

Concept Paper

Terms for Talking about Information and Communication

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Received: 4 June 2012; in revised form: 17 August 2012 / Accepted: 20 August 2012 /

Published: 27 August 2012

Abstract: This paper offers terms for talking about information and how it relates to both matter-energy and communication, by: (1) Identifying three different levels of signs: *Index*, based in contiguity, *icon*, based in similarity, and *symbol*, based in convention; (2) examining three kinds of coding: *Analogic differences*, which deal with positive quantities having contiguous and continuous values, and *digital distinctions*, which include “either/or functions”, discrete values, and capacities for negation, decontextualization, and abstract concept-transfer, and finally, *iconic coding*, which incorporates both analogic differences and digital distinctions; and (3) differentiating between “information theoretic” orientations (which deal with *data*, what is “given as meaningful” according to selections and combinations within “contexts of choice”) and “communication theoretic” ones (which deal with *capta*, what is “taken as meaningful” according to various “choices of context”). Finally, a brief envoi reflects on how information broadly construed relates to probability and entropy.

Keywords: sign; index; icon; symbol; coding; context; information; communication

*“If you have an apple and I have an apple
and we exchange apples
then you and I will still each have one apple.
But if you have an idea and I have an idea
and we exchange these ideas,
then each of us will have two ideas.”*

—George Bernard Shaw

“Of all of the things in this world,

*information is the hardest to guard,
because it can be stolen without removing it."*

—Erving Goffman

*"The great enemy of communication
is the illusion of it."*

—Pierre Martineau

1. Introduction

Information relates to matter-energy by always being dependent “upon it” and fundamentally “of it”, and yet at other levels of analysis somehow “*about* it”. As the rules of a game exist at a different level than that of the game itself, information basically enables a coding or structuring or patterning that, by occurring at various levels of abstraction not reducible to physical matter and by opening ranges of space and time beyond the immediate now, enable forms of work to be done. If energy can be defined as the capacity of a system to do work, largely by being able to set matter in motion, then information can be defined as the capacity of a system to do work logically or structurally, to organize and pattern matter or energy (or information) not found at the level of physical or chemical systems [1]. Anthony Wilden instructively overviews these issues and nicely sets the context for the following discussion where he writes: “Information in the simplest sense is a pattern of variety... carried by a matter-energy marker or medium.... Information is in no intrinsic way distinct from any other kind of variety. For a given goal-seeking system, however, information is *coded* variety (relative order); *uncoded* variety (relative disorder) is noise.... Matter-energy and information are distinct from each other both in kind and level of reality.” ([1], p. 72) The key word is “*levels*”, for information (and reality too) always occurs at more than the level of matter-energy, and much information, as coded-variety, is *about* other forms of variety including other forms of information. Hence, as new orders of complexity emerge, or even as we change levels of abstraction or levels of logical typing in our signs, we accordingly must attend to the particular kinds of information that come into play.

Information occurs throughout the inorganic and organic world; nature not only exhibits emerging orders of complexity but the whole of reality does not occur all on the same level. This means that although energy can be transformed, exchanged, and used but not created or destroyed, information is, depending upon context as well as level of analysis, continually created and destroyed, and it is also negated, distorted, falsified, and misread. Hence, the amount of energy in the cosmos is basically constant; it simply changes form according to various kinds of interaction. In significant contrast, writes Wilden, “the amount and diversity of information in the cosmos has been increasing since the beginning of time (the origin of organization)—more so since the beginning of life (biological organization) and the evolution of increasingly complex organisms, and yet more so since the emergence of human social systems at the beginning of history.” ([1], p. 71) Without the forms of order that make various kinds of information possible, life on this planet would not have emerged, to say nothing of the precarious achievement of humanity, with its very abstract species or varieties of symbolic information and communication.

To illustrate the range of issues here as well as provide some useful vocabulary for understanding the nature of information, I first outline three different levels of signs (index, icon, symbol).

2. Levels of Signs: Index → Icon → Symbol

Three kinds of signs must be outlined, each of which bears a particular orientation, set of relations, and, depending upon context, level of abstraction. As a first cautionary note, although each kind of sign can be considered individually for the purposes of discussion, they represent emerging orders of complexity and a dependent logical hierarchy such that latter levels depend upon earlier levels. Hence, all three remain present (or can be identified) at the symbolic level (e.g., a spoken or written language). And, as a second cautionary note, the present focus on the three *levels* of signs is offered heuristically. It represents a working understanding I developed, not from moving out of the original source of the terms, Charles Sanders Peirce, but rather, mainly from responding to student questions while teaching the ideas of Gregory Bateson and Anthony Wilden. Readers interested in the other accounts of the evolution of signs (e.g., icon, index, symbol) might consult Floyd Merrell's *Change through Signs of Body, Mind, and Language* [2].

