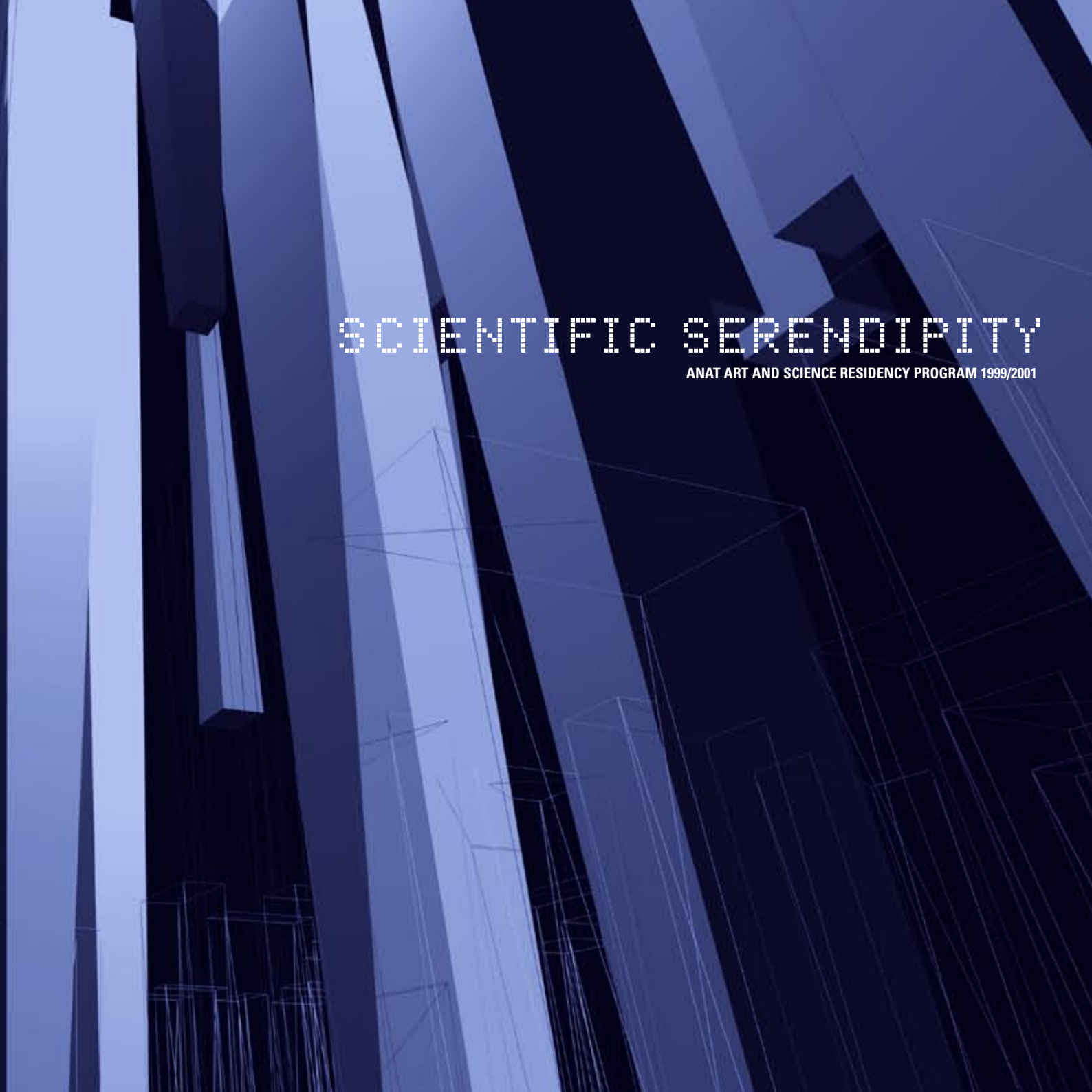


SCIENTIFIC SERENDIPITY

ANAT ART AND SCIENCE RESIDENCY PROGRAM 1999/2001

SERENDIPITY

INTRODUCTION

JULIANNE PIERCE
Executive Director, ANAT

The *Scientific Serendipity* artist in residence program was initiated by the Australian Network for Art and New Technology (ANAT) in 1998, as part of a larger series of thematic programs called *Deep Immersion*. These programs aimed to provide a platform for research and development in the areas of theology; art and technology in the Asia Pacific region; and the interface between science and art.

The science and art focus included a range of initiatives which in part celebrated the 30th anniversary of the important exhibition, *Cybernetic Serendipity*, held in 1968 at the Institute of Contemporary Art in London. This exhibition was one of the first international art and technology exhibitions, recognising the increasing interest in and engagement between art, technology and science practices. By initiating the *Scientific Serendipity* program, ANAT looked to contribute to the ongoing art and science dialogue, and to develop resources and research and development opportunities for Australian artists either working or interested in the art/science interface.

The residency program was developed and co-curated by Amanda McDonald Crowley (ANAT Director 1995–2000) and Linda Cooper (Adelaide-based science curator and advisor), with the aim of '. . . developing collaborations between artists and scientists, opening up dialogue between these disciplines and encouraging the generation of unexpected and alchemic outcomes'. With funding from the New Media Arts Board of the Australia Council and Department of Science, Industry and Resources, a call for applications was made. Artists were required to submit proposals for a self-directed residency with scientists or within a science organisation.

The proposals from artists covered a broad arena, ranging from engagement with geological sciences and biology through to research in acoustics. The first two residencies were held in 1999, with Sydney-based artist D.V. Rogers developing the *Earthquake Simulator* and Perth-based Oron Catts and Ionat Zurr working at the University of Western Australia on the *Tissue Culture & Art Project*. Following an 18-month break, the final two residencies occurred in 2001. Brisbane artist Adam Donovan (with assistance from Linda Cooper) developed a residency program at the Underwater Acoustics and Ocean Measurements, Maritime Operations Division, Defence, Science & Technology Organisation (DSTO) in South Australia. Justine Cooper (New South Wales/United States) was in residence at the American Museum of Natural History in New York, assisting with The *Genomic Revolution* exhibition.

The residency program provided some funding and a period of time for the artists to research

their work, and to access technology, knowledge and resources that may otherwise be unavailable to them. It also encouraged dialogue between the artists and their host organisation or science contacts. This was envisaged as a two-way discourse, offering the potential for the science host to engage with artistic practices and methodologies. In most cases, the research conducted by the artist was a direct collaboration with the science host and has contributed to and enriched the host organisation's own knowledge and resource base.

As a continued contribution to these dialogues, ANAT has produced this publication to document the residencies and to garner some of the responses and benefits for both the host organisations and artists. Through a series of interviews, the artists describe their experiences of and provide insight into their residencies. To complement the interviews, San Francisco-based commentator, Rich Gold (creator of the Xerox PARC artist-in-residence program), offers illuminating perspectives on notions of collaboration and the 'alliance' between science and art.

The *Scientific Serendipity* publication airs a range of issues surrounding the art and science nexus. For ANAT, the continued support of this field is an important step in bringing art, science and technology together. At the same time, we encourage debate encompassing broader issues around scientific developments, the changing nature of innovation and the processes of collaboration. As part of the ongoing support of research into the art and science sector, ANAT is developing the *Synapse* database (online August 2002) for the New Media Arts Board of the Australia Council. As a major component of the Board's Synapse, art and science initiative, the database is an essential tool in the ongoing development of art and science collaborations.

I would like to thank the artists for contributing their comments to the publication and to Kathy Cleland who conducted the interviews. I would also like to thank the host organisations, which provided expertise and resources for the artists to undertake periods of research and development— an important and invaluable space for thought and experimentation in the development of an artist's practice. Finally I would like to acknowledge the Department of Science, Industry and Resources who supported *Scientific Serendipity* through a Science and Technology Awareness (STAP) Grant and the New Media Arts Board of the Australia Council, for its continued support of ANAT and its programs.

THE ART OF DISCOVERY

TERRY CUTLER
Principal, Cutler & Company; former Chairman Australia Council

I began my working career in the unusual context of a special inter-disciplinary think tank charged with exploring possible telecommunications futures. This team comprised electrical engineers, economists, psychologists and sociologists. The daily process of looking at technology developments from many different perspectives was an eye opening experience. It taught me that creativity and innovation are nurtured by thinking outside the box-like frameworks of disciplinary specialisation and received wisdom. It taught me about the value of creative collaborations. Regrettably, back then in 1975, no one thought to include an artist as a member of the core team. Commissioning an artist to illustrate the team's thinking was an afterthought.

No longer. The Australian Network for Art and Technology and the New Media Arts Board of the Australia Council have been assiduous in promoting an ongoing dialogue and engagement between artists, technologists and scientists.
The residency program documented in this publication has given rise to a series of novel experiences of interactive learning and discovery.

The human mind works in mysterious ways to produce new insights and to generate new knowledge. This is the serendipity of intelligence and discovery. Somewhere at the heart of the matter is the making of unexpected connections and novel linkages.

Exploring, pushing back the frontiers of an unmapped continent, fuelled the imagination of Australia's European colonists. Now indigenous people like Brett Leavy in Queensland are taking us on a journey of cyber dreaming, making connections between the world's oldest traditions and the world's newest technologies. Now art and science collaborations push back the frontiers of knowledge and understanding. To coin Peter Sellar's wonderful phrase, these collaborations "open windows into realities under construction".

This exploration of new frontiers is an important undertaking when one lives in a global knowledge economy. This is a political economy in which intellectual capital and human skills are the natural resources for wealth creation and our quality of life. Art and science collaborations enlarge and extend the value of our investment in research and development which builds the national stock of intellectual capital.

Australian artists are at the forefront of an international push to develop 'clusters' and collaborative research and development opportunities. ANAT assists these processes through its programs and initiatives, such as the *Synapse* art and science database (supported by the New Media Arts Board). By creating tangible resources and by highlighting serendipitous outcomes we can encourage increased investment in cultural and scientific knowledge exchange.

FOREWORD

LINDA COOPER
Co-curator of *Scientific Serendipity* residency program

There is much that art and science have in common.

Many of the similarities are embedded in the recognition of the role of *process* in the research and development of a creative idea. Experimentation is indeed as much a part of the making of art as it is a part of the scientific method. A fascination with the obscure, the mysterious, and with quirky phenomena is also a shared interest. Rather than the individuals, it is perhaps our love of the institutions and their traditional 'safety' and inflexible systems that has kept these disciplines apart. In recent years, Australian artists engaging with science phenomena have generated interest internationally, and their work is emerging as an artform in its own right, despite the perceived cultural clashes.

Scientific Serendipity is a project that has attempted to dismantle the institutional barriers separating the communities of artists and scientists. Four residencies were established for Australian artists currently working with scientific phenomena to research their own art practice within the context of an appropriate science organisation. No prescribed residency model was suggested, rather *Scientific Serendipity* explored the notion of an 'artist in residency' as a model for pursuing interdisciplinary practice.

Many artists working with technology are engaged in the debate about the impact of technology on our daily lives—as individuals, members of communities and on society as a whole. Science and technology have raced ahead in the growing recognition that knowledge leads to power. It was the Industrial Revolution that first showed us that modern science could help solve practical problems. It was during this period that science became most strongly identified with its application technology. Our resulting belief in progress was originally inspired—and is now largely supported—by these advances in technology.

But science is not only about building new machines and new applications, it is also about building new understandings.

