1. Details about the project – Description of the project, activities undertaken and the artists involved:

The project undertaken was a one-year research residency in The Tissue Engineering & Organ Fabrication Laboratory, Massachusetts General Hospital, Harvard Medical School.

The artists involved in this project were Oron Catts and Ionat Zurr.

Through our communications with Dr. Vacanti prior to the residency, it was decided that we would be assigned positions of research fellows in the laboratory and take part in all the lab's activities. This put us in an equal position to all other researchers in the lab. The lab consisted of more than twenty researchers (the vast majority of which were MDs performing research as part of their specialization in surgery). In the team we had researchers from Japan, Germany, China, Iran, Porto-Rico and USA. Beside the surgeons there was a molecular biologist, a material scientist, a mathematician, two lab technicians and students. We worked very closely with other laboratories in MIT (Massachusetts Institute of Technology) and Harvard University.

In this project we further researched the use of tissue engineering as a new palette for artistic expression.

Our research in the laboratory followed the principals of Tissue Engineering (hence for TE) from acquisition of materials (cells and synthetic materials) through methods, processes and instrument design, to constructing, growing, and monitoring cell/polymers hybrids. This year has enabled us to work and interact with scientists working with TE and related fields as well as with artists, anthropologists, authors and other scholars.

We attended a weekly Forum of the Center for Integration of Medicine and Innovative Technology (CIMIT), in Massachusetts General Hospital <http://www.cimit.org>(where we also presented our work) and other lectures. We immersed ourselves in the wealth of knowledge that Boston has to offer and observed different models of art & science collaborations. This year gave us the opportunity to present the project and interact with audience on various occasions and places in North America and Europe. We were interested in exploring different models of Art/Science collaborations and the flow of ideas and perceptions regarding biology in general and tissue technologies in particular.

Exhibitions and Installations:


Presentations:


- Media Arts & Culture Colloquium, Department of Art, The Ohio State University, Wexner Centre, Ohio USA, 7th March 2001.
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? “The Tissue Engineering and Organ Fabrication Laboratory, Center for Minimally Invasive Therapy (CIMIT), Wellman Building, Massachusetts General Hospital, Boston USA, 2nd January 2001.


2. Values and benefits of the project/activities

We feel that this residency was very successful and of value to the community, our art form (wet biology art practice), and to our personal professional and artistic development. It provided us with greater knowledge and understanding of the techniques, skills and practicalities of our art practice and insight into the hub the biomedical research and the discourses associated with it in North America. The benefits to the emerging art form of wet biology practice were numerous and on many levels.

Value & Benefits to the community (general and/or Australian):

- We see the benefits to the community in the challenges that our work presents and by the dissemination of the knowledge we gained during this one-year of intense research, by means of installations, presentations, collaborations and teaching. We have already given talks in UWA and are planning to give more presentations in WA and nationally.
- We hope that through our interaction with biomedical researchers and practitioners we helped some of them to approach their work form a fresh and different perspective that would lead them to find novel and better ways to treat and heal illnesses and injuries, and by that helping the wider community. We also feel that we help to increase their awareness to the broader implications of their work.
- We believe that this year would help us in creating the model of operation of SymbioticA, the Art & Science Collaborative Research Laboratory in the Department of Anatomy & Human Biology, UWA.
- Through our interactions and presentations we have generated considerable amount of interest in SymbioticA and the opportunity to reside there. This kind of international residencies would benefit the local community by the exposure to leading voices and figures in the field of art & biology.
- We feel that our work, and in particular the work we have done this year, helps to demystify some aspect of biomedical science to non-scientists, and open up scientists to contemporary art practice and thought:
  - We were the first artists in residence in Massachusetts General Hospital and as such we had to justify our position while formulating a model and methodology for the residency so that other non-scientists would be able to benefit from further collaborations.
  - We feel that we were successful in mediating between our lab and people form the humanities. Through our connections and initiatives an anthropology PhD student has been appointed a research fellow in the lab.
  - We have presented a poster titled “The Use of Tissue Engineering as a Medium for artistic Expression” at the biannual meeting of The International Tissue Engineering Society. We feel that the fact the poster was chosen and the scientific context in which it was presented had an impact on some of the 500+ delegates that attended the meeting. We have presented a use for the technologies they are researching, which most (if not all) did not think about. By that, we hope, we made them more aware of the broader implications of their work and forced them to consider their research in a new light.

