

What is Information? - Propagating Organization in the Biosphere, the Symbolosphere, the Technosphere and the Econosphere

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An Epilogue to What is Information?

Chapter 1 – What is Information? – Introductory Remarks to Frame the Investigation

1.1 Prologue

What is information? - a fitting question given the importance of information and the central role it plays in the economic and cultural life at the beginning of the 21st Century. It is said that we live in the Information Age, a claim that is hard to dispute given the ubiquity of the vast array of information technology (IT) at our disposal to generate, communicate, interpret and exploit information. We are surrounded by information thanks to computing and the digital “new media” such as the Internet, the Web, blogs, email, instant messaging, text messaging, cell phones, VOIP, Web cams, iPods, Blackberries, iPhones, virtual reality, virtual worlds, RFID or smart tags, nanotechnology and ubiquitous computing. In addition to the proliferation of these many informatic devices we also have to contend with the information explosion in the physical and biological sciences, engineering, social sciences, and humanities. In addition computing and IT have become the principal metaphor through which so much of our life and our world is understood as well as forming the underpinning of artificial intelligence (AI) and artificial life (AL). The ultimate information conceit, however, belongs to Edward Fredkin who insists that the universe is a computer and that life including human life is merely a program running on that computer (Hayles 1999, p. 240-42).

The irony of our total immersion in information and the central role it plays in our economic, social and cultural life is that for the most part we do not really have a clear understanding of exactly what information is. Information is not a simple straightforward concept but rather it is a very slippery notion used in many different ways and in many different contexts. Linguistically and grammatically the word information is a noun but in actuality it is a process and hence is like a verb. A consideration of the concept of information gives rise to a number of interesting questions, which we will explore in this study.

Is there only one form of information or are there several kinds of information? In other words is information an invariant or a universal independent of its frame of reference or is it context dependent?

What is the relationship of information to meaning, communication and organization?

Is information a thing like a noun or a process like a verb?

Is information material, a form of energy or is it just a pattern?

Is information a uniquely human phenomenon or do non-human forms of life contain information?

What is the role of information in the propagation of life?

What is the relationship of energy and information?

What is the relationship of information to science?

These are some of the questions we will address in this book as we try to flesh out our understanding of exactly what it is that we call information. We will consider the historic development of the concept of information to get a handle on the exact meaning of this thing or process that defines our age and is also the engine of economic growth. We trace the development of the concept of information from the earliest uses of the word to the beginning of information theory as formulated by Shannon and Wiener. We will also study the role of information in the four spheres of influence on human life, namely, the biosphere of living organisms, the symbolosphere, which consists of language, the human mind and all the products of the mind including culture; the technosphere of technology, and the econosphere of economics and government.

The Background to “What is Information?”: Three Previous Projects

This study grows out of three previous projects (described below) that have engaged my attention over the past few years. The actual question “what is information” arose out of a conversation with Stuart Kauffman and Robert Este in Ottawa immediately following the inaugural meeting of the Canadian Systems Biology Society. Stuart opened the conversation, as I best recall, by asking what is systems biology. I retorted by asking, isn't it about information in biotic systems. He responded by saying but what is information in a biotic system anyway? After a lively discussion of not more than an hour we concluded that Shannon information cannot properly describe biotic information. That conversation led to the first of three projects upon which this book is based and is entitled *Propagating Organization: An Enquiry* (Kauffman, Logan, Este, Hobill, Goebel and Shmulevich 2007) hereafter referred to as POE. In this enquiry we showed that biotic or instructional information is quite different than Shannon information and is related to the constraints that allow a living organism to convert free energy into work that allows it to operate its metabolism and replicate itself thus propagating its organization. The results of POE are summarized in Chapter 2.

It should be mentioned that the concept of propagating organization was originally formulated by Kauffman (2000) in his book *Investigations* and that it will play a key role in this investigation. In fact it was by generalizing Kauffman's notion of propagating organization to language, culture, science, technology, and economics that I began to realize that there were many different forms of information in addition to Shannon and biotic information.

