Exchanging Information: metaphors of computation in neuroscience, genetics and new media art

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ABSTRACT
This paper argues that a common element of language exists between art and science. However, this element does not assist transparent communication between the two fields, as it is primarily *metaphor* that is the shared aspect. This paper offers a brief history of one aspect of this shared relationship in the field of new media arts practice, specifically during the 1990s when genetic metaphors were predominant. Further, it argues for identifying the shared metaphors of emerging directions of new media practice in order to develop more critical and self-reflexive forms of art work.

The language of genes took a significant turn in 1953 with Francis Crick and James Watson's discovery of the double helix structure, heralded by many as the most significant scientific breakthrough of the twentieth century. The scientists stated:

> "In a long molecule, many different permutations are possible, and it therefore seems likely that the precise sequence of the bases is the code which carries the genetical information." [1]

Yet this would also have profound semiotic effects. According to Evelyn Fox Keller, it was the use of genetics in conjunction with a theory of information that was the stroke of genius (Fox Keller, 1995). To fully understand the implications of Watson and Crick's seemingly innocuous use of the word 'information', it is necessary to establish the broader context in which it is used. In a digital age, words such as information, message, text, program, instruction and code, generally evoke visions of computers and their associated programming languages. So perhaps it is not surprising that in 1990, Harvard molecular biologist and Nobel laureate Walter Gilbert proclaimed:

> "One will be able to pull a CD out of one's pocket and say, "Here is a human being; it's me!'… To recognise that we are determined…by a finite collection of information that is knowable will change our view of ourselves. It is the closing of an intellectual frontier, with which we will have to come to terms." [2]

Perhaps the most accurate part of Gilbert's hypothesis lay in the admission, albeit one not intended in the negative, that an intellectual frontier had been closed. Interestingly, what we now have, with all its religious overtones, is a concept such as 'The Book of Life', the term consistently used to describe the mapping of the Human Genome Project.

Corporeality, by way of these discourses of genetics, is reduced to information. Gilbert did not invent the catachresis he has so enthusiastically adopted; he simply extended it into the more contemporary and perhaps easily understood context of popular, digital culture. The words information, message, text and so on, in their relationship to molecular biology and specifically genetics, have a far more complex history than can be summarised in Gilbert's CD metaphor. The origins of his proclamation can be traced back the scientific and biological research between 1943-54 – the development of cybernetics and information theory. Both theories and their subsequent applications developed out of a unique Cold War structure in which this research took place, one that I will refer to as the industrial–military–academic complex.

In his 1948 book *Cybernetics: or Control and Communication in the Animal and the Machine*, Wiener established a hypothesis that argued for similarities in the functioning of human beings and machines. Wiener and his colleagues observed that

both people and machines were purposeful and systemically organized, tended towards equilibrium and used information in order to communicate their goals. One of their most important shared characteristics, according to Wiener, was the use of feedback. Wiener sought to argue that machine devices and human beings operated in similar ways, insofar as they could be considered communication systems, and strongly promoted the adoption of cybernetics in the biological sciences.

Information theory, too, was adopted by the biological sciences and, like cybernetics, is compromised within the context of this merger. Lily Kay points out that when Claude Shannon and Warren Weaver addressed the concept of information, they were not referring to its meaning dating back to the late fourteenth century, signifying the act of *informing,* communicating knowledge, news, or intelligence. [3] Their use of information operated at a purely syntactical level. As Weaver states:

> "The word 'information' in this theory [mathematical theory of communication] is used in a special sense that must not be confused with its ordinary usage. In particular, information must not be confused with meaning." [4]

But information was already becoming a metaphor. An information system was one that only took the qualities of passing or not passing a signal to describe its processes; the meaning of that signal and, thus the full connotations of the notion of information, were irrelevant to the functioning of that signal. Whether a signal carries biological information or digital information is in a sense irrelevant; the question becomes whether that information gets from A to B or whether it is corrupted by noise on the way. What is adopted from the original notion of 'informing', then, is only the movement of conveying, and hence the theory of information uses the notion of information metaphorically. This metaphoric adaptation, only connoting signal transmission and not its meaning, was adopted by Watson and Crick in 1953 to describe the process of protein synthesis that would lead to the discovery of the double helix. What began as a metaphor has entered into our understanding of genetic processes and has become adopted as constituting the literal activities that the genotype plays out in relation to phenotypical characteristics. Douwe Draaisma refers to this kind of phenomenon as the operation of a 'dead metaphor', insomuch as the metaphor now represents a precise and literal description of a given process. [5] This is significant, for if DNA is perceived to carry information – unaltered and unchanging – then clearly the *social* subject becomes the bio-product of genetic inheritance and genetic determinism and a quantifiable concept. As Kay argues:

> "When applied metaphorically to biological phenomena, 'information' becomes even more problematic: it seems actually to restore its first sense as intelligence and meaning, but as such it violates the precepts of information theory, which supposedly and initially legitimized the biological applications. It thus becomes a metaphor of a metaphor, a catachresis, and a signifier without a referent." [6]

The collapse of the biological and the digital through these kind of metaphorical exchanges established a precedent for genetics to become associated with information and, ultimately, a process of control. Yet this control process – currently evident in biological cloning – is curtailed by constant corruption and ultimately mutates as it becomes embodied. Think, for example, of the 277 attempts to clone Dolly and her subsequent 'youthful' demise. Amid this exchange of metaphors, another group would begin to seriously investigate the processes and ramifications of the biologically digital – artists.

The work undertaken by many new media artists from the early to mid-1990s was closely associated with research and development in the field of artificial life, as well as explorative work done in the fields of generative behavior and robotics. However, it is not enough to merely note this association; we need to investigate the underlying conceptual and methodological reasons behind the adoption of evolutionary biological metaphors within artificial life and in the development of this formative period of digital artistic practice. I believe that an evolutionary biological framework provided ground for simulating the appearance of open systems within artists' work. Furthermore, I would argue that open systems became an area of interest for artists because of some of the very limiting technical conditions they were experiencing with interactivity during this period. At the same time, I also want to suggest that importing the metaphors and framework of late twentieth century biology brought a certain epistemological politics to those artists' work. By using the metaphors of evolutionary biology artists privileged *technology* as a mode of controlling the chaos and mutation of the open systems they were attempting to build. By using technology aesthetically to simulate life, we are also able to maintain a form of control over organic life.

The theoretical model upon which a-life is constructed is that of a biological *cybernetic* system, with outcomes often stemming from indeterminate structures and relations. The genetic adoption of information from cybernetically and informatically informed frameworks paradoxically set a precedent for thinking life through closed, determined structures. This became the epistemological origin of genetic determinism. This operates inversely in a-life where the biological, constructed as an open and changing system, is supposed to operate as the model and extended metaphor for an engineered system. At this juncture it would

be naïve to ignore the history of the relations between cybernetics and biology that have dominated the life sciences in the second part of the twentieth century. For if, as I have suggested, biological systems are seen as the phenotypic outcome of a determining genotype within post-1953 genetics, then deterministic biology segues into the realm of engineered life toward the end of the twentieth century. That is, biology slides seamlessly into a-life because determination has become the key direction guiding them both.

A paradoxical relationship has therefore emerged between the various fields of genetics and artificial life; each, while adopting information-based metaphors, would appear to be striving towards the other's position. Genetics, with its code and information now tightly packaged as 'The Book of Life', appears to be more determinist than ever. Its teleological approach implies that it does not align itself comfortably with the prospect of not knowing and hence not controlling all possible outcomes. On the other hand, a-life's code and information is a search for, as Christopher Langton has inferred, 'a biology of any possible life-forms'. [7] To this end, its approach is indeterminate, having the potential to accept all possible outcomes. A-life therefore reached a juncture where it needed to decide between a fluid biological model or relying upon a set of defined parameters to maintain some control over the evolutionary outcomes.

During the mid-1990s when Thomas Ray was evolving his famous *Tierra* programme, a number of exchanges took place between artists and a-life researchers. Theoretical biology, the basis of a-life, would provide a platform for an emerging field of visual arts practices using digital technologies. The potential of Ray's research – and outcomes – gave credibility to the merger of the biological and the digital. The lynch pin here was Richard Dawkins' popularisation of genetics. The popular culture status awarded Dawkins generally, and present within the 1990s new media arts field, is easier to understand when we note his populist approach to science. This may well lie in the accessibility of his strong metaphorical style. Dawkins was bringing complex science to the level of the non-specialist reader, conflating evidence with unproven hypothesis by using relatively simple metaphors. [8] As I have suggested, the use of metaphor in relation to the biological sciences is not unique to the late twentieth century, flowing seamlessly through cybernetic theory and into molecular biology. Dawkins' popularity as a scientist for the layperson, then, provided a resource to draw upon for much digital art of the period.

In July 1995, *Wired* Magazine featured Dawkins on its front cover. Although hardly comparable to making the cover of *Time* magazine, the cover of each issue of *Wired* was eagerly anticipated by computer engineers, software developers, new media artists and theorists. This placed Dawkins on the digital map, although he had influenced mathematically oriented artists such as Ray as well as Langton's artificial life theories as far back as 1989 with his paper 'The Evolution of Evolvability' (1989). His work was praised because of the fluid exchange he facilitated between biological and digital evolution. For the likes of theoretical biologists working actively in a-life, such a collapse between biological and digital information assisted the work they were already doing. The *Wired* article proclaims:

> "With his skilful articulation of evolutionary issues – combined with his digital breeding of biomorphs – many researchers consider Dawkins a conceptual godfather of the artificial life movement. He is as comfortable with digital media as with the genetics of fruit flies." [9]

Dawkins' appeal went beyond artificial life and began to directly influence the work of new media artists working within the still emerging fields of interactivity and online communications. To many he embodied what I will refer to as the *seemingly endless* possibilities of interactivity – a concept that could really only exist within systems that attempted to simulate openness such as a-life. By insisting that a-life environments are open systems and effectively collapsing digital and biological information, the computer itself became the environment in which life and its endless possibilities could be explored.

The relationship between Dawkins' theory of evolution and its application to the work done in artificial life systems legitimated the merging of two systems operating under sets of interrelated rules – interactivity and a-life. But within interactivity, controlled evolution required special consideration be given to the user's *choice* in the development of artwork. Yet interactive systems nevertheless participated in the potential offered by an open system – that of unending growth via technological means. Thus what was immediately appealing in Dawkins' work was his *technophilia*. The techno-euphoric merging of the digital and the biological was of significant value to a field of new media arts practitioners perceived more as fringe-dwellers than real artists. Could it be that in the work of a molecular biologist digital artists might finally find a conceptual framework for interactivity? Would an interactive piece *evolve,* and come to life as it were, based on its responses to user-activated events? Here the user is not a static bystander but the very environment facilitating change and growth.

An example of this approach can be seen in the work of Australian artist Jon McCormack. McCormack concerns himself with the specificities of generative algorithms and a concept of aesthetic fitness in order to regulate the artificial world found in his work

Turbulence: An Interactive Museum of Unnatural History (1994). The work is unquestionably a visually rich experience; the viewer is propelled on a journey though a landscape alien yet familiar, populated by species of flora that both repel and captivate. It is aesthetically resolved and presented in a compelling museum-like context. For those experiencing the work in its installation form, a corridor lined with jars containing specimens real or imaginary had to be traversed before reaching a cylindrical room with a plinth housing a touch-screen. Depending on what the user initially chose onscreen, a segment of the thirty-minute landscape appeared projected in the space behind the screen. The landscapes in *Turbulence* are saturated, complex and highly contrived in their aesthetic design.

McCormack's artistic concerns reflect his background in computer science – many of his ideas are informed by cybernetics, information theory, emergence theory, and generative algorithms. He writes the software that creates his unique aesthetic populations yet he – and the subsequent work – never seem to completely mesh. McCormack infers that on some level *Turbulence* represents the chasm between what we desire in nature – its untamed beauty – and our constant destruction of it in the name of development and containment. Yet there is a parallel chasm operating here between the artist-produced programme (genotype) and the public visual display of the work (phenotype). The viewer experiences a world unfolding before him or her, even evolving. Yet the evolution took place long before the public viewing, in a world known only to McCormack himself. His generative algorithms do create his aesthetic reality yet he never discusses the programming or aesthetic choices he makes in order to produce the final viewer experience. Is the viewer experiencing an a-life art piece emerging as a result of genetic algorithms or an interactive artwork? McCormack insists:

> "There is no start or end to the work, but as the user progresses with the interaction the software 'learns' about which areas the user is exploring and responds with inter-related options (i.e. the work tries to adapt to the personality and whims of the user)." [10]

There is another possibility for thinking through this piece – McCormack's prior training as a filmmaker provides us with a work that is a tightly constructed linear narrative, edited and displayed for optimum enjoyment. The work does not unfold so randomly or turbulently, then, in front of the viewer. Instead, it is comprised of short sequences of moving image clips, already edited in order to stitch seamlessly with any other sequence. In the end what we see is closer to a narrative cinematic experience complete with sound track.

The a-life and interactive work of another Australian, Troy Innocent, is relatively soft in terms of its reliance on the work of genetic algorithms and it is visually rich and complex. It lies within the terrain of interactivity with the artist using user-driven events to perpetuate the appearance of a-life evolving. Innocent is the first to acknowledge that his work is not artificial life. However he is quick to introduce the rhetoric that a-life and biological systems deploy into the interactive domain. *Iconica* (1999) is described as:

> "A unique, surreal artificial world made of language with the capacity to evolve, change and mutate through human interaction and its own evolutionary process." [11]

Innocent's *Iconica* does use genetic algorithms to develop its outcomes; to an extent, then, the user can participate in the evolutionary process. It is easy to gloss over the implications of user engagement with an evolutionary process due to fact that the creatures that populate his worlds appear to be only symbolic. Furthermore, the world does not, as the artist makes clear, mimic the biological world – its metaphoric status is evident. Yet Innocent falls victim to his own rhetoric through his ill-conceived use of the word *mutation*. Thi becomes a catch-all phrase:

> "During the period of installation the space evolves, changes and mutates through visitor's interaction and though it's [sic] own artificial evolutionary processes." [12]

But there is no visual evidence of mutation in *Iconica.* What we have, more precisely, is the development of colonies of symbolic figures underwritten by a genetic algorithm that allows them to grow within certain parameters. A set of icons with certain programmed properties identified as forms include one form labeled 'mutation'. Innocent also adopts the ever-adaptive concept of the meme, which suggests that he is wandering further into the potential reductionism of biological metaphors. Dawkins' theory of memetics was extremely popular in new media circles throughout the mid-to-late 1990s and *Iconica* is just one instance in which this concept proliferated throughout digital worlds:

> "3. Meme: In *Iconica,* memes influence the mood and behavior of an entity when encountered. Memes may also be absorbed, allowing the entity to influence the mood and behavior of others." [13]

I have been relatively critical of what I see as the problems of both a-life and interactivity in the work of new media arts practice during a particular period. Specifically, I have located the point at which the new media and biology overlap as this provides the ground for the import and flow of certain biological metaphors. And if genetics were the dominant metaphorical framework for new media art in the 1990s, I now want to suggest that neuroscience may become the foundation for much exploration in the 21st century. Here I briefly raise the work of Warren Neidich and his use of the concept of "neuroaesthetics". This term has its origins in the field of neuroscience where it is used to describe the underlying functioning of the brain in relation to perception of colour and so forth in art (Zeki, 1993). However, Neidich's *critical* inquiry and practice in the field has identified that artists are more interested in what he refers to as 'strategies of seeing'. [14] Taking this idea, I would suggest that neuroaesthetics can describe the *aesthetic* metaphorical response of artists to the imaging processes of neurology as these become strategies for 'seeing' the brain.

New media's relationship to science and its technological processes can be identified as indicative of larger cultural and technological shifts. Accordingly, the metaphorical engagement operating through the scientific gaze requires new media practices to produce an aesthetic model that can identify the significance of powerful computing metaphors. These metaphors operate in neurology when we describe the brain and its functioning as 'hardwired', an information processor or as networked. I would suggest that an empirical investigation, especially via practice-based artistic research, is now required to explore the metaphors between neurological and digital processes, of the brain 'computing' and computers becoming more organic. This might elucidate how new media arts could offer strategies of seeing the brain as mutable and dynamic. One approach would be to engage dynamic/interactive user environments that offer a *dynamic* neuroaesthetic metaphor of brain functioning. In doing so, however, new media must first look to its recent past and understand that a metaphor is a metaphor for a very good reason.

References and Notes

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