

Life Transformation — Art Mutation

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ABSTRACT

In 1998 I introduced the concept and the phrase "transgenic art" and proposed the creation (and social integration) of a real dog that glows with a green light. Transgenic art, a new art form based on the use of genetic engineering to create unique living beings, must be pursued with great care, with acknowledgment of the complex issues it raises and, above all, with a commitment to respect, nurture, and love the life it creates. I exhibited new transgenic artworks in 1999, 2000, 2001, and 2004. The implications of this ongoing work have particular aesthetic and social ramifications, crossing several disciplines and providing material for further reflection and dialogue. What follows is an overview of these works, the issues they evoke, and the debates they have elicited.

For almost two decades my work has explored the boundaries between humans, animals, and robots [1]. Thus, transgenic art can be seen as a natural development of my previous work. In my telepresence art, developed since 1986, humans coexist with other humans and non-human animals through telerobotic bodies. In my biotelematic art, developed since 1994, biology and networking are no longer co-present but coupled so as to produce a hybrid of the living and the telematic. With transgenic art, developed since 1998, the animate and the technological can no longer be distinguished. The implications of this ongoing work have particular social ramifications, crossing several disciplines and providing material for further reflection and dialogue.

The presence of biotechnology will increasingly change from agricultural and pharmaceutical practices to a larger role in popular culture, just as the perception of the computer changed historically from an industrial device and military weapon to a communication, entertainment, and education tool. Terms formerly perceived as "technical", such as *megabytes* and *ram*, for example, have entered the vernacular. Likewise, jargon that today may seem out of place in ordinary discourse, such as *marker* and *protein*, for example, will simply be incorporated into the larger verbal landscape of everyday language. This is made clear by the fact that high school students in the United States already create transgenic bacteria routinely in school labs through affordable kits. The

popularization of aspects of technical discourse inevitably brings with it the risk of dissemination of a reductive and instrumental ideological view of the world. Without ever relinquishing its right to formal experimentation and subjective inventiveness, art can, art should contribute to the development of alternative views of the world that resist dominant ideologies. As both utopian and dystopian artists such as Moholy-Nagy and Tinguely have done before, in my work I appropriate and subvert contemporary technologies — not to make detached comments on social change, but to *enact* critical views, to make present in the physical world invented new entities (artworks that include transgenic organisms) which seek to open a new space for both emotional and intellectual aesthetic experience.

I have been employing the phrase "bio art" since 1997, in reference to my own works that involved biological agency (as opposed to biological objecthood), such as "Time Capsule" [2] and "A-positive" [3], both presented in 1997. The difference between biological agency and biological objecthood is that the first involves an active principle while the second implies material self-containment. In 1998 I introduced the phrase "transgenic art" in a paper-manifesto with the same title [4] and proposed the creation (and social integration) of a dog expressing green fluorescent protein. This protein is commonly used as a biomarker in genetic research ; however, my goal was to use it primarily for its visual properties as a symbolic gesture, a social marker. The initial public response to the paper was curiosity laced with incredulity. The proposal is perfectly viable, but it seemed that few believed that the project could or would be realized. While I struggled to find venues that could assist me in creating the aforementioned project, entitled "GFP K-9", I too realized that canine reproductive technology was not developed enough at the time to enable me to create a dog expressing green fluorescent protein [5]. In the meantime, I started to develop a new transgenic art work, entitled "Genesis", which premiered at Ars Electronica '99 [6].

GENESIS

Genesis is a transgenic artwork that explores the intricate relationship between biology, belief systems, information technology, dialogical interaction, ethics, and the Internet. The key element of the work is an "artist's gene", a synthetic gene that was created by translating a sentence from the biblical book of Genesis into Morse Code, and converting the Morse Code into DNA base pairs according to a conversion principle I specially developed for this work. The sentence reads: "Let man have dominion over the fish of the sea, and over the

fowl of the air, and over every living thing that moves upon the earth." It was chosen for what it implies about the dubious notion--divinely sanctioned--of humanity's supremacy over nature. Morse code was chosen because, as the first example of the use of radiotelegraphy, it represents the dawn of the information age--the genesis of global communication. The Genesis gene was incorporated into bacteria, which were shown in the gallery. Participants on the Web could turn on an ultraviolet light in the gallery, causing real, biological mutations in the bacteria. This changed the biblical sentence in the bacteria. After the show, the DNA of the bacteria was translated back into Morse code, and then back into English. The mutation that took place in the DNA had changed the original sentence from the Bible. The mutated sentence was posted on the Genesis web site. In the context of the work, the ability to change the sentence is a symbolic gesture: it means that we do not accept its meaning in the form we inherited it, and that new meanings emerge as we seek to change it.

