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**Media ecology, the biology of Stuart Kauffman and Terrence Deacon's *Incomplete Nature: Much Ado About Nothing***

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**Abstract**

A review is made of the systems biology work of Stuart Kauffman and Terrence Deacon. A parallel between their work and media ecology is developed. An argument is made that Media Ecology is about the application of systems thinking to understanding media, communications and the impact of technology.

**Keywords**

Systems thinking; media ecology; Kauffman; Deacon; *Incomplete Nature*; emergence

**Introduction**

This article based on my talk at the Media Ecology Association Conference in 2012 is about the parallels of systems thinking and media ecology. It is part of the series that develops the theme that media ecology is practiced by many who are not recognized as media ecologists as well as the notion that media ecology has an influence outside of the field per se. I will explore the work of systems biologist Stuart Kauffman (2000) and biological anthropologist and neuroscientist Terrence Deacon with a focus on Deacon's (2012) book *Incomplete Nature: How Mind Emerged from Matter*. Both Kauffman and

Deacon are concerned with the origin of life and make use of complexity and emergence theory in their approach to biology and neuroscience.

### **Incomplete nature**

Deacon addresses the mysteries of life, such as purposefulness, sentience, consciousness, mind, values and meaning, which he describes as ententional phenomena. He attempts to connect them to the physical sciences and hence build a bridge between physics, biology, the social sciences, philosophy and, in particular, the origin of life and mind.

Rather than invoking dualism as some philosophers do to treat ententional phenomena, or ignoring them as the sciences do, Deacon proposes to link the mysterious ententional qualities of life not directly to matter itself but the way in which matter is organized by constraints and to what he terms absentials for things that are not there. Hence: 'Much Ado About Nothing'.

The term 'ententional' is 'a generic adjective to describe all phenomena that are intrinsically incomplete in the sense of being in relationship to, constituted by, or organized to achieve something non-intrinsic' (Deacon 2012: 27). The term 'ententional' derived from intentional goes beyond the meaning of intentional to encompass those attributes that are characteristic of living things that are not found in inanimate matter and include such things as a sense of self, self-maintenance, self-preservation, purpose, goal-orientedness, end-directedness, function, reproduction, evolution, adaptiveness, subjectivity, value and meaning or semiosis. Ententionality involves a living organism's

behaviour to preserve or maintain itself and to propagate its organization. Deacon describes ententional phenomena in the following way: Ententional phenomena include functions that have satisfaction conditions, adaptations that have environmental correlates, thoughts that have contents, purposes that have goals, subjective experiences that have a self/other perspective, and values that have a self that is benefited or harmed (Deacon 2012: 27).

We are presented with a Zen puzzle but a puzzle that gets at the roots of what we are. Constraints are conditions that prevent certain things from happening and hence they create absences or things that do not happen and these absences Deacon calls, coining a neologism abstententials. Deacon also connects information to constraints following some work I did with Kauffman et al. (2007), which has a peripheral connection to McLuhan's 'the medium is the message', which I will explain below.

Deacon (2012) begins Chapter 9: Significance of *Incomplete Nature* (2012) with a quote from an article that Kauffman and I and a number of other systems biologists wrote (Kauffman et al. 2007). Here is the quote:

The first surprise is that it takes constraints on the release of energy to perform work, but it takes work to create constraints. The second surprise is that constraints are information and information is constraint. (quoted in Deacon 2012: 392)

**Propagation of organization: An enquiry**

The story of how Kauffman and I arrived at the second surprise (or key insight) involves McLuhan's idea that 'the medium is the message' (McLuhan 1964). Kauffman, the founding director of the Institute of Biocomplexity and Informatics at the University of Calgary, and Robert Este, its deputy director, were relaxing over a beer at the Chateau Laurier Hotel in Ottawa after attending the inaugural meeting of the Canadian Society of Systems Biology. Stu asked us 'what is systems biology' and I responded 'isn't it the study of the flow of information in biotic systems'. To which Stu responded, 'well what is information in a biotic system, anyway. We really do not know how to define the information of a biotic system'. He went on to explain as he had done in his book *Investigations* (Kauffman 2000) that a living organism is an autonomous agent and an autocatalytic system that propagates its organization and performs at least one thermodynamic work cycle. He then explained that in order for a living organism to do work it has to constrain the flow of free energy like the cylinder in a car engine that constrains the energy released by the combustion of the gasoline vapour and air mixture to drive a piston and thereby do work. Kauffman went on to say: but it takes work to build those constraints and the mystery is how were the first living organisms able to do the work to build those constraints. I responded after McLuhan's (1964) famous one-liner 'the medium is the message' flashed through my mind, 'Stuart, I don't know how those constraints got built but the constraints are the information'. I made the remark, half jokingly and half seriously as a probe, much as McLuhan might have done so.