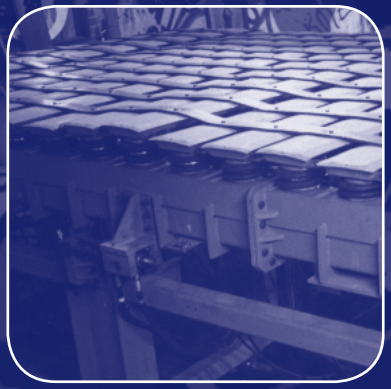
In this historical context, artists working with new technologies is a relatively new practice. It has emerged from the new medias and the explosion of resources and networks available in this age of information. Initially, the relationship between artist and technology could have been interpreted as hierarchical; one of servant to master. I would suggest that this relationship is changing with the growing understanding of the role science has in underpinning the technology that is driving this work. Artists are now working beyond the limitations of the technology as the 'black box'—the predetermined mode of delivery—making these investigations the content of their work.

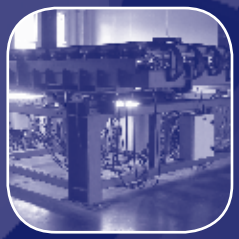
The role of the artist is also to question and create new ways of seeing and understanding our world. Artists can bring different perspectives and alternative ways of thinking. As Justine Cooper comments, 'while acknowledging the knowledge (and creativity) of science, I preferred to situate science somewhere other than the centre . . . '. The imagination can invigorate our sensibilities and firmly place our humanity at the core—a belief system that has been missing from our current world of progress.

This publication gives us a fascinating collection of personal stories and experiences from the artists who have participated in *Scientific Serendipity*. These impressions are valuable reading for anyone interested in collaborative work.

This publication is also timely. The interest in the relationship between the arts and sciences has grown before we have the language to articulate and discuss the resulting work in an art context. In addition, the expression of these ideas and processes as physical *installations* is a challenge. Where do we exhibit these collaborative efforts and who are the audiences? Are there new public spaces for this work that are yet to be defined?

Congratulations to ANAT! Once again, with limited resources, a seed for future development in cutting-edge art practice has been planted.





The residency undertaken by D.V. Rogers was primarily self-directed by the artist and no statement from a host organisation is included.

D.V.ROGERS

INTRODUCTION AND INTERVIEW

Kathy Cleland

Images: clockwise from top

Vertical Motion Hydraulic Actuators, Leichhardt Workshop, 2001. Photograph D.V.Rogers.

Earthquake Simulator, Leichhardt Workshop, 2001. Photograph D.V.Rogers.

Seismonitor **installation, Artspace, Sydney, 2002.** Photograph D.V.Rogers.

D. V. Rogers is a Sydney-based artist who has worked across the fields of photography, performance art and machine-based installation. He was a founding member of the performance art collective, the Post-Arrivalists (1991–1996) and collaborated with machine performance artists Triclops International from 1996–2000.

In 1996, Rogers 'liberated' a decommissioned earthquake simulator from the Earth Exchange Museum in Sydney. The simulator had been 'retired' from its original existence as an amusement ride, where members of the public would stand on it and experience a simulated earthquake with a magnitude of 5.6, similar to that of the 1989 Newcastle earthquake. Rogers' rescue saved the simulator from an otherwise inevitable journey to the scrap heap and gave it a second chance at life. Rogers arranged for the disassembly and transport of the gigantic 5.2m x 3.3m structure to the industrial workshop in Sydney, which he shared with Triclops International. The transition of the earthquake simulator from amusement ride to artwork took place over the next few years.

Rogers' project has essentially been one of self-directed research, aimed at returning the earthquake simulator to its original state of operation, but with a modular design that would enable it to be moved around and installed in different locations. Rather than being concealed beneath a rubber floor the way it had been in the Earth Exchange Museum, Rogers wanted to display the simulator openly in its own right as an industrial artwork. The second part of Rogers' plan for the project was to design and implement a telematic real-time control system so that the simulator could be hooked up to an online database of globally monitored earthquakes and simulate earthquakes—in real-time—by means of remote data transmission.

Rogers' task started in earnest in 1998 with a small development grant from the Australia Council, and this was followed by the ANAT *Scientific Serendipity* residency grant in 1999. The acquisition of sophisticated engineering and software programming skills was essential to the successful completion of the project. With few prior engineering skills, the ANAT residency gave Rogers the opportunity to engage in the extensive research and development needed to develop his skills base to the level the project required. During the residency, Rogers started reengineering the simulator and researching ways in which the earthquake simulator could be triggered by real-time globally monitored seismic data. Kevin McCue, Head Seismologist at the Australian Geological Survey Organisation (AGSO), was an enthusiast of the project, and at the completion of the residency wrote a persuasive letter of support for Rogers' application to the Australia Council for a grant to continue work on the real-time control for

the simulator. As well as face-to-face contact with scientists at AGSO and with other researchers, such as Professor Bijan Samali, Head of Structural Dynamics at the University of Technology Sydney (UTS), a large amount of Rogers' research has been self-directed. It has taken place via the Internet liaising with scientists and programmers around the world.

In January 2002, Rogers' earthquake simulator had its first public outing in the art world, exhibited under the title of *Seismonitor* at Artspace in Sydney.

HOW DID THE ANAT SCIENTIFIC SERENDIPITY RESIDENCY ASSIST YOU IN REALISING THE GOALS OF YOUR PROJECT?

Foremost, I guess, it gave me some small financial support toward the work. And to some degree it validated that it was OK to be working away quietly in a dark corner on a massive project that in the real world would have a large budget and five experts working on it.

In a nutshell, the residency planted a seed of how to approach science bodies with a view toward collaborating on the crossover between science and art. I feel the work that was undertaken during the actual residency period certainly did not realise the outlines as originally intended; however, as the project continued—and it is ongoing—it maintains a relevance to the original intention of the *Scientific Serendipity* project.

WHAT EXPERTISE DID YOU GET FROM AGSO? WHAT WAS AGSO'S INTEREST IN YOUR PROJECT?

I got no actual expertise form AGSO; they were supportive, but also possibly confused about what I was trying to achieve. Kevin McCue, Head Seismologist, was very supportive of the work, but he was stretched by limited resources and available time to help in any significant way. However, he wrote a great letter of support for the Australia Council grant. Now that the simulator is fully operational and a new control is up and running. I would like to reestablish contact.

Interestingly, I have drawn my own conclusions from my experience with AGSO and UTS in that government-funded science institutions are supportive of most things, in a sense they are a public service. But I suspect that because of limited resources they can be protective of their research and reticent to make it publicly available. They are also very busy and, as a result, time is not always available to give information to others in any great detail.

WHAT ADVICE DO YOU HAVE FOR ARTISTS WANTING TO COLLABORATE WITH SCIENTISTS AND SCIENTIFIC INSTITUTIONS?

My advice based on my experiences with the science institutions is to be clear about your goals. Be persistent, but polite and, importantly, develop a self-reliant approach to successfully realising the work. Without the world wide web my research work would not have been possible. It allowed me to be indirectly involved with science-based activities without actually being directly involved with a science-based institute.

The most interesting contact I made was with a US Geological Survey (USGS) seismologist, Andrew Michael. I have only had contact with him over the past six-to-nine months. He is also a musician who has written, performed and recorded scores based on actual seismic recordings. He kindly gave permission for one of his scores to be performed at the opening of *Seismonitor* at Artspace in January. Our contact has been exclusively via email, and he has also pointed me in the right direction to a more direct and responsive data feed without asking too many questions.

YOUR PROJECT INVOLVED REENGINEERING AND RECONSTRUCTING THE EARTHQUAKE SIMULATOR. IS THERE A PARTICULAR MACHINE AESTHETIC THAT ATTRACTED YOU TO WORKING IN THIS AREA?

Reconstructing/reengineering, I guess, contain all facets of art practice if one wants to incorporate industrial-oriented hardware and components into their work. The stuff is expensive, and not that I label myself as an industrial artist, salvaging 'stuff' is a must for this kind of work. The simulator was this readymade monster and all this 'stuff' was available to get dirty with. I like to think I have merely 'ready made aided' the simulator.

THE EARTHQUAKE SIMULATOR RECREATES GLOBALLY MONITORED EARTHQUAKES THROUGH REAL-TIME REMOTE DATA TRANSMISSION. HOW DOES THIS WORK?

The simulator is triggered by near real-time globally monitored seismic data. It is important that I clarify that the data source is *near* real-time and *not* real-time. A delay of anything between four-to- 12 hours after the event actually occurred is the usual norm with the current control system. When an event is reported the simulator will run a sequence of events determined by the magnitude of the reported earthquake. The control logic for hydraulic actuation of the simulator is written in the C programming language. The best way to think of the control is to consider a reported seismic event as merely a trigger/switch for running the simulator.

HOW DID THE AUDIENCE EXPERIENCE THE WORK WHILE IT WAS EXHIBITED AT ARTSPACE?

For the duration of the installation, the odds of experiencing an earthquake were very low. For the duration of 23 days, running 24/7, only 57 seismic events were reported. When *Seismonito*r is not running a reported seismic event, it is breathing. A pneumatic airbag system is constantly switched—approximately every 60 seconds. This represents the fact we do not live on a static planet. It also gives a constant life to the simulator akin to a ready awakening. For me, what is interesting about the simulator breathing (pneuma, Latin for breath) is that experiencing the *Seismonitor* installation was more about the moments between earthquakes and not the actual global seismic events reported.

HOW DID YOU DEVELOP THE PROGRAM THAT TRANSLATED THE REAL-TIME EARTHQUAKE DATA INTO THE MOVEMENTS OF THE SIMULATOR?

I was influenced by the open-source philosophy of non-proprietary operating systems and software. Hence the control has been written to run exclusively under Linux, though (God forbid) it would not be too difficult to port to a Windows based environment. Conceptually, and from a moral computing point of view, this was integral to the work. Choosing the Linux path involved an awful lot of research before I selected the correct hardware that had Linux driver support and some existing development under Linux for the I/O card I am using to switch hydraulic solenoids.

HOW DID YOU ACCESS THE SOFTWARE AND THE EXPERTISE YOU NEEDED TO REALISE THE PROJECT?

Fortunately, the open source community is normally very supportive in advice and giving bits and pieces away (that's why open source works). Dr Warren Jasper, Head of Textiles Research, North Carolina State University had already developed a Linux driver for the I/O card I am using.[1]

Curt Wuollet, a machine automation engineer in the United States was already using Warren Jasper's driver to control two CNC lathes and CCD cameras for a precision machine engineering application. Curt was happy to give me the basis of his source code to get the hardware up and running under Linux. This was a huge bonus and likely to have saved me hundreds of hours of work. Curt is also the main spokesperson for MatPLC, an open source project developing a Linux based Programmable Logic Controller. MatPLC is not far away from its first binary release, and I am hopeful to have the simulator running under MatPLC during the next phase of control work. [2]

The main influence and co-collaborator with this work is a close colleague of mine, Des Devlin. Des put the seed into my head to go the Linux path. Without his support and encouragement it is likely the work would not have come this far. Des wrote the Perl parsing script that reads updated seismic events posted by the USGS along with fine-tuning of Curt Wuollet's source code.

WHAT CONCEPTUAL IDEAS WERE YOU EXPLORING WITH THE WORK?

