FCJ-073 Technology transfer present and futures in the electronic arts

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Introduction

The intersection of art and technology is not new, yet the context and history of this interchange have largely been ignored, though it extends back hundreds, even thousands of years. For most of that time the arts exerted a strong influence on technological and scientific invention and discovery; it is only recently that the arts have depended quite so heavily on technology to lead the way (Goldberg, 2001).

Art and science are both cultural activities (Wilson, 2003). The push for a new interplay between them has come both from artists trying to access new technologies and researchers desiring additional creative insights into modern innovation.

Access to sciences techniques or technology, in order to critique or use them aesthetically, is restricted in many ways. It is not as simple as buying 'off the shelf' paints as used by the traditional arts. There are real barriers to getting access to these new creative spaces because of the technologies' complexity.

As a scientist, I had easy access to life science technology, but when I chose a career path outside of medical life science research, that ceased. Fortuitously, it was at this time that I encountered artists and technologists collaborating through the Converge symposium and exhibition in 2002. It was at this Adelaide conference that I first heard and saw Tissue Culture and Art's (TC&A) work. The exhibited piece Pigs Wing was a living sculpture. It was the first time I had seen a tissue culture lab in a gallery. The installation consisted of degradable polymers seeded with pig cartilage cells. These sculptures were small, less than an inch high, and were growing inside a rotating incubator within the bespoke lab. TC&A also exhibited previously grown 'wings' as gold coated artefacts. The wings grown were angel, bird and bat representing the good, the known, and evil respectively. In this way TC&A interrogated the utopian medical future. This was inspirational and I travelled to Perth Biennale of Electronic Art to see more related works and artists. Here I saw TC&A's semi-living Worry Dolls. These tiny dolls were made out of degradable polymers and surgical sutures that had been seeded with endothelial (skin), muscle and osteoblast (bone) cells. As the cells grew, the polymer degraded. The outcome of this trip were ideas for works I wanted to explore in a life science laboratory, however access (economic, intellectual and regulatory) was suddenly the overriding problem. For this reason, I have been intensely interested in how artists address this problem in different fields.

Ingenuity is required to solve the pressing problem of access for contemporary artists. Access can be broken into three separate albeit interrelated aspects (Table 1):

Access	How it restricts access	Example
Economic	Does the artist have the means to buy it?	Expensive technology e.g. rapid prototyping
Intellectual	Does the artist have the right to use it?	Patented technology e.g. cell markers
Regulatory	Does the artist have regulatory approval to use it?	Restricted technology e.g. stem cells

Table 1. Types of access

20 The problem of economic access is hardly new. For painters working up to the invention of oil paints in 1856 the problem was access to colour (Finlay, 2003), both the pigment and the techniques for making them into a paint. Certain colours in the 1600s were so costly and scarce that only rich patrons could afford to buy them for their artists. For example, ultramarine, a pigment made from lapis lazuli from Afghanistan, cost 100 florins per pound in 1508 (Finlay, 2003: 318). This scarcity may be the reason that the Virgin Mary robe is unpainted in Michelangelo's the entombment as only ultramarine was deemed worthy of her in Renaissance Italy (2003: 310). As a pigment, it is still expensive today at £2500 per pound, however there are inexpensive oil paint equivalents. A recent example of the expense of technology is the cost of rapid prototyping for Ken Rinaldo's and Matt Howard's Auto Telematic Spider Bots (Marshal, 2006). Rapid prototyping of the components in the spider bots would have run to US $50 000. The piece was only possible because of the gifting of material and time on their machines by the rapid prototyping company, Laser Reproductions. As it was, the artists' needs exceeded the capacity of the equipment. This necessitated a rethink in terms of what parts could be created using more traditional fabrication techniques (Ken Rinaldo, personal commmunication).

21 The products of innovation that artists wish to access are often protected by trade secrets or patents. A patent is a right granted for any device, substance, method or process which is new, inventive and useful (ipaustralia.gov.au). Patents allow a limited window (up to 20 years) where the originator may exploit the financial rewards of their invention. This is not intended to stifle creativity, as patents that are granted are also published. The main type is a utility patent which covers novel processes and products. For example, Apple might have patents on the iPod navigation wheel (product) and buy a licence from another company to use their patent to make the silicon chips (process). Most technology (e.g. the polymerase chain reaction technology (PCR), commonly used to replicate DNA) is tied heavily into patents with licensing that proscribes the ways a product may be used. When a researcher buys a PCR kit, they are buying a licence to use it. The machine used to carry out the PCR likewise will be licensed and covered by patents. These licences stipulate that it is for non-commercial research. A commercial licence for diagnostics costs more (e.g. see the Extended PCR License Information at https://www.abgene.com/Static_Pages.asp?page=33).

