CYBERNETICS AND THE INTERACTION BETWEEN PURE AND APPLIED SCIENCES AND THE HUMANITIES

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In this paper I argue that the interactions between arts and humanities and applied science are more successful than with pure science. Further that the reason for this difficulty is the different paradigms used by those working in the post-modern humanities and the modernist, positivist scientists, that they are in fact incommensurable.

Silent Barrage under construction for the Silver Artrage Festival at The Bakery, Northbridge, Perth, Western Australia. This piece is by Guy Ben Ary and Phil Gamblen with the Potter lab in Atlanta Georgia. Each column bears a rapidly and noisily rotating disc which draws on the paper surface of the columns, the movement of the drawing discs are controlled by dissociated cortical neurons held in culture in the Potter lab and communicating with its embodiment over the internet.

SymbioticA, was founded in 2000 with financial help from the Lotteries Foundation of Western Australia, matched by funding from the University of Western Australia. [1] The original grant was written by Stuart Bunt, Oron Catts, and Miranda Grounds to provide a space for artists and scientists to interact in a

situation of mutual respect rather than dependency. One of the first projects of *SymbioticA was Fish and Chips* produced by the *SymbioticA* research Group was seminal in developing the principles and directions of this research laboratory. The researchers involved in this project formed a loose collective known as the SymbioticA Research Group or SARG. Using techniques developed during my D.Phil [2] research. Guy Ben Ary gathered a team of experts to produce a complex art work. Guy, and the kinetic sculptor Phil Gamblen have gone on to perfect, develop and extend this work with later pieces such as *MEART* and *Silent Barrage* which have been exhibited world-wide. [3]

For details of these works the readers are referred to the *Fish and Chips* web site. [4] Briefly these pieces consist of neural tissue driving a mechanical drawing device. In the pioneering *Fish and Chips* work the valves of the beautifully sculpted pneumatically driven arm, designed by Phil Gamblen, were controlled by the output from the region of a goldfish's brain connected to an isolated eye (the optic tectum). [5] An electrode picked up the electrical output of the tectal neurons in response to the images provided to the fish eye. A computer program written by Iain Sweetman then extracted patterns of neural activity and used them to control the pneumatic valves operating the drawing arm.

This relatively trivial science (the original physiological methods were first used in the 60's), [6] when brought into the public arena (*Fish and Chips* was first shown publicly in The Bruckner Opera house at Ars Electronica in 2001) [7] produced a powerful art work to be appreciated on many levels. How did we feel about such a "semi-living" object; part fish, part machine? A machine controlled by a non-human brain, with no human intervention can be very confronting. Could isolated neural tissue be creative? Did such an "artist" need feedback, to see what it produced? What were the ethics of using living animals in an art work? Later we were to encounter problems of ownership – who had the IP and moral rights on the - art works - produced by *Fish and Chips*?

In this paper I want to use *Fish and Chips* and other mechano-organic devices as exemplars of the interactions between art, science and engineering/medicine. I intend to make a clear distinction between these three practices and discuss the positive and negative interplay between them. I do not subscribe to the recent fad for suggesting a "third way," a romantic fusion of the arts and sciences, [8] a movement practically ignored by the sciences, but gaining popularity in the new media art world. In fact. I will argue that the language and gestalt of postmodern or post – postmodern arts are, in the words of Thomas Kuhn, incommensurable with those of the essentially modernist sciences. By science I mean pure or basic science, which is research carried out purely to increase our knowledge and understanding of the world. It presupposes an external reality independent of the observation or observer and in this way differs significantly from the creative arts that attempt to communicate an individual internal opinion about the world or to encourage the audience to bring their own interpretation to the work or performance; and from the post – modern humanities that resist the idea of contextually, semantically independent "truth."

