Chapter 5 - Propagating Extra-Somatic Organization in the Symbolsphere

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Section 1 – Introduction

In Chapter 2 we reviewed the enquiry of Kauffman et al. (2007) hereafter referred to as POE in which it was shown that living organisms that occupy the biosphere propagate their organization materially by the constraints that allow them to channel free energy into work for their metabolism and replication. These constraints are connected to information: in fact, simply put, the constraints are the biotic or instructional information that we have already defined.

The non-material, extra-somatic symbolic domain of human language and culture, which occupies a special place in the biosphere, was only cursorily identified in POE and not analyzed at all. The objective of this chapter is to consider these symbolic and conceptual aspects of human behavior, which comprise the symbolosphere, which is also described in this chapter in Section 2. We will analyze the way in which the elements of the symbolosphere including language and culture (treated in Section 3) and the three aspects of culture we treat separately, namely, 1. technology (in Section 4), 2. science (in Section 5) and 3. government and economics (in Section 6) representing propagating organization akin to the propagation of material organization in the biosphere as identified in POE. We treat the three elements of culture: technology, science, and governance and economics separately because they provide vivid examples of propagating organization.

The paper POE was based in part on Kauffman's book *Investigations* where he developed a number of interesting theses related to propagating organization. In the final section of this paper, Section 8, we extend to language and the different aspects of culture three of the properties Kauffman identified in *Investigations* for living organisms, namely the notions of

i. the exploration of the Adjacent Possible,
ii. the maximization of variety and hence Kauffman's putative fourth law of thermodynamics, and
iii. self-constructing systems.

Actually Kauffman included technology and economics in his analysis from time to time to illustrate these three notions. We will, however, attempt a more systematic approach to these three notions by including language, culture and science, which Kauffman did not deal with explicitly.

Section 2 - The Symbolosphere

In POE based on Kauffman and Clayton (2006) we argued that biology cannot be reduced to physics and that this implies that "the future evolution of the biosphere cannot be finitely prestated." In the same way that biology cannot be reduced to physics it is also the case that the symbolic conceptual aspects of human behavior, namely, language and culture cannot be reduced to, derived from or predicted from human biology. Nor can the future evolution of language and culture (the symbolosphere) be finitely prestated. The emergence of verbal language from mimetic communication described in Chapter 3 could never have been predicted from or reduced to the properties of mimetic communication. One could never have predicted the emergence of Proto-Indo-European nor its divergence into its many descendants such as English, Sanskrit, Greek, Latin, Italian and Romanian. Nor could one prestate the preadaptations of the cultures of the world, their technologies, economies and forms of governance, all of which depended on the

physical environment they found themselves in. Nor can we prestate or predict the development or evolution of science and mathematics.

The symbolic domain of human language and culture is a product of human conceptual thought (Logan 1997, 2000, 2006a & 2007) and represents emergent phenomena and also, as we will show, propagating organization. They differ from the phenomenon in the biosphere that was the focus of the analysis in POE in that they are abstract, conceptual and symbolic and they are not materially instantiated nor do they have extension with the exception of technology. In the case of technology it is the symbolic concepts and organization that goes into the creation of the physical tools that propagates not the actual physical tools themselves. Another motivation for consideration of the propagation of organization represented by language and culture is the fact that the rate of linguistic and cultural evolution far outstrips the rate of human biological evolution and is therefore essential for understanding the evolution and development of the human experience.

The notion of the biosphere was introduced to distinguish it from the abiotic part of the physical universe, which we will hereafter refer to as the physiosphere. The biosphere as we have already indicated consists of living organisms, which represent a level of complexity above and beyond that of the physiosphere and as such are emergent phenomena. For the purposes of our analysis we would like to suggest that the biosphere contains a more complex and emergent domain, the symbolosphere. The notion of the symbolosphere was first introduced by John Schumann (2003a & b) and later elaborated in Logan and Schumann (2005) and Logan (2006b). The symbolosphere is defined as the human mind and all the products of the human mind including symbolic abstract thought, language and culture. The universe constructs itself from energy, the biosphere constructs itself from biomolecules in the physiosphere and the symbolosphere constructs itself from

concepts acting as strange attractors in the human brain of neural-based percepts as described in Section 2.

The part of the symbolosphere represented by the human mind is distinguished from the brain and is the domain of conceptual thought made possible by language. In Logan (2000 and 2007) mind is playfully defined using the formula: mind = brain + language. In this model the brain is part of the physiosphere and is basically a percept processor. It is only with language that conceptual thought by the human mind becomes possible as was described in Chapter 3.

By culture we will make use of Geertz's (1973, p. 8) notion that culture is embodied symbolically. All of the elements of culture are products of human conceptualization and represent emergent phenomena.

The symbolosphere is embedded in the biosphere and emerged from it just as the biosphere is embedded in the physiosphere and emerged from it. The symbolosphere includes aspects of human symbolic thought and culture such as, language, technology, science, governance, economy, writing, mathematics, computing, the Internet, poetry, music, and the visual arts all of which represent propagating organization. We will restrict ourselves in this analysis for the sake of brevity to the first elements of human culture in the above list, namely, language, technology, science, governance and economy.

With these definitions or this taxonomy we see that there have been three distinct levels of diversity and hence symmetry breaking in the history of the universe since the big bang, namely the emergence of a non-symmetric physical universe, the emergence of life or the biosphere on this planet and perhaps elsewhere in the universe and finally the emergence of the symbolosphere in the form of abstract generative symbolic

language and culture among humans on earth and possibly elsewhere in the universe with other forms of life possessing symbolic intelligence.

Although the forms of organization in the symbolosphere are extra-somatic, non-material, and non-extensive they are, however, instantiated in some physical medium and represent human behavior and thought. Spoken language requires a number of organs of the human body for production and reception and the physical medium of air for transmission, which is sometimes enhanced through electronic devises such as the telephone or the microphone. Technology, science, governance, economy and all other aspects of culture are conceptual and symbolic. They are forms of organization that are physically instantiated in the material things they shape and/or control through downward causation.

All of the extra-somatic and non-material forms of organization that we will consider in this chapter originated basically with humans, although there is good evidence that some aspects of human culture emerged earlier in the Homo genus with Homo habilis, Homo erectus or Homo neanderthalis. A debate still rages as to whether earlier forms of genus Homo were capable of language. They certainly had a primitive form of culture, as they were toolmakers. We shall avoid this controversy, as it does not bear on the central theme of this chapter, namely the existence of the propagation of extra-somatic organization in the symbolosphere.

There is also a debate as to what extent animals that are not of the genus Homo also have culture and language. There is certainly evidence that some primates have a very crude culture and an equally crude use of technology as they propagate certain behaviors that enhance their survival such as using a long thin stick to extract termites from a termite nest or using rocks to crack open

nuts. There is also the case of the monkeys on a Japanese island that wash their potatoes before eating them. The issue is whether or not this primitive or rudimentary form of culture is symbolic. I believe it is not. As far as language goes only humans seem to possess a fully generative language. The best that non-human feral animals can do is communicate with a small set of signals of not more than 50 in number.

It is also the case that human technology is far more sophisticated than any use of tools by non-human animals. Only humans use fire. Only humans use tools to make other tools. Only humans have organized their knowledge and developed science. Our focus will therefore be on the propagation of organization through human language and culture leaving the discussion of non-human instances of this, if any, to those more expert in the behavior of non-human animals.

The importance of the consideration of the symbolosphere is that we humans are, in the words of Terry Deacon (1997), "the symbolic species". What this means is that we are the only species capable of conceptualization and symbolization, i.e. of dealing with or processing information about an object or source that is not present to our senses in either space or time. Only humans are able to enter into a semiotic relation with an abstract symbol, i.e. a sign that symbolically stands for a concept or something that we cannot immediately apprehend or sense.

Section 3 – The Propagation of the Organization of Human Language

Based on Schumann's (2003a & b) work and the Extended Mind model (Logan 2000 & 2007) it has been postulated that the symbolosphere, human language and abstract symbolic conceptualization co-evolved and emerged at the same time (Logan and Schumann 2005). Human language is an emergent

phenomenon and a complex adaptive system, which propagates its extra-somatic organization and evolves in a fashion very similar to that of living organisms as was described in Chapter 3. Another hypothesis that supports our hypothesis that human language propagates its organization is Dawkins' (1989) notion of the meme, which replicates elements of culture including language, and which we will treat in more detail in Section 4.

According to Kauffman (1995, p. 49): "A living organism is a system of chemicals that has the capacity to catalyze its own reproduction." Generalizing Kauffman's definition a language operates as a symbolic organism that has the capacity to catalyze its own reproduction. If we consider the language produced and comprehended by each individual speaker as a non-autonomous symbiont organism then we may regard language reproducing itself and propagating its organization each time a child acquires the language of his or her parents and other linguistic conspecifics.

By defining the language of each individual in the society as an organism not only do we meet Kauffman's criteria that an organism catalyzes its own reproduction but we are able to consider the evolution of this organism using Darwin's simple one line definition of evolution, namely, "descent with modification and selection." By descent Darwin meant reproduction, which is the acquisition of language by youngsters. One can now apply the concept of natural selection to the linguistic organism of each individual in a society, which undergoes modification by the way that individual uses the language making up new words or syntactical structures. Selection occurs when a neologism or a new use of an existing word catches on and is picked up by other speakers of the language.

Catalytic closure, which Kauffman (1995, p. 50) has suggested is at the heart of the origin of life, might also provide a mechanism for the way in which language is reproduced from parents to

children. If language exhibits the property of catalytic closure then the reproduction of some elements of the language catalyze the reproduction of others. Words are not isolated; they are part of a semantic web of meaning. The meaning of any given word is always given in terms of other words and therefore words catalyze each other and this is the sense in which a language exhibits catalytic closure.

By reproduction of the language we are talking about the "individual" language of each speaker and the process whereby young children are able to acquire the language of their parents with great ease. The biological capacity to imitate that hominids/humans acquired through biological selection plays the role of the analog of autocatalytic chemical reactions that create more of the same products. Catalytic closure is possibly the mechanism that allows acquisition of language to proceed so rapidly.

If we can accept the hypothesis that language is a non-autonomous symbiont organism that arises from catalytic closure we have a possible alternative to Chomsky's contention that the UG he formulated is hardwired. At the root of autocatalysis is self-organization or what Kauffman (1995) calls "order for free." "We have seen that the origin of collective autocatalysis, the origin of life itself, comes because of what I call 'order for free'—self-organization that arises naturally (ibid., p. 71)." If language emerged through a process of self-organization it comes with its UG already in place. The UG does not sit hard-wired in the brains of its users but rather it is an emergent property of the language itself, which replicates itself every time the symbiont language of the parent or caregiver reproduces itself as a symbiont language of the child. Kauffman's "order for free" translates into "grammar for free," the self-organization of the language itself. Put simply language as an organism evolved in such a way as to be easily

acquired by an infant obviating the need to posit Chomsky's Language Acquisition Device.

Our definition of the reproduction of language as a living organism does not embrace Kauffman's (2000) definition of a living organism as an autonomous agent composed of biomolecules that is "able to act on its own behalf in an environment, (as) an autocatalytic system carrying out at least one thermodynamic work cycle". Language is clearly not a molecular system nor does it carry out a thermodynamic work cycle, but it does act on its own behalf propagating its organization. It does not have to perform thermodynamic work cycles, however, because it is a beneficial non-autonomous symbiont parasite that derives its energy from its host and in return increases the ability of its host to source and exploit free energy.

For the living organism that performs thermodynamic work it takes constraints to do that work and work to build those constraints. The constraints are built into the propagating organization of the autonomous agent by autocatalysis and have been identified in POE as instructional or biotic information to distinguish it from Shannon information.

For language the basic units are the words that comprise the semantics of a language whereas the constraints are the grammar or syntax. The autocatalysis of language arises from the fact that it takes concepts and grammar to make words and words to make concepts and grammar. Semantics and grammar are autocatalytic in the tradition known as the lexical hypothesis, which posits that "the lexicon is at the center of the language system (Donald 1991, p. 250, see also Levelt 1989 and Hudson 1984)." Because words can only be defined in terms of other words they form a semantic web as has been pointed out by Deacon (1997, p. 136).

> The metaphoric use of words and the way in which their various meanings interact can be likened to the web of symbol-symbol relationships that Deacon (ibid.) introduced to describe syntax. But the web of symbol-symbol relationships between different meanings of the same word create a semantic web of sorts which I suggest is the mechanism… to understand the evolution of words and the way language as an ecological system changes (Logan 2007).

In conclusion the analogy between living organisms and linguistic organisms consists of the following points:

- both propagate their organization;
- both evolve through descent, modification and selection;
- both are emergent phenomena;
- both arise from self-organization and catalytic closure; and
- both have a form of instructional information or constraints.

The analogy that both have a form of instructional information is less straightforward than the others and requires some explanation. For biotic agents instructional information provides the constraints necessary for guiding free energy into chemical channels so that work can be done to maintain and replicate the organism. The analogy for a linguistic organism is the grammar or syntax of the language, which constrains the flow of semantic elements to create meaningful propositions and to provide a structure of the language so that it can be easily learned by an infant and hence transmitted or replicated. We will call this form of instructional information linguistic instructional information to distinguish it from biotic instructional information and hereafter use the term instructional information as the generic term to refer to either form of instructional information.

Section 4 – The Propagation of the Organization of Human Culture

Culture is socially transmitted information, which takes the form of conceptual and symbolic mental representations in people's minds (Geertz 1973, p. 8). This means that culture is an extra-somatic and non-material form of organization that propagates from person to person.

Because culture propagates its organization and evolves like living organisms and language, we proposed in Chapter 4 that culture may be considered as a symbolic non-autonomous symbiont organism in the same manner in which we described language as a symbolic organism and symbiont ala Christiansen and Ellefson (2002).

Culture as an organism catalyzes its own reproduction. Each individual in the society, however, transforms or modifies the culture they inherit from their society to meet their own specific needs. Once again we have “descent with modification and selection” ala Darwinian evolution as the modifications of culture made by an individual are selected or ignored by the society based on their fitness. In this manner culture propagates its organization as described in POE.

We have argued that the culture embraced by individuals could be treated as a symbolic organism. As was the case with language culture is not an autonomous agent performing thermodynamic work cycles but rather a beneficial parasite, which pays for its consumption of energy by enhancing the ability of the individual and the society to which they belong to better source and exploit free energy. The relationship is symbiotic and is similar to that of those plants that play host to a fungus that fixes nitrogen and hence enhances the plants ability to transform sunlight into usable energy, which the plant then shares with the fungus.

For living organisms we identified the constraints operating on them as those of organic chemistry and chemical autocatalysis while for linguistic organisms we identified grammar or syntax as the form of instructional information operating in this system. With respect to culture the constraints are the social pressure to conform, which results in a more or less uniform behavior in a society. This uniformity does not apply in every case because of individual idiosyncrasies or rebellion. This provides the modification of the descent of culture from one individual in the society to another. It is by a process of selection that the cultural norms in a society change and evolve paralleling the evolution of living organisms.

The basic units of a culture are the patterns or models for behavior that comprise the individual's belief system. The constraints, on the other hand, are the social norms and social pressure of the society. The autocatalysis of culture is the fact that societies self-organize themselves.

In conclusion the analogy between living organisms and cultural organisms is similar to the one for linguistic and living organisms. They all propagate their organization; evolve through descent, modification and selection; are emergent phenomena; arise from self-organization and catalytic closure; and have a form of instructional information.

The culture of a society incorporates among other things its technology, science, economy and system of governance, which will be treated in Sections 5, 6 and 7 respectively. We now turn to an examination of these individually because they too represent propagating organization and display a pattern of evolution ("descent with modification and selection") very much like that of living organisms.

Section 5 – The Evolution of Technology

The emergence of technology almost certainly preceded language as evidenced by the fact that hominid toolmakers can be traced back to Homo habilis. The refinement of tools and their proliferation as well as the beginning of a technology-based culture, however, seems to have begun much later, about 50,000 years ago. According to Dunbar (1998, p. 105):

> Symbolic language… would have emerged later as a form of software development… probably at the time of the Upper Paleolithic Revolution some 50,000 years ago when we see the first unequivocal archaeological evidence for symbolism (including a dramatic improvement in the quality and form of tools, the possible use of ochre for decorative purposes, followed in short order by evidence of deliberate burials, art and non-functional jewelry). (ibid., p. 105)

The evolution of technology follows a pattern similar to that of living organisms as has been pointed out by a wide variety of authors. The first was the English critic and satirist Samuel Butler writing a mere four years after the publication of The Origin of the Species. More recent and more serious suggestions have been made by Basalla (1988), Mokyr (1990), Vincenti (1990) and Cziko (1995).

Basalla (1988) cites three basic analogies between technological and biological evolution. The first is the fact of the great variety of both biological organisms and technological tools. Basalla cites the fact that the U.S. Patent Office granted approximately 4.7 million patents between 1790 and 1988, the date of the publication of his book *The Evolution of Technology*. As he put it: “The variety of made things is every bit as astonishing as that of living things.”

Basalla’s second point is that technology evolves through a process of descent and modification: "Any new thing that appears in the

made world is based on some object already in existence (ibid., p. 45)." He cites many examples of how innovative technologies borrowed significantly from earlier technologies citing the cotton gin, the electric motor and the transistor as three examples.

Gutenberg's moveable type printing press is another example. Gutenberg made use of the ideas of Laurens Janszoon Koster who had earlier built a block printing press in which a page was carved out of a block of wood in reverse. Koster also made use in some instances of movable type fonts also carved in wood. Koster's press was not original either but was borrowed from the block printing presses used in China, the idea for which was derived from the Chinese practice of printing patterns on silk cloth.

The third point that Basalla makes is that technologies survive through a selection process by which a society chooses a particular technology from a large number of variations for incorporation into its material life.

Mokyr's (1990, p. 275) approach to the evolution of technology is to consider the evolution of know-how rather than the physical artifacts:

> The approach I adopt here is that techniques…, namely, the knowledge of how to produce a good or service in a specific way--are analogues of species, and that changes in them have an evolutionary character. The idea or conceptualization of how to produce a commodity may be thought of as the genotype, whereas the actual technique utilized by the firm in producing the commodity may be thought of as the phenotype of the member of a species. The phenotype of every organism is determined in part by its genotype, but environment plays a role as well. Similarly, the idea constrains the forms a technique can take, but adaptability and adjustment to circumstances help determine

> its exact shape. Invention, the emergence of a new technique, is thus equivalent to speciation, the emergence of a new species.

Vincenti's (1990) approach to the evolution of technology was to develop a "variation-selection model for the growth of engineering knowledge." He suggests that the most efficient way to design new technology is to create variations vicariously and cheaply through modeling (either physical models or computer simulations) and then employ a selection process to pick the form of technology that will be finally built. Vincenti's focus like that of Mokyr is on know-how and also the most efficient way of achieving it through vicarious variation and selection.

Cziko (1995), who cites the work of Basalla (1988), Mokyr (1990) and Vincenti (1990), has created a Universal Selection Theory that includes the notion that technologies evolve in a manner similar to living organisms. "The adapted nature of technology and its progress is hard… to doubt."

Finally I cite my own work in which I too saw the evolution of technology as analogous to that of living organisms:

> Cognitive tools and physical technology are two resources at the disposal of human innovators, and the needs or demands of society are often the motivating force. Necessity is the mother of invention, yet invention does not occur in a vacuum. All of the previous innovations in a culture provide the resources, both cognitive and physical, for the next level of innovation. The previous innovations also contribute to changes within the socioeconomic system that give rise to new social demands. Each new invention, technological innovation, or discovery gives rise to new technical capabilities, new cognitive abilities, and new social conditions. These then interact with the existing economic,

> political, social, cultural, technical, and cognitive realities of the culture to set the stage for the next round of innovation. Thus, technological change in our model is part of an ongoing iterative process. It began with the inception of Homo sapiens and continues to this day at an ever-quickening pace (Logan 2004b, pp. 125).

Section 6 – The Evolution of Science

Science is another symbol-based activity unique to humans, which also propagates its organization. The mechanism for the propagation of science's organization is what Thomas Kuhn (1972) termed normal science. Every success in science gives rise to a paradigm, which is articulated and applied to as many phenomena as possible. This is the mechanism of descent. Once a paradigm fails to provide a satisfactory description of nature a period of revolutionary science begins with the search for a new paradigm. This is the mechanism of modification. If the new paradigm provides a satisfactory explanation to the science community by providing replicable results a new round of normal science begins. This is the mechanism of selection. Science propagates its organization through normal science and evolves by descent, modification and selection just like living organisms. The analogy between the Darwinian evolution of living organisms and the process of descent, modification and selection in Kuhn's model led him to cautiously conclude at the end of his analysis of scientific revolutions the following:

> The analogy that relates the evolution of organisms to the evolution of scientific ideas can easily be pushed too far. But with respect to the issues of this closing section it is very nearly perfect. . . . Successive stages in that developmental process are marked by an increase in articulation and specialization. And the entire process may have occurred, as we now suppose biological evolution did, without benefit of

> a set goal, a permanent fixed scientific truth, of which each stage in the development of scientific knowledge is a better exemplar (Kuhn 1972, pp. 172-73).

Karl Popper (1979, p. 261) whose description of science differs from that of Kuhn's, nevertheless also found an analogy between the evolution of science and that of living organisms:

> The growth of our knowledge is the result of a process closely resembling what Darwin called 'natural selection'; that is, the natural selection of hypotheses: our knowledge consists, at every moment, of those hypotheses which have shown their (comparative) fitness by surviving so far in their struggle for existence; a competitive struggle which eliminates those hypotheses which are unfit.

Section 7 – The Evolution of Governance and Economics

Because governance and economics are so intertwined and because economics by and large determines governance we will treat them together. Economic and political institutions propagate their organization and evolve in much the same way as living organisms and symbolic ones like language and culture through "descent, modification and selection".

Biological factors dominated the evolution of pre-human hominid and human existence at first. With the emergence of technology, language, and culture, these factors also played a key role in human evolution. Human biology and culture co-evolved (Boyd and Richerson 1985). "Population and technology have a feedback relationship; population growth provides the push, technology change the pull. But... it is fundamentally population growth that propels the evolution of the economy (Johnson & Earle 1987, p. 5)."

Johnson and Earle (1987) identified the following stages of socialization that emerged with each incremental increase in population density:

1. *family-level groups*, which divided into either the family camp or the family hamlet;
2. *local groups* of 5 to 10 times the number of families of the family-level group, which came together for the purpose of defense or food storage;
3. *regional polities* that arose out of local groups and at moderate populations formed into a *chiefdom* and at large population levels into a *state*.

The individual units of governance and economy that Johnson and Earle identify, the family, the hamlet, the tribe headed by a big man, the chiefdom and finally the state are all forms of organization that propagate from one generation to another. With an increase in population due to the success of the economy at a lower level of organization a higher more complex level of organization emerges just as more complex biotic organisms emerge from simpler ones.

> As we have seen, at each evolutionary stage existing organizational units are embedded within new, higher-order unifying structures. Hamlets are made up of families, local groups of hamlets, regional chiefdoms of local groups, and states of regional chiefdoms. The earlier levels continue to operate but with modified functions. Thus the local group of a stateless society, which had formerly been a unit of defense, is transformed into a unit of taxation and administration as it becomes incorporated into the state. (ibid., p. 322)

Complexity, Emergence and the Evolution of Economic-Polities

As human societies succeeded in their ability to procure through hunting and gathering natural sources of food (and hence free energy) their population density increased, which led in the long run to a depletion of their food supply. The population overload led to new challenges and chaos. From this chaos far from equilibrium a new level of order emerged ala Prigogine (1997) in the form of the domestication of plants and animals. This pattern of domestication occurred throughout the world in isolated communities approximately 10,000 years ago at the end of the last ice age. While it is true that at the local level one society might learn domestication from its neighbors it is also true that agriculture and pastoralism emerged independently on every continent and in almost every ecosystem in the world. The explanation of the emergence of domestication out of the complexity of population overload parallels the strong emergence model described by Clayton (2004) and Kauffman and Clayton (2006).

The domestication of plants and animals led to new challenges and new levels of complexity, which in turn gave rise to new levels of increasing order in the form of family-level groups (camps and villages), local groups ('big man' systems) and regional polities (chiefdoms and states). Each new political system emerged from the population overload of the previous political system. It was a result of propagating organization through social and cultural transmission that the features of the previous economic-political system were incorporated into the new political order as was pointed out by Johnson and Earle (1987).

Section 8 – The Adjacent Possible, the Maximization of Variety and the Self-Constructing Symbolosphere

In his book *Investigations* Kauffman (2000) deals with the many levels of complexity of the material world but one level that was

only dealt with cursorily was the non-material symbolosphere of language and culture. In this section we will extend to language and culture, i.e. the symbolosphere, Kauffman's arguments made for the biosphere. We shall attempt to expand Kauffman's notion that the universe, including the biosphere is constantly probing the Adjacent Possible and ever increasing the diversity of the symbolic universe by showing that the symbolosphere is also constantly probing its Adjacent Possible and as a consequence increasing the diversity of the universe. We will also attempt to extend to the symbolosphere Kauffman's putative fourth law of thermodynamics, which states that self-constructing open systems like the biosphere maximizes the rate of creating diversity. And finally we will attempt to show that the symbolosphere like the biosphere is a self-constructing system. Kauffman has also argued that human economies and technology are also constantly probing the Adjacent Possible. We will extend this notion to all aspects of the symbolosphere, which are also constantly probing the Adjacent Possible.

The Adjacent Possible

A central thesis of *Investigations* is the existence of the Adjacent Possible in the biosphere, which Kauffman (2000, p. 22) defines in the following manner:

> Autonomous agents forever push their way into novelty—molecular, morphological, behavioral, organizational. I will formalize this push into novelty as the mathematical concept of an 'Adjacent Possible," persistently explored in a universe that can never, in the vastly many lifetimes of the universe, have made all the possible proteins sequences even once, bacterial species even once, or legal systems, even once. Our universe is vastly nonrepeating; or… nonergodic.

We claim that there exists an 'Adjacent Possible' for the symbolosphere. In fact, Kauffman (2000, p. 54) acknowledges this for certain elements of the symbolosphere. "Science, technology, and art tumble into the Adjacent Possible in roughly equal and yoked pace." "The universe is vastly non-equilibrium, vastly nonergodic at the level of complex organic molecules. A fortiori, the universe is vastly nonergodic at the level of species, languages, legal systems and Chevrolet trucks (ibid. 145)." We claim that all elements of the symbolosphere are nonergodic. In the Extended Mind model (Logan 2007) words are regarded as representing concepts as strange attractors for the percepts associated with those concepts. Words are strange attractors because they never return to the same place in the configuration space of meaning because their exact meaning depends on the context of their use or the semantic web that surrounds their use. Since they are strange attractors they are nonergodic.

Kauffman (2000, p. 143) claims that "the biosphere has been expanding, on average, into the Adjacent Possible for 4.8 billion years" and as a result "there are now a standing diversity of 100 million species" with an estimated 10 trillion different genes representing a diversity that "is likely to be hundreds of trillions or more" organic chemical species.

The symbolosphere, on the other hand, has only existed by most accounts 50 to 150 thousand years (some will claim a million or two years) but has generated an enormous amount of diversity. There are extant some 6,000 languages not counting various local dialects. There are also many languages, which have become extinct. Most extinct languages leave no fossils with some exceptions like Proto-Indo-European or Latin that have diverged into many other languages and in the case of Latin have left a written record.

How many words in each language? English has approximately one million. Assuming the others have on average only 100,000 then the sum total of extant words in all the languages of the world is over half a billion words. But this is not the extent of the variety in the symbolosphere. We must also take into account all of the propositions or sentences that have been constructed from these words since the beginning of language. Let us assume a population of 6 billion people (we are only counting those alive today) with an average lifetime of 50 years uttering a hundred sentences per day. This yields some 10,000 trillion (10^{17}) sentences since the symbolosphere came into existence. Each year the number of sentences will increase by 200 trillion at today's population level. And the reckoning only takes into account spoken language. There is also all the variety created in the written word, technology, economics, laws, and cultural artifacts such as clothing, jewelry, art objects, etc.

Maximizing Variety and 4th Law of Thermodynamics

As we saw in the last section by probing the Adjacent Possible "autonomous agents forever push their way into novelty" with the result that there is a "persistent evolution of novelty in the biosphere (ibid., pp. 22 & 5)." The same dynamic holds in the symbolosphere, which for example increases linguistic novelty or variety in a number of ways including the creation of new words (neologisms) and new grammatical elements or structures through grammaticalization and by bifurcating into myriad accents, dialects and new languages such as the way Latin diverged into French, Italian, Spanish, Portuguese, Catalan, and Romanian. The symbolosphere is also increasing its novelty through the diversification of culture a fact Kauffman (ibid., p. 229) acknowledges for the economy: "The economy, like the biosphere, is about persistent creativity in ways of making a living." It is worth noting that the persistent economic creativity Kauffman

identifies is in part due to conceptualization and the use of language.

Kauffman (ibid., pp. 3-4) formulates a putative Fourth Law of Thermodynamics based on the persistent emergence of novelty in the Adjacent Possible for both the biosphere and the econosphere. "Biospheres maximize the average secular construction of the diversity of autonomous agents… On average, biospheres persistently increase the diversity of what can happen next." Our claim is that this putative fourth law, if it is correct, applies with equal validity to all elements of the symbolosphere as is evidenced by the persistent novelty of technology, science, the law, literature, music, and the visual arts.

Self-constructing Systems

A central theme in *Investigations* (Kauffman 2000) is the notion that the universe and the biosphere are self-constructing systems. "A coevolving biosphere accomplishes (the) coconstruction of propagating organization (ibid., p. 5)." We wish to posit that the symbolosphere is also a self-constructing system. It takes thoughts or concepts to create words and words to create thoughts or concepts. Just as autonomous agents emerge in the biosphere through autocatalysis a similar mechanism works in the symbolosphere.

> The emergence of language and conceptual thought is an example of an autocatalytic process. A set of words work together to create a structure of meaning and thought. Each word shades the meaning of the next thought and the next words. Words and thoughts are both catalysts and products of thoughts and words. Language and conceptual thought are emergent phenomena. They bootstrap themselves into existence.

> It is impossible for us to determine because of the remoteness of the events which came first, the language skills, the social/communicative skills or the cognitive skills but one can argue that language, social/communicative skills and cognitive skills form an autocatalytic set of skills which reinforce each other (or bootstrap each other into existence) and which conferred upon those hominids that possessed them a reproductive advantage. (Logan 2007, pp. 45 &173)

The driving force of the self-construction of the biosphere is autocatalysis, which Kauffman (2000, p. 37) attributes to a phase transition. He argues that, "as molecular diversity of a reaction system increases, a critical threshold is reached at which collectively autocatalytic, self-reproducing chemical reaction networks emerge spontaneously (ibid., p. 16)."

Let's extend this argument to the symbolosphere. Perhaps with the increased lexical/conceptual diversity of a protolanguage system (presumably the first form of human language in which there was only a semantics and no syntax) a critical threshold is reached at which collectively autocatalytic, self-reproducing symbolic networks emerge spontaneously with a full-blown syntax and grammar.

Some evolutionists suggest that it is difficult to explain cooperation and altruistic behavior in terms of natural selection because selfish individuals would have a selection advantage over altruistic ones. Various solutions to this problem have included group selection, kin selection and reciprocal altruism. A debate still rages as to which of these mechanisms if any can explain altruism. In *Investigations* Kauffman (2000, p. 75) makes an interesting attempt to resolve this issue by focusing on cooperation instead of altruism with its implication of sacrifice. "The central factors underlying (the) buildup of organization are the same factors that apply in an economy—that merely human extension of

biospheres. The central factors, in fact, center on ‘advantages of trade’.”

We already saw the ‘advantage of trade’ at work in the example of symbiosis between a fungus and a plant where the fungus fixes nitrogen and absorbs energy from the root of the plant. A similar ‘advantage of trade’ can be used to understand the emergence and use of language, which is a beneficial parasite, a symbiont. There is also a mutual advantage to individuals exchanging information and coordinating activities that helps all participants. Consider the following example, which illustrates the ‘advantage of information trade’.

The information I_a that cost agent A the work W_a to obtain can be shared with agent B at very little extra cost to either agent A or B. Let W_x be the cost to A to share I_a and W'_x the cost to B to obtain I_a from A. Agent A shares his information in the hope that agent B will reciprocate at some later time by sharing information I_b that costs agent B W_b to obtain plus W_x to share. It will also cost A W'_x to obtain I_b from B. Let us assume for simplicity that $W_a = W_b = W$ and $W_x = W'_x$. Then we can calculate the economic advantage of the exchange of information I_a and I_b between agents A and B. Let us assume two scenarios where A and B both obtain I_a and I_b: once by cooperation and once independently without cooperation.

With cooperation: The cost to agents A and B is the same, namely, $W + 2\ W_x$ for a total cost to the two of them of $2W+ 4\ W_x$.

For the independent non-cooperation scenario: the cost to each for info I_a and I_b is 2W for a total cost of 4W to the two of them.

Given that $W >> 2W_x$ we immediately see the advantage of the cooperative scenario. We can conclude from this that in this model there is a natural advantage to cooperating and hence we have an explanation of the kind of organization that leads to altruism and

how it is connected to language. We see that altruism can arise through natural selection in the same way that the plant and fungus formed a symbiotic relationship and a mutual economy to the advantage of both.

In *Investigations* Kauffman (2000) draws an analogy between living organisms interacting cooperatively and human economics. Given that language is part of the infrastructure of human economics it follows that language coevolved with human cooperation.

Non-human economics is conducted by non-symbolic signs or iconic and indexical signs. Natural selection and co-evolution give rise to symbiotic relationships and cooperation among and between species. Human economics, on the other hand, is conducted by language and culture or symbolic signs. Symbiotic relationships are conceived of and communicated through the symbolic activities of human language and culture. The conceptualization that language makes possible gives rise to a great variety of human economic systems that have allowed humans to populate almost every corner of the globe and has given rise to the domestication of plants and animals; manufacturing and most recently the knowledge economy.

Conclusion

The propagation of organization is not only a characteristic of living organisms but also, as we have shown, a number of abstract, symbolic, extra-somatic, non-material, non-extensive mental activities of humans in the symbolosphere including language, culture, technology, science, governance and economy. This result extends the results obtained in POE in which the propagation of organization was demonstrated in the material abiotic and biotic worlds. It also indicates a universality of the propagation of

organization and the emergence of more complex forms of organization from simpler ones.

To understand the true nature of the evolution of humans we need to consider the coevolution of two domains:

1. the physically instantiated human body including the brain
2. the non-extensive symbolosphere of the human mind and all of the products of the human mind including abstract symbolic thought, language, culture, the technosphere, science, governance and economics.

There is a symbiotic relationship between these two domains and a parallel development. Both domains constantly probe their respective Adjacent Possibles. Both domains maximize their variety as predicted by Kauffman's (2000) putative fourth law of thermodynamics. As a matter of fact the symbolosphere seems to increase its variety at a much faster rate than the human body. And finally both domains are self-constructed systems as suggested by Kauffman.

A Highly Speculative Postscript - A Possible Bridge between Shannon and Biotic Information?

In POE reviewed in Chapter 2 we showed that biotic instructional information that informs or instructs living organisms is quite distinct from Shannon's classical definition of information as negentropy. If language and culture propagate their organization in a manner similar to that of autonomous biotic agents, i.e. living organisms, perhaps there is some common feature(s) that are shared by biotic or instructional information informing biotic systems and Shannon information informing human symbolic thought.

Let us start with the notion that materially instantiated instructional or biotic information informs or instructs the biomolecular

components of a living organism how to behave through biochemical processes. Shannon information operating in the context of linguistic and cultural systems informs or instructs the human psyche through non-material symbols. Is there a sense in which Shannon information can be considered a form of instructional information? Shannon information informs or instructs the receiver of what information is being sent by the sender. If we accept these definitions then we can define a generalized instructional information that embraces both instructional or biotic information defined for living organisms and Shannon information defined for human symbolic communication. This seems like a natural complementarity as the term information implies that someone or something is being informed and hence instructed. Therefore all forms of information are instructional but the precise nature of the instructional information is determined by context, i.e. by the nature of the recipient of the information, hence the distinction between Shannon and biotic information.

In POE we suggested that information was not an invariant independent of the frame of reference in which it operates but it depended on the context in which it is used. This statement is still correct but there is one common aspect of these two different forms of information we have identified which is that they both inform by definition and hence they both instruct. Biotic information instructs the cell how to convert free energy into work needed for growth and replication. The human symbolic information, i.e. Shannon information, contained in language and culture performs a similar function in that it affects human activity in such a way as to enhance the way in which sources of free energy can be found and converted into useful work. The purpose of language and culture is ultimately to enhance the ways in which human can source energy and perform work and ultimately enhance human propagation.

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