

## Are the Semi-Living semi-Good or semi-Evil?

**By Ionat Zurr & Oron Catts**

The Tissue Culture & Art Project, hosted by SymbioticA, the Art and Science Collaborative Research Laboratory, School of Anatomy and Human Biology, The University of Western Australia.

### Introduction

The use of animals or parts of animals by humans has been practiced since the dawn of our species. Selective breeding represented one of the major shifts in human society and culture. By employing the principals of hereditary traits humans transformed themselves into agrarian sedentary societies while transforming wild species into domesticated varieties that never existed before. Living organisms were appropriated by humans and modified/enhanced for functional and aesthetical purposes as the basis for agricultural practices (such as ornamental plants and fish, husbandry animals and pets). Much earlier, the use of fresh and preserved organisms (wood, leather, ivory etc.) been part of the human constructed world.

With the aid of our newly acquired knowledge of life processes – from ecologies to molecular biology – we can exercise an ever growing degree of control over the manipulation of living biological systems to the extent that the techno-sphere ('human made') and the biosphere ('nature') are increasingly indistinguishable. The ability to cut and paste genes from different organisms, the prospect of designing artificial genes, and the possibility of coercing living functional tissue (outside of an organism) to grow and behave according to human determined plans, are just some examples of this merger. Artists are now exploring the new knowledge and tools offered by modern biology to manipulate and create living and semi-living works of art.

Are the kinds of manipulations offered by modern biology so different from the past ones?

For one, Western urban society is different; therefore our relations with other living systems and their manipulations are different. The language we use to describe living and semi-living systems reflects our changing relations towards them. This paper will explore some of the language used to describe life and evolutionary processes; from bacteria to collections of cells.

Then we will discuss the Semi-Living entities created by the Tissue Culture & Art Project (TC&A) (1), and the possible different engagements with them, in the light of increased suspicion and intolerance in urban western society. Different notions of life will be looked at in the context of current rhetoric used in our pre-war (2) global society.

## **Contemporary Settings**

This paper is written in the light of the hideous rhetoric used in these pre-war times, and it's relevancy to the creation of a new class of object/being, the Semi-Living, which are grown/constructed by TC&A. TC&A was initiated in Perth, Western Australia. In The West Australia paper we recently read about the commencing Australian campaign against terrorism offered by the Australian government as part of the new plan to combat global terrorism and to protect the Australian people (excluding the refugees who are enclosed detention centres). The extract below discusses the changes made to an Australian government advertisement campaign for a free toll number to report "suspicious behaviour". The campaign was launched on 30<sup>th</sup> of December 2002:

'To avoid alarm, the government has ditched images of balaclava-clad Special Air Service troops storming houses and police look outs on the Sydney Harbor Bridge for the first phase of the campaign, in favor of softer pictures. Originally tested among focus groups, the pictures have been replaced by smiling Muslims girls, indigenous children and summer scenes of park crickets and barbecues, spliced with shots of army, Customs personnel and sniffer dogs at work.

"Australians are friendly, decent, democratic people, and we're going to stay that way. Security agencies have been upgraded and are ready to detect, prevent and respond to terrorism. We can all play our part by being alert, but not alarm."

(The West Australia, 28.12.02 pp.1, 10 by Karen Middleton)

The same newspaper, on the same day announced that the Colnoid Company, established by the Raelians had success in creating the first cloned baby: 'Sci-fi cult claims birth of first cloned baby' (p.3).

Our new knowledge of biological sciences and its applied technologies enable human civilization to create new forms of life. Drawing on the example of the Raelians, there is enough variety and eccentricities in our own species to make it a reality. Though looking at the level of compassion to living systems of our own species, from different ethnicities, religions, races and class, we are worried in regard to these new lives. The difference between being alert and being alarmed is as illusive as the difference between a 'terrorist' or 'a freedom fighter'. Who is excluded/included from the definition of being an Australian? And is that reflecting them as friendly, decent, democratic people? We doubt that.