This off-handed remark struck a chord with Stuart and led to an article that the three of us

co-authored with three others entitled ‘Propagating organization: An enquiry’ (Kauffman et al. 2007). In that article we examined the nature of biotic information and concluded that Shannon information could not describe biotic information. According to the Shannon’s definition of information, a structured set of numbers like the set of even numbers has less information than a set of random numbers because one can predict the sequence of even numbers. By this argument, a random soup of organic chemicals has more information than a structured biotic agent. The biotic agent has more meaning than the soup, however. The living organism with more structure and more organization has less Shannon information. This is counterintuitive to a biologist’s understanding of a living organism. We therefore conclude that the use of Shannon information to describe a biotic system would not be valid. Shannon information for a biotic system is simply a category error.

The simplest way to describe our project is to quote from the abstract to give the reader a sense of our enquiry.

Our aim in this article is to attempt to discuss propagating organization of process, a poorly articulated union of matter, energy, work, constraints and that vexed concept, ‘information’, which unite in far from equilibrium living physical systems.... we also try to place in context some of the extant discussion of information as intimately related to DNA, RNA and protein transcription and translation processes... Here we seek a non-reductionist explanation for the

synthesis, accumulation, and propagation of information, work, and constraint, which we hope will provide some insight into both the biotic and abiotic universe, in terms of both molecular self reproduction and the basic work energy cycle where work is the constrained release of energy into a few degrees of freedom. The typical requirement for work itself is to construct those very constraints on the release of energy that then constitute further work. Information creation, we argue, arises in two ways: first, information as natural selection assembling the very constraints on the release of energy that then constitutes work and the propagation of organization. Second, information in a more extended sense is ‘semiotic’, that is *about* the world or internal state of the organism and requires an appropriate response.

Our conclusions, to date, of this enquiry suggest a foundation which views information as the construction of constraints, which, in their physical manifestation, partially underlie the processes of evolution to dynamically determine the fitness of organisms within the context of a biotic universe. (Kauffman et al. 2007, original emphasis)

### **McLuhan’s influence on Deacon**

Coming back to Deacon’s book *Incomplete Nature* (2012), which I would like to think was influenced by Kauffman et al. (2007) and hence through me with McLuhan.

Deacon’s formulation of the absential created by constraints represents what McLuhan

would call a figure/ground reversal in which, instead of focusing on matter, one focuses on the interactions between material forms.

A counterintuitive figure/background reversal, focusing on what is absent rather than present, offers a means to repair some of the serious inadequacies in our conceptions of matter, order, life, work, information, representation and even consciousness and conceptions of value.... It requires reframing the way we think about the physical world in thoroughly dynamical, that is to say, process terms, and recasting our notion of causality in terms of something like the geometry of this dynamics instead of thinking in terms of material objects in motion affected by contact and fields of force. (Deacon 2012: 44)

So here we see the influence of McLuhan's figure/ground thinking on Deacon, which he acknowledged in an e-mail to me when I pointed out the parallels of his thinking to that of McLuhan,

McLuhan was an early influence on my thinking and probably has been a subliminal ground for my own development ever since.... Without question the f/g [figure/ground] reversal logic has been a hallmark of my own approach to the puzzles I have chosen to work on, and not just those discussed in *Incomplete Nature*, though this is where it is probably best developed. (private communication)



A key idea that Deacon takes from systems thinking that is at the heart of McLuhan's figure/ground thinking and all ecological/systems thinking (biological, media or otherwise) is the notion that system properties do not arise from the properties of the components of a system but from their interactions with each other, in other words, emergence. Deacon formulates this in describing life, sentience and mind as:

There is more here than stuff. There is how this stuff is organized and related to other stuff. (2012: 544)

### **Thermodynamics, morphodynamics and teleodynamics**

Deacon then formulates three different ways that 'stuff' or matter interact through thermodynamics, morphodynamics and teleodynamics.

Thermodynamic interactions are without constraints and as a result such systems tend to maximize disorder, thereby increasing entropy resulting in a net loss of organization.