Conceptually this work is seeking to explore theories of site and non-site. These ideas are influenced by the work and writings of Robert Smithson, particularly in his essay *Entropy and the New Monuments*. My work with the simulator is an investigation toward creating a machine control (automaton) arising from live representation (mirror) of a remote physical environment (earth). An installation-based system (telematic) artwork mapping the terrain of the spatio-temporality of shifting tectonics and digital information networks.

WHAT IS YOUR OPINION OF THE RELATIONSHIP BETWEEN SCIENCE AND ART? WHAT DOES ART OFFER THE FIELD OF SCIENCE AND VICE VERSA?

Some say that the new science of today is the art of now! This is very true; the definition of artistic practice is becoming increasingly blurred. Science has had to continually redefine its conception of the world. So has art. Artists and scientists share similar attitudes, but I still believe science is becoming more influential on the new media art of today rather than vice versa. It is likely the most influential period that art has had on science was the sci-fi writers of the mid-1980s to mid-1990s. It goes back further to the likes of Arthur C. Clarke in the 1950s writing of satellites in orbit around the earth, transmitting information between one another and reflected to receivers on the earth. It is not surprising artists and scientists share a common interest in sci-fi, and it does not surprise me that sci-fi writing is influential within the open source movement also.

I guess the connection between the two might be linked to the quest for seeking out the new. Again, some say that the role of art is to question, while at the same time reflect like a mirror of representation of our times.

I would like to see more science in art without the baggage of art context. My criticism of the sci-art movement is the science is less than the art, and often models the traditional metaphors art has always strived for so hence sci-art is often cute and nice. I am guilty to an extent.

On a personal level, to transcend the traditional domain of cultural representation I believe that artists must broaden their definitions of art material and contexts. My work with the simulator addresses my curiosity about scientific and technological research, while at the same time I go about acquiring the skills and knowledge that will allow me to develop practices to significantly participate in this *new* world.

WHAT ARE YOUR FUTURE PLANS FOR THE EARTHQUAKE SIMULATOR?

The next phase of work will incorporate improving the data feed, enabling the simulator to be switched by more events with less delay.

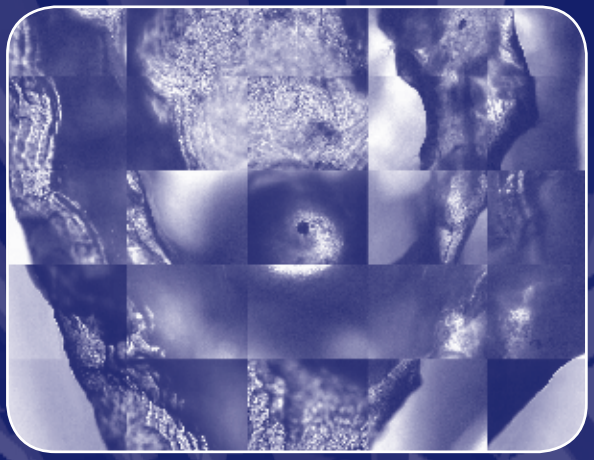
I would consider being involved with a science-based or academic institute if the simulator could be installed for a six-month period to undertake displacement, velocity and acceleration (DVA) tests, and explore the possibility of the simulator being used for actual seismic testing of scaled objects and structures.

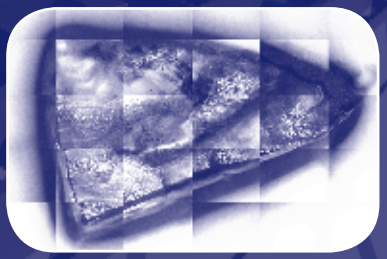
I would ideally like to take the simulator to Japan and/or the United States, and eventually I would like it to find a permanent home.

1. **Reference for Linux driver for the I/O card http://ligon.wcpss.net/sciblast/jasper/research.htm**
2. **Reference for MatPLC http://mat.sourceforge.net/**

Full documentation of D.V. Rogers' work can be found at http://www.allshookup.org


THE HUMAN MIND WORKS IN MYSTERIOUS WAYS
TO PRODUCE NEW INSIGHTS AND TO GENERATE
NEW KNOWLEDGE. THIS IS THE SERENDIPITY
OF INTELLIGENCE AND DISCOVERY. SOMEWHERE
AT THE HEART OF THE MATTER IS THE MAKING OF
UNEXPECTED CONNECTIONS AND NOVEL LINKAGES.
Terry Cutler





ORON CATTS AND IONAT ZURR

Sharp, 1999
Muscle tissue from mice grown over a hydrogel replica of a neolithic stone tool, 10,000 years old.

Oron Catts, Ionat Zurr and Guy Ben-Ary at conVerge: where art and science meet **(2002 Adelaide Biennial of Australian Art).** Photograph Grantly Trenwith.

Sharp 1, 1999
Muscle tissue from mice grown over a hydrogel replica of a neolithic stone tool, 10,000 years old.

All images courtesy of the Tissue Culture & Art Project (Oron Catts, Ionat Zurr and Guy Ben-Ary).

STATEMENT FROM HOST ORGANISATION

Stuart Bunt
Co-director, SymbioticA
Dept of Anatomy & Human Biology, University of Western Australia

Oron and Ionat came to us with a unique idea, to translate what had been theoretical work into real living objects. To take their ideas out of an academic thesis and make the items real. To attempt to grow their semi-living objects in the real world.

Our department has a long history of having artist's in residence. Hans Arkveldt, a famous sculptor, has long had a studio in our department and, until recent cutbacks, we had a resident graphic artist, Martin Thompson. This, I think, gave us the courage to take on such an unconventional project; little were we to know where it was to lead.

Oron is now manager of SymbioticA, the first art and science research laboratory in a biological department that we are aware of in the world. I find myself as a director of this facility, and a whole new dimension has been added to my work by contact with Oron and Ionat. We have a queue of international artists who want to come and work in SymbioticA; social scientists who want to study the phenomenon; and scientists happy to collaborate with the artists.

Following their residency in our department (now its own school in our university's restructure, one of the few departments to be considered diverse enough to stand on its own as a complete new school of Anatomy and Human Biology helped, in part, I am sure, by the presence of SymbioticA), Oron and Ionat went to work in Vacanti's laboratory in Boston, the world centre for advanced organ culture. They brought many new techniques back to Perth to put into practice in our laboratories.

The quality of the work is there for all to see, and led to us (Professor Miranda Grounds, Oron and me) applying for and receiving funding from the Lotteries Commission to set up a permanent art and science laboratory to support further initiatives following Oron and Ionat's lead. This funding was matched by the University of Western Australia, which recognised the pioneering, cross-disciplinary nature of this venture to enable us to literally 'raise the roof' of the Department of Anatomy and Human Biology to form SymbioticA.

My collaborations with Oron and Ionat have also lead to my involvement with a large collaborative art project, *Fish & Chips*. This formed a major work at Ars Electronica in 2001. I would never have had a chance to participate in such a venture if Oron and Ionat had not established a good reputation (with their *Tissue Culture & Art (ificial) Wombs* installation in 2000), such that Ars Electronica were willing to fund their return in 2001.

I have also been challenged repeatedly by their new and different approach to science. This has made me think very carefully about the background of my work and that of other neuroscientists. At the Perth Biennale of Electronic Art to be held this August we will all be participating in a forum, *The Aesthetics of Care*, about the ethics of the use of living material in art.

Oron and Ionat's residency has had a lasting and continuing impact way beyond what even they may have anticipated. Their work continues to challenge, both the art world and the school of Anatomy and Human Biology, and the scientists that work there.

ORON CATTS AND IONAT ZURR

INTRODUCTION AND INTERVIEW

Kathy Cleland

In 1996 Oron Catts initiated the *Tissue Culture & Art Project*, an ongoing artistic research and development project into the use of tissue culture and tissue engineering as a medium for artistic expression. The idea for the project arose from Catts' research into product design and into how new biotechnologies could be utilised, beyond their current agricultural and medical applications, as a medium for product design and art creation. Ionat Zurr, a photography and media studies graduate specialising in biological and digital imaging, joined the project shortly after it was set up in 1996. Guy Ben-Ary, the third member of the team, has been collaborating with Oron and Ionat since 1998, bringing skills in microscopy and biological imaging as well as a background in programming and web development.

The *Tissue Culture & Art Project* works at the interface of science and art constructing semi-living artefacts and sculptures made from living tissue grown over/into structures made of bio-polymers and glass. The results have been exhibited as art installations in different settings (art galleries, science museums and public spaces), using a variety of modes of representation, such as microphotographs (unenhanced and digitally manipulated), videos, web-based applications, 3D models as well as the actual objects fixed in formaldehyde. In the last two years, they have been able to present living sculptures in galleries by constructing a fully functioning tissue culture laboratory as part of their installations.

By presenting their semi-living sculptures as artwork and exhibiting them in the public domain, the group hopes to draw the public's attention to the ethical issues surrounding the expanding fields of biotechnology. Their work uses art as a generator of critical and aesthetic debate to stimulate a dialogue between the scientific and wider community regarding new developments in biological technologies. The artists also explore the new relationships created with artworks that consist of living matter and the notion of caring for these artworks.

Scientists have already been successful in creating living skin for use in skin grafts and are now working at creating whole organs. Cloning and stem cell research are currently hot topics in the media along with plans to redesign the human body through genetic engineering. The artists follow these types of developments closely and comment:

'It is obvious that technological and scientific developments are exceeding the cultural capacity to comprehend those changes. This is why this kind of artistic expression is so important now. Art can

be seen as the optimal medium for generating discussion and debate dealing with the contradictions between what we know about the world and society's values, which are still based on old and traditional perceptions of the world.'

Ongoing research and development is central to the *Tissue Culture & Art Project*, with the team members forming close research partnerships with science-based organisations. This has enabled them to gain access to the necessary skills, expertise and equipment for their research. They have been artists in residence at the Department of Anatomy and Human Biology at the University of Western Australia for more than six years; six months of which was supported by the ANAT *Scientific Serendipity* residency.

This highly successful research partnership has been formalised by the creation of SymbioticA—the Art and Science Collaborative Research Laboratory. The SymbioticA laboratory is now hosting the ongoing work of the *Tissue Culture & Art Project*, and the work of other artists and thinkers who want to explore the new possibilities and issues presented by biotechnologies.

CAN YOU DESCRIBE THE PROCESS OF HOW YOU DEVELOPED THE RESIDENCY WITH THE DEPARTMENT OF ANATOMY AND HUMAN BIOLOGY AT THE UNIVERSITY OF WESTERN AUSTRALIA AND THE SCITECH DISCOVERY CENTRE IN PERTH?

The ANAT *Scientific Serendipity* residency represented a continuation of our research and our relationship with the department and the university, which we had already developed at earlier stages of the *Tissue Culture & Art Project*.[1]

Most of our research was done in the laboratories of the Department of Anatomy and Human Biology, which we used as a base to work with other scientific institutions and the other host of this residency, the Scitech Discovery Centre. The inclusion of Scitech as a host derived from our interest in exploring ways of presenting our work. Scitech specialises in presenting scientific concepts in approachable and entertaining ways. We were interested in learning some of their strategies and methods, which assisted with developing and setting up the installation for our *The Stone Age of Biology* exhibition.

CAN YOU TELL US MORE ABOUT THE PROJECT YOU WERE WORKING ON DURING THE ANAT SCIENTIFIC SERENDIPITY RESIDENCY?