22 When the inventor perceives that a process can't be patented, trade secrets are used, the most familiar example being the secret coca cola ingredient. Trade secrets allow a monopoly to be maintained, as there is no publication of the process. In medieval times pigments and their origin was often a closely guarded trade secret. Artistic guilds held the secrets on how to produce paints, pigments, and painting surfaces. Artist guilds were organizations that controlled the flow of knowledge by training trusted apprentices. Gradually the know-how to make paints moved from the artist to the 'colour men', professionals with knowledge of the formulation of colours (Finlay, 2003: 16). Artists no longer had to deal with the messiness of pigment grinding and making, giving them more time to work. However this speed came at a cost; artists no longer understood the technology underlying painting. Pre-Raphaelite William Holman Hunt despaired at this state of affairs in 1880 (Hunt, 1880). This paper was a call to arms for artists to understand their media. In a similar way, over a hundred years later, electronic artist Stephen Wilson makes the same call to understand modern technology underlying the arts. In his introduction to Information Arts: Intersections of Art, Science, and Technology, he describes finding out about how radio works as part of his arts practice (Wilson, 2003: xxiii). A modern example of trade secrets in life science may be the specific method of disaggregating and purifying a particular cell type from an organ or a new process for making silicon chips.

23 Regulatory access to technology is one of the additional layers of difficulty that comes with working with living systems. In bioart these include the amount of regulation and infrastructure required to satisfy governments' desire for control, security and risk management. The act of sacrificing an animal for the sake of art is controversial, although every day it is done for food and scientific research. In Australia, experiments carried out in universities involving animals are reviewed by an internal ethics board. They use the 'NHMRC Australian code of practice for the care and use of animals for scientific purposes' as their guide to determine whether ethics clearance should be granted (Australian Code of Practice). This is to satisfy the condition that the experiment

is necessary, involves the minimum number of animals, and has a clear benefit to society. This places artists in a difficult position. Artists must satisfy the same committee, although it is much harder to prove a clear benefit to society unless there is a clear scientific outcome as well. In Australia experiments involving the use or creation of genetic manipulated organisms must satisfy an institutional biosafety committee. This allows the evaluation of the experiment into the categories: a) exempt; b) a notifiable low risk dealing (NLRD); c) a dealing requiring a license from the Office of the Gene Technology Regulator. Projects falling into the NLRD classification require a lab built to a minimum containment level to reduce the risk of spread of biological materials in order to comply with the Gene Technology Act 2000 (Office of Research Integrity, ANU). Non-regulated or non-institutional use of micro-organisms, even the relatively safe ones in the exempt category can be equated with bioterrorism. This is apparent in the arrest of Steve Kurtz of Critical Art Ensemble in the United States as a suspected bioterrorist because of cultured bacteria being found at his house (Sholette, 2005) although these are used to teach biology in high schools.

24 Where are some of these new technologies coming from? Broadly, advances are in the fields of nanotechnology, biotechnology, robotics, and materials sciences. Nanotechnology is the manipulation of matter at the atomic scale made famous by physicist Richard Feynman (1960); biotechnology is the manipulation of living processes, in order to generate therapeutic products, new organisms and remediate contaminated environments; robotics is the generation of artificial autonomous entities for purposes ranging from manufacturing to the military to human welfare; materials science provides some of the oldest examples of technology, with epochs of civilisation defined by the uses of materials (i.e. the bronze, silver and iron ages). It can be said that we are entering the carbon age, with advances in carbon nanotubes predicted to have wide application. Although these areas of technology are quite different, a single project in either science or art may use technology from multiple fields. For example, whole organ culture requires an artificial scaffold made of polymers (materials science), created using microfabrication for an artificial vascular system, which entails knowledge of fluid dynamics on the cellular level and life science techniques to succeed.

25 Significant collaborations between engineers and artists such began in the late 1960s. Experiments in Art and Technology (E.A.T.) founded by engineers Billy Klüver and Fred Waldhauer and artists Robert Rauschenberg and Robert Whitman in 1966, produced a large body of over 500 works (Kluver, 2000: 72). It became clear that achieving ongoing artist-engineer relationships would require a concerted effort to develop the necessary physical and social conditions. E.A.T. saw itself as a catalyst for stimulating this involvement of industry and technology with the arts (Kluver, 2000). Although successful in opening a dialogue between artist and scientist-engineer, however, it did not address the role of artists in research, which later endeavours such as Xerox Parc did (Wilson, 2003).

26 This paper is my investigation into how artists currently access technology and offers some predictions as to what may happen in the future. It also covers my personal journey from scientist to artist. During this time I have had opportunities to work closely with and observe at first hand the art organisations at the forefront of the hybrid arts. I draw on interviews with and observations of Blast Theory, SymbioticA Research Group and FoAM. These groups have been selected for the central role research has in their practice and the various modes of access to technology they utilise.

Organisations, Collaborations, Works

27 ***Blast Theory and I like Frank in Adelaide***

28 ***'I like Frank in Adelaide' 2004***

29 Blast Theory was approached by the Thinkers in Residence Project of Adelaide (see internode.on.net). This residency for three months had a broad brief including a survey of Adelaide's strengths and weaknesses in the New Media arts, to liaise with key policymakers in the education, IT and government to promote New Media. Additionally they had the opportunity to create and perform I Like Frank in Adelaide. As part of the development of I Like Frank in Adelaide, five art practitioners (myself included) had the opportunity to collaborate with Blast Theory/Mixed Reality Lab (MRL) in its creation and execution.