Evolutionarily, I would suggest, *indexes* are the basic rule and the dominant functioning or regulating sign-system, the concrete on-going codification by which both inorganic matter and life at various levels organizes itself. Indexes codify physical and material kinds of variety by contiguity; an index is always symptomatic of and registers some given state-of-affairs, and, to that extent, such information cannot be weaned from its original physical context of occurrence. At the level of the indexical sign, then, energy-matter and information are nearly identical; they merge if only in that the energy or matter comes to be physically altered or structured by relations of contiguity within the particular interaction *per se*. Some simple examples of indexes include: Various pheromones given off by an animal in heat, plants turning toward sunlight, the reddening color of the leaves during Fall, the accumulation of sedimentation on geological formations, the changing orientations of a wind-vane, the thermocouple within a thermostat, the blush of a face, or a bite as an act of aggression, or even a scar left from an animal bite.

Through a long evolutionary period, *iconic* forms of communication emerged within organismal teleonomy and were significantly amplified and extended through various forms of threat, deception, camouflage, and mammalian play (also see [3–8]). At this level of organic life, iconic signs enable energy-matter and information to increasingly diverge; organisms increasingly can discern resemblances between different items and at levels of abstraction once removed from immediate materials. Iconic signs allow for information storage and retrieval through a wider range of materials and also enable new vistas for kinds of interaction. An iconic sign is thus a sign whose meaning emerges from some kind of semblance or similarity. Here the sign appears to be similar to (or bears a physical or structural resemblance to) some existing or known thing or state-of-affairs. Although indexical signs often operate without any conscious purpose, or well below the level of intention, iconic signs commonly presume more abstract and conscious levels of interaction; they require the emergent complexity of organismal goal-seeking and capacities for dealing with appearances and semblances. A few examples of iconic signs include: Perception, a drawing or painting of a likeness, a scarecrow, any manufactured object, sounds that have well-known rhyming sounds, emoticons,

photographs, and visual gestalts. A clear illustration also comes from considering the well-known image of the “Old Women or Young Lady” (see Figure 1).

Figure 1. Old Woman or Young Lady.



In this image, two different iconic signs can be seen at a level of abstraction different than the sensory (*i.e.*, indexical) level of the inked piece of paper or physical medium.

Iconic sign-use within communication can be found in the operations of eidos: Organisms map their environments and bring forms of intelligibility that allow for generality and the emergence of meaningful experiences rather than mere fleeting attention to sensory differences immediately present. Low-level concepts, still inextricably installed within the immediate perceptual environment, are examples of iconic signs. Our sensory organs of olfaction, touch, taste, even to some extent hearing and vision, mostly operate indexically by codifying sensory differences into information but perception *per se* (*i.e.*, in contrast to mere sensation) enables iconic representation, a capacity to map and frame and introduce nascent forms of conceptualization, even if the concepts have not been weaned from their installment in the immediate sensory environment. Said otherwise, the ability to recognize similarities across different perceptual items, say rectangles of different dimensions, or circles of different sizes, displays a higher-order complexity than merely attending to the immediate fields of sensation. By such base-level conceptualization, organisms move beyond a world of endless variety and are able to learn from experience even though no two items, situations, or encounters are ever entirely the same. Hence, sensory differences are coded into perceptual process, and this enables organisms to deal with their immediate environments through iconic forms of conceptualization, but the levels of iconicity do not stop there. Higher-order, or second-level, iconic signs can be found within the “framing” behavior of mammalian play.

Gregory Bateson nicely illustrates the evolutionary progression from the level of indexical signs to the various levels of iconic signs when he at various places suggests that, “The playful nip denotes the bite but does not denote what would be denoted by the bite” (see [4–8]). Within mammalian play, then, forms of interaction and purposeful engagements rely upon information increasingly removed from the physical materials of the interaction. Admittedly, a nip looks quite similar to a bite and occurs within a context that could have a real bite only moments away. Also, there is good reason to believe that the metaphoric sign, as a kind of substitution, evolutionarily begins through temporal synecdoche (a temporal part-to-whole relation): As the beginning of a sequence, repeated often enough, eventually

comes to suggest the sequence as a whole, the nip comes to mean the bite without meaning what the bite means. Nevertheless, the psychological or conceptual *frame* between “play” and “not-play” remains precarious and subject to sudden dissipation, and yet, it still retains enough coherence to enable organisms to mean a bite without meaning what that bite would mean. It may help to comparatively consider how a staged kiss within a play can mean a kiss though not mean what a kiss would mean, or perhaps, how written symbols in newspapers such as “sh*t” or “f*ck,” can mean a particular word without meaning what that word would mean. At the least, once organisms have reached enough complexity to engage in play, they are capable of multileveled information exchange (*i.e.*, complex iconic sign use), including some management of communicative frames or communicative contexts.