The residency represented Stage 3 of the *Tissue Culture & Art Project*, which began with research into the growth of skeletal muscle from mice, and neuron cells from goldfish over hydrogels P(HEMA). We grew muscle and nerve tissue over miniaturised replicas of prehistoric stone tools. The structures were made out of biofriendly plastics and produced using a 3D scanner and plotter. We titled this research and development residency *Force (muscle tissue) & Intelligence (nerve tissue) over Plastic*.

We also created time-lapse movies of the growth of spinal cord nerve cells. We experimented with the production of the P(HEMA) scaffold using CAD/CAM systems. The work developed during the residency (The Stone Age of Biology) was exhibited as part of the 2000 Perth International Arts Festival (PIAF). In the installation we presented a new way of capturing and presenting microscopic imagery using a sophisticated computerised stage and specialised software. We also presented a seven-minute video, the actual stone tools (from the anthropological collection of the Western Australian museum), the P(HEMA) miniatures with the tissue fixed on them, and other 3D work related to this stage.

DO YOU HAVE ANY ADVICE FOR OTHER ARTISTS ABOUT HOW TO SUCCESSFULLY MAINTAIN RELATIONSHIPS WITH RESEARCH HOSTS?

One of the main problems with artist residencies in places like science laboratories is that the role of the artist is not usually defined and is barely understood. This often leads to unrealistic expectations on both sides as to the ways the residency is set up and its outcomes. We found that our most rewarding residency was when we were appointed as research fellows (as opposed to artists in residence) and were on an equal footing with our fellow researchers. It took us more then four years to reach this level (being a research fellow in that laboratory was equivalent to postdoctoral research). In terms of advice, the important thing to remember is to do some research about what you are intending to do in order to understand basic principles and to be able to propose a feasible project. It is also important to work together with the scientists and be aware of not abusing their time. Help them if you can with their projects—find areas of common interests that can be useful for both of you. Be responsible in your laboratory work, clean after yourself; do as much as possible to eliminate damage to other experiments. We were also using our own grant money and surplus materials from scientists. We were quite strict in not abusing scientific resources. It is a lot about getting along with people and finding common points of interest.

HOW DO YOU SEE THE RELATIONSHIP OR INTERACTION BETWEEN ART AND SCIENCE.

The interaction of art, science, industry and society is recognised internationally as an essential avenue for innovation and invention, and as a way to explore, envision and critique possible futures. Science and art both attempt to explain the world around us in ways that can be complementary to each other. Artists can act as important catalysts for creative and innovative processes and outcomes. There is a need for artists and other professionals in the humanities to actively participate in research into possible and contestable futures arising from these developments.

CAN YOU DESCRIBE SOME OF THE RESPONSES TO YOUR WORK FROM SCIENTISTS?

The responses from scientists range from very enthusiastic to resentful, but the same can be said about the response we get from artists and others. It is obvious that the scientists who choose to work with us are generally supportive and sympathetic to our cause. They get to look at their own work from different perspectives and are usually content with the issues we raise. Some may see our work as a way of informing and educating the public about scientific developments—'turning people on to science' was one of the expressions used in regard to our work. Other scientists share our concerns about potential directions of technology derived from their research and join us in imagining alternative directions. There are also negative reactions from scientists who see what we do as a misrepresentation of science at best and as a waste of scientific resources at worse. Some scientists as well as members of the public and the arts tend to question our ethics and our morals. We welcome these reactions as we feel that a discussion regarding the ethics of using living systems for human-centric activities is acutely needed.

SCIENTISTS HAVE TO GET CLEARANCE FROM ETHICS COMMITTEES FOR THEIR RESEARCH. DID YOU HAVE TO GO THROUGH A SIMILAR PROCESS WITH YOUR PROJECT?

We are working very closely with the animal research ethics people at the University of Western Australia. We have a very clear stance in regard to the source of the tissue we are using for the purpose of the *Tissue Culture & Art Project*. We will never kill an animal solely for our work. We are scavengers and use mainly leftovers from scientific research and meat production for which we do not have to apply for clearance.

Matters are more complex when live animals are used or killed for art, and that represents a major challenge to the university. The ethics committee does not have the tools to evaluate potential benefits of an art project as opposed to the known suffering of the animals. To date, one project, which originated in SymbioticA, was submitted to the university's ethics committee, and as it had scientific merit as well as artistic intention, it was approved based solely on its scientific component.

WHAT ANIMALS HAVE YOU SOURCED CELLS FROM?

To date we have grown: epithelial (skin) tissue from rabbits, rats and mice; connective tissue from mice, rats and pigs; muscle tissue from rats, sheep and goldfish; bone and cartilage tissues from pigs, rats and sheep; mesenchymal cells (bone-marrow stem cells) from pigs; and neurons from goldfish.

HAVE YOU USED HUMAN CELLS?

We have used some human cell-lines for our experiments, but we tend not to use human cells for two reasons. The first is that human tissue is considered to be more risky than other animals as the chances of the existence of pathogens that affect humans is much higher (viruses such as HIV and hepatitis). The second reason is that at the level we are operating at there is not much difference between human tissue and animal tissue. Our work is about a new kind of entity we refer to as semi-living; emphasis on human tissue may detract from dealing with our treatment of living biological systems.

WHAT HAVE RESPONSES BEEN LIKE FROM MEMBERS OF THE GENERAL PUBLIC? DO YOU GET EXPRESSIONS OF HORROR AND OUTRAGE BECAUSE YOU ARE PLAYING AROUND WITH LIVING MATERIAL?

Our work is often misrepresented as being to do with genetic engineering—a misrepresentation usually propagated by the media and ill-informed commentators who perceive anything to do with new biological technologies as genetic engineering. This leads people to comment about our work with the same kind of knee-jerk reaction developed toward genetic engineering. Hence an obscuring of the issues we are dealing with which are mainly related to the shifting borders of what we perceive to be alive and the relationships we form with living biological systems. One of the best opportunities we had to gauge public reaction was at the 2002 Adelaide Biennial of Australian Art, where we showed the *Pig Wings* project. As part of the installation, I had to feed the wings once a day while giving a talk to the general public. Most responses were of wonder and interest. I am aware of negative feelings toward our work, but it is very rare that people express these feeling to us directly.

WHAT IS YOUR ETHICAL STANCE ON WORKING WITH TISSUE CULTURE AND OTHER RELATED BIOTECHNOLOGIES? WHAT DO YOU THINK IS AND ISN'T ACCEPTABLE IN THIS AREA?

Working and manipulating living systems should not be taken lightly. Modern biology enables us to objectify living systems and to create semi-living beings. As wet biology art practitioners who use tissue technologies to create semi-living sculptures, we are acutely aware that the semi-living beings that we create are dependent on our care for survival and well being. We try to formulate the broader questions to the extent to which we can morally manipulate and exploit living biological systems for human-centric activities.

What kind of relationships are we going to form with these entities? Will we care for them or abuse them? Where will semi-living objects be positioned in the continuum of life and how will this effect our value systems with regard to living systems including bodies - human or otherwise?

HAVE ANY NEW PROJECTS ARISEN AS A RESULT OF THE RESIDENCY?

During this residency we experimented for the first time with the culture of central nervous system cells of goldfish, and this knowledge was very important to the development of *Fish & Chips*.[2] Following this residency, we received funding from the New Media Arts Board of the Australia Council for a one-year residency at the Tissue Engineering & Organ Fabrication Laboratory, Massachusetts General Hospital, Harvard Medical School, where the *Tissue Culture & Art(ificial) Womb* (the *Worry Dolls*) and the *Pig Wings* projects have been developed. We have no doubt that ANAT's support was instrumental in our professional practice and development that led to our appointment as research fellows at Harvard.

YOU HAVE ALSO SET UP THE SYMBIOTICA LABORATORY IN CONJUNCTION WITH THE DEPARTMENT OF ANATOMY AND HUMAN BIOLOGY AT THE UNIVERSITY OF WESTERN AUSTRALIA. HOW DID THAT COME ABOUT?

After being artists in residence in the Department of Anatomy and Human Biology for almost four years (six months of which were supported by ANAT), there was a mutual feeling that our relationship with the department needed to be formalised in some way. We also thought that the model of collaboration we developed could be extended to other artists seeking to collaborate with the Department. With Professor Miranda Grounds and Dr Stuart Bunt we applied for funding from the West Australian Lotteries Commission for the purpose of building SymbioticA, a physical space for artists in the

Department of Anatomy and Human Biology. The SymbioticA laboratory has now been running for two years, and has hosted 20 artists from Australia and overseas for short and long-term residencies.[3]

WHAT ARE THE GOALS OF THE SYMBIOTICA LABORATORY?

SymbioticA is a venue in which interdisciplinary research and other knowledge and concept generating activities can take place. One of the major roles of SymbioticA is to identify trends in science and their applications, and explore possibilities for the purpose of proposing alternative directions and contestable scenarios in order to initiate cultural debate. It also provides an opportunity for researchers to pursue curiosity based explorations free of the demands and constraints associated with the current culture of scientific research. As well, SymbioticA offers a new means of artistic inquiry; one in which artists actively use the tools and technologies of science, not just to comment about them, but also to explore their possibilities. There is a need for artists and other professionals in the humanities to actively participate in research into possible and contestable futures arising from the developments of biotechnology.

1. **For more information on the first two stages of the** Tissue Culture & Art Project **visit the website www.tca.uwa.edu.au**
2. **The aim of** Fish & Chips **is to assemble a semi-living artistic entity from fish neurons grown over silicon chips. This 'wetware' semi-living entity was connected to computer software and visual and audio art output devices allowing it to become an 'artist'.**
3. **More information about the SymbioticA laboratory can be found at www.symbiotica.uwa.edu.au**

JUSTINE COOPER

STATEMENT FROM HOST ORGANISATION

Elaine Charnov

Director, Public Programs, American Museum of Natural History,

Images: clockwise from top

Transformers (detail), **video installation, 2002.**

Justine Cooper on the roof of the American Museum of Natural History, New York, 2001.

Transformers, 2002 Latex, DVD, projectors, 6m x 2m x 2m installed at conVerge: where art and science meet **(2002 Adelaide Biennial of Australian Art).**

All images courtesy of Justine Cooper.

Justine Cooper's advent as artist in residence at the American Museum of Natural History was itself an act of serendipity. A few years' back I was presented with one of her video shorts in our annual international film festival. Afterwards, we remained in infrequent email contact. When she approached me about finding a host institution to sponsor her project on genetic art, the museum happened to be in the throes of organising a major exhibition entitled *The Genomic Revolution*.

We were the ideal site for Justine because of the connections to scientists and the DNA sequencing laboratory, and she was ideal for us because she came with an innovative and fully funded project. Thus was forged the American Museum of Natural History's first artist-in-residence project.

As in any city or village, communities are often isolated; disconnected from one another. And sometimes it takes someone from outside to weave disparate communities together. The American Museum of Natural History in New York is a huge community. An avenue wide and four blocks long, it holds more than half a-million objects and in its dozens of scientific divisions, laboratories and exhibition halls house hundreds of scientists, exhibition preparators and educators.

During her residency, Justine journeyed the labyrinthine museum halls and back rooms, visiting special collections, meeting with scientists and forging relationships that were as new to us as they were to her. She influenced and shaped some of the public media programs in our *Science for Art's Sake* series and partnered with one of the museum educators who was producing a genome educational web project.