Although the question “What is Information?” arose out of that original conversation with Kauffman and Este I should also mention that the idea for the simple title of this book and this study, *What is Information?*, was very much influenced by Irwin Schrödinger's (1944) famous and highly influential book *What is Life?*

A second project that has contributed to my thoughts about the nature of information has been my ongoing work in media ecology and linguistics dating back to my collaboration with Marshall McLuhan (McLuhan and Logan 1977) and includes a study of the impact of the alphabet on the development of Western civilization (Logan 2004a), an attempt to understand the evolution and origin of human communications and language (Logan 2007) and its evolution ranging from speech, writing and mathematics to science, computing and the Internet (Logan 2004b). These results will be reviewed in **Chapters 3 and 4** where we also examine the nature of the human mind. The motivation for understanding the human mind is that the original meaning of information pertained to giving a form to the mind. It is also the case that it is by the agency of the mind that information is formulated, communicated and received. We will therefore examine the nature of the human mind and its relationship to language and culture as developed in the Extended Mind model for the emergence of language and culture (ibid.). One of the key results from this work that is pertinent to addressing the question, “what is information?” is the way in which it was shown that verbal language, culture, technology and economics can be treated as though they were living organisms because of the way in which they evolve, have agency and represent emergent phenomena.

The third project of relevance to understanding the nature of information arises from John Schumann’s (2003a & b) formulation of the notion of the symbolosphere reviewed in **Chapter 5** and the collaboration Schumann and I (Logan and Schumann 2007) developed by combining his notion of the symbolosphere and my ideas from the Extended Mind model (Logan 2006a, 2007) to develop a neo-dualistic representation of reality. This work is reviewed in **Chapter 6**. The neo-duality representation suggests that reality consists of two basic elements: i. physical elements with extension occupying the physiosphere or what Descartes called *res extensa* and ii. symbolic elements like language, culture and mind, which are without extension and occupy what Schumann defined as the symbolosphere. The symbolosphere corresponds to Descartes’ *res cogitans* but is agnostic with respect to the notions of God, soul and spirit. Logan (2006b) has extended the neo-duality concept to include media, science, music and the fine arts, which is also reviewed.

The reviews of these past projects that I have sprinkled throughout this book are provided as the background for this study of the nature of information and have been collected in this volume for the convenience of those readers not familiar with some of my past work. The new material in this book is based on a number of explorations I have made and essays that I have written over the past five years all of which have related in one way or another to the notion of information, a concept or notion, which I find most puzzling. The fundamental questions that have intrigued me for the past five years are of the form “What IS X” where X is information, language, communications, culture, mind, altruism and life. Hopefully I have shed light on these questions and the nature of information as it is used in such diverse fields of study including linguistics, communications, computer science, knowledge management, physics, biology, and cybernetics. I cannot claim expertise in any of these fields with the possible exception of physics where I earned my Ph.D. As an “intellectual tourists” and a genuine interdisciplinarian, however, I hope to shed light on all of these fields.

The Organization of this Book

Having described the three previous projects, which gave rise to this study we now turn to a description of the remaining chapters of this book.

Chapter 2 introduces some of the issues associated with understanding the nature of information. The chapter begins with an etymological analysis of the term information and a history of the use of the word based on entries in the Oxford English Dictionary. Next we trace the history of the concept of information including Shannon's (1948) formulation of information theory, Weiner's (1948 and 1950) formulation of cybernetics, and the criticisms and limitations of Shannon information. We also explore the relationship of information to thermodynamics and entropy and argue, as have many physicists before us, that information and entropy are opposites and not parallel as suggested by Shannon.

We then turn to the use of information in the biological sciences and extensively review the article POE (Kauffman et al. 2007) where we show that Shannon information fails to describe biotic information. We also show that information is not an invariant but depends on the frame of reference or context in which it is used. We illustrate this latter point by examining the relationship of information to materiality and meaning in both biotic and symbolic information systems. We then show that there exists a link between information and organization in biotic systems and in the various aspects of human culture including language, technology, science, economics and governance. We end Chapter 2 by discussing whether a living organism like a human being is information or flesh and what is the relationship of information and flesh.