The form and the application of our newly acquired knowledge will be determined by the prevailing ideologies that develop and control the technology, which in turn will change according to new possibilities offered by the knowledge. George Canghilhem, referring to Darwin's observation that variations in nature will not have any effect without the forces of natural selection asks: 'What could limit the ability of this law, operating over a long period of time and rigorously scrutinizing the structure, overall organization and habits of every creature, to promote good and reject evil?'"(3) (4). We might need to direct him to G.W. Bush's speeches post September 11 to find an answer to this question. When the manipulation of life takes place in an atmosphere of conflict and profit driven competition, the long-term results might be disquieting. One role that art can play is to suggest scenarios of 'worlds under construction' and subvert technologies for the purpose of creating contestable futures, and exploring variations that might have an effect. This role of art makes the emergence of the Semi-Living and the multi leveled exploration of its use so relevant. Collections of cells cooperating/competing together for some sort of coherence that will enable survival are now being manipulated/exploited by us.

### **Evolution and Cell Theory: Competition Versus Collaboration**

"The introduction of cell theory in the biology, first of plants (around 1825) and later of animals (around 1840) inevitably turned attention toward the problem of integrating elementary individualities and partial life forms into the totalizing individuality of an organism in its general life form. (5) The very word 'cell' was coined by Robert Hooke, who was first to observe the structure of cells in slices of cork. The structure reminded him of honeycomb. Cangulihem inquires 'Yet who can say whether or not the human mind, in consciously borrowing from the beehive this term for a part of an organism, did not unconsciously borrow as well the notion of the cooperative labor that produces the honeycomb? ...What is certain is that effective and social values of cooperation and association lurk more or less discreetly in the background of the developing cell theory. '(6)

The dominant discourse/rhetoric surrounding evolutionary principles based on models of competition and struggle lead to the concept of the survival of the fittest. This ideology has originated in Darwin's own writing. Darwin's writing on the origin of species stemmed from the economic theories that were developed in the late eighteen-century. Adam Smith's *An Inquiry into the Nature and Causes of the Wealth of Nations*, which was published in 1776, argues for a natural basis for poverty and the need for a free market as a model for progress and innovation.

Evolution has no aim, it is not a linear process and it does not progress towards 'something'. According to Gould 'There is no progress in evolution. The fact of evolutionary change through time doesn't represent progress as we know it. Progress is not inevitable. Much of evolution is downward in terms of morphological complexity, rather than upward. We're not marching toward

some greater thing.'(7) The nature of the explanations of the mechanisms governing evolutionary principles reflects the dominant ideologies of our society rather than some scientific truth.

The microbiologist Lyn Margulis (1981) has offered an alternative emphasis in regard to the evolutionary process. She theorized that some of the greatest leaps in evolutionary development are caused as a result of cooperation and symbiotic relationships. She suggested that a eukaryotic cell is a result of the evolutionary symbiotic relations between two prokaryotic bacteria (8). Her theory was based on the existence of more than one set of DNA in the eukaryotic cell, one which originated in the germ cells and is found in the nuclei of the cell, and the others which are based in the protoplasm of the cell (which has some functions to do with the activity within the cell). In 1927 the American biologist Ivan Wallin (1883-1969) wrote, 'It is a rather startling proposal that bacteria, the organisms which are popularly associated with disease, may represent the fundamental causative factor in the origin of species'. (9) Can it be that the basic building blocks of our own bodies, hence the eukaryotic cell, is a result of symbiotic relations between two entities (different bacteria)? Can it be that the origins for our own functioning body are collaborations between the entities we consider to be our enemies? Drawing on Margulis theory we reveal the complexity of our definitions of what is 'Us' (our own body) and the 'Other' (the enemy). The rhetoric and the context of these elements in the fabric of human existence are determined by the ideologies they rose to serve. Good and evil might seem as clear definitions to the president of United States (and the Australian Prime Minister John Howard) but even in the context of what consists the evolution of our own physicality these definitions are blurry and contradictory.