The success of Justine's project and her initiative helped us to develop *Art/Science Collision*, a new museum project that will become an integral part of our public programs. Through it, we hope to continue celebrating the nexus of art and science through both the visual and the literary. Justine's work here planted the seed for future innovative collaborations.

JUSTINE COOPER

INTRODUCTION AND INTERVIEW

Kathy Cleland

Justine Cooper has been working across the fields of art and science since 1995. Her work utilises medical and scientific imaging technologies to explore new ways of viewing the body and investigating complex social, cultural and scientific notions of self and identity. Rather than focusing on external markers of the body that make up our sense of self and identity, such as hair, facial features, skin colour and body shape, Cooper uses imaging technologies to show us views of the internal bodyscape and the microscopic worlds housed within our cells. These new views of the body reveal an identity that is both personal in its extreme intimacy and yet alien because it is usually hidden and unseen.

To access imaging technologies such as Magnetic Resonance Imaging(MRI) and Scanning Electron Microscopy (SEM), Cooper has established relationships with a variety of scientific and medical institutions in Sydney (Australia). These institutions include Vislab, Ray Scan Imaging (a private imaging lab), Children's Hospital Radiology Department (Westmead) and the Australian Key Centre for Microscopy and Microanalysis (part of Sydney University). She has also worked with individual scientists in the Histology Department at Sydney University.

In her 1998 video work *Rapt*, Cooper used MRI to capture her body in a series of interior transversal slices. These slices were then animated to create a beautiful yet disturbing view of the body; a self-portrait that is constructed, built up slice by slice, and then destroyed . . . deconstructed before our eyes.

Trap (1998) and *Lamina* (2000) also used imaging technologies to explore the notion of identity and the self-portrait. In *Trap*, Cooper used MRI scans of her head printed on photographic film and sandwiched between 19 sheets of perspex to create a 3D sculptural 'bust' of her head. In *Lamina* the idea of personal identity is abstracted even further to the level of DNA. Cooper used the DNA sequence of her ACE gene, replicating it to cover two, nested 2m-high cylinders, creating a revolving light sculpture. As the inner column spins, the DNA patterns continually combine and recombine, endlessly creating and recreating different DNA sequences, different identities. Cooper describes the work as ‘a (r)evolving self-portrait’.

Reducing identity to the level of DNA follows new discoveries in the field of genetics and a growing scientific paradigm which sees identity as being determined by our genetic make up. We are who we are because of our DNA, or as Richard Dawkins would put it, we are 'walking code'. This new genetic determinism and questions of 'nature' versus 'nurture' inform Cooper's new work *Transformers*, which uses hair samples, fingerprints and photographs from a variety of participants to investigate contemporary cultural and scientific notions of identity.

In 2001, Cooper started an ANAT *Scientific Serendipity* residency at the American Museum of Natural History in New York to continue her work on the *Transformers* project. Cooper was the first-ever artist in residence at the Museum.

CAN YOU DESCRIBE THE PROCESS OF HOW YOU DEVELOPED THE RESIDENCY AT THE AMERICAN MUSEUM OF NATURAL HISTORY AND THE ROLE ANAT PLAYED IN THIS?

I had a previous relationship with the museum through the Margaret Mead Film and Video Festival. The director of the festival, Elaine Charnov, suggested I approach the museum to be my host.

As to ANAT's role, its funding and support gave the museum a way to feel comfortable having me there. I wasn't the 'lone artist' let loose amongst them.

Technically the funded residency was not very long. To allow for serendipity, I chose to spread the time over a longer period by not being there full time. This meant things could evolve, instead of me pushing through to get them done. I went more for a ripple-effect approach.

Once I was on the inside, ID badge secured, I started investigating the different departments. Of course the priority was to find a molecular biology laboratory and a cooperative scientist. I had access to visit and view the facilities, But in order to use them I had to have a legitimate purpose. So to use the laboratories to sequence the hair samples for *Transformers* was fine. If I'd wanted to go and hang out with the flesh-eating beetles I might have had a problem. The museum presents vast opportunities. Yet there comes a point when you need to more carefully aim your bow. At that point you begin to negotiate your right to do so. That said, there is an openness in the museum environment especially among people interested in similar projects. As the first person to do a residency there, there was no protocol. But I was fortunate. Even within the year since I was there the museum has gone into a mode of heightened security, due to both the realisation of how valuable their collections actually are and the September 11th attacks. Access has become increasingly difficult to obtain.

TRANSFORMERS, THE WORK YOU WERE DEVELOPING DURING THE RESIDENCY, DEALS WITH CONCEPTS OF IDENTITY INCLUDING BOTH BIOLOGICAL AND CULTURAL MARKERS OF IDENTITY. CAN YOU DESCRIBE THE PROJECT IN A BIT MORE DETAIL?

In *Transformers* I was interested in the significance of biotechnologies on the individual, and on the idea of identity. Science and technology are increasingly mediating identity, or being relied on in that way.

We have only to look at genetic screening clinics and DNA fingerprinting as examples of this. While acknowledging the knowledge (and creativity) of science, I prefer to situate science somewhere other than the centre. For *Transformers*, I collected physical evidence of identity from 12 subjects: hair, from which I used the follicles to extract DNA to sequence: fingerprints; photographs; and more intangible and cultural identifying information, like personal histories. Combining the tools of science—Scanning Electron Microscopy (both stills and video) and DNA sequencing—with the construction of identity as a rhizomatic experience, the intention was to retain the elasticity of who we are and what we can become, without resorting to a simplistic nature versus nurture type argument. In fact, those kinds of distinctions seem to serve very little purpose. What I would rather focus on is a need to value difference. Although the project grew out of my interest in genetics, ultimately *Transformers* was a counterpoint to the weight being given to genetic determinism.

WHAT AREAS OF SCIENTIFIC EXPERTISE DID THE RESIDENCY GIVE YOU ACCESS TO?

Dr Jim Bonacum, in invertebrate zoology, was enormously zealous about molecular systemics and evolutionary biology. He was interested in discussing any manner of things relating to it. Owing to him, I feel my understanding of the processes involved is much greater. He also directly helped with the most outwardly pressing aspect of my project, to extract and sequence DNA for *Transformers*.

A big breakthrough for me was reconfiguring how I think of genetics. Instead of a gene *for something*, learned to think of genes more conceptually. I used two genes: one that represented difference and one that represented similarity, without concern for what the gene codes for.

I have been lucky to be able to access equipment on short notice, even after the residency ended. For example, I needed a scanning electron microscope to scan and make stills and video from the hair follicles of my subjects for *Transformers*. Much of the earlier material had been destroyed in my World Trade Center studio.[1] Fortunately, the hair was still at the museum because it had been sequenced there. With a few phone calls and favours called in I was able to get time on their machine.

WHAT WAS THE RESPONSE OF THE SCIENTISTS TOWARDS YOUR WORK?

They were very supportive. I spent just as much time, if not more, with ‘non-scientists’ as I did with scientists. This included the exhibitions staff, the special collections folks, and the curatorial associates, and of course the Education Department where I was based.

RICHARD DAWKINS SAYS THAT WE ARE ALL WALKING GENES, WE ARE ALL DETERMINED BY OUR GENETIC MAKEUP. WHAT IS YOUR VIEW ON THIS?

I used to be much more enchanted with that idea of genetic determinism, of the gene in control, the substantiation of personality as directed by our code, than I am right now. It takes a lot of pressure off oneself to think something else is running the show.

However, I'm sceptical at a very basic level. The scientific metaphor I would use is the theory of punctuated equilibrium. Interestingly, Niles Eldridge (from the American Museum of Natural History) and Stephen Jay Gould developed this theory in the early 1970s. What it amounted to was that Darwinism alone couldn't explain the variation and speciation in life (although he did include chance in his theory as it related to natural selection). Randomness and contingency had to be brought into the evolutionary equation. An example would be the belief that asteroid impacts are thought to be responsible for mass extinctions. Now if you apply this to the population at large, why not suggest that 'punctuated equilibrium' can happen at the individual level as well. This may be a fanciful interpretation on my part, and I guess some would simply call this the affect of the environment on the individual. In the 19th century, Lamarck had argued that changes in the organism were caused by changes in the environment. Of course this has been reinterpreted and objected to as a belief in the inheritance of acquired characteristics.

However, at the bottom of all of this is the fact that I would view Dawkins as misunderstood. Yes, for him the job of genes is to copy themselves and a belief we operate at a genetic level, not a group (species) level, as far as self-interest goes. However he doesn't discount how the environment affects us behaviourally, he doesn't say you can not learn altruism. So I don't disagree that genes *created* us, I just don't think they *control* us.

DURING THE RESIDENCY AT THE AMERICAN MUSEUM OF NATURAL HISTORY YOU TOOK PART IN A PANEL ENTITLED SCIENCE FOR ART'S SAKE, WHICH ACCOMPANIED THEIR EXHIBITION THE GENOMIC REVOLUTION. CAN YOU TELL US MORE ABOUT THIS?

Elaine Charnov, Melanie Kent and Kate Hurowitz, of the Margaret Mead Festival, also create public programming. To coincide with *The Genomic Revolution* show, they worked to develop a number of panels revolving around the issues of genetics. I was invited to participate in that process, viewing

possible films for inclusion, discussing relevant themes, especially in relation to what would be a forum called *Science for Art's Sake*. This gave me the time to develop a deeper understanding and rationale for my motivations in making *Transformers*.

YOU SAY THAT YOU DON'T THINK THE METHODOLOGIES OF ARTIST AND SCIENTIST DIVERGE AS MUCH AS SOME WOULD THINK. CAN YOU ELABORATE ON THAT? WHAT DO ARTISTS AND SCIENTISTS HAVE TO OFFER EACH OTHER IN THIS AREA?

Well scientists and artists can have similar processes, procedures and even natures. The desire to learn and question isn't exclusive to one or the other. Intrinsically, a scientist asks the question 'How?'—the artist asks the question 'Why?'. It's not a question of semantics here—it's fundamental. To ask why is to lend the object of study a subjectivity, a motivation. These questions aren't quantitative. Maybe I'm being too empirical in my thinking of science here. I'm finding the dichotomy of scientist and artist to be unproductive. Both are capable (or incapable) of creative thought, rational thought and expertise. So doesn't it ultimately come down to a symbiotic skill set and a willingness to engage with another brain? I can't be prescriptive here.

WHAT DO YOU THINK ARTIST RESIDENCIES HAVE TO OFFER THE HOST INSTITUTION? WHAT ARE THE BENEFITS FOR THEM?

Well the obvious thing is *perspective*. Generally artists operate from the margin. By positioning them on the inside you get the residual affect of their former location. Most artists are self-motivated, adept at seeking knowledge and developing ideas. I could be talking about a scientist in that last sentence. In the context of a host institution I think they would benefit by the creative capital, in conjunction with the alternate perspective, that the right artist has in tow.

DO YOU HAVE ANY ADVICE FOR ARTISTS ENTERING INTO RESIDENCIES WITH SCIENTIFIC INSTITUTIONS?

On one level it comes down to personality; you need to be able to get along with folks and communicate effectively. Something I have been fairly persistent about is the absolute necessity of knowing why you have chosen a particular institution and what it is you want to accomplish there. It is much better to initiate something in a concrete manner and allow the experimentation to spiral out of that. Oftentimes artists take the inverse approach. Vagueness is supposed to lead to clarity. I'm not persuaded that's an effective model.