While presenting Genesis, I also gave a public lecture in the context of the symposium "Life Science", presented by Ars Electronica '99. My lecture focused on the "GFP K-9" proposal. To contextualize my presentation, I reviewed the long history of human-dog domestication and partnership, and pointed out the direct and strong human influence on the evolution of the dog up to the present day. Emphasizing that there are no packs of Poodles and Chihuahuas running in the wild, and that the creation of the dog out of the wolf was a technology -- a fact that we seemed to have lost conscience of -- I proceeded to point out the complex relationship between dogs and humans throughout their long history together, going back to at least fourteen thousand years, according to archeological records. While some showed support and appreciation for the work, others reacted against the project and voiced their position. The stage was set for a very productive dialogue, which was one of my original intentions. As I see it, the debate must go beyond official policy-making and academic research to encompass the general public, including artists. "GFP K-9" was discussed in art magazines and books and science journals. Daily papers and general magazines also discussed the work in progress. While specialized publications showed greater appreciation for "GFP K-9", the response in the general media covered the whole gamut, from forthright rejection to consideration of multiple implications to unmistakable support. The shock generated by the proposal curiously caused one critic to declare "the end of art" [7]. As I see it, there's no reason to see the beginning of a new art as the end of anything.

GFP BUNNY

This pattern of response repeated itself, at a truly global scale, when I announced in 2000 the realization of my second transgenic work. Entitled "GFP Bunny", the work comprises the creation of a green fluorescent rabbit ("Alba"), the public dialogue generated by the project, and the social integration of the rabbit. This work was realized with the assistance of Louis Bec and Louis-Marie Houdebine. Louis Bec worked as the producer, coordinating the activities in France. Bec and I met at Ars Electronica (September 1999) and soon afterwards he contacted Houdebine on my behalf, for the first time, to propose the project. Months later, in 2000, Alba was born, a gentle and healthy rabbit. As I stated in my paper entitled "GFP Bunny" [8], "transgenic art is a new art form based on the use of genetic engineering to create unique living beings. This must be done with great care, with acknowledgment of the complex issues thus raised and, above all, with a commitment to respect, nurture, and love the life thus created."

"GFP Bunny" attracted local media in the south of France in June 2000 when the former director of the French institute where Alba was born used his authority to overrule the scientists who worked on the project and refused to let Alba go to Avignon and then come to my family in Chicago. This arbitrary decision was made privately by one individual (the former director of the French institute where Alba was born). He never explained his reason for the refusal, so it remains unknown to this day. Bec and I denounced the censorship through the Internet and through interviews to the press [9]. If the objective was to silence the media, the result backfired. "GFP Bunny" became a global media scandal after a front-page article appeared in the Boston Globe [10], sharing headlines with articles about the 2000 Olympics and US presidential debates. Articles about Alba were published in all major countries, with wire services further spreading the news worldwide [11]. Alba was also on the cover of Le Monde, San Francisco Chronicle and L'Espresso, among others. Der Spiegel and Chicago Tribune dedicated full pages to "GFP Bunny". She also appeared on the front page of the Arts section of the New York Times. Broadcasts by ABC TV, BBC Radio, and Radio France also took the Alba story to the whole planet. From mid-2000 to early 2003 the relentless response to "GFP Bunny" has been equally intense and fascinating, with fruitful debate and both strong opposition and support. Since October 15, 2000, the "Alba Guestbook" has been collecting general opinions about the work and expressions of support to bring Alba home [12]. Through lectures and symposia, Internet postings and email correspondence, the debate intensified and became richer, more subtle and nuanced, as I had hoped. The response to

"GFP Bunny" constitutes extremely rich material, which I hope to revisit in the near future.

As part of my intercontinental custody battle to obtain Alba's release, between December 3 and December 13, 2000, I staged a public campaign in Paris, which included lectures, broadcasts, public and private meetings, and the public placement of a series of seven posters. I placed individual posters in several neighborhoods, including: Le Marais, Quartier Latin, Saint Germain, Champs de Mars, Bastille, Montparnasse, and Montmartre. The posters reflect some of the readings afforded by "GFP Bunny". They show the same image of Alba and I together, each topped by a different French word: Art, Médias, Science, Éthique, Religion, Nature, Famille. [13]. Between December 3 and December 13, 2000, parallel to radio (Radio France and Radio France Internationale), print (Le Monde, Libération, Transfert, Ça M'intéresse, Nova), and television (Canal+, Paris Première) interviews and debates, I posted these images on the streets in an effort to intervene in the context of French public opinion and gather support for my cause to bring Alba home. I also engaged the public directly through a series of lectures (Sorbonne, École Normale Superior, École Superior des Beaux Arts, Forum des Images) and through face-to-face conversations on the street sparked by the public's interest. In total, I reached approximately 1.5 million people (about half of the population of Paris). This was an important step, as it allowed me to address the Parisian public directly. In 2001 I created "The Alba Flag", a white flag with the green rabbit silhouette, and started to fly it in front of my Chicago-area house. The flag not only signals publically the green bunny home, but most importantly stands as a social marker, a beacon of her absence.