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I like Frank was the first 3G phone mixed reality game. Through their partners MNet, Blast Theory were granted exclusive access to the prototype 3G network, which was required in order to use of video calling as part of the experience. Earlier works such as Can you See Me Now and Unkle Roy all Around utilised PDAs and WiFi networks:

31 The second half of the residency involved developing and staging I Like Frank In Adelaide, a public performance based upon 3G technologies. This extended a previous work, Uncle Roy All Around You, building a relationship between street and online players as they journeyed through Adelaide and an online virtual model of Adelaide, exploring the themes of loss, memory and the crossing of boundaries (amutualfriend.co.uk).

32 Street players moved though a journey narrated by Frank's unnamed friend, following mobile phone screen clues and assisted by online gamers to find postcards hidden in the city. The street player could respond to questions from online players with a yes or no. In the final sequence, the player was directed into 'futureland' via a video call from Frank. In futureland (a leafy alcove in the middle of four unoccupied business tower blocks), the street player was asked to read out the question on their postcard and answer it. These questions, such as 'who makes you feel safe?', were open ended, ambiguous and involved players explaining their own connection with others. The player writes down a response on the postcard and leaves it there, and the postcard was then sent to the online player that assisted the street player (Flintham et al, 2007). I Like Frank is based upon the ideas of interaction and software as developed in Unkle Roy all Around and Can You See Me Now. It also built on the use of colour maps as a way to design the game narrative, requiring the player to map literate. The game used self-reporting as the locative mechanism rather than a separate global positioning (GPS) receiver, and players also explored the surrounding game by self-reporting a little ahead of themselves. In a comparison of GPS and self reporting, Blast Theory/ MRL has shown that self reporting was as reliable as GPS in mixed reality games (Benford et al, 2004), and moreover, GPS receivers have line of sight problems in the urban environment.

33 Developing for the mobile phone brought a number of limitations that were not present when developing for PDA devices. The phone has limited memory, and no touch screen. Additionally when using java to program the phone there was limited access to the phones intrinsic functions such as video calling and voice calling. Whilst as a performance it was successful, it was unsuccessful in becoming a model for a scalable mixed reality game because of the human and technical resources required. This performance was experienced by less than 100 people and required a team of 12 people to develop and run it. The backend required constant supervision, whilst on the street runners supervised street players from a distance, ready to assist should the phone crash or network go down. For further discussion about these issues see the 'A Mutual Friend' (amutualfriend.co.uk) website. This site details Nick Tandavanitj's research into mixed reality gaming and outlines novel ideas for getting around these problems in new mixed reality works.

Blast Theory

34 Blast Theory are an UK based interactive art and performance group. Started in 1991 by Matt Adams, Ju Row Farr and Nick Tandavanitj, the group, now a team of seven, is based in Brighton, UK (blastheory.co.uk). In the early 1990s Blast Theory saw dance clubs as a new cultural space, and wanted to explore that such spaces through dance and theatre ('More about Blast Theory', 2007). Using the clubs themselves as art galleries Blast Theory placed art in a fluid and less controlled arena with a new audience.

35 Their earlier works Can You See Me Now and Unkle Roy all Around are mixed reality pieces. i.e. they occur both on the street and in a virtual space within the computer. In Can You See Me Now, online players are 'chased' by street players/actors using PDAs and GPS navigation. In Unkle Roy all Around online players and street players collaborate to find Uncle Roy's office before being invited to make a year long commitment to a total stranger. This last idea of commitment to a stranger runs throughout Blast Theory's work, where connections are sought between players, and between the player and a long absent friend, and an implicit challenge to trust in another.

36 Blast Theory are involved in mixed reality gaming as a social activity, as a performative event, and as a spectacle. The group's work explores interactivity and the relationship between real and virtual space (mixed reality) with a particular focus on the social and political aspects of

technology. Access to a network is required to mediate a lot of their artworks, as they are interested in using the Device (their terminology) the handset, headset, PDAs and networks to create novel ways of interaction through messages as text, video and audio.

Blast Theory's collaborators

37 The main collaborator of Blast Theory is the Mixed Reality Lab at Nottingham University (mrl.nott.uk.au). Matt Adams from Blast Theory met the head of MRL, Steve Benford, when Blast Theory was undertaking a research and development residency at Nottingham University in 1997. During this residency, Blast Theory developed a system to project video on falling water for their piece Desert Rain. The head of MRL recognized in their art work similar ideas to that which he was exploring in his research into traversable interfaces (screens that you step through in order to enter a virtual world). They entered into a dialog: "It took about 18 months to bridge the gaps in process and vocabulary between the two organisations" ('More about Blast Theory', 2007). Since then, MRL has assisted with the technical needs of Blast Theory's projects Can You See Me Now? and Unkle Roy All Around. Martin Flintham, Jan Humble, Ian Taylor and Steve Benford from MRL assisted Blast Theory with I Like Frank in Adelaide, providing essential feedback on gameplay issues, programming the phones and software for the game, and maintaining/troubleshooting the system during gameplay.

38 For their part, MRL are a research organisation interested in the ethnography of human and machine mediated human interaction. They describe themselves as 'a dedicated studio facility where computer scientists, psychologists, sociologists, engineers, architects and artists collaborate to explore the potential of ubiquitous, mobile and mixed reality technologies to shape everyday life' (mrl.nott.ac.uk). Blast Theory's mixed reality pieces produce a wealth of data that can be analysed in order to study human interactions with technology and each other. In some ways Blast Theory's projects can be seen simultaneously as an art work and an ethnological experiment, and MRL can use these works as an independent zone of research.

39 This collaboration is mutually beneficial to both parties involved; Blast Theory gains technological support (subsequently allowing them to overcome economic, intellectual and regulatory access issues) and MRL gain invaluable and unique data from them. It is also instrumental in getting out of the lab and into the real world. The elegant truth is that the knowledge that MRL gains can be incorporated into further games to enable a better user experience. Blast Theory benefits from this partnership, with in-kind donations of expertise, technology and time. Additionally, co-authoring of papers in peer reviewed journals gives their works academic status.

40 Furthermore, through this robust partnership a powerful multi-skilled organisation with artistic, technical and ethnological expertise has been created which has attracted major blue chip companies such as Sony, and strengthened their applications for the EU funded 'Integrated Project on Pervasive Gaming (IPerG)' (mrl.nott.ac.uk) and contributions to the Equator Project.

For I like Frank in Adelaide, M-Net (IPerG, 2007) provided access to the prototype 3G network, Internode, the web/internet for the game servers, and the Thinkers in Residence commissioned the work (M-Net, 2007). Additional support For I Like Frank in Adelaide came from the Arts and Humanities Research Board (AHRB) and Arts Council of England (ACE) and the Engineering and Physical Sciences Research Council (EPSRC) through the Equator project.

41 ***Transient Reality Generators (TRG)***

Transient reality generators (TRG) (FoAM)

42 TRG is a project that builds upon the two previous immersive installations/responsive environments: TGarden and txOom. TGarden is a responsive Play Space whose visitors shape the media environment through movement and gesture. txOom is embodied as a wearable fabric, which transmits signals from movement to the environment. All three projects are concerned with the 'irreal' in new media art. The conceptual framework within which the artists develop their concepts and designs is 'simulation of physics and physicality of simulation'. FoAM through this work is reality mixing, making visible and tactile the underlying electro-magnetic, and gravitational forces through interactive environments. Their concept of the 'irreal' is the physical manifestation of following a philosophy to the end, of making reality thin and allowing an experience of large and small scales. This immersive environment seeks to give the participant a visceral experience, the

environment evolving based upon interaction between the participants. Rather than an art work, it seeks to become an art world and a new social space.

43 The TRG environment was designed to give the impression of a merging of physical and virtual worlds. It was intended to be robust enough to work almost continuously for several weeks, affordable (i.e. within a limited budget), and to be understandable, modifiable, or extendable enough to be used by others. The hardware was based on similar setups from FoAMs previous installations: computers (mac and linux boxes), firewire cameras, sound system, video projectors, and sensors. Software was open source/free software (FLOSS) with the programmer Stephen Pickles writing the graphics output software, using these publicly available libraries and tools. The majority of the work was in getting the various components to mesh. Sound was created using supercollider (also FLOSS) with sensor analysis, networking and video tracking software FoAM had developed for previous works. (Nik Gaffney, personal communication). TRGs rationale, design ideas, implementation, and progress can be seen in FoAM's wiki 'libarynth' (Project TRG, 2007). It is a milestone in FoAMs research, with the next instantiation, the guild for reality integrators (gRIG), building upon this body of knowledge.

FoAM

44 The Foundation of Affordable Mysticism (FoAM) was set up at Starlab (a Brussels blue sky research organization), directed by Maja Kuzmanovic. Following the dissolution of Starlab in 2001, she, Lina Kusaite, Guy van Belle and Nik Gafney set up FoAM as an independent organization in Brussels, Belgium (FoAM newsletter, 2003). The second workspace in Amsterdam, Netherlands, provides an additional space to create work, run workshops and seminars: 'FoAM provides a legal and financial framework for approximately 20 artists and scientists (the number changes based on project sizes) to establish partnerships with public and private research institutions, cultural organisations, educational structures and businesses, while remaining an enticing experimental territory' (Communique, italics added). Moreover, 'FoAM is a workspace for a multitude of professions interested in interdisciplinary cultural, aesthetic and political experiments' (Communique).

45 FoAM are more interested in making spaces for play than traditional static 'works of art'. They explore new and old cultural experiences (such as food/art/story telling), tangible and intangible aesthetic experiences.They create mixed reality artwork and installations with mathematical concepts embodied in physical play (txOom/Tgarden/TRG), or ecological concepts communicated through social settings (GroWorld). GroWorld, for example, is a research project to counter the 'rapid decrease of diversity in the social, biological and cultural habitats' (GroWorld, 2007). In order to realize their vision they seek out collaborators and technologies. One of their current inquiries is into ways of making open source collaborative art.

46 FoAM received funding for TRG from the Culture 2000 Programme of the European Commission and the Flemish Ministry of Culture.

FoAMs Collaborations for TRG

47 FoAM collaborates with Times Up! Located in Linz, Austria, but the latter don't provide FoAM with the technology. Their collaboration is based upon exchanging knowledge, based on their relative strengths. Times Up! provides to FoAM knowledge on pneumatics and mechanical engineering, maths (mainly in practical issues, sometimes theoretical), digital physics and media dynamics. FoAM in return provides knowledge on materials research, performance studies and storytelling, real time audiovisual systems and movement studies. (Maja Kuzmanovic, personal communication).

48 In order to access technolgy, FoAM develop and scavenge quite a few things themselves (in collaboration with free-lance scientists and engineers). They also set up European projects, where they team up with other organisations and universities who have complementary skills, and with whom they can work on developing something specifically for their productions. Nevertheless, FoAM chooses to not attach themselves to a university or an industrial research lab. They prefer instead to remain independent and therefore ideally equal partners with the scientists. They offer, among other things, the testing of their prototypes, access to the public and a consultation on these new applications. FoAMs collaborations are of course not all about access to technology, but also access to different perspectives, and more minds. In these contexts, FoAM has contacts and

information exchanges with the MRLab in Singapore, Free University of Brussels, University of Leuven, TU Delft, Philips, Concordia, Sony, and the BBC.

SymbioticA and Multi-Electrode Array Art (Meart)

MEART

50 MEART – The Semi Living Artist is a geographically detached, bio-cybernetic research and development project exploring aspects of creativity and artistry in the age of new biological technologies (MEART, 2007). This project builds on the Fish and Chips project which SymbioticA Research Group exhibited at the Ars Electronica Festival, themed 'Takeover', in 2001. This artwork consisted of goldfish neural slices growing over a computer chip. Nerve potentials from the goldfish neurons controlled both the robot arm that drew, and a sound piece. The feedback loop was the output from the sound piece being fed back to the neurons through electrode stimulation. MEART is a logical extension of Fish and Chips, however as the artwork no longer involved fish or growing cells on silicon, a name change was required. It is an ongoing project, having been exhibited multiple times (Ben-Ayr, personal communication).

51 The MEART art work itself is also constantly evolving. In its physical form, MEART is a culture of rat nerve cells growing on a Multiple Electrode Array of 61 electrodes (MEA – an advanced two way interface to/from the neurons), a robotic arm that draws based upon inputs from the rat nerve cells and a network to transmit the information between the two parts. The neural culture resides in the Potter lab in Atlanta, USA, with the rest of the artwork being portable. In the Black Square project, for example, the input was comprised of a simple square of black representing the pixel, and MEART was 'commissioned' to draw from this simplified input. Boryana Rossa and Oleg Mavromatti (Ulturafuturo Group) facilitated the Black Square exhibition of MEART in ART Digital 2004, the first Russian biennale for contemporary arts. The ultrafuturo group have a serious interest in rights for artificial intelligences. This group provided a conceptual space for MEART to explore, that of the black square, from Kasimir Malevich's Black Square on a White Ground (1918). This abstract work can be understood in relation to future developments in space travel and cryonics at the turn of the 20th century. It was an example of supremacist art, concerned with transcendence and leaving the earth (McRae, 2007). In the current era the black square was represented by the pixel. In effect, here MEART is 'contemplating' the past to its future; it is one of the futures foreseen by Malevich.

52 As the culture evolves, connections between the neurons form and degrade. Importantly, there is a feedback loop where electrical stimuli may be applied to the nerve culture, these based upon inputs such as a digitised photo of a person. This feedback loop affects the connections between the neurons. An emergent property of this system is learning. As an artwork, it is complex and living and requires constant tending; the neuron culture itself is unstable and may die. When this happens a new culture is swapped in and the piece starts again with a naïve neural culture (McRae, 2007).

53 Working with rat tissue brought up an additional layer of complexity, as the regulations controlling mammalian experimentation is much more stringent that fish experimentation. SymbioticA needed regulatory approval in order to make this work:

54 SymbioticA's research projects have to apply to the same ethics committees as scientific projects involving the use of living material. When MEART first applied to the ethics committee at the University of Western Australia for approval to create a semi-living entity, the committee concluded by disqualifying itself from making a decision because the chairman felt that the committee was not equipped to make such a decision concerning the use of cells for artistic rather than scientific purposes (McRae, 2007).

55 The application was granted by the vice chancellor with the proviso that the project had a greater science component.

SymbioticA Research Group

56 SymbioticA Research Group is an independent artist run studio within the Human Anatomy department of the University of Western Australia. It was established in 2000 by cell biologist Professor Miranda Grounds, neuroscientist Professor Stuart Bunt and artist Oron Catts:

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Research projects within SymbioticA are dedicated to artistic inquiry into new knowledge and technology with a strong interest in the life sciences. SymbioticA has resident researchers and students undertaking projects that explore and develop the links between the arts and a range of research areas such as neuroscience, plant biology, anatomy and human biology, tissue engineering, physics, bio-engineering, museology, anthropology, molecular biology, microscopy, animal welfare and ethics ('Research at SymbioticA').

SymbioticA provides a space for critiquing biotechnology through aesthetic and physical bioart. It hosts the Tissue Culture and Art project responsible for Pig Wings, semi-living Worry Dolls, Stelarcs 1/4 Ear and the Fish and Chips project responsible for the creation of MEART – the semi living artist. Additionally, it provides a place where artists may learn about wet biology techniques and develop new collaborations and work.

SymbioticA Research Group's collaborators for MEART

SymbioticA has members from a wide range of fields, however, in order to support their work they may travel further afield. For example, to advance the technology behind Fish and Chips Guy Ben-Ayr approached Dr Steve Potter (Potter lab, Georgia Institute of Technology, Atlanta, USA). A few weeks before ARS Electronica 2001 (the premier of Fish and Chips) he found papers that were written by Dr Potter about embodiment of neurons and his attempt to build an animat (Demarse et al, 2001). Dr Steve Potter is a leader in the field of 'in vitro learning'.

Ben-Ayr identified the synergy with the Potter lab; it was obvious to him that one of the main issues with MEART would be the feedback loop, and Potter had developed an advanced two way interface to/from the neurons (MEA), a very expensive technology that SymbioticA did not have. While 'Fish and Chips was chaotic' (a proof of concept), MEART is based on solid science yet still explores ethical and philosophical questions to do with the semi living artist. Ben-Ayr was impressed to see that Potter approached the same issues as SymbioticA did from a different angle – a scientific one: 'After ARS Electronica I sent him an e-mail with pictures about Fish and Chips telling him what SymbioticA did in ARS Electronica' (Guy Ben-Ayr, personal communication). Potter replied stating his interest in their project. During a trip to Australia, Potter presented a lecture to SymbioticA on his work with rat nerve cell cultures. He was studying their interaction with virtual 3D environments and in particular was looking for a way of giving his cultures a physical embodiment, and learnt that the SymbioticA Research Group were seeking future collaborations to produce MEART or semi-living artists.

Through the Potter Lab, the SymbioticA Research Group was granted access to Multiple Electrode Arrays and the rat neuronal cell cultures in order to make MEART a reality, although access to the Potter lab technology has not changed the artistic intent of the piece. Rather it made the piece more solid, based on scientific research. While the work still explores the same questions and realities, the increased complexity of the rat neuron cultures and accuracy of the feedback loop makes the piece more exciting than Fish and Chips, since a wider range of entity-behaviour can now be envisioned. Additionally, as a result of the collaboration, MEART now touches on the artificial life issues of behaviour, embodiment and agency. In this case, collaboration means more than just access to technology; it means access to additional bodies of knowledge and viewpoints.

Methods of Access

To address the problem of access to technologies, artists employ a number of strategies (Table 2).

Access

Solutions

Economic

Grants

Sponsorship

In kind donations

Alternative ways of evoking the technology

Intellectual

Granted licence

Residencies Workshops

Open Source

Regulatory

Approval

Different organism

Table 2. Solutions to access.

There are significant crossovers in the various solutions and often it is not possible to separate the relative components. However, many countries have recognised the importance of supporting the creative and innovative dialogue between artists and scientists. For example, Ionat Zurr and Oron Catts, of the Tissue Culture and Art group (which went on to establish SymbioticA), received a grant from the New Media Arts Fund of the Australia Council of the Arts, enabling a one year residency/ fellowship at the Harvard Medical School where they learned about organ fabrication techniques ('Fish-bird', 2003). This learning period was crucial to their further works.

In Australia, the Australia Council of the Arts and Australian Network for Art and Technology (ANAT) have been supporting the placement of artists within science or cultural institutions through the Synapse and artist in residence programs. The participating organisations include the Australian Broadcasting Commission, SymbioticA, and various divisions of the Commonwealth Science and Industry Research Organisation (CSIRO). The Australian Research Council through an industry linkage grants system supports art and science collaborations. e.g. Mari Velonaki's development of the installation FISH–BIRD CIRCLE B–MOVEMENT C with the Australian Centre for Field Robotics received an ARC Linkage grant of $AU 240 000 spread over four years (Gere, 2006). This is still a small budget, but indicates a willingness to support collaborative research.

The Wellcome Trust does a similar job in the UK, funding artists and collaborative research. The Wellcome trust support collaborations through its sciart grants. These grants are specifically for 'projects aimed to stimulate fresh thinking and debate in both disciplines, and to reach and engage with diverse audiences on the social, ethical and cultural issues that surround contemporary biomedical science' (Wellcome Trust).

NESTA (the national endowment for Science, Technology and the Arts) also supports innovation by initiating programmes to support and foster collaboration. NESTA has recently initiated research into the role of the arts in innovation: 'It's clear that the UK's vibrant arts and creative scene has a far broader impact than simply cultural – it underpins our creative economy. However, very little analysis has been done to evaluate this broader contribution' (NESTA).

Artist groups that position themselves in a certain field may, because of their profile, attract sponsors. Works are then commissioned such as Blast Theory's I Like Frank in Adelaide. However, this sponsorship is often not matched with sufficient funding or support, as can be seen in the technical issues that Blast Theory/MRL needed to surmount in order to provide an enjoyable user experience for I like Frank in Adelaide.

Groups like FoAM, on the other hand, often create their own material in conjunction with freelance scientists and engineers:

> We often use the metaphor of scavenging – sometimes we manage to get our hands on the cutting edge technology, but more often we learn what the technology does and assemble a kind of 'cargo-cult' version of it – that is cheaper, possible to make in your kitchen/bathroom/garage, incorporates both off the shelf and custom developed components (Maja Kuzmanovic, FoAM, personal communication).

The 'cargo cult' metaphor is based upon the folklore of islanders in the Pacific observing planes landing and disgorging goods on the next island. They wished to get the goods too, and reasoned wrongly that by making a clearing/runway themselves, the planes would land there. However, in the case of the arts, I believe that the 'planes' often land by chance. In SymbioticA Research Group's case with MEART, they encountered Potter who was developing advanced technology that could be used in their artwork, and the seriousness of their application and familiarity with his work meant that he was willing to collaborate.

Even when access is granted, Legget (2004) points out that there can be pitfalls. Nigel Helyer worked with Lake Technology in 1999 and was instrumental in them patenting the technology being developed: 'The tangible outcomes have been of considerable value to Lake, but because the

intricacies of patent law (as distinct from copyright) were new to Helyer and the Australia Council, financial returns to the artist have been less than satisfactory (Legget, 2004). Heyler could not exhibit his artwork Sonic Landscapes at ConVerge as Lake Technology had sold the patent to another company. This is the disadvantage of basing artworks on a proprietary technology; the access to technology is removed because of economic reasons and the legal ability to exhibit it is lost.

81 Regulatory access may delay the project. The process of obtaining the necessary permission takes time (many months), and means that even relatively simple works are delayed. In some cases, changing the organism or location of the work may result in less stringent regulations. Technology and software based upon open source does not have this disadvantage. Additionally, open source software is created and improved by a team of developers that are used to collaborating. When the source code is available, for example, the software that FoAM uses for its installations can to be tailored to the installation.

Conclusions

82 The case studies above show three different types of art organisations and how they obtain the technology they require. All use collaboration as a means to overcoming the difficulties of access. However, the type of collaboration varies from distinct partnerships to fluid knowledge exchange. The technology the artist uses need not be hi-tech in order to attract collaborators, just embody a similar paradigm to the technology that they ultimately wish to access.

83 FoAM is an organisation which works on an independent basis with technology organisations, seeking new ways of gaining access to smart/responsive materials that will enhance the experience of their installations. Their emulation of new technology allows them to sidestep the issue of access. In a 'cargo cult' fashion, they work on the assumption that they have access to all the technology they require; technology 'finds a way' to their door. Moreover, the cargo cult of art also works to attract researchers, and facilitates new ways of collaborating.

84 Blast Theory is an organization that has a strong synergistic relationship with the university-based research lab MRL. Principally, they are concerned with creating a humanistic interactive performance while their partner MRL utilises the game as a social experiment. They seek to concentrate on social interaction in the game, disseminating the narrative of their performances without the excessive human intervention required for running I like Frank in Adelaide.

85 SymbioticA Research Group are an independent art studio based in a medical research unit at the University of Western Australia. This enables them to attract collaborators from the science community and also provides a place where artists can learn the techniques of the life sciences. MEART, the work of the SymbioticA Research Group, explores the idea of a disembodied artificial artist and provides the Potter lab with a novel environment for their cell cultures. This group have continually debated upon a future where their semi-living entities will live outside the confines of the lab, and view this possibility with ambivalence and trepidation. They seek to test the hypothesis of a 'victimless utopia' within the life sciences. Thus far, the unsuccessful experiments of victimless steak and leather, by TC&A, demonstrate that there is no reality of a 'victimless utopia'.

86 Access to technology becomes easier over time as proprietary platforms become commercial; gradually the technology (e.g. computers, the internet, digital photography, GPS, grafted plants) becomes readily available. Other technology is destined to remain esoteric: the particle accelerators of modern times, electron scanning microscopes, atomic force microscopes, medical scanning equipment. Yet even this specialist domain is not inaccessible for the most tenacious artists.

87 Currently, there is a push from both hobbyists and institutions to continue development of open source biology. With the completion of the Human Genome Project and other sequence projects, large DNA and protein data sets are available to all. This is still a relatively new arena for the artist/amateur and is giving rise to a movement called 'biohacking' which seeks to bring biology to the backyard shed. This erases some of the problems of access for artists, though of course issues relating to regulation remain. Artist Phil Ross is quoted by Sacha Pohflepp at the two-day workshop about art and biotechnology at ISEA/Zero One as suggesting that 'a reasonably high-level biotechnology lab can be set up for $US 3000′ (Pohflepp). This technology is both available

and affordable. These borderline cases are interesting, particularly life science techniques where a new era of hobbyists, craftspeople, artists and technologists will coexist. Broadening the base of people interested and involved in the life sciences is essential to increasing the publics' engagement with this technology.

88 The expiration of patents also enables new opportunities. The intellectual encumbrances are removed, and with the monopoly gone, the technology becomes cheaper. For instance, the major patents for the PCR product and process (US Patent No's 05352600 and 4889818) have now lapsed. A question to answer, however, is whether cutting edge technologies will become as cheap as paint or photo developing; Maja comments:

89 Some of them will, but as things go, artists always find new and expensive things that we want to use as our tools. I also think it's not only a matter of expense – it's also a matter of access. Computers were very expensive and available only in research labs, when first media artists began making their work in the 60s. Internet was difficult to access when net-art began, at this moment, we're struggling to get access to 'smart materials', etc. also – maybe once the technology becomes cheap and accessible, the art-forms become less experimental? (Maja, FoAM, personal communication).

90 New media artists will always seek new experimental fields within which to operate. From a biological science background it is easy to see techniques and discoveries that will provide fertile ground for art experimentation and critique. Synthetic biology is an example of converging technologies, drawing from biotech, nanotech and information technology in order to design and create new biological artefacts ('Extreme Genetic Engineering', 2007). RNA interference (RNAi) allows switching off of genes and holds great promise for treating a wide range of diseases such as macular degeneration, the leading cause of blindness in older people (Cromie). From an artist's point of view it could be used to switch off various pigment genes in order to make transiently patterned organisms. Bio printing is also an emerging technique to explore, providing a new and relatively rapid way of printing tissues from assemblages of cells. Gunnar Green, for example, used bioprinting to explore text or letters, using plant seeds, bacteria and pheromones in various works (Pohflepp, 'Living Letters').

91 There is a real need for new collaborative ventures because of the demise or downsizing of several influential blue sky research organisations after 2000 (e.g. Bell Labs, Brussels' Starlab, Europe's MIT Lab). I believe that collaborations between artistic, scientific and humanistic researchers will grow to occupy and utilise these voids as new areas of creativity. Strong interaction between the arts and sciences will lead to a convergence, and interdisciplinary research is required.

92 In order to work in interdisciplinary fields an understanding of the language of technology is required. Mari Velonika explains in an interview in New Scientist that she convinced the researcher Hugh Durrant-Whyte, director of the Australian Centre for Field Robotics, to work with her on her Fish-Bird project by demonstrating that she knew how to design, and construct a circuit board. i.e. they had a common language (Nowak, 2006). Areas of agreement are more useful to these enterprises than trying to work out irreconcilable differences; it is about spending time where it is most useful, not on dogmatic arguments. Both parties reserve the right to interpret the 'object of the enterprise' in different ways, and for different purposes. This process can take time; Blast Theory and MRL took 18 months to bridge the gaps in process and vocabulary between the two organisations.

93 However, one field that needs a special focus is the bioarts, which by its very nature has complex issues of access. Any artist wishing to work in the sphere of bioart with cutting edge medical science will always need familiarisation with scientific methods. In order to clear ethical regulatory hurdles and conduct experiments, artists need a similar research rigor to that of scientists. As well as laying the foundation for successful collaborations in the future, interdisciplinary education can support the emergence of a researcher who is comfortable in both the arts and sciences. Yet what do the scientists gain? They reap real benefits from working with the artist, from the artist's fresh thinking and innovative approach and unique insight into their work.

94 Arts and humanities councils are now playing a major role in encouraging and developing meaningful dialogue between scientists and artists. This generates good working relationships and mutually beneficial collaborations. Yuri Soloviev predicted that in the future artists and scientists would create a 'special language' that would evolve over time, and would 'co-operate…new ways

will be found to explain their purposes; perhaps also a new higher creative activity will come into being; designing new material and spiritual values, a kind of synthesis of all tasks and methods involved in pursuing all the aims of science, technology and art' (Soloviev cited in D'Arcy, 1968: 11).

95 In the future, the trend is for more complex collaborations. Some significant problems of access are being erased by open source approaches and knowledge-sharing networks. Technology workshops are erasing other barriers. This is crucial as artists cannot critique new technologies without access and literacy. Moreover, how can artists be involved in and enhance the direction that these technologies take without access? Indeed, the regulatory access issues around bioart are major and merits significant research. As generalists and agents comfortable with occupying uneasy positions, artists are in a prime position to become equal researchers to the technologists and scientists. With the opportunities currently available there has never been a better time to bridge the cultures of art and science.

Author's Biography

Brian Degger is a UK based artist whose self directed arts development was in Adelaide, South Australia. A formally trained biotechnologist, he plays with notions of ecology, alienation, and what it means to be an urban inhabitant. He does this through word, moving image and sound. His first foray as an artist was spoken word in the Interactive Art Gallery, Adelaide. He has had two photographic exhibitions of local Adelaide live acts (AdLibEmulsion) and animals (FFS, fur, feathers & scales), as well as musical performances of his own and others songs. His moving image pieces have been screened in Adelaide as part of SA living Artists week (2003, 2004, 2005) and OpenHouse (2003). His images have also been projected in DriversLane, Melbourne (2004) and by Epoch, Dublin, Ireland (2005).

He has participated in a number of workshops and master classes given by national and international artists. During the 2004 Adelaide fringe, he was part of a team of artist that assisted Blast Theory(UK) stage and perform "I like frank, in Adelaide". For this mixed reality game he, in collaboration with Nick Tandavanitj, designed the online environment, a 3d representation of Adelaide city. During the running of the game, he was on the streets to help stranded players with their mobile devices. In 2006 he helped install Ken Rinaldo + Mat Howards exhibit ' Telematic Spider Bots' as part of the north eastern England media festival, Avfest (Newcastle/Sunderland/ Middlesbrough). His current research direction is in exploring how artists get access to the cutting edge technology (networks, tissue culture,mixed reality etc) they wish to explore. See https:// transitlab.org

Acknowledgments

Thankyou to SymbioticA, Blast Theory and FoAM for allowing me to find out about the collaboration processes. In particular I wish to thank Maja Kuzmanovic, Nik Gaffney from FOAM, Guy Ben-Ayr, and Oron Catts from SymbioticA, and Matt Adams from Blast Theory for insights into the specifics and generalities of collaboration. Thanks to Sarah McDonnell for her continual support.

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