YOU WERE THE FIRST ARTIST IN RESIDENCE AT THE AMERICAN MUSEUM OF NATURAL HISTORY. DO YOU KNOW IF THEY ARE PLANNING MORE RESIDENCIES?

Charlene Teters, a native American artist from New Mexico, is there at the moment. There is a show called *Baseball as America* currently running at the museum. Her idea was to create a work that was a more well-rounded concept of what America is. Similarly she brought funding from outside. However, this is a different model from the one I think the museum would like to set in place. I have worked with Elaine Charnov, the Director of Public Programming, to set up guidelines and possible scenarios for implementation of a residency program.

DESCRIBE TRANSFORMERS AS IT WAS EXHIBITED AT CONVERGE? WHAT WAS THE AUDIENCE RESPONSE TO YOUR WORK?

The piece was exhibited as it had been proposed—a 6m-long, 2m-high latex tent. I had created a 12-subject layered animation, six per side. Four DVD players drove four projectors, mounted to project in parallel with the walls of the tent. It was a simple structure. The idea of the tent shape came from the notion that we erect and collapse them as necessary, an extra skin. It alluded to identity as a similarly built process. The audience response is impossible to gauge because it's not a scientific experiment, there's no control group. I'm thrilled to hear that people were lying down in the tent, not just walking through. That's always my preferable type of interactant, someone who curates an experience for him or herself.

HAVE ANY NEW PROJECTS ARISEN FOR YOU AS A RESULT OF THE RESIDENCY?

I'm attempting to do a project later this year (2002) on various storage areas within the museum. All that is good about the institution is represented through their collections: preservation, scientific investigation, record keeping, and all that is dubious about it as well; a 19th century legacy of colonialist violation, greed, and pseudo-scientific validation (eugenics.) A complex web of science, history, and human desire—across geographical space, and over time—is encapsulated within the storage. In many ways it's the latent meaning I find so intriguing.

1. Justine Cooper was part of the Lower Manhattan Cultural Council's World Views residency program at the time of the September 11th attack. Much of her current work and archives were destroyed.

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ADAM DONOVAN

STATEMENT FROM HOST ORGANISATION

Images: clockwise from top

Researchers Binh Nguyen and Joe Cashel with Adam Donovan in his lab at DSTO, Edinburgh SA.
Photograph courtesy DSTO.

Perimetry, interactive installation, acoustic lens and robotic tracking, 2002
Photograph Phil Hargreaves.

Sketches from the artist's notebook.

Sound likes a good idea—art and defence science.

Adam Donovan is a 27 year-old Brisbane artist working in the area of acoustic and visual art. In September 2001 he began a 10-week residency at the Defence Science & Technology Organisation (DSTO)-Edinburgh, South Australia. The project was initiated by the Australian Network of Art and New Technology and is the first time the Defence Department has hosted an artist in residence.

Adam Donovan is at the forefront of developing new and innovative methods of incorporating applied physics into artistic work. A sculpture graduate of the Queensland College of Art, Griffith University (1994), his work has been exhibited at the Queensland Art Gallery, the Institute of Modern Art and the Pratt Institute (New York). Adam is currently developing public artworks for the new River Walk Project (commissioned by the Brisbane City Council).

Adam's artist in residency at DSTO-Edinburgh is one of a series of science residencies, hosted by various organisations, called *Deep Immersion: Scientific Serendipity*. The scheme facilitates the marriage of art, science and technology and has proved fertile ground for artistic and scientific collaboration.

The Maritime Operations Division (MOD) of DSTO is facilitating Adam's art/technology research by sharing its expertise and knowledge in acoustics. Here he has conducted research into the development of parametric acoustic arrays. These 'acoustic lenses' focus highly directional ultrasound, which is demodulated by its passage through air to produce audible sounds that can only be heard within a narrow 3D beam over a range of some 200m. MOD is one of the few research organisations in Australia to work extensively with ultrasound as part of their sonar technology research.

'This is the best science lab I have worked in', says Adam. 'I wish I could be a permanent artist in residence at DSTO, moving about from lab to lab.'

At MOD, Adam has set up a small laboratory and has access to MOD scientists and equipment. He pays particular tribute to the stimulation and advice he has received from MOD researchers such as Dr Henry Lew, Binh Nguyen and Joe Cashel. Adam says that thanks to these people his design has completely changed since his arrival at DSTO. 'I came with a concept and about 10 articles on parametric acoustic array lensing effects. Now I have a complete idea of the problem and the range of technical solutions available to me.'

'Adam's concept of sound projection from multiple sources and spatial sensitivity to listeners is novel', says Dr D. (Nanda) Nandagopal, Chief, Maritime Operations Division. 'This kind of artist-scientist fusion of ideas stimulates innovation and certainly has useful spin-offs for us. I favour such activities because they encourage defence scientists to think "outside of the box".'

The artwork that has been the focus of Adam's time at DSTO is to be exhibited in *'conVerge: where art and science meet; the 2002 Biennial Exhibition of Australian Art'*—part of the forthcoming Adelaide Festival program. It will include two acoustic lenses linked to a robotic tracking system to follow viewers of the exhibition and create an interactive installation of acoustic and visual projections.

Adam says that he has been using an art/science approach since around 1993. His earlier work was with optical lensing and he has now moved into acoustics. Initially his audio work used parabolics to achieve lensing effects, but these were nowhere near as effective or exciting as the parametric acoustic devices he is now working with.

'This is possibly the biggest development in loudspeaker design in 75 years', says Adam. 'Its history goes back to 1934 when the parametric effect was first discovered, but only in last 10 years has the technology become available that makes its application possible. Acoustic lenses have tremendous potential in virtual reality environments but there is still no parametric acoustic array commercially available anywhere in the world.'

ADAM DONOVAN

INTRODUCTION AND INTERVIEW

Kathy Cleland

Adam Donovan's work combines the highly specialised field of scientific acoustics with the visual arts. Donovan has been researching focused acoustics and acoustic lenses since 1996 drawing on scientific research in this area to create interactive sound installations.

Donovan's interest in using lenses in his artwork evolved while he was completing his Fine Arts Degree at Griffith University.

'The initial attraction to lenses was in their beauty and later formed into ideas about human perception and memory. For me the lens is an infinite model for my work; lenses represent the collecting of information/emotion and define a person's view of the world. This model of perception led me to think about other senses. Auditory awareness was of particular interest because it's secondary to vision. It became an obsession of mine in 1996 to find a way to control sound (or focus sound), I wanted to sculpt sound in space and change they way people perceive their auditory environment.'

Scientific collaboration has been an integral part of Donovan's work enabling him to gain the skills and expertise he has needed to develop prototypes for his exhibitions. In this unusual area of interdisciplinary art practice, Donovan has found himself at the forefront in developing new and innovative methods of incorporating applied physics with installation art. Donovan's collaborations are also challenging for the research scientists with whom he works, as he is often asking them to extend the boundaries of currently available technology and their (usual) uses.

As a participant in the ANAT *Scientific Serendipity* residency, Donovan chose to work with the MOD of the DSTO, one of the few organisations in Australia working extensively with ultrasound and parametric arrays. The goal of the residency was to develop a prototype acoustic lens, which would operate in a similar way to an optical lens, but instead of focusing light, the acoustic lens would focus sound. Donovan's developmental work at DSTO looked at ways of using high amplitude ultrasound to project a very narrow directional beam of audible sound which could only be heard within the projected beam.

The prototype developed during the residency was used as the basis for the creation of an acoustic lens for an interactive art installation. Donovan incorporated the lens with a robotic tripod, which controlled the angle at which the sound beam was projected and followed people around the room. Camera tracking systems were used to add audience interactivity to the work so the sound beam could be triggered and manipulated by audience movement. The prototype work was exhibited as *Perimetry* in the 2002 Adelaide Biennial of Australian Art *(conVerge: where art and science meet)* at the Art Gallery of South Australia.

CAN YOU DESCRIBE THE PROCESS OF HOW YOU CHOSE THE HOST VENUE AND DEVELOPED THE RESIDENCY? WHAT ROLE DID ANAT PLAY IN THIS?

I was first approached by Amanda McDonald Crowley (the previous director of ANAT) about the possibility of a residency in 2000. It took some time to negotiate what the residency would involve. The host venue was chosen after researching a few organisations that had some of the equipment that was required for the development of the acoustic lens. Both myself and Linda Cooper (co-curator of the *Scientific Serendipity* residency program) looked into organisations (some of them being commercial companies) before we agreed on approaching the DSTO. Linda Cooper had some contacts with the DSTO and started liaising with them. I made a trip to Adelaide to meet with them and discuss if the idea was feasible. Having ANAT behind this residency was definitely a big advantage.

HOW DID THE RESIDENCY PROGRESS? WHAT STAGES DID IT GO THROUGH?

The first step was getting help from the scientists involved in the project so I could become familiar with the lingo of the technology and understand some of the basic physics of ultrasound. A lot of time was spent testing ultrasonic transmitters to see if we could find any off-the-shelf products. Through this basic testing we eliminated all the ready made products (I searched through hundreds worldwide), and decided we would need to build our own from scratch. Once the basics were dealt with we constructed a few prototypes to further test the theory. Following successful testing, I set out to design a final prototype, which was then constructed by an engineering firm in Brisbane.

CAN YOU DESCRIBE IN MORE DETAIL THE RESEARCH YOU WERE WORKING ON WITH THE DSTO SCIENTISTS DURING YOUR RESIDENCY.

The area of research for the lens we were developing at the DSTO was in the area on non-linear acoustics. The device itself is a parametric array and one of the current accepted terms for the method we applied to it is 'acoustic heterodyning'. Another way of describing acoustic heterodyning can be found in the principles of 'difference tones'. For example, if you measure with a microphone and an oscilloscope two equal amplitude tones above a certain amplitude you not only get the two tones but also the sum of the tones and the difference between them (this is caused by air distorting sound). Using this principle we created a parametric array (a parametric array is basically many speakers in a hexagonal pattern). The reason for many speakers is that the creation of a culminated beam of a particular frequency requires that

the emitter is much larger than the wavelength. So the device we were designing in itself can emit very focused ultrasound (currently about 5 degrees over 150m). Our aim was to combine the phenomenon of difference tones into the very focused ultrasound array and create audible sound only within the ultrasonic column.

DID YOU ENCOUNTER ANY PROBLEMS IN THE CONSTRUCTION OF THE PROTOTYPE ACOUSTIC LENS FOR PERIMETRY?

The construction of the lens and all of its processes was a really big project, so yes there were problems every moment of the residency. Most of the problems were because of a lack of information regarding the device we were building. The housing (kind of like a speaker cabinet) posed some real problems as it had to contain and indefinitely hold nearly a full vacuum (this turned out to be a very difficult thing to do and we broke some general engineering rules to do it). I spent nearly two months fiddling around with two hand-built prototypes that kept leaking or the ultrasound film kept shorting out due to the high voltage we were using. Also the amplifier needed to be specifically designed for it to work with the lens as high frequencies are usually filtered out in audio amplifiers. The signal that drives the lens (a type of AM radio wave) was also very tricky (and still is). These processes were hard to deal with because if you get them wrong then you simply don't hear anything at all. In fact, the only thing we got to hear during the residency was a very weak 2khz tone. I had to wait until the finished lens housing was completed (late January 2002) before I had a reliable lens that produced more audible frequencies.