Continuing my efforts to raise awareness about Alba's plight and to obtain her freedom, in 2002 I presented a solo exhibition entitled "Free Alba!" [14] at Julia Friedman Gallery, in Chicago (May 3 - June 15, 2002). "Free Alba!" included a large body of new work comprised of large-scale color photographs, drawings, prints, Alba flags, and Alba t-shirts. Seen together for the first time were the posters from my public interventions in Paris (2000), an Alba flag flying outside the Gallery (2001), photographs that reclaim green bunny narratives circulated by global media (2001-02), drawings that reflect on our closeness to the "animal other" (2001-2002) and Alba t-shirts that extend Alba's cause beyond gallery's walls (2002). Through the leitmotif of the green bunny, this exhibition explored the poetics of life and evolution. The story of "GFP Bunny" was adapted and customized by news organizations worldwide, often generating new narratives that, both intentionally and unintentionally, reinstated or overlooked the facts. My "Free Alba!" exhibition featured

photographs in which I reappropriated and recontextualized this vast coverage, exhibiting the productive tension that is generated when contemporary art enters the realm of daily news. The photographs in this series dramatize the fact that the reception of GFP Bunny was complex, taking place across cultures and in diverse locations. I will continue to develop new strategies to make Alba's case public and to pursue her liberation.

Parallel to this effort, transgenic art evolves. One new direction involves the creation of nanoscale three-dimensional structures built of amino acids. This "proteic art", or "protein art", can be experienced in many forms, including in vivo, in vitro, and expanded into other settings, such as rapid-prototype models and online navigational spaces. All of these forms, and many others, can be combined through new biointerfaces. A prominent aspect of this path is the fact that these three-dimensional structures are assembled according to combinatorial rules that follow strict biological principles (otherwise it is not possible to produce them), even if one invents and synthesizes a new protein.. This constraint imposes a biomorphology that offers a new and fascinating creative challenge. A second new direction involves complex interactive transgenic environments with multiple organisms and biobots, biological robots partially regulated by internal transgenic microorganisms. In what follows I offer a discussion of these developments, both of which I explored in 2001.

SCULPTING NEW PROTEINS

While the first phase of "Genesis" focused on the creation and the mutation of a synthetic gene through Web participation, the second phase, carried out in 2000/2001, focused on the protein produced by the synthetic gene, the Genesis protein [15], and on new works that examine the cultural implications of proteins as fetish objects. The Genesis protein is another step in the translation of the original Biblical text, this time from the Genesis gene (itself encoding the English sentence) to a three-dimensional form made up of discrete parts (aminoacids). The transmogrification of a verbal text into a sculptural form is laden with intersemiotic resonances that contribute to expand the historically rich intertextuality between word, image and spatial form. The process of biological mutation extends it into time.

A critical stance is manifested throughout the Genesis project by following scientifically accurate methods in the real production and visualization of a gene and a protein that I have invented and which have absolutely no function or value in biology. Rather than explicating or illustrating scientific principles,

the Genesis project complicates and obfuscates the extreme simplification and reduction of standard molecular biology descriptions of life processes, reinstating social and historical contextualization at the core of the debate. I appropriate the techniques of biotechnology to critique the language of science and its inherent ideologies, while developing transgenic art as an alternative means for individual expression. In its genomic and proteomic manifestations, the Genesis project continues to reveal new readings and possibilities.

Protein production is a fundamental aspect of life. Multiple research centers around the world are currently focusing their initiatives on sequencing, organizing, and analyzing the genomes of both simple and complex organisms, from bacteria to human beings. After genomics (the study of genes and their function) comes proteomics (the study of proteins and their function). Proteomics, the dominant research agenda in molecular biology in the post-genomic world, focuses on the visualization of the three-dimensional structure of proteins produced by sequenced genes [16]. It is also concerned with the study of the structure and functionality of these proteins, among many other important aspects, such as similarity among proteins found in different organisms. The second phase of "Genesis" critically investigates the logic, the methods, and the symbolism of proteomics, as well as its potential as a domain of artmaking.

In order to arrive at the visualization of the "Genesis" protein, I first explored aspects of its two-dimensional structure [17]. The next step was to compare the predicted folding pattern of the "Genesis" protein to another known protein to which it is similar: Chorion. With the goal of producing a tangible rendition of the nanostructure of the "Genesis" protein, I researched protein fold homology using the Protein Data Bank, operated by the Research Collaboratory for Structural Bioinformatics (RCSB). I then produced a digital visualization of the "Genesis" protein's three-dimensional structure [18]. This three-dimensional dataset was used to produce both digital and physical versions of the protein. The digital version is a fully navigable web object rendered both as VRML (Virtual Reality Modeling Language) and PDB (Protein Data Bank) formats, to enable upclose inspection of its complex volumetric structure. The physical rendition is a small solid object produced via rapid-prototyping, to convey in tangible form the fragility of this molecular object [19]. This object was used as a mold for casting the final form of the protein used in the creation of the "Transcription Jewels".