Value & Benefits to the art form:

- 2000 was a year in which wet biological art practice has attracted a considerable amount of international media attention. We feel that our work and the residency in such a prestigious internationally renowned research lab (thanks to the support of the media art fund) had a part in it (see attached media clippings).
- This residency has provided us with the opportunity to present for the first time living
tissue-engineered sculptures in a gallery context (at Ars Electronica Festival 2000).

The prestige of the laboratory and the fact that we were funded by the new media arts fund has opened many doors to us. We formed collaborations and received assistance that would have never be possible other wise. The groups we collaborated with were from academia and industry, which we feel are now more receptive to work with more artists.

Personal & Professional Development:
In this year of residency we have acquired new skills, better understanding of tissue engineering and its branching fields. Areas of research in which we gained new skills and expertise are:

- **Tissue and cell acquisition and culture:**
  - Harvesting and culturing cells from primary sources.
  - Harvesting, culturing and differentiating stem cells (Mesenchymal cells - bone marrow stem cells from pig), using different growth factors. As the area of stem cells is being extensively researched in the lab as a key component for the future of the field of TE, we were immediately drawn to it, mainly due to the ethical implications of using embryonic and adult stem cells. We acknowledge the importance of this area for the future development of more complex semi-living sculptures that will contain different specialized tissues that will grown on 3D polymers embedded with different growth factors.

- **Biomaterials and scaffold Design:**
  - The use of biodegradable/ bioabsorbable polymers (Poly glycolic acid (PGA), PLGA, P4HB).
  - Growth and attachment of different cells over/into different 3D biodegradable/bioabsorbable polymers scaffolds in a rotating bioreactor.
  - One of the main area of research in the Laboratory is the growth and construction of capillary system using MEMS technologies. A capillary system will enable us to grow bigger constructs and is vital for the growth of replacement organs and, for our purposes, for the growth of bigger sculptures to which the audience will relate in a more direct way. We hope that such a capillary system will enable us to grow a skin layer that will enable us to introduce tactility to our work. Working closely with the scientists on the capillary system have enabled us to further learn the possibilities and limitations of such technology and as a result to perceive in more realistic terms the future possibilities of the field of semi-living objects.
  - 3 dimensional modeling and printing of scaffolds, using the 3DP in the Biomechanical engineering laboratory in MIT.

- **Design and construction of Bioreactors:**
  - Oron was actively involved in the design and construction of a rotating pulsating bioreactor for the growth of blood vessels. This experience lead him to his new area of research into the construction of a bioreactor for long term art installations, with the ability to remotely interact and manipulate the conditions of the environment in the bioreactor and the constructs within it.

- **Biological imaging:**
  - Ionat has researched and specified for research a sophisticated imaging system suited to the lab’s particular needs.

- **Setting up and displaying an art installation involving living materials:**
  - This residency coupled with the invitation to exhibit our work at the Ars Electronica Festival 2000 provided us with the opportunity to practically explore ways to display live tissue engineered sculptures in a gallery context. To achieve this end we had to set up a tissue culture laboratory in the gallery. This
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experience (and indeed “this experiment”) was of enormous value to us, as we had to consider issues of bio-safety, containment, and the practical and technical demands of constructing a fully operational tissue culture laboratory in non-specialized space.

Art Science collaborations and international media:
- We see this year as a beginning of an ongoing collaboration with Dr. Vacanti’s lab (see attached letter from Dr. Joseph Vacanti).
- This residency provided us with the opportunity to engage in international art/science discourses on a level that was rarely available to us before. We see it as a starting point for an ongoing dialogue with international artists and thinkers that would be facilitated through the activities of SymbioticA.
- The media exposure we received expended our skills in dealing with the media on an international level.