'By symbiosis different varieties of bacteria came together and made cells with nuclei. These cells with nuclei often cloned themselves into multiple copies that stayed in physical contact after reproduction...But plant, animal and fungal life greatly expanded the complexity of the free-living protist cell by repeating it to make multicellular copies that ultimately evolved into separate tissues, such as reproductive and nerve tissue, with distinct functions.' (10)

By evolutionary processes, which largely depend on mutative incidents and adaptation to environmental factors, communities of eukaryotic cells have created collaborating communities that 'enabled' differentiations into varied specialised functions within one community. These communities enabled survival and immortality by sexual reproduction.

TC&A is exploring the level of organised cell communities - the tissue as a palate for manipulation. Drawing on the collaborative nature of cells, we are growing these tissues

separated from the body and coercing them to grow in predetermined shapes by the use of artificial scaffolds. We are also interested in employing their differentiated function for purposes other than what they were intended for. By that we are exposing and questioning long held beliefs and assumptions in regard to the nature of things.

### **TC&A and the Semi-Living**

Manipulations of a whole organism have been traditionally done as part of selective breeding practices. The interventions into living systems are now being perfected as part of molecular biology, which enable more precise and faster control over the manipulation as well as allowing cross species merge. Artists dealing with genetics consider the genetic code in a similar way to the digital code. As a result the manipulation of life becomes 'manipulation of a code', though with 'real' physical consequences that may appear in the phenotype of the manipulated organism. The manipulation of living tissues (from a complex animal) outside and independent from the animal they were derived from is possible by and dependent on other tools of modern biology- tissue and cell culture techniques as well as the emerging field of tissue engineering. From our own perspective, manipulations in the level of the tissue, raises the most intriguing epistemological and ethical questions, as there is not yet an existing discourse that deals with the semi-living. Growing parts of an organism independent to it complicates notions of what life, self and identity are.

TC&A looks at the level above the cell and below the whole organism, hence at the collective behavior of cells which forms tissues. We are using tissue engineering and stem cells technologies to create Semi-Living sculptures. The TC&A is introducing a new class of object/being in the continuum of life: the Semi-Living are sculpted from living and non-living materials, and are new entities located at the fuzzy border between the living/non-living, grown/constructed, born/manufactured, and object/subject. The Semi-Living relies on the vet/mechanic, the farmer/artist or the nurturer/constructor to care for them. They are a new class of object/being that is both similar and different from other human artefacts (human's extended phenotype) such as selectively bred domestic plants and animals. These entities consist of living biological systems that are artificially designed and need human and/or technological intervention for their survival and maintenance. As artists we are examining the Semi-Livings as evocative objects (11); prompting the re-evaluation of our perceptions of what is life and our treatment of other forms of life.

Our Semi-Living sculptures need to be kept in sterile conditions, immersed in nutrient media and kept at a temperature that suits their needs (mammalian tissue usually kept in 37°, fish and amphibians can be left at room temperature). For their survival they need to be protected and fed

on a daily basis. As a result of these needs, the exhibition of the semi-living sculptures in galleries (or other public spaces) involves new procedural acts and rituals as part of the artistic experience. In order to sustain the sculptures alive we need a tissue culture laboratory.

We have made a decision to incorporate the laboratory as part of the installation in order to present the environment in which such Semi-Living entities can thrive. A lab in the gallery also enable us to perform the duties needed to care for the sculptures in a manner that the audience can watch and comprehend the commitment and responsibilities we have to exercise towards the living systems we created. This involves construction of an enclosure area, a sterile hood, artificial environment for the semi-living sculptures (a bioreactor), laboratory consumables and the safety requirements of physical containment level two laboratories. All are being examined and designed/constructed as integral to the conceptualization and theatrical intentions of the installation.