"Transcription Jewels" is a set of two objects encased in a custom-made round wooden box. The word "transcription" is the term employed in Biology to

name the process during which the genetic information is "transcribed" from DNA into RNA [20]. One "jewel" is a 2" genie bottle in clear glass with gold ornaments and 65 mg of purified "Genesis" DNA inside. "Purified DNA" means that countless copies of the DNA have been isolated from the bacteria in which they were produced and accumulated and filtrated in a vial. The gene is seen here out of the context of the body, its meaning intentionally reduced to a formal entity to reveal that without acknowledgment of the vital roles played by organism and environment, the "priceless" gene can become "worthless". The other "jewel" is an equally small gold cast of the three-dimensional structure of the "Genesis" protein. By displaying the emblematic elements of the biotech revolution (the gene and the protein) as coveted valuables, "Transcription Jewels" makes an ironic commentary on the process of commodification of the most minute aspects of life. Both the purified gene in "Transcription Jewels" and its protein are not derived from a natural organism, but rather were created specifically for the artwork "Genesis". Instead of a "genie" inside the bottle one finds the new panacea, the gene. No wishes of immortality, beauty, or intelligence are granted by the inert and isolated gene sealed inside the miniature bottle. As a result, the irony gains a critical and humorous twist by the fact that the "precious commodity" is devoid of any real, practical application in biology.

All pieces described and discussed above, including the net installation with live bacteria, were presented together in my solo exhibition "Genesis", realized at Julia Friedman Gallery, in Chicago, between May 4 and June 2, 2001. The multiple mutations experienced biologically by the bacteria and graphically by the images, texts, and systems that compose the exhibition, reveal that the alleged supremacy of the so-called "master molecule" must be questioned. The Genesis series (including the installation, « Transcription Jewels », and other works) challenges the genetic hype and opposes the dominant biodeterministic interpretation, stating that we must continue to consider life as a complex system at the crossroads between belief systems, economic principles, legal parameters, political directives, scientific laws, and cultural constructs.

THE EIGHTH DAY, A TRANSGENIC NET INSTALLATION

"The Eighth Day" is a transgenic artwork that investigates the new ecology of fluorescent creatures that is evolving worldwide. It was shown from October 25 to November 2, 2001 at the Institute for Studies in the Arts, Arizona State University, Tempe [21]. While fluorescent creatures are being developed in

isolation in laboratories, seen collectively in this work for the first time they form the nucleus of a new and emerging synthetic bioluminescent ecosystem. The piece brings together living transgenic life forms and a biological robot (biobot) in an environment enclosed under a clear Plexiglas dome, thus making visible what it would be like if these creatures would in fact coexist in the world at large.

As the viewer walks into the gallery, she first sees a blue-glowing semisphere against a dark background. This semisphere is the 4-foot dome, aglow with its internal blue light. She also hears the recurring sounds of water washing ashore. This evokes the image of the Earth as seen from space. The water sounds both function as a metaphor for life on Earth (reinforced by the spherical blue image) and resonate with the video of moving water projected on the floor. In order to see "The Eighth Day" the viewer is invited to "walk on water".

In the gallery, visitors are able to see the terrarium with transgenic creatures both from inside and outside the dome. As they stand outside the dome looking in, someone online sees the space from the perspective of the biobot looking out, perceiving the transgenic environment as well as faces or bodies of local viewers. An online computer in the gallery also gives local visitors an exact sense of what the experience is like remotely on the Internet.

Local viewers may temporarily believe that their gaze is the only human gaze contemplating the organisms in the dome. However, once they navigate the Web interface they realize that remote viewers can also experience the environment from a bird's eye point of view, looking down through a camera mounted above the dome. They can pan, tilt, and zoom, seeing humans, mice, plants, fish and the biobot up close. Thus, from the point of view of the online participant, local viewers become part of the ecology of living creatures featured in the work, as if enclosed in a websphere.

"The Eighth Day" presents an expansion of biodiversity beyond wildtype life forms. As a self-contained artificial ecology it resonates with the words in the title, which add one day to the period of creation of the world as narrated in the Judeo-Christian Scriptures. All of the transgenic creatures in "The Eighth Day" are created with the same gene I used previously in "GFP Bunny" to create "Alba", a gene that allows all creatures to glow green under harmless blue light. The transgenic creatures in "The Eighth Day" are GFP plants, GFP amoeba, GFP fish, and GFP mice. Selective breeding and mutation are two key evolutionary forces. "The Eighth Day" literally raises the question of

transgenic evolution, since all organisms in the piece are mutations of their respective wildtype species and all were selected and bred for their GFP mutations.