Funding for such basic research is now rare and increasingly under pressure as public understanding and political support waivers (those in the arts will be all too familiar with this). Most research grants now demand an opening statement as to how the research will benefit the funders or mankind. Most research carried out in universities is now applied research, research to solve a known problem. This is engineering, bioengineering, not science, and I include in this medical research. It involves developing new technology, applying science, not adding new basic knowledge of the world. I see this as quite different in its methodology to pure science although there has historically been a continual positive feedback between science and technology.

The interaction between the arts and humanities and applied science and engineering is often positive. Here, the purity of the methodology is less important than finding a solution. Creativity and imagination have important roles. Much of current art practice and research involves the finding of a solution, how to communicate or represent the artist's concept, how to engage the audience, there are more similarities here than with the coldly analytical pure sciences. In many cases the arts identify new issues and problems to solve before engineers have even approached the solutions. There is a rich history of science fiction pre-dating or even inspiring later inventions. If we look at cyborgs, science fiction has often anticipated later developments, from Isaac Asimov's laws of robotics to prosthetically assisted soldiers. This positive relationship between the creative arts and applied science has been recognized recently by the Chinese government. Recognizing that many of the innovators and entrepreneurs of Silicon Valley were great science fiction fans when younger, they are now mandating more reading of science fiction in an attempt to increase the imagination and innovation of its engineers. [9]

While there is a clear interplay between the pure and applied sciences it is difficult to find any solid examples of a positive exchange between the arts and pure science. For example if we examine the field of bio-mechanical machines we see that the basic science involved requires an understanding of neuroscience, in particular how neurons and how the neural circuits they form, operate. The science underlying the electronics involves, understanding electromagnetism and with the use of transistors some quantum mechanics. This science has provided much inspiration for the humanities, "quantum" must be one of the most misunderstood and misquoted words in science. However it is difficult to find art/science collaborations that have contributed to our basic understanding of neuroscience or electro-magnetism. The humanities may have enhanced our understanding or misunderstanding of the implications of these discoveries and the errors that can creep into research due to human fallibility, but have they contributed to their discovery?

When we look at the art works involving mechanical arms and nervous tissue, they raise issues about the ethics of using living tissue, our ambiguous relationships with semi-living organisms, even reservations about the perversion of living material that this may be seen by some to represent. However, there is little contribution to the basic science. Take the examples of *MEART* and S*ilent Barrage*. Here the driving material is dissociated cortical neurons cultured in the lab of the engineer Steve Potter. [10] Potter's laboratory was set up to investigate the self-organising properties of neurons in culture. In his "normal" lab work Potter's lab has looked at the way these neurons can control external agencies and whether feedback from the outside world can be used by the neurons. While this looks like basic science, it is nearer to an engineering project or even an art research project as the neuroscientific foundation for the work is weak or non-existent (although in a nod to the funders statements are made about solving epilepsy). All neuroscientific evidence we have points to the almost crystalline precise organisation of cortical neurons (which is laid down in early development) as being crucial to cortical function. Any disturbance of cortical organisation in development leads to severe functional deficits.

Where the art work has succeeded is in highlighting future possibilities and drawbacks of this work. Anyone presented with *MEART* or the whirling drawing poles of *Silent Barrage* cannot fail to engage with the confronting embodiment of a possible future "machine." No scientific paper can communicate so directly with the public. However, one could argue that this interplay between basic science and the arts has been largely negative as works are often displayed out of context and with minimal documentation (this is after all an art piece not a scientific exhibition). The audience may take away a predominantly negative impression of the potentials of the technology. This may well be a needed antidote to the positive "spin" of the medical companies advertising their surgical robots or prostheses, but the art works have far less control over what they communicate and may well misinform. Many viewers of *Fish and*

Chips embodied it with impossible sentience and feared it unnecessarily. This has lead some scientists to be wary of working with artists, for fear of the negative impact.