We can playfully illustrate some of the relations to be found between index, icon, and symbol by turning, perhaps somewhat surprisingly, to Hilary Putnam’s *Reason, Truth and History*, a book more concerned with problems of reference in philosophy than with nuances of semiotic theory. Nonetheless, Putnam instructively sets the context for the present discussion where he writes, “An ant is crawling on a patch of sand. By pure chance the line that it traces curves and recrosses itself in such a way that it ends up looking like a recognizable caricature of Winston Churchill. Has the ant traced a picture of Winston Churchill?” ([9], p. 1) Putnam’s point, largely about the problem of reference, is that the ant couldn’t possibly have *intended* to depict Churchill; it doesn’t know of Churchill, has never seen Churchill nor even a picture of Churchill, and we do not assume ants to have such intelligence. Although the ant is likely without such representational capacities, we are not. In fact, someone very well could look down at some ant tracks, basically an index left from an organism’s movement, and see an icon, a physical similarity at a different level of abstraction, of the physical likeness of Winston Churchill. At the level of iconicity, then, matter and information increasingly diverge, but they are not yet as divergent as in the *symbol*, where the ant’s walking line would need to trace the shape, however unlikely, of the written words “WINSTON CHURCHILL” in an attempt to refer to or *signify* Churchill. We can nicely summarize these progressions in levels of signs by maintaining, with Wilden, that, “Information (coded variety) is qualitatively distinct from sensing (perception), meaning (connotation), signification (denotation).... Sensing is coded information, meaning is coded sensing, and signifying is coded meaning” ([1], p. 185).

Outlining various developments involved in the evolutionary process by which human symbolicity emerged, Wilden writes that “the more complex the organism, and the more extensive its relations with other organisms, the more abstract the information becomes, the more levels it involves, and the less it resembles the matter-energy that bears it.” ([1], p. 171) The last level to emerge, as already suggested, is the symbolic, which refers to wholly abstract signs that gain or express their informational or relational value not through contiguous space or time position (*indexicality*) nor through likeness and similarity (*iconicity*), but through learned and/or historically-shared convention. Some examples of symbols include: Natural languages, flags, abstract art, various conventionalized nonverbal gestures, money, theme parks and monuments, identity claims made through clothing, certain kinds of gifts, *etc.* Symbolic information represents the highest level of abstraction in conceptualization and also exhibits the greatest divergence from the matter-energy used to convey it.

Again underscoring the dependent-hierarchy between index, icon, and symbol, we need to combat the all-too-common tendency to treat language as if it were merely or exclusively a symbolic system,

one that represents through “arbitrary” relations. Language, not reducible to the symbolic level, also has an indexical and an iconic underbelly. It is indexical not only because all real, actual speech and language occurs at factual places and times, but also, at a different level of analysis, because many kinds of linguistic indexes, words such as “now”, “here”, “this”, pervade language use (see [10,11]). And, we can appreciate the degree to which language is iconic when we think of how many words sound similar to other words and how valuable such rhyming is for memory and recall. Indeed, if sounds were not iconic to each other, we would be highly limited in one of our greatest anti-chance devices (*i.e.*, memory), and poetry would be impossible.

The information employed within human language, then, is multileveled. From a fixed set of elements selected from and combined according to various rules of grammar and syntax (e.g., phonemes, syllables, words, and letters of the alphabet), we can produce an infinity of meaningful propositions and can even signify what is *not* to be found in any existing physical or material states-of-affairs. Carefully examine, as one seemingly simple example, the multileveled nature of the following sentence: “*This statement is in English*”. Note immediately that if one were to translate the sentence into any other language, the proposition conveyed becomes false. Hence, many levels of signs are present in this simple statement [8]. First, there must be a physical medium and code for conveying the proposition and it must occupy some physical space, even if only momentarily. Whether spoken aloud or written out as it is here, the indexical level refers to all the ways the information conveyed by the words depends upon factual relations in the material world and the specific space or time relations. Also, the indexical word “this”, sometimes called a “shifter”, is a word whose referent gains determination only by forms of contiguity rather than by learned convention. Moreover, the metalinguistic words (e.g., “statement” and “English”) occur at higher levels of abstraction than everyday object language (e.g., “The cat sat on the mat.”), and, when such abstract metalinguistic words are combined with a low level indexical word such as “this”, the grammatical combination enables a self-reflexive as well as a potentially paradoxical proposition (*cf.* [12]). The important theoretical point is that only information at the level of *symbols* can be explicitly, denotatively, true or false. Of the three sign levels, then, symbols are the last to emerge and yet they somehow enable some forms of strategic retardation; a few highly abstract words within language, words such as “this”, “here”, “now”, “it”, “I”, *etc.*, can retain a sense of indexicality (similar to neoteny) by operating in conjunction with and yet still beneath the symbolic. This is also partly how and why paradoxes occur within self-referential systems (see [7,13]). Such indexical words, as kinds of context-bound pointers, follow conventionalized traditions and rules regarding the pragmatic use of indexes and ostensible reference.

Before concluding this section, I offer three more sets of examples to clarify and illustrate the dependent and hierarchal nature of the three different levels of signs. I first briefly review these terms by considering publically posted signage, how such terms bear upon criminal activities and detective work, and finally, I briefly address the relevance of the terms for understanding the operations of DNA.