"The Eighth Day" also includes a biological robot. A biobot is a robot with an active biological element within its body which is responsible for aspects of its behavior. The biobot created for "The Eighth Day" has a colony of GFP amoeba called *Dyctiostelium discoideum* as its "brain cells". These "brain cells" form a network within a bioreactor that constitutes the "brain structure" of the biobot. When amoebas divide the biobot exhibits dynamic behavior inside the enclosed environment. Changes in the amoebal colony (the "brain cells") of the biobot are monitored by it, and cause it to move about, throughout the exhibition. The biobot also functions as the avatar of Web participants inside the environment. Independent of the ascent and descent of the biobot, Web participants are able to control its audiovisual system with a pan-tilt actuator. The autonomous motion, which often causes the biobot to lean forward in different directions, provide Web participants with new perspectives of the environment.

The biobot's "amoebal brain" is visible through the transparent bioreactor body. In the gallery, visitors are able to see the terrarium with transgenic creatures from outside and inside the dome, as a computer in the gallery gives local visitors an exact sense of what the experience is like on the Internet. By enabling participants to experience the environment inside the dome from the point of view of the biobot, "The Eighth Day" creates a context in which participants can reflect on the meaning of a transgenic ecology from a first-person perspective.

MOVE 36

"Move 36" makes reference to the dramatic move made by the computer called Deep Blue against Chess world champion Gary Kasparov in 1997. This competition can be characterized as a match between the greatest chess player who ever lived against the greatest chess player who never lived. The installation -- presented for the first time at the Exploratorium, in San Francisco, from February 26 to May 31, 2004 -- sheds light on the limits of the human mind and the increasing capabilities developed by computers and robots, inanimate beings whose actions often acquire a force comparable to subjective human agency.

According to Kasparov, Deep Blue's quintessential moment in Game Two came at Move 36. Rather than making a move that was expected by viewers and commentators alike--a sound move that would have afforded immediate gratification--it made a move that was subtle and conceptual and, in the long run, better. Kasparov could not believe that a machine had made such a keen move. The game, in his mind, was lost.

The installation presents a Chess board made of earth (dark squares) and white sand (light squares) in the middle of the room. There are no chess pieces on the board. Positioned exactly where Deep Blue made its Move 36 is a plant whose genome incorporates a new gene that I created specifically for this work. The gene uses ASCII (the universal computer code for representing binary numbers as Roman characters, on- and off-line) to translate to the four bases of genetics Descartes' statement: "Cogito ergo sum" (I think therefore I am).

Through genetic modification, the leaves of the plants grow multiple plantlets. In the wild these leaves would be smooth. The "Cartesian gene" was coupled with a gene for the expression of the plantlets, so that the public can easily see with the naked eye that the "Cartesian gene" is expressed precisely where the plantlets grow.

The "Cartesian gene" was produced according to a new code I created especially for the work. In 8-bit ASCII, the letter C, for example, is: 01000011. Thus, the gene is created by the following association between genetic bases and binary digits:

A = 00

C = 01

G = 10

T = 11

The result is the following gene with 52 bases:

CAATCATTCACTCAGCCCCACATTCACCCCAGCACTCATTCCATCCCC
CATC

The creation of this gene is a critical and ironic gesture, since Descartes considered the human mind a "ghost in the machine" (for him the body was a

"machine"). His rationalist philosophy gave new impetus both to the mind-body split (Cartesian Dualism) and to the mathematical foundations of current computer technology.

The presence of this "Cartesian gene" in the plant, rooted precisely where the human lost to the machine, reveals the tenuous border between humanity, inanimate objects endowed with life-like qualities, and living organisms that encode digital information. A single focused light shines in a delicate luminous cone over the plant. Silent square video projections on two opposing walls contextualize the work, evoking two chess opponents in absentia. Each video projection is composed of a grid of small squares, resembling a chess board. Each square shows short animated loops cycling at different intervals, thus creating a complex and carefully choreographed thread of movements. The cognitive engagement of the viewer with the multiple visual possibilities presented on both projected boards subtly emulates the mapping of multiple paths on the board involved in a chess match.

A game for phantasmic players, a philosophical statement uttered by a plant, a sculptural process that explores the poetics of real life and evolution. This installation gives continuity to my ongoing interventions at the boundaries between the living (human, non-human animals) and the non-living (machines, networks). Checkmating traditional notions, nature is revealed as an arena for the production of ideological conflict, and the physical sciences as a locus for the creation of science fictions.