Our installation involves performative elements that emphasise the responsibilities, as well as the intellectual and emotional impact which results from manipulating and creating living systems as part of an artistic process: *The Feeding Ritual* – is preformed every day. In this act we express notions of caring for semi-living sculptures, and invite the audience to view the process of feeding. The act that we refer to as feeding is being performed routinely in laboratories around the world and involves the replacement of used nutrient solution. At the end of every installation we are faced with the ultimate challenge of an artist – we have to kill our creations. Transferring living material through borders is difficult and not always possible, and as there is usually no one who is willing to ‘adopt’ the Semi-Living entities and care for them daily (under sterile conditions), we have to kill them. The killing is done by taking the Semi-Living sculptures out of their containment and letting the audience touch (and be touched by) the sculptures. The fungi and bacteria which exist in the air and on our hands are much more potent than the cells. As a result the cells get contaminated and die (some instantly and some over time). *The Killing Ritual* also enhances the idea of the temporality of living art and the responsibility that lies on us (humans as creators) to decide and act upon their fate. It is important for us, as part of the broader issues regarding life that we raise through our work, to expose to the public what happens to living systems artistically created at the end of the exhibition.

If the lab aesthetics should emphasise the nurturing aspects of life or their mortality, can it express both as life without each one of these components cannot exist? At this stage of our project (and the scientific and technological abilities) human direct physical touch of the Semi-Living destined the Semi-Living to a process of death. The bacteria and fungi on the external layer of our skin contaminate the cells of the semi-living sculptures which lead to their demise. By the most obvious or ‘natural’ act of human nurturing, through caressing, we kill communities of cells which are stripped from their host body and immune system. When interacting with Semi-

Living entities humans must learn to translate their limited understandings and perceptions towards a different set of instincts of a different living system.

### **The Different Treatments of the Semi-Living**

Semi-living sculptures are made out of parts of complex organisms that can only survive outside of a body with the aid of artificial support mechanisms (12). Back in 1916, Edward Uhlenhuth, one of the pioneers in tissue culture declared 'Through the discovery of tissue culture we have, so to speak, created a new type of body in which to grow cell' (14). This 'new type of body' can be seen as a new life form. However, this new artificial life form is, at least at this stage; completely dependant on the good will of its operators for survival. The vocabulary associated with the Semi-Living entities is of crucial importance for its well-being. The irrational rhetoric leading to the next big war forces us to realise that we, humans, can be seen as 'tissue of horrible and disgusting absurdity' (15). Though as 'tissue artists' we found our tissues sculptures rather humble collaborative, dynamic living communities that are in need of care.

The Semi-Living sculptures have no immune system and at this stage need to be protected from the external environment. One of our aims is to be able to grow an external protective membrane layer, rather like our own natural skin that will enable to expose the Semi-Living to the external environment and will enable a direct and tactile interaction with the audience (15).

Up to date we have grown/sculpted Semi-Living in different shapes, forms and tissue types and encouraged symbolic interaction with them. For example, in the Tissue Culture & Art(ificial) Wombs installation (firstly presented in Ars Electronica festival 2000) we grew Semi-Living Worry Dolls. The Worry Dolls are based on a Guatemalan tradition in which kids tell their worries to the dolls, than put them under their pillow with the belief that the dolls will take the worries away. We have grown Semi-Living Worry Dolls inside a bioreactor. Alongside the bioreactor we put a computer or 'a worry machine' to which people were encouraged to write their worries to the Semi-Living Worry Dolls. We have promised the audience that we will whisper their worries to the dolls with the hope that they will take their worries away. By logging to our web site you can view people's worries from all around the world (and add your own). This document is also a reflection of current anxieties; some are in regard to our own work, the ethics of biological art and biotechnology in general as well as in regard to life in era of increasing global conflicts.