Notice that most traffic signs and publically posted billboards display all three levels of the sign. First, the physical material of the sign as well as where it is actually placed manages it in its indexicality. If it is a traffic sign, it will need to be placed at a distance appropriate for an assumed speed of encounter. If it is to indicate an upcoming off-ramp, it needs to give enough distance or time

but not too much. If the sign is for a men's or a women's bathroom, it will need to be placed on the appropriate door, or at least at a non-confusing location. In addition to the logistics of signage size and placement, many publically posted signs display icons or graphic images in addition to carrying written language. The icon might be an arrow, a representation of an upcoming fork in the road or of an off-ramp. If it is a bathroom sign it may bear some likeness to customary male or female clothing. A no-smoking sign might depict a graphic image of a lit cigarette (an icon) with a circle over it and a diagonal line across the circle, a conventionalized sign (a symbol) for "don't". And, obviously, all written language on any signage, as always posted somewhere and always in some kind of font, embodies all three levels.

For a second illustration of the differences and dependent relations between index, icon, and symbol, consider how criminals, detectives, and forensic scientists all play their part in employing the different kinds of signs: After a crime is reported, detectives enter the scene and carefully look for indexes of what happened [14]. In their attempt to reconstruct the event as it likely occurred, they look for hard evidence, indexical signs, of what actually took place. They look for symptomatic or evidential information, perhaps signs that the criminals did not even notice they were leaving behind. The criminals, on the other hand, likely attempted to attend to the indexes very carefully so that they left the crime scene without implicating themselves; investigators will be either without a clue or purposefully misled. Note that if the criminals did attempt to misdirect by covering their trail or leaving counter-clues, they basically needed to attend to their indexes and carefully leave behind iconic signs. The iconic signs would have been planted pieces of evidence that the criminals left behind which, if the investigators naively take to be indexes, will successfully mislead. Thus the criminals are interested in monitoring and concealing their indexes, while leaving behind materials that will iconically give false impressions. For even further illustration along these lines, notice that in forging a signature on a check, a criminal needs to not only have the correct symbolic information but the signature needs to physically resemble (be iconically coded as) the original signature, whether that original signature is cursively written (an analogic code) or printed out (a digital code). Symbolic signs and forms of language in particular, perhaps obviously, are employed throughout both criminal activities and detective work, but less obvious, *they are absolutely necessary for clearly and articulately disambiguating between indexical signs and iconic ones.*

As one final consideration of the different levels of signs, reflect upon the differences between the processes of DNA and all of our talk about it. First, only few segments of DNA are solely devoted to expressing traits and characteristics, while other parts counter against noise by providing redundancy at different levels, others still regulate what other parts and sequences do and when they do them (*i.e.*, contain rules about other parts of the sequence and their operations). DNA, somewhat similar to the transformational grammar of natural languages, includes much information that occurs at more than one level of abstraction, much that might be called meta-instructions. Jeremy Campbell writes, "Rules constrain, but they also make rich expression possible.... Grammar is an antichance device which still allows plenty of room for novelty." ([15], p. 98) Campbell's popular, journalistic book provides quite an illuminating account of information and yet he persistently fails to distinguish indexical or even iconic signs from symbols. Clearly, it is one thing to say that much genetic information is other than a one to one correspondence between a gene and an expressed trait, it is another thing to suggest that much of the DNA sequence codes redundancy and carries materials akin

to meta-instructions, commands regarding which protein to synthesize, activate and when. Moreover, it is yet another claim to recognize that a virus or bacterium mimics structure hence has some kinds of iconicity, but it would be a wholly a different order of argument to suggest or imply that DNA works with symbols. Even though DNA is quite varied and is especially so for vertebrates, the kinds of signs (e.g., symbols) which humans use to talk about what is *not* the case, and the kinds of distances both in space and time that occur between commands and obedience, somewhat glosses over important distinctions. Wilden, once again, offers useful insights and greatly helps to clarify these issues [1,8]. Information coded within DNA are both analogically and digitally stored, and, in *level*, operate as indexes and icons but not as symbols. Chemical commands and the development of proteins, and structural mutations and the on-going record of the changes, all of these are geared into non-decontextualizable relations with the past and potential future; they are not speculative nor are they liberated from their concrete occurrence nor are they available for imaginative free variation in a vicarious medium. How different this is than when forensic scientists enter a crime scene and attempt to verbally reconstruct what took place earlier from the various kinds of signs and evidential information now left behind. They look for indexical signs of the past such as footprints, fingerprints, hair, blood, and maybe even DNA, but much of the symbolic and imaginative reconstruction is based on a kind of verbal dance between possibility and probability. Symbols, it needs to be underscored, have no necessary or obligatory status; they were never “regulating” or merely “symptomatic” signs. Talk within detective work thus spans what is *not* the case and often what never could have been the case. Moreover, what is most crucial is our ability to speak articulately about *possible* past events, to handle them in decontextualized form through our use of words, *to reconstruct the scene without touching it or physically moving anything in the room*.

The three levels of signs (index, icon, symbol) emerge as increasing orders of complexity, and they form a logical hierarchy such that the latter levels depend in various ways upon former. In addition to these levels of signs, we need to distinguish between and among three different kinds of coding: Analogic, digital, and iconic. Information, said otherwise, regardless of the particular sign-level at issue, can be coded in at least three different ways.