CONCLUSION

Quite clearly, genetic engineering will continue to have profound consequences in art as well as in the social, medical, political, and economic spheres of life. As an artist I am interested in reflecting on the multiple social implications of genetics, from unacceptable abuse to its hopeful promises, from the notion of "code" to the question of translation, from the synthesis of genes to the process of mutation, from the metaphors employed by biotechnology to the fetishization of genes and proteins, from simple reductive narratives to complex views that account for environmental influences. The urgent task is to unpack the implicit meanings of the biotechnology revolution and contribute to the creation of alternative views, thus changing genetics into a critically aware

new art medium.

The tangible and symbolic coexistence of the human and the transgenic, which I have developed in several of my works discussed above, shows that humans and other species are evolving in new ways. It dramatizes the urgent need to develop new models with which to understand this change, and calls for the interrogation of difference taking into account clones, transgenics and chimeras.

The Human Genome Project (HGP) has made it clear that all humans have in their genome sequences that came from viruses [22], acquired through a long evolutionary history. This shows that we have in our bodies DNA from organisms other than human. Ultimately, this means that we too are transgenic. Before deciding that all transgenics are "monstrous", humans must look inside and come to terms with their own "monstrosity", i. e., with their own transgenic condition.

The common perception that transgenics are not "natural" is incorrect. It is important to understand that the process of moving genes from one species to another is part of wild life (without human participation). The most common example is the bacterium called "agrobacterium", which enters the root of plants and communicates its genes to it. Agrobacterium has the ability to transfer DNA into plant cells and integrate the DNA into the plant chromosome. [23]

Transgenic art suggests that romantic notions of what is "natural" have to be questioned and the human role in the evolutionary history of other species (and vice versa) has to be acknowledged, while at the same time respectfully and humbly marveling at this amazing phenomenon we call "life".

NOTES

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2 - Atkins, Robert . "State of the (On-Line) Art", *Art in America*, April 99, pp. 89-95; Carvalho, Mario Cesar. "Artista implanta hoje chip no corpo," *Folha de São Paulo, Cotidiano*, 11 November 1997, p. 3; Cohen, Michel. "The Artificial Horizon: Notes Towards a Digital Aesthetics", in: Wonil Rhee (editor). *Luna's Flow . The Second International Media Art Biennale. media_city seoul 2002* (Seoul Museum of Art, Seoul, Korea, 2002), p. 20 and pp. 32-33; Decia, Patricia. "Bioarte: Eduardo Kac tem obra polêmica vetada no ICI", *Folha de São Paulo, Ilustrada*, 10 October 1997, p. 13.; Dietz, Steve. "Memory_Archive_Database", *Switch*, Vol. 5, N. 3, 2000. <http://switch.sjsu.edu>; Dietz, Steve. "Hotlist", *Artforum*, October 2000, p. 41.; Esnal, Luis. "Un hombre llamado 026109532", *La Nacion*, Section 5, Buenos Aires, 15 December 1997, p. 8. ; Kac, Eduardo. "Time Capsule", *InterCommunication*, N. 26, Autumn 1998, Tokyo, pp. 13-15. ; "Time Capsule", in *Database Aesthetics*, Victoria Vesna, Karamjit S. Gill and David Smith, eds., special issue of *AI & Society*, Vol. 14, N. 2, 2000, pp. 243-249.; "Art at the Biological Frontier", in Roy Ascott, ed., *Reframing Consciousness: Art, Mind and Technology* (Exeter: Intellect, 1999), pp. 90-94.; "Capsule Temporelle", in : O'Rourke, Karen (ed.). *L'Archivage Comme Activité Artistique/Archiving as Art* (Paris: University of Paris 1, 2000), n.p.n.; Machado, Arlindo. "A Microchip inside the Body," *Performance Research*, Vol. 4, N. 2, "On Line" special issue, London, 1999, pp. 8-12. ; Paul, Christiane. "Time Capsule", *Intelligent Agent*, Vol. 2, N. 2, (1998) pp. 4-13. ; Scheeres, Julia. "New Body Art: Chip Implants", *Wired News*, March 11, 2002.; Sherlock, Maureen P. "Either/Or/Neither/Nor", in Grzanic, Marina (ed.), *Gallery (Dante) Marino Cettina - Future Perspectives* (Umag, Croatia : Marino Cettina Gallery, 2001), pp. 130-135.; Stiles, Kristine. "Time Capsule", in *Uncorrupted Joy: Art Actions, Art History, and Social Value* (University of California Press, 2003); Strickland, Stephanie, "Dalí Clocks: Time Dimensions of Hypermedia", *Electronic Book Review*, N. 11, 2000.; Tomasula, Steve . "Time Capsule: Self-Capsule", *CIRCA*, N. 89, Autumn 1999. Ireland, pp. 23-25.