In a later project, 'MEART' aka 'Fish & Chips' (16), we began to 'demand' our Semi-Living for some information, tapping to the hazy area of sentience. Growing neural tissue (the 'thinking' units) and retrieving data from it, we have created what we refer to as 'A Semi-Living Artist': We

have picked up electrical activity from neural tissue and transferred it to a computer program that drove a robotic arm and manipulated a musical score (17). We used a sound sensitive switch to control the audio output as a source of electrical stimulation feedback to the neurons. Working with communities of interacting neurons cells, was an emotional experience. Our understandings of neural tissue as a 'thinking' unit, and as the place where consciousness reside made its manipulation more difficult. Questions in regard to the 'understandings' and sentience of the tissue that we hardly understand but yet manipulate made it ethically challenging. Epistemologically, the idea of future 'intellectual' communication with a neural tissue, which is grown independently from a body, raises many inspirations for better understandings of the different levels of life.

### **Living and Semi Living Systems as Food - 'Disembodied Cuisine'**

Our latest project titled 'Disembodied Cuisine' explores another way of treating/interacting with living systems - by consuming them as food. Humans, like the rest of the animal kingdom, have always practiced this ultimate way of exploiting other living systems. Though, as human society becomes urban and direct relations to what is consider of 'wild nature' weaken, this behavior is being further questioned. Furthermore, as our understanding of life increases, we employ different attitudes and hypocrisies to be able to continue this need (one must not forget that vegetables are also living systems). We recently heard a story from Jason Davidson, an aboriginal artist, who documented his hunting trips as a way to explain to his community about functions of internal organs. He presented one of these videos to a white urban audience. In this video he showed a wild water buffalo been hunted and cut open for the dual purpose of food and education. One of the viewers could not hide her disapproval any longer; she accused him of being cruel, and suggested to him that next time he should go to the supermarket and get his meat there. This story epitomizes the hypocrisy of the western urban society in relation to meat consumption. These neatly packed parcels of meat on the supermarket shelf bare very little reference to its source. One can argue that the act of buying meat in the supermarket, which is produced by growing animals in cramped industrial farms, is much crueller than hunting (for food) an animal that had a good life in the wild. In the project 'Disembodied Cuisine' we have decided to further explore these relations with living systems by looking at the possibility of eating Semi-Living systems.

Semi-Living systems are a new construction/creation, made possible by the use of the tools of modern biology and 'disobey' evolutionary processes. Furthermore, Semi-Living as food enables us to eat parts of the animal while the animal is still alive, complete and healthy (after a short process of healing). There is also the possibility of creating non-pathological immortal cell lines

for this purpose, and by that producing victimless meat. These new possibilities create an opportunity to discuss the relations between humans and their living food from a different and refreshing angle.

We have developed the project during 2000-2001, while we were research fellows at the Tissue Engineering and Organ Fabrications, Massachusetts General Hospital, Harvard Medical School. We first published our intentions in an interview to the Washington Post in December 2000 (18). We have used pre-natal sheep cells, harvested from a sheep uterus, to grow steaks the size of a coin. Since then NASA have been experimenting in growing tissue engineered fish skeletal muscle for food consumption in space travel (19).

According to Claude Levi-Strauss, throughout history humans have instituted a strict division between what can and cannot be eaten. However, these divisions are not always clear, and we must practice some kind of hypocrisy in order to be able to love and respect living things as well as to eat them. Dogs are an example of such confusion; in some cultures they are 'man's best friend' (pets), and also ornaments that are selectively bred for aesthetic qualities. Dogs in other cultures are being eaten. Peter Singer refers to such division as: Speciesism in Practice – Animals as Food (20).

Disembodied Cuisine deals with one of the most common zones of interaction between humans and other living systems and will probe the apparent uneasiness people feel when someone 'messes' with their food while exposing the inconsistency of the ethical framework our society set up for dealing with non human living systems. It can be argued that this inconsistency in turn plays a part in the double standard so apparent in the war rhetoric of G.W. Bush and John Howard. In 'Disembodied Cuisine' the interaction/relationship with the Semi-Living is one of consumption and exploitation. However, it is important to note that it is about "victimless" meat consumption. As the cells from the biopsy proliferate the 'steak' in vitro continues to grow and expand, while the source, the animal from which the cells were taken, is healing. Also, by that we may eliminate some of the problems associated with eating a whole sentient animal and with the way animals, destined for the meat/poultry industry are being treated. However, by making our food a new class of object/being – a Semi-Living – we risk making the Semi-Living into a new class for exploitation.

In 'Disembodied Cuisine', which will be installed and performed as part of the international biological art exhibition 'L'arte Biotech', in Le Lieu Unique, Nantes France from 13<sup>th</sup> of March 2003, we will attempt to grow frog skeletal muscle over biopolymer for potential food consumption. A biopsy will be taken from the animal that will continue to live and be displayed in the gallery along side the growing 'steak'. This installation will culminate in a 'feast'.

One of the students in the Vivoart class which is ran by SymbioticA the Art and Science Collaborative Research Laboratory in the School of Anatomy and Human Biology, the University of Western Australia (21) has offered a new twist to human confusion between 'living or semi-living system' and 'a piece of meat'. Poppy, a vegan who believes in minimizing harm to animals, has confessed to us that recently she has had the urge for meat (can it be an 'evolutionary' desire for protein rich food or the thrill of the hunt, or is it just an aesthetic desire for a different taste and texture of the food we decide to consume?). This desire of meat and the belief in not eating other species have found an outlet based on the idea of Semi-Living food. Poppy suggested taking a biopsy of her own body, rather than injuring an animal and inflicting physical and psychological pain (even if temporary) on another animal. By that we will be able to grow for Poppy stakes made of her own flesh. The questions we were pondering were not if it is against nature (we are a long way away from nature for a long time). Also humans have practiced cannibalism before), nor if it is moral (it is done by a full consent from an aware adult), but rather questions of bio-safety and furthermore, the rhetoric that will be used by our society to deal with such a concept.

### **The Uneasiness**

Why do we feel uneasy and even threatened in regard to the manipulation of life outside of the bounds of the evolutionary rules? As mentioned before, biological evolution cannot be described as a linear progress towards something better, stronger or wiser. However, human intervention in evolutionary biological processes is usually done 'in the name of progress'. Humans are accumulating better control; though not necessarily better understandings of the long-term results of such interventions. In many ways we are not smarter than a cell or bacteria, and we can learn about our behavior from the building blocks of our own bodies. The use of collaborative colonies of cells outside of a body is epistemologically and ethically a very relevant artistic expression which forces us to look at human civilization and its shifting rhetoric from an alternative position. Learning about communicative cells in a new 'unnatural' environment is like shining a mirror at our own behaviors

We feel extremely uneasy in relations to the rhetoric used by our own government. Drawing on the quotation from the Australian campaign to combat global terrorism, in the beginning of this paper, we are asking: Do smiling Muslim girls' represent a twisted mirror-reflection of balaclava-clad Special Air Service troops storming houses? Do the Semi-Living entities represent a dignified living system or a piece of meat for us to exploit and consume?

Growing Semi-Living entities might seem at first sight as technological determination or as going against nature. However, our motives are based in exposing social hypocrisies in regard to what

is natural and also the shifting definitions of the 'other'. If we are not able to be compassionate for differences in our own species, will the existence of a the Semi-Living or a collaborative symbiotic collection of cells enable, even a little bit, to present a mirror of our absurdities? Can the natural-ish qualities of the semi-living act as a surrogate to the 'real' nature that seems to vanish from the lives of urban humans? Is that an answer for E.O Willson' Biophilia? (22).

The Semi-Living entities complicate notions of life and of self as opposed to the 'other'. They are forcing us to realise that our cultural norms and values are ill equipped to deal with the new knowledge in biology and the new creations made possible by biotechnology. Any technology is a double-edged sword and the uses of technology rely on complex interdependent relationships with the dominant ideologies at the time. Therefore, looking at the prevailing ideology of our times we are examining our Semi-Living sculptures as evocative entities, which offer tangible alternatives and contestable futures.

There are many issues that have to be resolved by humanity as a whole before we can proceed with large-scale exploitation of modified/designed living biological systems. This is of grave concern as decisions which are being made now will determine the directions in which exploitation of living systems take. It is of particular concern as we are entering an era of conflict and intolerance to the other, coupled with an extreme form of capitalism and profit taking. Artistic inquiry as the creation of Semi-Living sculptures generates engagement with these issues.

### **Notes and References**

1. For more see the Tissue Culture & Art Project web site: <http://www.tca.uwa.edu.au>
2. By the time this paper will be published, the situation of 'pre-war' might be changed to 'a war' or 'after-war' situation. We are aware that we can use the term 'war situation' on a continuous basis as in our current global world there are continuous localities of war situations. Though, this paper refers in particular to the 'war against terrorism' and the war against Iraq.
3. Canguilhem Georges cited in Delaporte Francois, Ed. A Vital Rationalist: Selected Writings from Georges Canguilhem (NY: Zone Books 1994) p. 211.
4. See also The origin of species by Charles Darwin, chapter 14.
5. Canguilhem Georges cited in Delaporte Francois, Ed. A Vital Rationalist: Selected Writings from Georges Canguilhem (NY: Zone Books 1994) pp. 84 – 85.
6. Canguilhem Georges cited in Delaporte Francois, Ed. A Vital Rationalist: Selected Writings from Georges Canguilhem (NY: Zone Books 1994) p. 162.
7. Gould G. Stephen cited in 'The Pattern of Life's History' The Third Culture, (NY: Simon & Shuster, 1995) p. 52

8. Margulis Lynn, Symbiosis of Cell Evolution (San Francisco: W.H Freeman and Company, 1981).
9. Wallin I.E, Symbioticism and the Origins of Species (Baltimore: Williams & Wilkins 1927) p.8.
10. Margulis Lynn and Dorion Sagan, What is Life? (Berkeley and Los Angeles, California: University of California Press 2000) P.135.
11. The term 'Evocative Object' coined by Professor Sherry Turkle, originally in regards to computers and other E-toys. For more see: Turkle, The Second Self: Computers and the Human Spirit (London: Granada, 1984).
12. Parts of an organism can be sustained alive for long period of times (and in the case of cell lines – forever) while the organism from which the cells were taken from can cease to live. Furthermore, the biomass of the Semi-Living can be larger than the biomass of the original host.
13. Landecker, Hannah, '*Building "A new type body in which to grow a cell:"*' Tissue Culture at the Rockefeller Institute, 1910-1914', (NY: Rockefeller University Centennial) November 2000.
14. Criticism on Mary Shelley Frankenstein, cited in Lederer Susan E., Frankenstein, penetrating the secrets of nature: An Exhibition by the National Library of Medicine (New Brunswick, New Jersey, and London: Rutgers University Press 2002) p.8.
15. By that the Semi-Living entities will become part of the environment, though without the ability to sexually reproduce.
16. For more see: <http://www.fishandchips.uwa.edu.au>
17. This project was developed by SymbioticA Research Group: Guy Ben-Ary, Phil Gamble, Dr. Stuart Bunt, Ian Sweetman, Gili Weinberg, Oron Catts, Ionat Zurr and Matt Richards.
18. Washington Post, December 29<sup>th</sup> 2000. p.A03, by Pamela Ferdinand,
19. For more see, New Scientist 21/2 December 2002 pp. 60-63, by Wendy Wolfson.
20. Singer Peter, Practical Ethics (NY: Cambridge University Press 1993) p.62.
21. For more see <http://www.symbiotica.uwa.edu.au>
22. Wilson Edward.O., Biophilia (Cambridge, MA: Harvard University. Press 1984).