Employment opportunities:
- As mentioned above, this residency has immensely increased our international profile. We have been approached by galleries and festivals from around the world to develop installations and presentations.
- We believe that our profile will enable us to obtain funding from international funding bodies.
- The skills and experience has helped Oron to secure his position as the manager of SymbioticA and to argue for university funding for this position.

Audience size, new audience:
This residency has provided us with the opportunity to present our work to new audiences in North America and Europe. We feel that the exposure we received through the different forums in which we presented our work, and the media attention we received, has substantially increased our audiences.

Professional network or community participation:
This year has provided us with a great opportunity to meet, collaborate and share ideas with artists and thinkers in the emerging field of art and biology. We have spent considerable time with the Boston based artists Joe Davis (the first artist to synthesis artistic DNA molecule, and self proclaimed father of the Bioart movement), and Adam Zarestky (an emerging bio-artist). We also spent time in Chicago and with Eduardo Kac (GFP Bunny, Genesis) and his students, in Ohio with Kenneth Rinaldo (Artificial life and kinetic artist) and Amy Young, and in New York with Natalie Jeremijenko. In Banff and Ars Electronica we have interacted with many other artists and thinkers (among them Martha De Menezes, Roy Ascott, Stave Kartch and more). These meetings where stimulating and fruitful and we feel that the connections we formed will be valuable for our practice. We have also networked with scientists and technologists in the Boston area mainly from MIT (Biology Department, Biomechanical Engineering, Media lab, Artificial intelligence, Science, Technology and Society, STS) and Harvard (Harvard medical school, teaching hospitals).
- Collaborations with industry:
  - Tepha: We made contacts with Tepha, a biotechnology company that produces P4HB biodegradable polymers (that are used in the lab). Tepha’s chief researcher, Dr. David P. Martin expressed a great interest in our approach to tissue engineering and offered for us to become beta testers to their polymers. From their perspective, artists, like us, are pushing the limitations of their medium and materials, use and “abuse” and open to “happy accidents”. We have brought this connection with us to
SymbioticA, and with free supply of polymers we are planning to further research the possibilities of semi-living entities, and continue the fruitful collaboration between the artists residing in SymbioticA and the industry oriented company Tepha. We believe that this international linkage will be successful to both sides and their respectful cultures.

- Synthecon:
  Synthecon is producing, among other products, bioreactors. They have provided us with RSRe bioreactor while residing in the laboratory in Boston. This bioreactor was also used for *The Tissue Culture & Art(ificial) Womb* Installation in Ars Electronica festival 2000. A section on this collaboration can be found on Synthecon web site: [http://www.synthecon.com](http://www.synthecon.com)
3. Successes and failures of the project/activity

We see this residency as very successful. In addition to the research we have produced two major bodies of work:

“Tissue Culture & Art(ificial) Womb” which was exhibited in the Ars Electronica Festival, September 2000 and the Australian Centre of Photography (see attached published article “The Tissue Culture & Art(ificial) Womb” in the “NEXT SEX” book of Ars Electronica and a Video).

The “Pig Wings” Project, the second major project developed in Boston, enabled us to practice the new materials, and techniques used in the laboratory (such as stem cell harvest and differentiation, biomaterials and 3DP) as well as collaborate with Adam Zaretsky on “musical dynamic seeding bioreactor” (a project we would like to further explore with him in SymbioticA).

In this project we have grown Mesenchymal cells (bone marrow stem cells) from pig, over into bioabsorbable polymers (PGA, PLGA, P4HB) in the shape of 3 sets of wings. The three sets of wings represent the three evolutionary solutions to flight in vertebrates and their respective attached cultural value: Bird/Angelic, Bat/Evil, Pterosaurs, which is ‘free’ of cultural value as it is extinct.