The humanities have always employed critical analysis. They have, quite appropriately, applied the blow torch of social science and commentary on the sciences and have shown its many flaws; its sexism, elitism, Western dominance and corruption, the influence of big business and government on what is and is not researched and published. This has had a positive effect by making scientists aware of the limitations of their endeavours, but has had a largely negative effect on public opinion as this negative publicity is rarely matched by positive stories outside of medicine (an applied art?) and manned space flight, even the latter is now coming under fire for being an indulgence since the 2008 financial crisis. In the 21st century, the implementation of science often has more to do with societal acceptance than whether the science is correct or the resultant products efficient. The resistance to genetically modified foods, nuclear energy and anthropogenic climate change is not based on deficits with the science or engineering but with concerns over the effects of its application.

Philosophers such as Feyerabend have shown that hypothesis selection in science is not necessarily logical; that advances may be delayed by all too human resistance to new ideas. However, in spite of all its flaws, basic science has been enormously successful in its explanatory power. The strength of science does not lie in its random methods of hypothesis selection but in the empirical method. The examination, over and over again if necessary, of evidence using counter-intuitive methods, first laid down by Francis Bacon in the 17th century, but still as valid today. These rules for examining evidence call on the practitioner to deny his or her human traits, to not follow personal feelings or biases, to not be impressed by fame or reputation, to not follow popular opinion, to always maintain a healthy, independent scepticism.

This is the major point of departure from the arts, where the art work is all about the opinions, intuitions and feelings of the artist and his or her interaction with the audience, the "populace." These are very high level interactions, complex and contextually situated. No wonder postmodernism emphasises the complexity of the world, the interconnectivity and relativity of "truth" and "evidence". In contrast scientists are trained to avoid (as far as possible) all relativity and be as objective as possible, to "de-humanise" their work and reports so that the evidence should be independent of their opinions and personal experience. When C P Snow wrote his seminal work *The Two Cultures* he was describing both a class war and a wall of ignorance between the humanities and the sciences, berating the academics for their ignorance about the basics of science. How times have changed, it is a rare practitioner in the bio-arts that does not have a good understanding of the applied science (if not the basic science) underlying their collaborative work. However, most scientists are stuck in a post-modern world, perhaps it is they that are the new Philistines, ignorant of advances in the humanities. Universities still teach undergraduate science students (if they are taught any philosophy at all) the philosophy of science of Karl Popper, first proposed in the modernist twenties. Hypothesis testing requires evaluation of evidence, far from postmodernism, there is no suggestion that all points of view may be valid, the evidence must be ranked and the most unlikely abandoned. Scientists will even (though sotto voce in today's POMO world) say there are "facts" – that water IS made of hydrogen and oxygen, that this is context independent, will be so whether measured in a lab in Manhattan or a primary school in Kinshasa. If there is a disjunct it is now the scientists who do not understand the postmodern world of the arts and humanities.

This "dialogue of the deaf" between the arts, humanities and pure science would be of only academic interest were it not for its effect on public policy. The media is dominated by the humanities and the postmodern view of all views being of equal validity not privileging science with any special right to the

"truth" or even acknowledging that there is such a thing as an independent truth. This leads to the curious spectacle of climate change skeptics and charlatans like "Lord" Monckton being given equal airtime with a sole representative of the thousands of highly qualified and specially trained climatologists convinced of the anthropogenic causes of climate change. The basic science is given no special value, and as the "audience" does not share the same anti-common sense rigour of the scientific community they have no problem with ignoring the scientific evidence for what for many (particularly those reliant on continuing expansion of consumption) "feel" is right. Recently the Australian chiropractic association refused to censor a member who was promulgating lies about immunization, including long discredited studies linking autism with the MMR vaccine, on the grounds that he was "entitled to his opinion." Worldwide scientific advisors have been politically marginalised as harbingers of vote losing doom. This abandonment of the empirical method is a frightening trend that leaves us no real alternative on which to base decisions that will effect our health, and the future well-being of the planet.

References and Notes:

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