THE RESEARCH WORK YOU WERE DOING DURING THE RESIDENCY CULMINATED IN THE EXHIBITION OF PERIMETRY IN THE CONVERGE EXHIBITION. CAN YOU DESCRIBE THIS WORK AND WHAT YOU WERE HOPING TO ACHIEVE WITH IT?

The title for the exhibition *Perimetry* comes from 'sound perimetry', the mapping, by a sound cage (or sound perimeter), of the subject's auditory space. The title relates to a previous installation titled *Phonelescope* and refers to the subject's (audience) awareness of sound. Sound as a beam is very different from the usual experience of everyday sound (I am looking at a very different perception of the sense). The object of the work was to make a type of virtual containment room. This room is defined by the beam and eludes bystanders because they are not directly in the beam. If you are the onlooker to the interactor, it seems like they are dancing to music that is not there (kind of like someone talking to themselves).

Basically the work consisted of 12 sound-absorbent foam panels that were in the arc of the sound beam.

A camera mounted on the tripod where the lens was also situated allowed the work to visually track its audience through this arc (about 160 degrees). The sound from the lens is also interactive. A camera mounted on the ceiling monitors people's actions and hand gestures in the space, triggering modulations in the sound, which causes changes in pitch.

YOU HAVE PREVIOUSLY COLLABORATED WITH ARTISTS AND MUSICIANS (FOR EXAMPLE, BEN MARKS) IN SOME OF YOUR EARLIER WORKS. WHAT WAS IT LIKE COLLABORATING WITH SCIENTISTS?

Generally speaking other collaborations have been for similar reasons—to create a work or performance that has the scope of more than just one individual's knowledge. They are very different in the way they were maintained because Ben and I could work more independently from each other (focusing more on each person's skills for the project rather than each of us needing to learn those skills). When working with a scientific concept you can't simply leave these gaps. Plus I think that if you are working with other artists you have more of a choice of who you might work with, but this is not the case with art and science because things get very specific. It could be seen not so much as a natural process, but then this also makes it more exciting as you have to form relationships with the people you are working with.

WHAT WERE THE KEY OUTCOMES OF THE RESIDENCY FOR YOU?

The residency was a catalyst for my ideas. Ideas that I would come up with were explored very quickly because I could confirm them simply by going and asking one of the scientists. Also, they had a lot of good equipment that I could use and was shown how to use. I feel the progress we made during the residency would otherwise have taken me about two years to complete on my own.

As it turned out, three months was not enough time to bring a project like this to a final developed piece of equipment. I do, however, have a very good understanding of the systems and will continue to develop the lens until it all works as well as I had originally perceived. At the moment I am trying to get companies such as Brüel & Kjær (a microphone company from Denmark) interested in taking the idea further by providing equipment for further testing. Ideally I would like an Australian company interested in this technology to provide some serious support

WHAT DID DSTO GET OUT OF THE RESIDENCY? WERE THERE ANY BENEFITS FOR THEM?

There was an interest in the new technology spin-offs that the DSTO might be able to implement into

their systems. I think it was also interesting for them to see how an artist would deal with real scientific problems. No direct outcomes have evolved for them (any useful equipment), though you could say that the exchange of methods or processes of thought was useful for encouraging non-linear thinking. As the project is ongoing I am confident that the device will have spin-offs for them in the future.

DO YOU HAVE ANY ADVICE FOR HOW TO SUCCESSFULLY MAINTAIN RELATIONSHIPS WITH SCIENTIFIC INSTITUTIONS?

Well I guess this one can be a bit tricky because not everyone is going to be as enthusiastic as the artist who is in residence, but it's important to really listen to what the scientists have to say and to genuinely follow through with their suggestions. Also it's important to try and form friendships with the people you are working closely with.

HAVE THERE BEEN ANY ONGOING RELATIONSHIPS OR ANY NEW PROJECTS THAT HAVE ARISEN AS PART OF THE RESIDENCY?

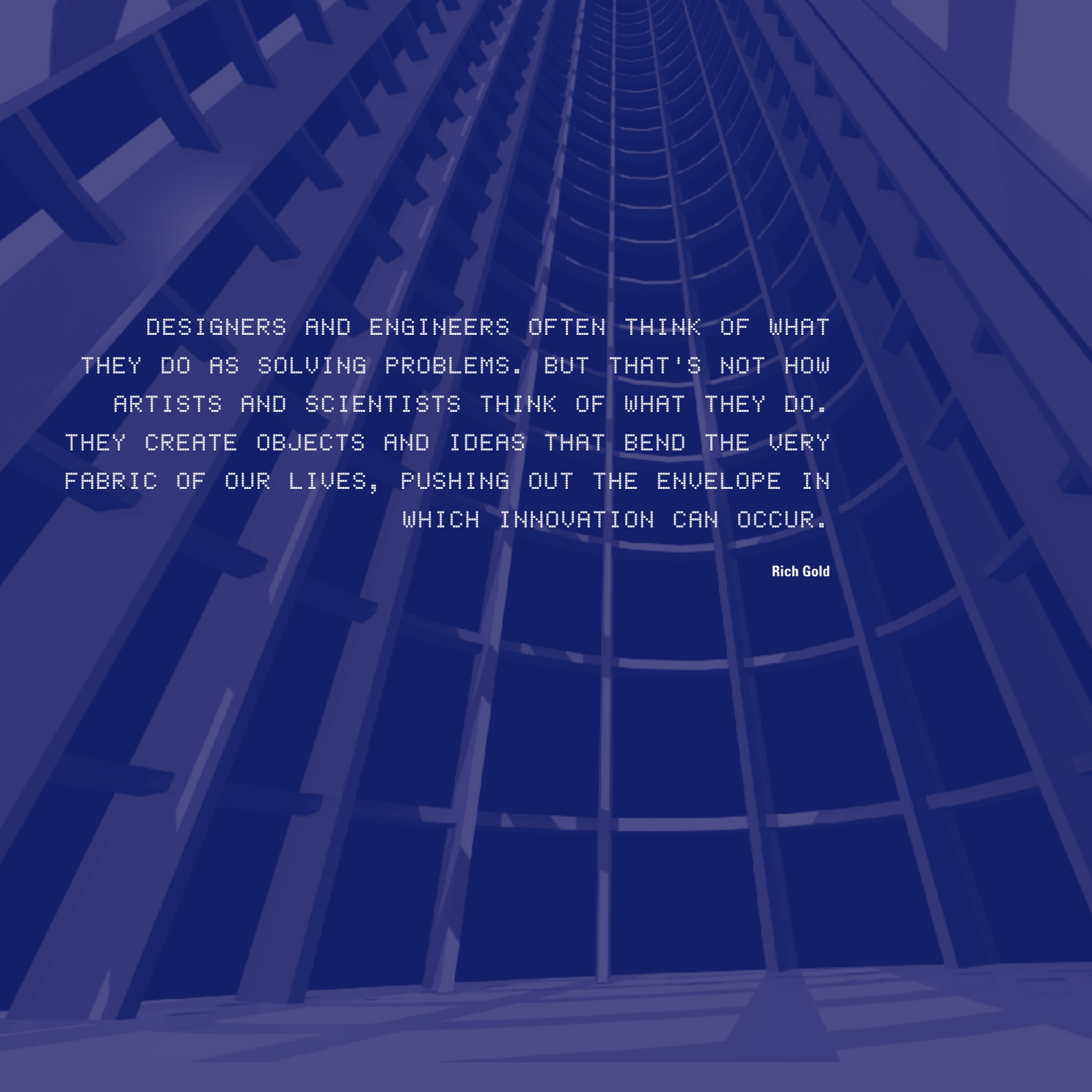
I still communicate the developments of the project, and the DSTO have done some further testing for me, but no other residencies have been planned at the DSTO. I have certainly had a lot of interest from galleries about showing *Perimetry*. I have also had some interest from engineering companies but nothing definite yet.

SINCE THE RESIDENCY FINISHED YOU HAVE BEEN CONTINUING TO DEVELOP THE WORK YOU EXHIBITED IN PERIMETRY? CAN YOU DESCRIBE THE NEW DEVELOPMENTS YOU ARE WORKING ON?

I think that one of the most interesting developments of this technology is its integration with Virtual Reality and I will be focusing on developing a 3D (IMAX) type installation that ties in 3D particle systems with the movement of the lens. I am also still working on the mathematics integral to signal processing for the lens, improving the amplifier and changing aspects of the array so that I can have a wider bandwidth of audible sound. The systems of perimetry will be incorporated with this 3D environment and will further explore the psychological meaning of 'sound perimetry'.

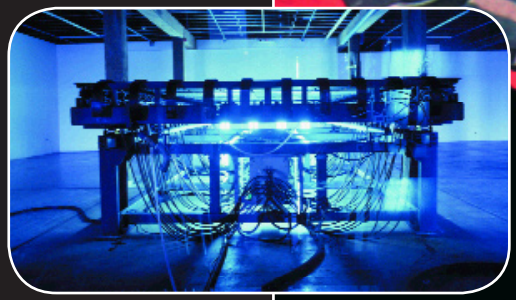
WHAT HAS THE IMPACT OF THE RESIDENCY BEEN ON YOUR PLANS FOR NEW WORKS?

The residency made me a lot more aware and gave me a lot of knowledge that I feel will generate works that I could not have achieved without the steep learning curve that I experienced. It has also made the work I do a lot more expensive, which is frustrating now that I do not have the support of such a good facility. I feel strongly about this last point because residencies like this give artists a good taste of what is possible but then when it's taken away it's like someone has confiscated your paintbrushes.



DESIGNERS AND ENGINEERS OFTEN THINK OF WHAT THEY DO AS SOLVING PROBLEMS. BUT THAT'S NOT HOW ARTISTS AND SCIENTISTS THINK OF WHAT THEY DO. THEY CREATE OBJECTS AND IDEAS THAT BEND THE VERY FABRIC OF OUR LIVES, PUSHING OUT THE ENVELOPE IN WHICH INNOVATION CAN OCCUR.

Rich Gold



D.V. Rogers

Seismonitor, poster image by D.V. Rogers.