3. Kinds of Coding: Analogic, Digital and Iconic

Nature exhibits at least three different levels of signs, and those signs are coded in different ways, though two general forms of coding seem to predominate. This issue is well brought out by Gregory Bateson when, in noting the difference between “number” and “quantity”, he suggests that you can have exactly three tomatoes but you never can have exactly three gallons of water [16]. His point is that we directly experience (and can find on countless levels of analysis) a fundamental difference between those codes that are discrete (basically coded by “either/or”) and those that are continuous (e.g., basically coded by “more or less”).

There is, in fact, a significant and important difference between those coded values (*differences of degree*), which are continuous and managed in terms of localized, gradual and infinitesimal gradations, and those coded values (*distinctions in kind*) that are discontinuous and can be decontextualized to serve vital regulative functions at higher and higher levels of abstraction [8]. Analogic *differences*, then, refer to the continuous and contiguous positive values that define relation-states among and

between physical and living systems, whereas digital *distinctions* operate by first introducing breaks into continuums and then offering either/or distinctions at higher levels of abstraction (also see [7]). Iconic coding integrates both modes of coding. As two quick illustrations, consider how the distances marked on a ruler as well as the opening and closing of the engine throttle by a governor both employ digital coding in computation and control within a predominantly analogic instrument, and in this regard, they are both analog and digital, meaning that they are iconic devices ([1], p. 223). To clarify further, I quote Wilden at length:

No two categories, and no two kinds of experience are more fundamental in human life and thought than continuity and discontinuity, the one full, complete, compact, dense, and infinitely divisible, the other partial, intermittent, atomic, discrete, and not divisible beyond the individual parts that make it up. Similarly with information: Analog coding, based on difference, is continuous, digital coding, based on distinction, is discrete; and iconic coding, based on both different and distinction, is both continuous and discrete. Analog differences, related by contiguity, are “more-or-less”; digital distinctions, separated by gaps, are “either/or” (and often “all-or-none”). Time and space as we perceive them are obvious examples of analog information; the alphabet and money are equally obvious examples of digital information. Perceptions consisting of analog differences organized by digital distinctions, as in visual images, distinct sensations, or specific events, are examples of iconic representation ([1], p. 222).

One of the general principles to notice is that analog differences operate at lower levels of abstraction but at higher orders of complexity, whereas digital distinctions, as higher-level abstractions, are lower orders of complexity. For example, by turning a stereo volume knob to the right, more volume is produced, and, by turning it to the left, less volume is produced. Although all sound volume levels are contiguous and continuous with neighboring ones, we can recognize meaningful differences along the continuum. Then, from within such continuous adjustment to the sound level in either direction, we can *signify*, at a higher level of abstraction, a lower order of complexity and suggest that: “The sound is ‘loud’” or “The sound is ‘quiet’”. Such spoken distinctions, through signification, introduce coded variety of the digital rather than merely analogic sort, and as such, the proposition can be argued to be “true or false”, “accurate or inaccurate”. Notice too that only what is said about the sound differences can be agreed to, disputed, or refuted. Only at the level of signification do we find denotative propositions about which people can haggle; we don’t actually argue about “the facts” as much as we argue about what someone said about “the facts”.

Other clear examples of analog, digital, and iconic coding can be found in the world of music. First, musical instruments, as iconic devices, make up an orchestra. Now, to the extent that any musician can take a moment of rest within a piece, the instrument has some base level of digital qualities, though these occur at a different level than the following: Piano keys and foot pedals are digital, whereas how long the notes are held is analogic. Guitars have strings as well as frets, making them fairly digital, though the length and volume of any note played remain analogic in character. The strings of the harp and lute are distinct and are separately digitalized by the fingers, though they can be played with varying levels of intensity and length. Violins have distinct strings but are without any frets or digital

distinctions in the bow; they are partly so difficult to play and master because they are so predominantly analogic. Regarding woodwinds (clarinets, flutes, oboes, saxophones, *etc.*), the strength of breath and volume level is analogic while the keys and notes played are digital. A recurrent feature across the different instruments is that digital coding operates to introduce *qualities* of which the analogic is the *quantity*; such instruments enable the sounding of analogic magnitudes that can be changed in quality through digital operations at a higher level of abstraction.

When listening to an instrumental composition played by a live orchestra, we can sense all of the sounds in the auditory field, overlapping, resonating, and intersecting in various ways. We might be able to sense the vibrations of the sound waves, and to feel the emotional contours of the sounds. But without lyrics, such music is unable to signify, unable to propose propositions about aspects of the world. It may be rich in emotional expression, and it may allow for acoustical iconic representation, especially to the extent that one can codify the sensed auditory field by identifying single instruments or orchestra sections. Consider the symbolic musical notation: The notation is generally symbolic in character (and digital as well), though the placement of notes along staff lines, signifying particular notes and keys as well as how long each are to be played, have indexical levels as well as forms of analogic and iconic coding.