In **Chapter 3** we examine the origin and evolution of human language and its relationship to communication and information. The chapter reviews three previous studies, namely:

1. The Alphabet Effect (Logan 2004a) which posits that the phonetic alphabet, codified law, monotheism abstract science, and deductive logic first arose in the narrow geographic zone between the Tigris Euphrates river system and the Aegean Sea between 2000 BCE and 500 BCE among cultures that were trading and interacting with each other. This hypothesis was developed to help explain why abstract science began in the West despite the fact that most technology originated in ancient China.
2. The Sixth Language (Logan 2004b) which posits that language is both a medium of communication and an informatic tool and that speech, writing, mathematics, science, computing and the Internet form an evolutionary chain of languages.
3. The Extended Mind (Logan 2007, Chapters. 1-12) which posits that language emerged as the bifurcation from percept based mental processes to concept based thinking as a way of dealing with the complexity of hominid life due to tool making, the control of fire,

the need to live in large social settings to take advantage of the hearth, large scale hunting and gathering and non-verbal mimetic communication needed to coordinate these activities. We also review the hypothesis developed by Christiansen (1994) and Deacon (1997) in which they posit that language may be treated as a living organism, an obligate symbiont that evolved so that it could be easily learned by young children. Their hypothesis provides obviates the need to invoke Chomsky's theory that a Language Acquisition Device and the Universal Grammar is hard wired into the human brain to explain why young children learn language automatically.

In **Chapter 4** we examine the relationship of culture, organization and information making use of (Logan 2007, Chapters 2-4). We show that Christiansen's argument that language may be regarded as an organism can be extended to culture. We posit that culture as an organism evolved in such a way as to be easily learned and that as a result given the universality of human cognitive structures we should not be surprised by the universality of human culture as has been documented by Donald Brown (1991).

In **Chapter 5** we combine the results of Propagating Organization: An Enquiry (Kauffman et al. 2007) with the notion developed in Chapters 3 and 4 that language, culture, technology, economics and governance and science can be treated as organisms that evolve, propagate their organization and represent emergent phenomena. We also show that all of these human information systems also behave like living organisms with respect to three properties that Kauffman (2000) identified in *Investigations*, namely like living organisms

- i. they constantly probe the Adjacent Possible,
- ii. they maximize the variety and hence obey Kauffman's putative fourth law of thermodynamics, and
- iii. they are self-constructing systems.

In **Chapter 6** we examine the intersection of emergence theory and the concept of duality within the context of information and propagating organization that is materially instantiated in the case of the biosphere and that is not materially instantiated in the case of the symbolosphere. We show that the conflict that Clayton (2004) suggests exists between emergence and duality is easily resolved by introducing the notion of neo-duality (Logan and Schumann 2005) described above. We also point out the differences between Cartesian duality and Logan-Schumann neo-duality.

In **Chapter 7** we describe the information content of the four spheres that directly influence the human condition, namely, the biosphere, the symbolosphere, the technosphere and the econosphere. We then compare the way in which the components of the four spheres, namely, living organisms, language and culture, technologies, and economic and governmental organizations:

1. contain information,
2. emerge and evolve,
3. develop their agency
4. are open to energy and information, and

5. enter into symbiotic relationships both within their own sphere and with those that reside in the other spheres.

In **Chapter 8** we examine the relationship of information, knowledge, science and logic with a focus on two topics. The first is the role of information in knowledge management. The second topic treated in the section, “What is Science?,” describes the limitations of science. We present a linguistic analysis and a formal mathematical proof, the Non-probativity Theorem, based on Popper’s criteria of falsifiability for a scientific proposition to show that science cannot prove the truth of any proposition but can only formulate hypotheses that continually require empirical verification for every new domain of observation. A number of historical examples of how science has had to modify theories and/or approaches that were thought to be absolutely unshakable are presented including the shift in which linear dynamics is now the anomaly and non-linear dynamics the norm. Complexity and predictability are shown to have a complementarity like that of position and momentum in the Heisenberg uncertainty principle. The relationship of complexity and predictability is also similar to that of completeness and logical consistency within the context of Gödel’s Theorem.

In **Chapter 9** we examine the future of the book in the context of digital information. We conclude that despite some predictions of the obsolescence of the book its future looks bright. We describe the potential future of the evolution of the book describing the SmartBook system in which the convergence of the codex book and the e-book using a RFID smart tag results in a reading system that is readable, searchable, networkable and smart.

In **Chapter 10** we examine the origin and nature of the non-verbal forms of information and communication inherent in the artistic expression through music, dance and the plastic arts of painting, sculpture, and photography. We also consider the connection between verbal language and artistic expression, which we believe is due to secondary perception, i.e. the perception influenced by verbal language and conceptual symbolic thought.

In the **Epilogue** we address a number of interesting questions of a philosophical nature, which are worthy of our consideration despite the fact that any answers to them will be highly speculative. We show that despite all our efforts to understand the nature of information it is still a mysterious and somewhat ambiguous notion.