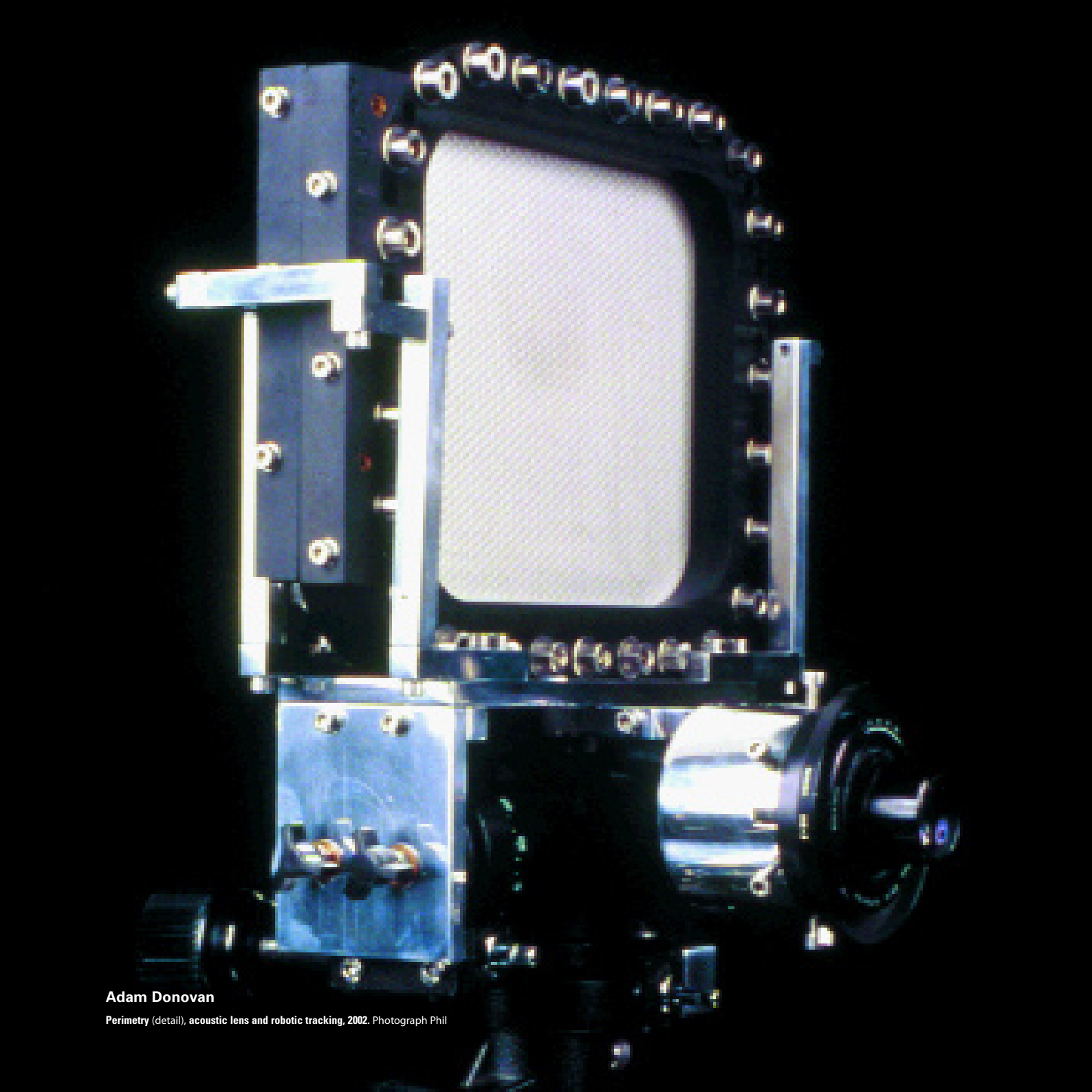
insert: Seismonitor installation, Artspace, Sydney, 2002. Photograph Alistair

Oron Catts and Ionat Zurr

Untitled, 1999. Muscle and neural tissue grown over hydrogel replica of a stone tool.
insert: SymbitiocA art and science research laboratory, Department of Anatomy and Human Biology, University of Western Australia.
insert: Arrow 1999. Muscle tissue from mice grown over a hydrogel replica of a stone tool, 13,000 years old, found on a site in Egypt.

Justine Cooper

Genomic Revolution Learning Laboratory at the American Museum of Natural History, New York.
insert: Scanning Electron Microscopy (SEM) Images of hair follicles.



Adam Donovan

Perimetry (detail), **acoustic lens and robotic tracking, 2002.** Photograph Phil

I'VE BEEN THINKING ABOUT COLLABORATIONS

RICH GOLD

I've been thinking about artist and scientist collaborations recently. I have been wondering why I find them so compelling and so important? Why, for instance, I am fascinated and drawn to the results and outputs of such collaborations? Why, when science and art join in these collaborations new ideas and understanding emerge that don't emerge in other ways? And in particular, why some of the results of these art and science collaborations give me some hope for the future. This at a time when many of the other results of technology, instead of making my life easier and more comfortable, as promised, make me a little nervous about our lives and even our planet?

So, that got me thinking about other forms of multidisciplinary collaborations. In particular, it got me thinking about the apparently successful, and widely practised, form of collaboration that we usually call the *corporation*. It combines multiple professionals, including designers, engineers, manufacturers, salespeople, marketers, logisticians, MBAs, lawyers and political lobbyists. The output of these collaborations has filled our malls, living rooms and bedrooms with so much stuff that it would make Ottoman Sultans, Aztec Emperors and the entire court of Louis the XIV collectively green with envy. It has filled our roads with swift and powerful vehicles, our skies with amazing flying machines, and our waters with small pleasure craft and massive tankers. And yet, I would say, they have not filled us with deep satisfaction and understanding.

These same collaborative forces, in conjunction with endless user tests, focus groups, customer feedback forms and surveys of all sorts have also produced vast oceans of popular art. Music of myriad genres is distributed on invisible waves and silvery disks and fills the stores. In theatres our eyes are overwhelmed with large moving pictures of real actors and synthetic creatures; in our living rooms we can view tens of channels devoted to humorous family bickering and police SWAT actions. And though many of these dazzling works are created with advanced technologies, I rarely come away enlightened or enriched.

These same global collaborations, having first scattered us about the landscape with planes and automobiles, have now given us amazing forms of communications to reconnect us. Just this morning, I talked by phone with my mother on the other side of a continent and received 10 pieces of email from friends in four countries. I can *Instant Message* with my son or put digital photos of my vacation on the Internet for all the globe to see. There is even remote video conferencing, invented with the express purpose of allowing far-flung employees to collaborate even better. Yet all these mediated meetings seem only like fragments of human interaction. I will travel great distances, at great expense, for a simple hug.

There is little doubt about the sheer inventiveness brought forth by these company based collaborations. I have worked in corporations and loved the complex human interaction and the creativity they engender. In fact, they seem to produce new things in such quantity, in such abundance that, frankly, we are getting the sense that it all might be about to destroy the world. This cornucopia has surely destroyed our sense of self in our own culture, in our own tribe. Where, really, did the 10,000 things in my kitchen come from? Who thought of them? What am I to make of them? I can't even remember buying most of them. Ask anyone and they will tell you they'd love to get rid of a lot of the junk that is cluttering their lives. Something deep and fundamental seems to have gone wrong, not with our ability to make things, but our ability to make things that matter.

So I've been thinking hard about collaborations and wondering if there might be other forms of collaboration, that together with our existing corporate collaborations, might together create a world we really want to *live in*.

Now there are two professions that seem to stand somewhat outside the usual process of making new products: *art* and *science*. They are unusual in that they seem more like callings than professions. Though there is something similar about them, they rarely get together on their own to collaborate. But when they do, and it usually requires some help, the result can be something special that helps us make sense of and understand our world. In the end this *sense making* and *understanding* may allow us to design and build new products and services that do what we all want: *create a world that we all want to actually live in*.

Of course, the scientist is not totally unconnected to the ongoing corporate collaborations. Scientific explorations of the physical world, and the resulting equations, make the work of the corporate engineer and designer both easier and more original. Thus large companies hire scientists as employees, feeling perhaps that they have cornered part of the equation market.

On the other hand, I don't think I am speaking out of turn in saying that this science-corporate relationship is a little uncomfortable. The transient, trend-driven commodities that are the output of companies are antithetical to science's deep and timeless way of thinking about the universe. The scientist attempts, with vision and intelligence, to sort through the local effluvia to find what is permanent, simple and universal. The secretive process by which a product is made is often in direct odds with the open, peer-reviewed one required by scientists for the untangling of nature.

The corporation may provide the scientist with a desk, cool tools and a paycheque, but it is at best a marriage of convenience.

Artists also collaborate with corporations but more tangentially. Their work, for instance, when purchased at all, is often purchased by companies for their lobbies, or by executives for their homes. Artists, unlike scientists, are not usually seated at company desks (partly of their own choice, partly because they are notoriously hard to manage.) But their visions and works help define the products of mass culture, including advertising—from the loopy riffs of Moby to the distressed, flickering pop-up ads on the world wide web.

The artist also acquires technology from the corporation. Unlike the camel-hair brush and violin, which were tools designed specifically for the artist, the video camera and the computer were developed by companies for industrial use and then for the general public, and appropriated by the artist. But this too is an uneasy marriage (like a labor activist marrying the boss's daughter.) *Am I using this digital tool because it makes interesting art, or am I making a statement by using it*, the artist asks at every turn.

So I have been thinking about collaborations lately, and how powerful they can be. In particular I have been thinking a lot about art and science collaborations and how, since they are so famously difficult to set up, what is it that compels us to push these somewhat like-charged particles together?

From the artist's perspective, it can't simply be to get more technology. As Billy Kluver, the Director of the early art/technology program *EAT* noted: 'artists need engineers, not scientists, to help them build and program their works'. And from the scientist's perspective, it can't simply be to help with complex visualisation and knowledge transfer problems. For that task, really, the scientist needs a good designer, not an artist.

From the enlightened curator's (or the concerned citizen's) perspective, the goal of such collaborations might be to shake the artist loose from the Sophist post-modernist stance where everything is 'socially constructed' and just 'language all the way down'. It's *not* and science is a good place to learn that. And likewise, it could be to shake the scientist loose from the equally Sophist, positivist stance where it's all particles and laws and fierce causality. It's *not* and art is a good place to learn that.

But I don't think that is what is at the heart of it.

So I have been thinking about collaborations and the future of the world lately. Our world. This speck of dust in the vast universe on whose surface we all live. Where, as it is now commonly said, half of the people live on less than two dollars per day. Where one half suffers from strange spiritual diseases such as 'information overload' and 'attention deficit disorder', while the other half dies of cancer from relocated factories and malnutrition from displaced local farms. Where, now that the Internet, CNN and Al - Jazeera[1] allow us to *see* each other, we seem to be only able to *speak* to each other by blowing up buildings and flattening villages.

Here's one thing we know about ecologies: diversity produces longevity, innovation and dense beauty. The artist/scientist collaboration is *not* oppositional to the corporate collaboration. Quite the opposite, it provides another source of creativity, one that is by its very nature both deeply historical and cutting edge. It may be the best way for art and science to intersect with corporations. It grows its flowers from the strata beneath the surface of the popular topsoil, from the fundamental parts of our culture. Neither Luddite, nor irrationally effusive, art/science collaborations can be dyads that seek the deep, the lasting, the thoughtful, the intelligent, the important, the pleasurable, the true: not as after-thought but as primary inspiration. They have, in conjunction with other collaborations, the potential of forming a meaningful backbone on which a new, variety strewn, planet-wide civilisation can be grown. It hurts my soul to think of the alternative.

Designers and engineers often think of what they do as solving problems. But that's not how artists and scientists think of what they do. They create objects and ideas that bend the very fabric of our lives, pushing out the envelope in which innovation can occur. Combining the aesthetic with the physical, the artist with the scientist, produces not with just more art and science (which it does); or better artists and scientists (which it does); but it might also transform the matrix of innovation here to create a spectacular and productive six billion-seat space ship that we want to live on.

That's what I've been thinking about.

1. Arabic language broadcast network.

Rich Gold (United States) is a composer, inventor, artist, cartoonist, lecturer and researcher. He created the widely emulated PAIR (PARC Artist-In-Residence) program, as well as the RED Group (which combines art and design with science and engineering).

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