In this work we are referring to the rhetoric associated with the developments in new biological technologies. This hype made us wonder if pigs could fly, and if they will, what shape their wings would take? By that we refer to the utopian and dystopian views in regard to a future immersed with new biological technologies and the responsibility lies on our society in shaping such a future.

The “Pig Wings” Project has generated interest form national and international galleries and festivals. This installation is short listed to be presented in Adelaide Biannual 2002, and discussions are under way with the new media curator of the DeCordova Museum in Massachusetts, USA.

We believe that the letter from Dr. Joseph Vacanti (see attachment), who summarizes his own impression from our residency, is of importance. We hope that this collaboration with Dr. Vacanti and his team will continue as we are establishing the Art & Science Collaborative Research Laboratory – SymbioticA in UWA. We see this letter as a sign of our successful residency in which both parties gained broader understandings and knowledge in regard to the possibilities of the field of tissue engineering, its effects and influence on society and culture, and in regard to art & science collaborative work in general.

The opportunity to become research fellows in one of the leading tissue engineering laboratories in the world has enabled the scientists and us to truly collaborate on an equal level as one team. This is a successful example of art and science collaboration, which has lead to many new and innovative ideas in regard to the utilization of TE technology. Seeing it in the broader context of the society from which it was raised and is going to be utilized.

During our residency in Boston we were invited to present our project in various places and occasions (For a list of the talks and presentations see attachment).

- We were invited to present a scientific poster in the meeting of the Tissue Engineering Society International, in Orlando Florida (see attachment). The title of the poster was “The use of tissue engineering for artistic purposes”. The reactions to the poster were varied; from questioning of the validity of such a poster in a scientific meeting, to appreciation and further discussions of the possibilities of TE technologies in art and in general.
- As an integral part of the laboratory we have presented out project along with other scientific projects in the laboratory presentation in the weekly meeting of CIMIT http://www.cimit.org

SymbioticA: In all our talks and presentations we emphasized not only the merits of our work but also the uniqueness and importance of SymbioticA, the Art & Science
Collaborative Research Laboratory in the Department of Anatomy and Human Biology, UWA. We have presented Australia as a place where new ideas flourish. We realized that SymbioticA is, as far as we know, the only place in the world which is a dedicated space for artists in a biological science department, in which artists have full access to the scientific laboratories and scientific protocols conducted in the department. Some artists expressed their will to reside in SymbioticA.

Collaborations with other artists. In Boston we have met international artists dealing or interested in wet biology as an art form: Joe Davis and Adam Zaretsky who works in the Biology Department in MIT, Eduardo Kac who is an Assoc/Prof in the Art Institute of Chicago, Kenneth Rinaldo from Ohio State University and Natalie Jarameico from New York University. The connections with these artists enable us to further explore our artistic discourses in an international level. We were invited by these artists to present our work in their respective institutions, and made them interested in the SymbioticA initiative. As the field of wet biology as art is relatively new, there are many ethical, philosophical and technical aspects that needs to be dealt with. Crossing geographical borders and communicating and discussing these emerging notions puts our project, as well as SymbioticA, in an international context.

During our residency we met a PhD anthropology student, Aslihan Sanal from the Society, Technology and Science program in MIT. Aslihan’s previous research dealt with organ transplantation in the Middle East, and she was interested in learning about TE organs (mainly kidney) as they are considered as the Holy Grail among patients who are waiting for organ donation. Aslihan and her supervisor, Prof Mike Fisher has said that they face great difficulties in gaining access to scientific labs. We have invited them to come and observe our, and other scientists research, in the laboratory. We believe that part of our role as artists dealing with wet biology is to act as mediators between scientists and people from other disciplines as well as make the actions made in the lab more transparent and better articulated to the public and vice vers. Aslihan became a one-woman audience of the Pig Wings Project; documenting the process and interviewing the people in the laboratory. She is now researching and writing a paper about artists dealing with wet biology, including her experience in collaborating with us.