Another domain that offers countless illustrations of the differences and relations between analog, digital, and iconic coding is the realm of sports and athletic events. For example, the particular movements and actions that make up any sport are caught within local analogic differences, while the countless gestures and distinguishable movements are iconically coded in perception and then digital statistics are taken ad infinitum. Hence, if we do not speak the language and are completely unfamiliar with a given sport being played, we can only see a flow of analog differences. If we are familiar with the language and with the sport played but are watching on TV with the sound off, we have the analogic codes of movement and posture coded by iconic representation of some moves and the like, but without any of the decontextualizing capacities of digital symbolic coding, including various statistics of the season, the event is highly limited in space and time.

Well beyond the scope of the present essay would be to examine the ways that visual information, once digitalized, makes for increased power, prediction, and control. The ability to make identical prints was crucial for scientific advancements [17]. Descriptions of vegetation are only so useful for scientific purposes, and today, criminal “mug shots” are much more accurate than police sketches. We also have countless scientific images, diagrams, engineering drawings, drafting schematics, maps, blueprints, radar, sonic imaging technologies, infrared scopes, and other forms of image scanning technologies, *etc.* The ways the digitalized graphic information is becoming increasingly available through technologies should have those concerned about control ever on the watch [18,19].

Everyday life is so replete with examples of analogic, digital, and iconic information that delimiting their range and scope can be difficult. One helpful way is to briefly reflect upon canine and human interaction, which, roughly summarized, contains a highly limited degree of digital coding and a large amount of analogic coding [20]. Many dogs seem able to sense the mood of an immediate encounter and may even be open to meaning conveyed by bodily posture, tone of voice, pitch, excitation level, and intonation. Despite such rich analogic competencies, they seem highly limited in capacities for detached reflection upon abstract concepts (e.g., “Did you like yesterday’s walk?”), and also seem mostly without the ability to sharply deal in “either/or” propositional content (e.g., “You can *either* go

outside *or* have a treat. Which one would you like?”). In fact, it is only at the level of human language that we find what Wilden [8] calls “second-order digitalization”. Here, beyond perceptions funded by iconic values and even beyond the interactional framing capacities of mammals in play, we here can distinguish abstract concept transfer as well as rich capacities for detachedly talking *about* the distant, the past, and the future in highly complex ways, including statements regarding what is not the case. It cannot be overstressed that there is no “is not”, nor is there “syntactical negation”, at the analogical level. Only by syntactical negation can we signify what is not the case or was not the case, or even, what cannot be the case. And such negation occurs on more than one level of abstraction [4,7,8,21]. Just as paradoxical oscillations readily occur when someone combines metalanguage with an indexical (e.g., “This is a lie.”), so too the word “not” is the source of countless paradoxes because it operates, often ambiguously, at many different levels of abstraction (e.g., “Do you *not* like me asking if it is *not* true that ‘tomorrow is *not* a chair?’”).

Within our speech, all of the continuous and contiguous values such as volume level, rate, tone, and posture are analogic, while the digital values refer to those that are discrete and, to some degree, decontextualizable (phonemes, morphemes, syllable, words, expressions, gestures, *etc.*). Analogic coding manages local and immediate differences whereas digital coding enables not only “either/or” distinctions but also the possibilities of decontextualization and abstract concept sharing. What people routinely mean by the word, “information”, or even better, “communication”, very likely refers to the digital aspects of language: The words or the propositional content conveyed. But spoken utterances exhibit at least two levels: One level, a “*report*” which conveys propositional content, perhaps even a denotative content, and a second level, a “*command*” which negotiates and manages the relationship between interlocutors [1,5,20]. So much of communication is other than transmitting information, especially if by information we mean “digital coding” explicitly discussing objects, events and other people; it often includes articulate but unvocalized and recognizable movements (*i.e.*, forms of iconic coding) as well as sound levels, rates of speech, and intensities of animation (*i.e.*, analogic coding) which offer meta-communicative information on the relationship between the interactants as well as disambiguations to the conveyed content. In fact, much scholarly thought attends to voice and its relationship to propositional content. Under the umbrella of “Speech Act Theory”, much scholarship focuses on the way that voice enables nuanced conveyance of propositional content with illocutionary force. That is, sound values are taken to have a pragmatic value of aiding the listener in determining how an utterance’s propositional content is to be taken (e.g., as fact, or in jest, or as a hypothesis, *etc.*). Another line, just mentioned (often under the umbrella term “systems theory” or “behavioral pragmatics”), addresses how voice manages current relation-states between interlocutors. Here focus rest largely upon aspects that might be taken as symptomatic of the emotional state of the speaker, or the attitude of the speaker toward the interlocutor, *etc.* Interestingly, males tend to focus on voice as a disambiguator to digital meaning (speech act theory), whereas females tend to attune to voice as an analogic relationship barometer (behavioral pragmatics). The common thread between these two lines can be identified if we examine sound values as redundant iconic codes added to various symbolic statements (e.g., interrogatives are slower and end with upward intonation, or commands have a downward and staccato sound). Such nonverbal and vocalic messages amount to multileveled meta-statements roughly the equivalent to: “This is how I see myself”; “This is how I see you”; “This

is how I see you seeing me”, *etc.* [22] A simple statement such as, “*Do you think that one will do?*” can be intoned in many different ways to imply a varied range of relationships and meanings [20].

Wilden identifies a common reflexive principle across these many different examples of the three kinds of coding. He writes,

Three levels of knowledge can also be distinguished: sensing, where analog continuity dominates digital discontinuity; meaning, where analog and digital coding combine in iconic coding; and signification, where digital coding dominates analog coding. Taking up the definition of information as coded variety (or diversity), sensing can be defined as coded information, meaning as coded sensing, and signification as coded meaning ([1], p. 185, p. 225).

One final example may help to clarify and further illustrate. Recently standing in a stalled checkout line at a local grocery store, I was holding a nearly empty basket. The cashier chatted on-and-on with a couple checking out; they exchanged pleasantries, gave animated gestures, and even hugged at the end of the sale. When my turn finally arrived, the cashier looked into my eyes and said, “I’m sorry; I can tell you’re in a hurry.” I denied her proposition, tried to be polite, and reassured her that, “I’m in no hurry at all” and further added, “It’s nice to see old friends enjoy a brief reunion.” In this situation, the combination of analogic and iconic coding enabled her, and me, to make a truth claim about the current relation-states of the parties involved. How so? Well, it happened on many fronts in addition to her knowing that, in this particular context, she was dallying and spending extra time with this particular set of customers. In addition to the length of time, there were overly animated gestures, personal topics of talk, bright inclusive smiles, and even a quick hug terminating the exchange. For my own part, in addition to the long line of customers behind me, my body was always in some position, and the movements I made were always contiguous and continuous. Standing in line, I must have had a certain slump, or perhaps it was the way I was holding the basket, or maybe even my slightly muffled sighs, or various moments when, while my eyes were wandering around, I looked longingly—and perhaps for a slightly prolonged duration—toward the door and parking lot. At any rate, the cashier did not see mere variety in motion within the visual field, nor merely sense analogically coded information in posture, nor even perceive meaningful nonverbal displays by iconic coding, she actually saw someone, me, who was in a hurry and she *signified* this fact verbally. She might not have been that astute; she might have merely registered the fact that someone was next in line. We might even imagine someone whose eyesight would have prevented her from reading more subtle facial expressions, especially when expressions leap across a face so quickly. The key point is that such information (the fact that she enjoyed a brief “reunion with old friends”, and that I was “in a hurry”) was functionally inseparable from the total context of the situation including the perception and speech of the interactants. Wilden again nicely summarizes these issues:

Once it is agreed that information and noise are not inherently distinct, then it follows that without context, there can be no information—*i.e.*, no distinction between information and noise. For any biological or social system, the existence of coded and uncoded variety or diversity presupposes the existence of goal-seeking subsystems dependent upon communication for survival. Communication is impossible without coding, and coding is impossible without context. We see, therefore, that information, communication, context,

order, and goal-seeking are all implicit in the original distinction between coded and uncoded variety ([1], p. 184).

As trite and hackneyed as it seems, we can re-examine the old philosophical question, “If a tree falls in a forest and no one is there to hear it, does it make a sound?” We might use the above terminology to respond as follows: There would be, admittedly, matter-energy but without an organism to make the distinction between uncoded and coded variety, there would be no sensed sound value (coded sensation), no meaningful experience of the sound being sudden or loud or near (coded perception), and certainly no propositional statements about the veracity of such abstract possibilities (coded meaning).

4. Information and Communication: Data and Capta

Richard L. Lanigan, working in resonance with Wilden’s provocative, “Context Theory: The new science” ([1], pp. 303–321) roughly makes a distinction between what he calls “information theoretic” models and “communication theoretic” models [23,24]. The basic problem Lanigan identifies is that too many people fail to recognize the key difference between what is *given* as meaningful and what is *taken* as meaningful. The former can be generated out of a “context of choice”, but the latter solidifies only within the “choice of context”.

“Information”, accordingly, refers to *data given* from various kinds of selections and combinations within various contexts of choice, while “communication”, on the other hand, refers to *capta taken* according to various choices of context (also *cf.* [25]). Communication entails information, as information is the subset of communication but information handling processes are qualitatively different than communication processes, even if communication manages and handles information. Without various levels of choice of context, there is only “data”, information without communication. Heuristically rich examples of this important difference appeared when IBM’s computer “Watson” was “competing” in the television show *Jeopardy* and successfully defeated two all-time champions. The win was beside the point; there were several moments when Watson did not have any sense of the *context* of what he was talking about; it was all “data” to Watson.

When we select from a stock of linguistic units (e.g., phonemes, letters, words) and then combine our selections with others, we produce data, information that emerges only because those selections were from a limited context of choice: There are only so many phonemes and morphemes, only so many letters to an alphabet, only so many words within a lexicon. The construction of data occurs on the side of the speaker or author by selecting from the stock of possible units and constructing a message while the listener or reader creatively participates in the communication by contextualizing the information, thus creating capta. *As speakers, people are information producers handling various contexts of choice. As listeners, people are communicators managing various choices of contexts.*

Imagine that a tabloid reporter, in a public square full of other people, shouts to a local politician: “Did you check into alcoholics anonymous yet?” or “Have you stopped beating your spouse?” or perhaps, “When will you quit lying to everyone?” Without the ability to stop and reframe and reinterpret, without the capacity to make explicit all the assumptions imbedded within any question or statement, anyone could be railroaded. It almost doesn’t make any sense to talk about symbols and signification without *de facto* including a choice of context. Without choice of context we could not

question the possibility of an error in a multiple-choice question. Choice of context often enables us to demonstrate how words can mean more than their speakers intend because languages hold repressed meanings and root meanings, incidental rhymes and other forms of meaning that overflow any speaker's or author's conscious intention. Hence, we can sometime surprise even ourselves by our utterances. Not only can we experiment with new combinations and arrangements of words and phrases, but we might alter and vary the context in which we take those words. Without that slight space between information production and communication creation, or if these were not separate functions, we would be trapped within a closed-system, cut off from innovation, self-astonishment, poetry, jokes, or even questioning. As Watzlawick, Beavin and Jackson nicely illustrate, "*Customers who think our wait staff are rude should see the manager*" ([20], p. 53).

Ideally, we recognize human communication as both information theoretic and communication theoretic, where the former is a subset of the latter. Without choice of context, humans are reduced to non-reflexive information processing systems. Lee Thayer writes, "One problem with the notion of 'information' is, of course, that the system in which it occurs is not decomposable.... The 'same' information, perceived as vital in one system, may be irrelevant in another—or even malignant" ([26], p. 41). This means that although species of data and information can be used in closed systems for decision-making, once they are symbolically introduced into communicatively open systems, they lose much of their imperative or obligatory nature, and at the human level, they become endlessly subject to a variety of uses, values, and interpretations. Someone who politely and articulately requests, "Will you please pass the salt?" may receive as a response: "No, your blood pressure is too high and you know it" and the outcome was neither intended nor desired but remained possible, thankfully, because of the choice of context.

One might well argue that part of the distinction between physical systems, biological systems, and cultural systems is more than the degree of constraints which allow forms of freedom: It also has to do with the nature of commands and obedience and the levels of permitted abstraction and decontextualization. At the level of physical systems, the command and the obedience are simultaneous (e.g., gravity or magnetic polarity). Within biological systems, the command gains some distance from obedience, even if ever so slightly and remains "locked in" by indexicality (e.g., DNA chemical instructions or the salivation of Pavlov's dogs). But by the time you get to human culture and symbolism, one finds commands at one time and their *potential* obedience at great distances or highly remote times (e.g., "The Ten Commandments" or the "Golden Rule"). Wilden writes:

As we descend the dependent hierarchy from inorganic nature to society and culture, the relationship between matter-energy and information radically changes. The more complex a system is, the more distinctive is the relationship between the two.... In the social and cultural order the relation between matter-energy and information becomes increasingly indirect and arbitrary, nowhere more so than in speech and language, where the matter-energy has no natural relation to what it symbolizes.... It also becomes richer, more complex, more flexible, more ambiguous, and less dependent on close connection: Continents or centuries may separate one sender-receiver from another ([1], pp. 171–172).

Perhaps even more important, the level of abstraction in symbolic information becomes increasingly evident in metaphorical expressions such as “ships passing in the night”, where the speaker is referring to neither vessels nor the evening. The same goes for ironic statements. We seem not truly at home in language until we can use and appreciate ironic statements, as when we say, “What a great day!” or “Such a fine move!” and mean the exact opposite of what we said [21].

Thayer’s provocative essay, “How Does Information Inform?” from his book *Pieces*, provides an excellent resource for thinking about the dynamic nature of open systems (*i.e.*, “communication-theoretic models”) and how that differs from closed systems (*i.e.*, “information theoretic models”). Thayer writes:

One knows what one is looking for when one shuffles through the sports section of the newspaper looking for yesterday’s results. If one wants to know whether or not a particular library has a particular book by a particular author, one can consult that library’s card catalog.... But one can also think of information as that which informs imaginative or inventive behavior in an open system—that is, where the response or the behavior that ensues is neither necessary nor specifiable. The person who goes to the library “looking for something interesting to read” would be an example.... In both cases, (closed and open systems), information and action mutually inform each other. In the one case, there needs to be an action that justifies and rationalizes the existence of certain prior and accessible information. In the other, certain information needs to be generated which will justify and rationalize the action.... It is precisely the degree to which the information-decision system is closed that makes it possible to “bureaucratize” that system.... Open systems, being nonrepetitive and historical—creative—have no regular logic that would enable us to routinize them, or reduce them to recipe.... We design and build closed system information-decision systems only by assuming that certain information is given, and that the users are interchangeable. But a person who assumes that he or she is the instrument of his or her own destiny is by definition noninterchangeable. And the information that appears to be given or—self-evident—for those who are interchangeable is likely to be differently interpreted by those who are not ([26], pp. 61–62).

If we now, taking Thayer’s line of thought as our guide, honestly reflect on the various failings of action within contemporary U.S. culture, we can see that it comes not from any shortage of information but from too many people who, goalless, expect “information” to carry the weight of deciding who they ought to be when they grow up. