

Chapter 7 - The Four Spheres of Influence on Human Existence

Human existence is moderated by four spheres of influence and organization in which the transmission of information and the propagation of organization is key. The four spheres are 1. the biosphere, 2. the symbolosphere, 3. the technosphere and 4. the econosphere where the latter two spheres are actually subsets of the symbolosphere. It suits our purposes, however, to treat these two spheres separately and to consider language and culture in general under the heading of the symbolosphere.

The physiosphere of the abiotic material world also influences human condition in that we are subject to the laws of physics. We are acted upon by gravity, we are subject to the laws of thermodynamics and we are affected by electromagnetic radiation. But we do not consider the laws of physics that rule the abiotic physiosphere as information or a form of organization that is propagated but rather as the ground in which the operations of the others spheres take place. The laws of physics are pervasive – they are not propagated as organization as is the case with the information in all the other spheres under consideration. The information contained in the other spheres is localized whereas the laws of physics are ubiquitous.

We have already indicated that with respect to our neo-duality model of reality described in the last chapter that phenomena can be assigned to either the physiosphere of material reality or the non-material conceptual reality of the symbolosphere. The physiosphere can be divided into the abiotic part of the physiosphere that can be described purely by physics and the biosphere of living organisms that arises from the physiosphere as an emergent phenomenon. The symbolosphere of non-material phenomena arises as emergent symbolic entities from that part of the biosphere that includes human life.

The symbolosphere includes the technosphere and the econosphere but we choose to analyze them separately from language and culture because of the difference in the mechanism by which they propagate their organization. Human language, culture, the mind (as opposed to the brain), the technosphere and the econosphere form the symbolosphere. They arise as emergent phenomena from and are nested in the biosphere. The biosphere, on the other hand, arises as an emergent phenomenon from and is nested in the abiotic physiosphere. The upper spheres arise from the sphere just below them as emergent phenomena and act through downward causation on all the spheres below them. Not only does one have to understand the biotic information stored in human DNA, RNA and the proteins but also all of the symbiotic organisms that live within the human organism plus all the other organisms with which humans interact.

The econosphere consists of all the concepts for economic and governmental activities such as businesses ranging from corporations to sole proprietorships, NGOs and government agencies ranging from the offices of the heads of states, parliaments, judiciaries and various administrative bodies such as ministries and departments. The elements of the econosphere that we are considering are conceptual and represent the organization of these organizations (pun intended) and not their actual day-to-day operations in the physiosphere. The term was first coined by Kenneth Boulding (1966).

We can think of the world economy or "econsphere" as a subset of the "world set," which is the set of all objects of possible discourse in the world. We then think of the state of the econosphere at any one moment as being the total capital stock, that is, the set of all objects, people, organizations, and so on, which are interesting from the point of view of the system of exchange. This total stock of capital is clearly an open system in the sense that it has inputs and outputs, inputs being production, which adds to the capital stock, outputs being consumption, which subtracts from it.

Our definition differs from that of Boulding as his econosphere contains the actual physical elements of the economy, which is why it is open to energy and matter as well as information. The econosphere that we are considering is purely symbolic consisting of the patterns for the economy and not the patterns of the economy paralleling the way Geertz defined culture as a symbolic entity. Our econosphere is therefore open only to information and not to energy and matter. The economic organizations that compose the econosphere are technologies in a certain sense in that they are systems and processes for exchange. It is useful, however, for the purposes of our analysis to consider them separately from technology.

Information Content, Evolution, Agency, Openness and Symbiosis

As was argued in Chapter 5 the elements of the symbolosphere including languages, cultures, technologies and economic entities can be treated as living organisms, albeit parasites or obligate symbionts, that propagate their organization. Living organisms contain biotic information in terms of the organization they propagate. They evolve by the Darwinian process of descent, modification and natural selection. They also have agency in that they are autonomous agents that act on their own behalf. They are open to matter, energy and information and they enter into symbiotic relationships with each other like the example of the fungus and the plant discussed in Chapter 5. All of these properties of autonomous living organisms that populate the biosphere as we will show are also true of the elements of the symbolosphere. They too contain information, evolve, have agency, are open to information and enter into symbiotic relationships with their human hosts and with each other. In this chapter we will consider and compare from the point of view of the transmission of information and the propagation of organization the elements of the four spheres of influence on human existence. We are particularly interested in comparing within the biosphere, the symbolosphere, the technosphere and the econosphere the following five properties of their constituents:

1. the nature of the information they contain,
2. the way in which they evolve,
3. the nature of their agency,
4. their openness to matter, energy and information, and
5. the symbiotic relationships they enter into.

The symbolic constituents of the symbolosphere, technosphere and econosphere are not autonomous agents that are able to source free energy on their own. As obligate symbionts they depend on their human hosts for their source of energy but they enhance the human organisms for exploiting sources of free energy and hence their relationship with their human hosts is symbiotic rather than parasitic. As a result we will consider only their openness to information as their openness to energy is through their human hosts and there is no openness to matter as they are non-material.

Biosphere

*Biology is not a physical science but a **semiotic** science* – Terrence Deacon

A living organism that populates the biosphere is an autonomous agent that is also

- 1) a heat engine converting free energy into work;
- 2) a factory for fabricating complex biomolecules from the raw materials of their environment;
- 3) an information processing device converting external signals into appropriate internal actions and subsequently appropriate interactions with its external environment; they convert the raw data of environmental information into complex behaviors that allows them to source the energy and raw materials they need to propagate their organization and to avoid the toxins and predators that might terminate their existence. While it has been argued that living organisms are computing devices they should not be confused with human manufactured computers which are devices that process symbolic information. The computing or information processing of living organisms is not symbolic but rather involves the processing of information that emanates from material substances;
- 4) a medium of communication generating appropriate messages to its conspecifics and other organisms. They also process environmental data to enter into social and symbiotic relationships with both conspecifics and other species and as such they may also be considered as a medium of communication.

Each of these activities is necessary for the living organism to sustain itself and its species by carrying out its metabolism and its replication or in other words propagate its organization. Each of these activities in one way or another involves **information**. Activities 1) and 2) require the constraints we identified as instructional information when we reviewed POE in Chapter 2. Activities 3) and 4) involve the flow of information back and forth between the organism and its environment.

There is a third kind of information, namely human generated symbolic information, which we deal with as part of the symbolosphere. The internal inherited information content consists of the organization that the living organism propagates. An example of this biotic or instructional information are the constraints that allow the organism to convert free energy into the work required for their metabolism and replication. Biotic information also includes their DNA, RNA and proteins that guide the development and growth of the organism.

As part of the propagating organization within living cells, the cell operates as an information processing unit, receiving information from its environment, propagating that information through complex molecular networks, and using the information stored in its DNA and cell-molecular systems to mount the appropriate response. Indeed, biology is acquiring many characteristics of an information science (Hood and Galas 2003).”

The above quote describes the information processing activities of a cell but there is also the flow of information between cells in multi-cellular creatures. In simple animals without a brain there is the gathering of information by receptors and/or sense organs, which leads directly to the action of the motor system. In plants information flows give rise to phenomena such as heliotropism. Finally with animals with brains there is the flow of information to the brain where it is processed and then results in signals to different parts of the body such as the motor system for example.

Among the four functions of living organisms that we have identified, namely informatics, energetics, bio-fabrication and communications there are many linkages. First of all the information contained in their organizational structures permit 1. the conversion of free energy into work, 2. the bio-fabrication of bio-molecules, 3. the processing of information from the outside world and its transmission to different parts of its structure and, finally, 4. its communication with others. The chemical reactions building the biomolecules that make life possible are endothermic and hence require the living organism to harness free energy from its environment and convert it into work or stored energy for times that are lean. As to the organisms ability to communicate this must arise from its ability to process information and select the appropriate message to communicate as well as having energy to carry out this activity. Communication, on the other hand, is essential for sex and hence the replication of organization as well as cooperative ventures that enhance the acquisition of energy. And finally biofabrication is an essential part of the organism’s metabolism and replication.

In view of this interlocking of energetics and informatics I am inclined to added to Kauffman’s definition of a living organism or autonomous **agent** as an autocatalytic system carrying out at least one thermodynamic work cycle the condition that it is also capable of carrying out the processing of information derived from its environment such as the location of free energy and the presence of dangers such as predators or toxins.

Since living organisms sustain themselves by their ability to source free energy and convert it into work they are **open** to energy. They are also open to matter, which they require along with energy for growth and replication. Finally they are also open to information through their receptors that are part of their organization and help them to source free energy and to avoid toxins and/or predators.

We have claimed Darwin’s model of descent, modification and selection with which he described the **evolution** of living organisms also provides a model that describes the evolution of the various elements of the symbolosphere.

Another important characteristic of living organisms is that they enter into **symbiotic** relationships with each other. Symbiosis literally means living together. All biotic agents from the simplest bacteria to the most complex plants and animals including humans enter into symbiotic relationships with other organisms. There are many examples. We humans could not survive without the many other organisms that live within us. Fungi that live on the roots of plants fixing nitrogen in an exchange for food that we have referred to earlier represent a classic case of symbiosis. Symbiotic relationships develop through the communication of information.

The one form of symbiosis that had the greatest impact on the biosphere and allowed life to evolve beyond single cell bacteria, i.e. prokaryotes, and gave rise to the animal and plant kingdoms was the emergence of eukaryotes. Eukaryotic cells emerged from the symbiosis of two bacteria. The bacteria that contributed to the nucleus of the eukaryote cell combined with mitochondria in the case of animals or chloroplasts in the case of plants. It is surmised that the first eukaryotes arose when one bacterium, for example a mitochondria, penetrated the wall of another bacteria to create a symbiotic relationship of two organisms that were originally prokaryotes. These two formerly autonomous organisms lived within the walls of a single cell to become a single eukaryote organism more complex than its two original prokaryote components. The birth of eukaryotes represents an example of emergence because the eukaryote's properties cannot be reduced to, derived from or predicted from the properties of the two prokaryotes of which it is composed. Even before the emergence of eukaryotes bacteria formed cooperative symbiotic networks or relationships in which one bacterium provided a function or service for another bacterium in exchange for food. It was surmised by Lynn Margulis (1970) that in the course of one of these symbiotic relationships one of the bacteria instead of lingering in the neighborhood of its partner actually entered into the cell of the other and thereby surrendered its autonomy. The resulting eukaryote cell then became more complex with one of the bacteria forming the nucleus and the other the organelle of mitochondria, the energy engine of the cell.

The Symbolosphere: Words and Language

Words and language gave rise to the symbolosphere as words are abstract symbols that represent something other than the sign that is the word. We begin our analysis of the symbolosphere by studying the five properties of language or words. Words are both a medium for representing, communicating and expressing information and a form of **information** in themselves. Words and language are a pure medium for the representation of information and like the light bulb is, according to McLuhan (1964, p.8), a medium without content. The user (or speaker) provides the content or as McLuhan once said "the user is the content."

The representation of information with words or language needs little justification but perhaps a word or two for the claim that words themselves are a form of information is in order. As was argued in Chapter 3 words act as strange attractors uniting all of the percepts associated with the concept that the word represents. Words therefore carry with

them the information of all the percepts with which they are associated plus all of the ways in which the words, as part of a semantic web, have been used.

Because they carry the information as a result of all of their association words have **agency** in that they carry and assert (or insert) additional meanings that the speaker might not have intended when using them. Poets are adept at making use of the multiple meanings of words allowing the agency of the words they choose to use to enrich their poetry.

Words are **sybiotic** in that they live together and work with each other. A word isolated by itself has no meaning. Words give meaning to each other through the syntax of the language and within the semantic web in which they exist. They change each other's meaning. They sometimes co-exist together in a single new word as house and boat in houseboat or in expressions like "by and large" or in compound words like steamboat, steamship, and airplane.

The meaning of words **evolves**. The word fair for Shakespeare meant beautiful or wonderful whereas today it means average. The word awful originally meant something that filled one with awe but now means something that is unpleasant.

Language as a medium for the representation and transmission of information is naturally **open** to information. A language is also open to the information in the sense that it is open to other languages through the use of loan words and their participation in a sprachbund, a union of languages that have certain similarities because of geographic proximity. Words are open to information in that they are part of and form a semantic web and they are open to each other through the grammar or syntax of the language. Language is also open to new information generated by the experiences of their users. New words are invented as novel experiences emerge such as the invention of new technologies or new social, political or economic situations. Existing words take on multiple meanings like the word "cool".

If we consider the language of each individual as an organism and a language like English or French as a species of all the individuals who can communicate with each other through that language then we see that the languages of individuals live together with the languages of other individuals, i.e. they are sybiotic. The species languages of English and French also interact as English speakers use French words such as chauffeur or RSVP and French speakers use englishisms such a le weekend or le pullover.

The Symbolosphere: Culture

Culture is a symbolic form of **information**, namely, "patterns for behavior" as Geertz (1973) has pointed out. Culture also serves as a medium through which information is generated and conveyed. As described in Chapter 4, cultures evolved in such a way so as to be easily learnt so that they can propagate their organization. The ability to propagate their organization and thereby preserve themselves reflects the **agency** of cultures. So does the fact that societal cultures often act in their own self-interest at the expense of

their hosts as is the case of an imperial culture, which requires the sacrifice of its citizens when calling upon them to put themselves in harms way during military operations. Cultures change or **evolve** to improve the chances of the survival of their hosts and hence themselves as environmental and/or social conditions change. They are able to do this, as they are **open** to information. As described in Chapter 4 the organisms of culture are those that belong to individuals, which interact with each other to form a society. The cultural organisms of individuals are therefore **symbiotic** in the sense they live together and by so doing they create the *culture* of their society.

The Technosphere

The technologies including products, services, processes and systems that have been invented by humankind belong to a space akin to the biosphere that is commonly known as the technosphere. The technosphere as we utilize the concept in this study consists of the abstract symbolic concepts that go into creating and using tools or technologies and not the actual physical tools or technologies themselves. These concepts, which are the patterns (ala Geertz) for the manufacture and utilization of tools, therefore form the **information** content of the technosphere.

Technologies, unlike living organisms that are able to sustain themselves by carrying out thermodynamic work cycles, are not autonomous agents. Rather technologies are obligate symbionts that depend on their human hosts for their inception, manufacture and the energy for their operation and their action on the environment and their human hosts. Technologies are therefore not autonomous and their **agency** is on the whole directed by the intentions of their human users. The question therefore arises as to what extent can we claim that technologies really possess agency. We begin addressing this question by asking what is an agent and what we mean when we attribute agency to an object or a process. A dictionary definition of an agent is one who acts or causes things to happen. This is an obvious trait of a living organism that acts on its environment exploiting its resources in terms of raw materials and free energy to propagate its organization and as a consequence causes changes to its environment. But, what about technologies? Let us consider a hammer. A hammer is an inert object that cannot of its own accord pound a nail into wood. It can only effect change through the agency of its human user. It is through its use by a human user that the hammer and its user together have agency. But looked at through a McLuhanian perspective the hammer may be regarded as an extension of its user and therefore the hammer partakes of the agency of its user.

It can also be argued that technologies possess agency by virtue of the fact that they also act upon their human hosts and the environment in ways that are independent of the intention of their users. McLuhan through his aphorism “the medium is the message” which includes all forms of technology and his observation that the effects of media and technologies are often counter-intuitive and unintended identified a certain level of agency for technologies and media. While strictly speaking technologies or media do not literally initiate their actions they do so metaphorically because part of their impacts or actions are totally unrelated to the intentions of their users.

Like biological living organisms technologies **evolve** through the Darwinian mechanism of descent, modification and selection as pointed out by Basalla (1988). The mechanism of descent applies to technologies because all tools start as a modification of a former tool with the very first original tools being found tools. The modification of the starting tools is done by the inventor and sometimes involves the convergence of two tools as was the case of the automobile or horseless carriage as it was first called, a marriage of the carriage and the motor.

The fact that two tools can combine to form a third tool illustrates that tools are **open** systems. The earliest example is the construction of the axe with a handle, which is the combination of the hand axe, which became the head of the axe and the lever in the form of a stick, which became the handle of the axe. After the invention of the steam engine the steam engine replaced the water wheel and the windmill and combined with the mechanical tools that were powered by running water and wind. These examples also illustrate how different tools like living organisms can enter into **symbiotic** relationships with each other in which the technologies support each other. The example of the automobile emerging from the horse drawn carriage and the gasoline engine is an example of techno-symbiosis that parallels the emergence of eukaryote cells where the carriage plays the role of the cell with a nucleus and the engine plays the role of the mitochondria. The symbiosis of technologies (techno-symbiosis) can take place with stand alone technologies supporting each other as is the case with the iPod, iTunes, personal computers and the World Wide Web. Users are able to download songs from the Web-based application iTunes onto their personal computer and from there upload the song on to their iPod. Apple Inc. created iTunes and the iPod to work together symbiotically taking advantage of the Web and notebooks.

The iPhone represents the symbiosis of a group of technologies that include the Web, the cell phone, the camera, the iPod, and the touch sensitive screen that combine to create this device. The iPhone is an emergent phenomenon in that it has properties in addition to those of its components that cannot be derived from, predicted from or reduced to the properties of its components. The success of a new technology depends on what techno-symbiotic relationships it can form with other technologies that support its success. For example the technology of the automobile requires the technology of roads and a distribution system for gasoline.

Other examples of techno-symbiotic relationships include:

- cultivation and irrigation;
- writing and paper;
- the movable type printing press, the alphabet, and paper;
- the book and the printing press;
- the steam engine and mechanical devices such as the locomotive and the steamship;
- the skyscraper and the elevator;
- the automobile and the highway;
- the electrification of mechanical devices, such as electric motors and the phonograph player or any of a variety of electric kitchen appliances;

the mainframe computer and programming languages; and the personal computer and software applications.

The analogy between living biotic organisms and technologies is fairly compelling given that they both have agency, evolve new forms, have information content, are open to information and enter into symbiotic relationships with each other. The only things lacking is that they depend on their human hosts for the energy of their operation and they are unable to reproduce themselves but require human intervention for their reproduction. Techno-organisms are therefore not autonomous agents but rather they enter into symbiotic relationships with their human hosts and may be regarded as obligate symbionts.

There is an interesting spin on the notion of technologies behaving like organisms in the sense that when they combine or cross-pollinate with each other – it is as though they are mating. Thus when the carriage of the horse and carriage mated with the motor the automobile was born. Or when the boat and the steam engine mated the steamboat was born.

In the 20th century computer scientists, cyberneticians, information theorists and artificial intelligence (AI) experts made use of the analogy or metaphor of the computer or Turing machine for creating their physicalist's models of life and intelligence just as Newtonian physics gave rise in the 18th century to mechanical models of life and intelligence. More recently with the development of emergentist self-organizing models of life and intelligence in the work of Kauffman (2000) and Maturana and Varela (1992) the metaphor of Turing machines is being superseded with biological models. This is the tack that I have taken in this study which I believe provides fresh insights into the nature of human behavior such as the invention and use of technology. If the focus of 20th century models was on computing I believe 21st century models will focus on biology and perhaps other emergent phenomenon like culture, language and the mind.

Disruptive technologies as saltations or examples of punctuated equilibrium

To support our notion that the evolution of technology is similar to the evolution of living organisms in the biosphere we will consider examples of disruptive technologies which function as punctuated equilibrium in the technosphere. The work of Eldredge and Gould (1972) on punctuated equilibrium in the biosphere suggests that natural selection can result in sudden discontinuous changes on time scales that are relatively brief on the geological time scale and correspond to speciation events, followed by longer periods of less dramatic change. Like punctuated equilibrium in the biosphere disruptive technologies represent sudden discontinuous changes in the array of human tools in time scales that are relatively brief on the time scale of the technosphere and correspond to a new technological era in which a number of new technologies arise taking advantage of the new disruptive technology while at the same time some older technologies become obsolete or take on less important functions.

We identify these technologies as disruptive because they led to major shifts in the development of other technologies and they brought about major social, economic and political change. Examples of disruptive technologies, which ushered in associated changes include:

- the first stone tools and the control of fire over one million years ago from which mimetic communication and culture emerged,
- the explosion of cultural artifacts or technological innovations in tool making circa 100,000 to 50,000 BCE, which many believe, corresponded to the same period that human language and symbolic representation such as art emerged (Bickerton 1998, pp. 354-5; Crow 2002, p. 93; Dunbar 1998, p. 105; Logan 2007),
- writing and mathematical notation circa 3,000 BCE associated with the rise of city states and civilizations with written laws and religious institutions,
- science circa 2,000 BCE and then modern science circa 1500 AD,
- the alphabet circa 1500 BCE associated with monotheism, philosophy, and deductive logic and led to the discovery of zero,
- zero and the place number system circa 200 BCE associated with algebra
- mechanical devices such as heavy plow, animal harnesses, wind mills, water wheels circa 1000-1400 AD associated with the rise of the bourgeoisie and modern cities and led to the printing press,
- movable type printing press circa 1450 AD associated with the Renaissance, the Reformation and eventually universal education and provided a model for mass production,
- steam engine associated with the industrial revolution circa 18th Century,
- electricity associated with electric mass media circa 19th to mid 20th century,
- computing in the last half of the 20th century and also associated with automation and robotics,
- Internet and World Wide Web from 1980 to present associated with Web 2.0 economics.

Each of these forms of disruptive technology is a perfect example of punctuated equilibrium. These discontinuities in the evolution of technology illustrates Prigogine's theory that far from equilibrium new levels of order can suddenly emerge as a bifurcation from a chaotic non-linear dynamic system which is the nature of human culture (Prigogine and Stengers 1984 & Prigogine 1997).

Exaptations

Another parallel of evolution in the biosphere and the technosphere are the presence of exaptations or spandrels. In St. Mark's Cathedral in Venice spandrels are architectural structures that are integral to the support the building. They were decorated with images of the evangelists and are an integral part of the decoration of the interior of the church. Gould used the metaphor of the spandrel to explain the phenomenon of exaptations in the evolution of biological organisms:

Under the spandrel principle, you can have a structure that is fit, that works well, that is apt, but was not built by natural selection for its current utility. It may not have been built by natural selection at all. The spandrels are architectural by-products. They were not built by natural selection, but they are used in a wonderful way—to house the evangelists. But you can't say they were adapted to house evangelists; they weren't. That's why Elizabeth Vrba and I developed the term 'exaptation'. Exaptations are useful structures by virtue of having been co-opted—that's the 'ex-apt'—they're apt because of what they are for other reasons. They were not built by natural selection for their current role (Gould 1996, p. 59).

An example of biological exaptations are the wings of insects which originally served as cooling devices but were exapted for flight. The same is true of dinosaur wings, which were originally upper limbs that were used to scoop up prey more efficiently and were exapted into devices for flight. Another example was the swim bladder that fish used to regulate the depth to which they could descend by changing the mixture of air and water the bladder held. This device exapted into lungs and resulted in the emergence of land animals.

Exaptation play an important role in the design of technology. Examples include the way in which three dimensional clay tokens discussed in Chapter 3 used for accounting in Sumer became exapted into two dimensional signs for agricultural commodities and numerical quantities that eventually evolved into writing and numerical notation. The Newcomb steam engine designed to pump water out of coal mines was exapted by James Watt to harness steam for locomotion and the operation of factories that had previously been powered by water wheels and windmills. The Gutenberg movable type press is another example of an exaptation of the wooden block print system of text which itself was an exaptation of textile printing. Exaptation is powerful tool in the design of new technology.

An Alternative to the Darwinian Evolution of Technology

We have to this point suggested a Darwinian model of descent, modification and selection for the evolution of technology and even drew analogies with punctuated equilibrium and exaptations. There is one difference, however, between the evolution of biological organisms and technology and that is in the modification step. In biology the modifications are random and unintentional whereas for technology the modifications are intentional and chosen by the designer of the new technology. As a result Olesen (2008) has suggested that perhaps the model of the Darwinian evolution has to be modified somewhat because of the role of the designer or innovator of the new technology. He wrote,

Neither a Darwinian random selection process nor a completely rationalized, planned Lamarckian-like process is a proper description of how media develop. We need a combination describing what perhaps could be called a new kind of evolution, alternative to the biological. Still, a fundamental question remains:

where do the purposeful creations of the designer stop and the general mechanisms of overall media development take over?

Technological Innovation, Design and Emergence

While Olesen was correct to point out the difference between bio- and techno-evolution, there still exists a parallel of the two processes. Van Alstyne and Logan (2006) in a study of industrial design at the Strategic Innovation Lab at the Ontario College of Art and Design have argued that the very act of designing an innovation involves a process of emergence similar to that of the emergence in the biosphere. They discovered the surprising and counterintuitive truth that the design process, in and of itself, is not always on the forefront of innovation. Design is a necessary but not a sufficient condition for the success of new products and services. They proposed that design must harness the process of emergence; because it is only through the bottom-up and massively iterative unfolding of emergence that new and improved products and services can be successfully refined, introduced and diffused into the marketplace.

They suggested the following parallels between the emergent design of technology and biological emergence:

- propagation of organization toward a goal or purpose,
- involvement of selection,
- development of differentiation from generality or an increase in complexity,
- morphogenesis or the birth of new forms.

They also identified the following differences between human design and emergence in nature:

- intentionality of the technology designer versus autonomy of massively multiple biological agents
- technology design is cognitive, conceptual, top down, controlling versus biological emergence which is just the opposite, a- cognitive, a-conceptual, bottom up, non-controlling
- fixing relationships versus maintaining relationships, and
- setting constraints versus exploring constraints.

Emergence as Nature's Form of Design (an excerpt from Van Alstyne and Logan 2006)

The question of control versus influence is the crux of the contrast between human design and natural emergence. Nature does not control; she merely accepts whatever is the best fit. Natural selection, the force that selects, is the result of the aggregate of environmental factors and the attrition of individuals incapable of mating or propagating their organization.

Perhaps human designers can learn from nature new ways to design more effectively. What is her secret? Well to start with she spawned these creatures, life forms that could organize themselves, act in their own self-interest, adapt to changing conditions while

continually and relentlessly searching for improvements in the Adjacent Possible, thereby creating new species, new genres and even new taxes. Nature did not actively spawn these creatures – she merely created a set of physical laws, including organic chemistry, which allowed them to emerge through self-organization. And why were these creatures able to achieve this magnificent accomplishment? The answer is so simple it is often overlooked. They had *purpose* – the purpose to propagate their organization. Those that were able to realize that purpose survived, lived and bred, and those that were not able fell by the wayside and were heard from no more.

So what is the bottom line for the designer? Purpose must be the starting point, the motivating factor. Next the materials must be in place, the elements that will go into the design. Then the designer must catalyze the process so that elements of the design self-organize into a pattern that can achieve the purpose or *telos* of the design.

These four elements represent the four causes of Aristotle: material, formal (the pattern), efficient (the designer) and final or *telos* cause (the purpose). The designer is the efficient cause trying to make the final cause – the purpose. Designing is causing.

Econosphere

The economic units or systems of exchange of the econosphere consisting of businesses, NGOs and governmental agencies are the symbolic patterns for the organization of materials, energy and human activity and as such they represent **information**. The actual physical instantiation of these economic units of the econosphere are open to energy, matter and information whereas the symbolic patterns of the econosphere are **open** only to information.

They **evolve** through the Darwinian mechanism of descent, modification and selection, as was pointed out by Johnson and Earle (1987) reviewed in Chapter 4. The mechanism of descent arises simply because all existing systems of exchange emerge as a modification of a former economic unit where the very first original human economic units were the biological family where the only exchange was between family members. The modification of economic units is initiated by a small cadre of leaders and social innovators and is then selected by the community as a whole.

Economic and governmental organizations have **agency** by virtue of the institutional will of the organization, which often supercedes the will of individuals within the organization. Citizens do not wish to pay taxes but they are obliged to do so by their government. In a company the employees cannot pursue their own self-interest but must act in the interest of their firm, which is to be profitable. For NGOs the objectives of the organizations become their agency.

Economic and governmental organizations are **symbiotic** in that they interact and trade with each other to form political economies and international trading partnerships. It is

also the case that businesses and NGOs depend on government agencies in order to function.

The analysis that we have just made is reviewed with the following matrix where the M_{ij} are described below:

Matrix of Spheres of Influence and their Properties

C1\R1	Info*	Evolution	Agency	Open*	Symbiosis
1. Biosphere	M_{11}	M_{12}	M_{13}	M_{14}	M_{15}
2. Symbolo- sphere	M_{21}	M_{22}	M_{23}	M_{24}	M_{25}
3. Techno- sphere	M_{31}	M_{32}	M_{33}	M_{34}	M_{35}
4. Econo- sphere	M_{41}	M_{42}	M_{43}	M_{44}	M_{45}

Info* = Information content; Open* = Openness to information and in the case of the biosphere openness also to energy and matter.

M_{11} : The information content of the biosphere is in the form of DNA, RNA, proteins and the other forms of biotic or instructional information as defined in POE.

M_{12} : The evolution of living things as described by Darwin in terms of descent, modification and natural selection.

M_{13} : Living organisms are autonomous agents that act in their own self-interest.

M_{14} : All living organisms are open to matter, energy and information.

M_{15} : All living organisms live in symbiotic relationships with other organisms.

M_{21} : Language and culture are symbolic systems, which carry information and are at the same time a medium for communicating information.

M_{22} : Language and culture evolve by descent, modification and selection through the mechanisms of memes.

M_{23} : Language and culture act as organisms with their own agency as described by Christiansen (1994) for language and Logan (2007) for culture.

M_{24} : Languages and cultures are open to information as this is the mechanism by which they are modified.

M₂₅: Languages and cultures are not isolates but live in interaction with other languages and cultures.

M₃₁: Tools and media that belong to the technosphere are not the physical instantiation of these technologies but the symbolic concepts of their design, i.e. patterns for the construction of the tools or media. As such they are forms of information.

M₃₂: Technologies evolve through the mechanism of descent, modification and selection as pointed out by Basalla (1988).

M₃₃: Technologies have agency by virtue of their unintended effects as pointed out by McLuhan (1964).

M₃₄: Technologies are open to information as this is the mechanism by which they are modified.

M₃₅: Technologies are symbiotic is that the success of one technology depends on the existence of other technologies they co-exist with.

M₄₁: Economic units and governmental agencies are symbolic patterns for the organization of materials and humans and as such they represent information.

M₄₂: Economic units evolve through the mechanism of descent, modification and selection as pointed out by Johnson and Earle (1987).

M₄₃: Economic and governmental organizations have agency by virtue of the institutional will of the organization, which most often supercedes the will of individuals within the organization.

M₄₄: Economic and governmental organizations are open to matter, energy and information but the constituents of the econosphere, which are the symbolic patterns of exchange, are open only to information.

M₄₅: Economic and governmental units organizations are symbiotic in that they interact and trade with each other to form political economies and international trading partners.