The next level of material interaction, known as morphodynamics, is the level where organization begins to appear as a result of self-organization and includes phenomena such as Bénard cells and crystal formation. The morphodynamics that are pertinent to the origins of life are autocatalysis as suggested by Kauffman (2000) or autopoiesis as suggested by Humberto Maturana and Francesco Varela (1980). Another morphodynamic

process key to life is the self-assembly or the crystal-like formation of the structures that eventually became the membranes of cells known as self-assembly. These morphodynamic processes, when combined, create life. However, they are not self-maintaining in and of themselves. What is required for the formation of life and mind is the third level of matter interaction, namely teleodynamics.

Deacon suggests that the interdependent combination of two morphodynamic processes, namely that of autocatalysis and the crystal like 'self-assembly' that produces viral shells or cell membranes, can produce a simple form of molecular teleodynamics. He suggests that this may even be a potential mechanism for how life might have emerged.

Deacon claims that autocatalysis by itself cannot give rise to a living entity because while it is self-promoting it is not self-regulating or self-preserving (2012: 295). A second feature is required, namely, self-containment. The self-organization of organic chemical structures that form the cell's membrane and provide containment is similar to the way that crystals form. 'Containment creates physical individuality and is a necessary step for the creation of a "self," a living self, that can act teleologically in its own self-interest' (Deacon 2012: 296).

Deacon has acknowledged the influence of McLuhan. Here are some examples of that influence or at least parallels:

To support his notion that absentials play a key role in the dynamics of matter Deacon quotes Lao Tsu: ‘Thirty spokes converge at the wheel’s hub, to a hole that allows it to turn’. (Deacon 2012: 18)

This parallels McLuhan’s notion that between the wheel and the axle there must be a gap or play or else the wheel seizes up (McLuhan et al. 1977: 9).

In addition to the one example of Deacon’s use of the McLuhanesque figure/ground notion already alluded to there are four others (where the bolding is mine to indicate the influence of McLuhan’s thinking):

Paying attention to the critical role played by constraints in the determination of causal processes offers us a **figure/background** reversal that will turn out to be critical to addressing some of the more problematic issues standing in the way of developing a scientific theory of emergence. (Deacon 2012: 192, emphasis added)

A complete account of the nature of information that is adequate to distinguish it from merely material or energetic relationships also requires a shift of focus, but the **figure/background** shift required is even more fundamental and more **counterintuitive** than that for energy. (Deacon 2012: 373)

Something will tend to be assessed as being more orderly if it reflects more constraint. We tend to describe things as more orderly if they are more predictable, more symmetric, more correlated, and thus more redundant in some features. To the extent that constraint is reduced variety, there will be more redundancy in attributes... The advantage of this negative way of assessing order is that **it does not imply any model-based conception of order**, regularity, or predictability... As we saw earlier, chaos theory provides an important context for demonstrating the usefulness of this **figure/background** shift in the analysis of order and organization. (Deacon 2012: 195)

Accepting the challenge of explaining how it could be that absent phenomena might be causally relevant, we began to reconceptualize some of the most basic physical processes in terms of the concept of constraint: properties and the degrees of freedom not actualized. This **figure/background** reversal didn't undermine any known physical principles, nor did it introduce novel, unprecedented physical principles or special fundamental forces into contemporary science... in order to account for what prior physical intuition seemed unable to explain about meaning, purpose or consciousness. (Deacon 2012: 540)

Ententional qualities such as sentience, mind, consciousness, purpose, meaning and values are unique to living systems and cannot be found in inanimate matter but they

some how arise out of the interactions of inanimate matter. Ententionality is not addressed by science and is basically ignored. Philosophers often sidestep this question by positing substance dualism.

Deacon's model is an attempt to find an alternative to substance dualism that is compatible with canonical scientific thinking. He contends that notions of duality as formulated by Descartes and others are essentially strategies to avoid the difficult question of how inanimate non-sentient matter became alive and sentient.

The Cartesian dualism that Deacon criticizes is substance dualism, the notion that there are two kinds of substance of which the world is constructed, namely physical substance (*res extensa*) and mental substance (*res cogitans*).

Deacon's system is actually one of property dualism in which there is just one kind of substance but there exist two distinct kinds of properties, physical and biological the latter of which also includes sentience and mind or in Deacon's terminology there are two kinds of properties, physical (mechanical) and ententional (emergent). Physical properties are described by thermodynamics and morphodynamics whereas ententional properties of life, sentience and mind are described by teleodynamics. The central idea is that the properties of matter are not intrinsic but depend on the nature of their interactions. The figure of the stuff that makes up the material world depends on the ground in which it operates.

When the ground is thermodynamic because there is a lack of constraints and matter has no organization. When the ground is morphodynamic and there are constraints matter can self-organize but not self maintain itself. Finally when the ground is teleodynamic and the constraints are both self-organizing and self-maintaining matter can organize into selves, i.e. living organisms, that are both self-organizing and self-sustaining that can act on their own behalf as described in *Incomplete Nature* (Deacon 2012) and Robert K. Logan's (2012) 'Review and précis of Terrence Deacon's *Incomplete Nature*' that can be found at <http://www.mdpi.com/2078-2489/3/3/290>.

**Ulanowicz and Clark: Two others systems thinkers who's work parallels Media Ecology**

Robert Ulanowicz (2009) in, *A Third Window: Natural Life Beyond Newton and Darwin*, has described what he calls 'process ecology', as a way of explaining in a non-reductive manner the origins of life, the behaviour of the ecosystems of living organisms and emergent processes in general. Process ecology is the third window for Ulanowicz superseding the first window of Newton's physics which is described by time reversal invariant and universal law and the second window of Darwinian evolution, which introduces history as a factor in the evolution of the species but still retains elements of Newton especially in his approach to species that he deals with as though they are static.

The focus in process ecology is with processes and not objects.

A configuration of processes can, as a whole strongly affect which objects remain in a system and which pass from the scene. This observation inverts to a degree, the conventional wisdom that it is objects that direct processes. The processes, as a union, make a palpable contribution toward the creation of their constituent elements. This reversal of the causal influence lies at the crux of process ecology, and it extirpates the Newtonian stricture of closure. (Deacon 2012: 75)

Ulanowicz's approaches parallels McLuhan's media ecology approach, which also focuses on process and the reversal of cause and effect. McLuhan wrote,

My writings baffle most people simply because I begin with ground and they begin with figure. I begin with *effects* and work round to the *causes*, whereas the conventional pattern is to start with a somewhat arbitrary selection of 'causes' and then try to match these with some of the effects. (Molinaro et al. 1987: 478, emphasis added)

McLuhan's work like that of Ulanowicz was concerned more with process than with law as the following McLuhan quotes indicate (the bolding of the word process in these quotes is mine):

Environments are not just containers, but are **processes** that change the content totally. (McLuhan and Zingrone 1995: 275, emphasis added)

Environments are not passive wrappings, but active **processes**, which work us over completely, massaging the ratio of the senses and imposing their silent assumptions. But environments are invisible. Their groundrules, pervasive structure, and overall patterns elude easy perception. (McLuhan and Fiore 1967: 68)

Andy Clark's (2003) Extended Mind Thesis (EMT) develops the hypothesis that physical human artefacts, tools and props as well symbolic and social–institutional structures extend the mind outside the skull. The ability to create external structure is what makes us humans so special. He wrote:

I am led to wonder whether the intuitive notion of mind itself should not be broadened so as to encompass a variety of external props and aids – whether, that is, the system we often refer to as ‘mind’ is in fact much wider than the one we call ‘brain’. (Clark 2003: 215).

Clark's work while not derived from the work of Marshall McLuhan does parallel McLuhan's notion that media, tools, technologies are ‘extensions of man’ and therefore McLuhan also believes that the mind also operates at times outside the skull as the



following quotes attest:

All media are extensions of some human faculty psychic or physical (McLuhan and Fiore 1967: 26).

In this electronic age we see ourselves being translated more and more into the form of information, moving toward the technological extension of consciousness (McLuhan 1964: 57).

Now man is beginning to wear his brain outside his skull and his nerves outside his skin; new technology breeds new man (McLuhan and Zingrone 1995: 264).

## **Conclusion**

I interpret the work of Kauffman, Deacon, Ulanowicz and Clark as a form of media ecology because of the intrinsic figure/ground relationships that create life, sentience and mind. For Kauffman et al. (2007) the medium is the constraints and the message is information. For Clark (2003) the medium is the scaffold of our information tools and the message is our extended mind. For Ulanowicz (2009) the medium is the environment and the message is process ecology. In Deacon's (2012) *Incomplete Nature* the medium is the constraints and the message is self-organization for morphodynamic constraints and life and sentience that is self-maintaining, self-preserving and ententional for teleodynamic constraints.

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