Media Coverage: We have received wide media coverage (see attached list of articles/interviews) from around the world. This positioned us as artists in an international arena.

We were invited to submit an article for the prestigious journal Leonardo (see attached manuscript) and our work is going to be included in Prof. Stephen Wilson new book “Information Technology” (due to come out in September 2001).

Upon our arrival to the Tissue Engineering & Organ Fabrication Laboratory in Boston, we realized that the lab lacked a good microscope or any other biological imaging system. In the early stages of our project we put a large emphasis on the visual representation of our semi-living sculptures in a shape of 2 dimensional images. Ionat, who is a photographer, did most of the research in these aspects. Finding access to such facilities proved to be difficult; due to the busy booking system in other labs and the difficulties of physically moving living and delicate biological constructs. This problem “forced” us to concentrate in the semi-living objects themselves and redefine the way we want to present them. We were fortunate to be invited, only couple of months after our arrival to Boston, to the Ars Electronica Festival, in which the idea of presenting live tissue engineered sculptures in a gallery setting became a reality. The actual presentation of our living constructs inside a bioreactor, and setting up a culture lab in the gallery that will enable us to sustain them alive was of enormous importance for us and for the project itself. We also observed (as we expected) that people’s reactions to our semi-living sculptures, when seeing them alive were much more direct. People were also exposed to all the facilities needed to sustain the TE sculptures alive. The whole concept of semi-living entities growing detached from an organism as part of the environment became a “reality” in the gallery, to which people were directly exposed. Therefore, we believe, it enhanced the experience and understandings of the ideas and concepts governing our project. The vital issue of having a semi-living entity that
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requires care and maintenance was physically exposed; the feeding of the sculptures was done as a performance for everyone to see. People could see an "undefined blob" of something, which is alive, growing, and in need of care for its survival. We enabled the viewer to see the cells on a monitor that showed one of the living constructs under a microscope in a heated chamber. This experience further showed us the importance of showing the TE semi-living sculptures, and to direct our efforts in examining and researching the conditions, technologies and tools needed to make this happen in public locations with the emphasis on the viewer. As a result we started researching a bioreactor for long-term art installations that will enable viewer interactivity and direct relations in addition to the growth and construction of different sculptures and cells.

This research is continuing in SymbioticA with great interest from both artists and scientists in the University of WA. This project requires collaboration from different disciplines as it is engulfing many technical, conceptual and ethical issues.

It means that in many respects, our difficulty in being able to explore imaging techniques enabled us to develop other areas that proved to be of great importance to our art form and our ideas. We exposed the viewer to a functioning tissue culture lab in the new context of an art gallery.

To conclude:
In our proposal to the New Media Art Panel we wrote: "We believe that we are in a stage in history in which biological related technologies, in particular biomedical technologies should be examined and used by artists. These technologies are going to revolutionize the perceptions of us as humans, perceptions of mortality, and the relations of humans with their environment. We believe that artists can and should take an active role in examining, shaping and communicating possible futures that could result from these technologies. The artificial separation between art and science should become collaboration. In this way, we, as a society, can explore the ways to go forward".

We believe that this year in Boston enabled us to take part in a stimulating and fascinating art & science collaboration and to expose our project and its collaborators to an international audience. In the proposal we stated, "we would like to be able to design, construct and monitor objects, which contain living tissue, and to be able to sustain them alive outside the lab. It seems to us that a 12 months residency would bring us very close to achieving this goal" – and it did. The installation in Ars Electronica enabled us for the first time to exhibit living TE sculptures in a gallery setting and to directly expose and communicate their new existence as part of the environment to a large audience. The knowledge we gained during this year brought us much closer to the goal we set. The philosophical and ethical issues surrounding the existence of our semi-living entities were further discussed in the media (see attached) and in the article we have submitted to the LEONARDO journal.

We hope that these successes will enable us to implement our new skills, experiences and connections in SymbioticA and to make it a centre for artists dealing with biological technologies, as well as other people from different disciplines who would like to research different aspects of the implementations of such technologies.