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4 - Kac, E. "Transgenic Art", Leonardo Electronic Almanac, Volume 6, Number 11, 1998. Also: <<http://www.ekac.org/transgenic.html>>. Republished in Gerfried Stocker and Christine Schopf (eds.), Ars Electronica '99 - Life Science (Vienna, New York: Springer, 1999), pp. 289- 296.

5 - At the time of writing, February 2003, canine reproductive technology is still not developed enough to enable the creation of a transgenic or cloned dog. However, research is underway to both map the dog genome and to developed canine IVF. Clearly, "GFP K-9" will be possible in the near future.

6 - Kac, E. "Genesis", Gerfried Stocker and Christine Schopf (eds.), Ars Electronica '99 - Life Science (Vienna, New York: Springer, 1999), pp. 310-313. Also: <<http://www.ekac.org/geninfo.html>>. "Genesis" was carried out with the assistance of Dr. Charles Strom, formerly Director of Medical Genetics, Illinois Masonic Medical Center, Chicago. Dr. Strom is now Medical Director, Biochemical and Molecular Genetics Laboratories Nichols Institute / Quest Diagnostics, San Juan Capistrano, CA. Original DNA music for Genesis was composed by Peter Gena.

7 - Mudede, Charles. "The End of Art", The Stranger, Volume 9, Number 15, Dec. 30, 1999 - Jan. 05, 2000, Seattle.

8 - Kac, E. "GFP Bunny", in Dobrila, Peter T. and Kostic, Aleksandra (eds.),

Eduardo Kac: Telepresence, Biotelematics, and Transgenic Art (Maribor, Slovenia: Kibla, 2000), pp. 101-131. Also:
<<http://www.ekac.org/gfpbunny.html>>.

9 - I had proposed to live for one week with Alba in the Grenier à Sel, in Avignon, where Louis Bec directed the art festival "Avignon Numérique". In an email broadcast in Europe on June 16, 2000, Bec wrote: "Contre notre volonté, le programme concernant «Artransgénique», qui devait se dérouler du 19 au 25 juin, se trouve modifié. Une décision injustifiable nous prive de la présence de Bunny GFP, le lapin transgénique fluorescent que nous comptions présenter aux Avignonnais et à l'ensemble des personnes intéressées par les évolutions actuelles des pratiques artistiques. Malgré cette censure déguisée, l'artiste Brésilien Eduardo Kac, auteur de ce projet, sera parmi nous et présentera sa démarche ainsi que l'ensemble de ses travaux. Un débat public permettra d'ouvrir une large réflexion sur les transformations du vivant opérées par les biotechnologies, tant dans les domaines artistiques et juridiques, qu'éthiques et économiques. Nous nous élevons de toute évidence contre le fait qu'il soit interdit aux citoyens d'avoir accès aux développements scientifiques et culturels qui les concernent si directement."

10 - Cook, Gareth. "Cross hare: hop and glow", Boston Globe, 9/17/2000, p. A01.

11 - For a bibliography on transgenic art, see:
<<http://www.ekac.org/transartbiblio.html>>.

12 - <<http://sprocket.telab.artic.edu/ekac/bunnybook.html>>

13 - These posters have also been shown in gallery exhibitions: Dystopia + Identity in the Age of Global Communications, curated by Cristine Wang, Tribes Gallery, New York, 2000; Under the Skin, curated by Söke Dinkla, Renate Heidt Heller and Cornelia Brueninghaus-Knubel, Wilhelm Lehmbruck Museum, Duisburg, 2001; "International Container Art Festival", Kaohsiung Museum of Fine Arts, Taiwan (from Dec. 8, 2001 to January 6, 2002); "Portão 2", Galeria Nara Roesler, São Paulo, Brazil (from March 21 to April 27, 2002); "Free Alba!", Julia Friedman Gallery, Chicago (from May 3 to June 15, 2002); "Eurovision - I Biennale d'Arte : DNArt; Transiti: Metamorfosi: Permanenze", Kunsthaus Merano Arte, Merano, Italy (from June 15 to August 15, 2002);

"Gene(sis): Contemporary Art Explores Human Genomics", Henry Art Gallery, Seattle, from April 6 to August 25, 2002. See also the following catalogues: Under the Skin (Ostfilden-Ruit, Germany: Hatje Cantz Verlag, 2001), pp. 60-63; Eurovision - I Biennale d'Arte : DNArt; Transiti: Metamorfosi: Permanenze (Milano: Rizzoli, 2002), pp. 104-105; International Container Art Festival (Kaohsiung: Kaohsiung Museum of Fine Arts, 2002), pp. 86-87.

14 - Stein, Lisa. "New Kac Show Takes a Look at Ethics, Rabbit", Chicago Tribune, May 10, 2002, p. 21.

15 - In actuality, genes do not "produce" proteins. As Richard Lewontin clearly explains: "A DNA sequence does not specify protein, but only the amino acid sequence. The protein is one of a number of minimum free-energy foldings of the same amino acid chain, and the cellular milieu together with the translation process influences which of these foldings occurs." See: R. C. Lewontin, "In the Beginning Was the Word", Science, Vol. 291, 16 February 2001, p. 1264.

16 - In 1985 I purchased an issue of a magazine entitled High Technology whose cover headline read "Protein Engineering : Molecular Creations for Industry and Medicine". Clearly, the desire to "design" new molecular forms has been evolving for approximately two decades. See: Tucker, Jonathan B. "Proteins to Order. Computer graphics and gene splicing are helping researchers create new molecules for industry and medicine", High Technology, Vol. 5, N.12, December 1985, pp. 26-34.

17 - Special thanks to Dr. Murray Robinson, Head of Cancer Program, Amgen, Thousand Oaks, CA.

18 - Protein visualization was carried out with the assistance of Charles Kazilek and Laura Eggink, BioImaging Laboratory, Arizona State University, Tempe.

19 - Rapid prototyping was developed with the assistance of Dan Collins and James Stewart, Prism Lab, Arizona State University, Tempe.

20 - Terms like "transcription", as well as "code", "translation", and many others commonly employed in molecular biology, betray an ideological stance, a conflation of linguistic metaphors and biological entities, whose rhetorical goal is to instrumentalize processes of life. In the words of Lily E. Kay, this merger integrates "the notion of the genetic code as relation with that of a DNA code as thing". See: Kay, Lily E., *Who Wrote the Book of Life: A History of the Genetic Code* (Stanford, Calif. : Stanford University Press, 2000), p. 309. For a thorough critique of the rhetorical strategies of molecular biology, see: Doyle, Richard, *On Beyond Living : Rhetorical Transformations of the Life Sciences* (Stanford, Calif. : Stanford University Press, 1997).

21 - The "Eighth Day" team: Richard Loveless, Dan Collins, Sheilah Britton, Jeffery (Alan) Rawls, Jean Wilson-Rawls, Barbara Eschbach, Julia Friedman, Isa Gordon, Charles Kazilek, Ozzie Kidane, George Pawl, Kelly Phillips, David Lorig, Frances Salas, and James Stewart. Additional thanks to Andras Nagy, Samuel Lunenfeld Research Institute, Toronto; Richard Firtel, University of California, San Diego; Chi-Bin Chien, University of Utah, Salt Lake City, and Neal Stewart, University of North Carolina at Greensboro. I developed "The Eighth Day" through a two-year residency at the Institute of Studies in the Arts, Arizona State University, Tempe. The exhibition dates: October 25 to November 2, 2001. Exhibition location: Computer Commons Gallery, Arizona State University, Tempe (with the support of the Institute of Studies in the Arts). Documentation can be found at: <http://www.ekac.org/8thday.html>.

22 - See Brown T. A.. *Genomes* (Oxford, UK : Bios scientific publishers, 1999), p.138; and Baltimore, David. "Our genome unveiled", *Nature* 409, 15 February 2001, pp. 814-816. In private email correspondence (28 January 2002), and as a follow up to our previous conversation on the topic, Dr. Jens Reich, Division of Genomic Informatics of the Max Delbrück Center in Berlin-Buch, stated: "The explanation for these massive [viral] inserts into our genome (which, incidentally, looks like a garbage bin anyway) is usually that these elements were acquired into germ cells by retrovirus infection and subsequent dispersion over the genome some 10 to 40 millions ago (as we still were early apes)." The HGP also suggests that humans have hundreds of bacterial genes in the genome. See: International Human Genome Sequencing Consortium. "Initial sequencing and analysis of the human genome", 15 February 2001 Volume 409, No. 6822, p. 860. Of the 223 genes coding for proteins that are also present in bacteria and in vertebrates, 113 cases are

believed to be confirmed. See p. 903 of the same issue. In the same correspondence mentioned above, Dr. Reich concluded: "It appears that it is not man, but all vertebrates who are transgenic in the sense that they acquired a gene from a microorganism."

23 - This natural ability has made a genetically engineered version of the agrobacterium a favorite tool of molecular biology. See: Herrera-Estrella L. (1983). Transfer and expression of foreign genes in plants. PhD thesis. Laboratory of Genetics, Gent University, Belgium; Hooykaas P.J.J. and Shilperoort R.A. (1992). Agrobacterium and plant genetic engineering. *Plant Molecular Biology* 19:15-38; Zupan J.R. and Zambryski P.C. (1995). Transfer of T-DNA from Agrobacterium to the plant cell. *Plant Physiology* 107 : 1041-1047.