, Bari 1995; Luigi Luca Cavalli-Sforza, *Geni, popoli e lingue,* Adelphi, Milan 1996; Roberto Marchesini, *Post-human. Verso nuovi modelli di esistenza,* Bollati Boringhieri, Turin, 2002. Concerning "Post-Human" cf. also Mario Pireddu, Antonio Tursi (editors), *Post-umano. Relazioni tra uomo* e *tecnologia nella società delle reti,* Guerini & Associati, Milan 2006.
8. Cf. Gerfried Stocker, Christine Schopf (editors), *Memesis. The Future of Evolution,* Springer, Vienna-New York 1996.
9. Luis P. Villareal, "I virus sono vivi?", *Le Scienze,* no. 438, February 2005, p. 43.
10. Quoted in Michael Russell, "Agli inizi della vita", *Le Scienze,* no. 454, June 2006, p. 93.
11. Sarah Simpson, "Le più antiche tracce di vita", *Le Scienze,* no. 417, May 2003; Michael Russell, op. cit.
12. Mark A. Reed, James M. Tour, "Molecole nel computer", *Le Scienze,* no. 384, August 2000.
13. Nadrian C. Seeman, "Nanotecnologie a doppia elica", *Le Scienze,* no. 431, July 2004.
14. W. Wayt Gibbs, "Vita sintetica", *Le Scienze,* no. 430, June 2004. Also, edited by the Bio Fab Group, "L'ingegneria della vita", *Le Scienze,* no. 456, August 2006; Ehud Shapiro, Yaakov Benenson, "Arriva il computer a DNA", *Le Scienze,* no. 457, September 2006.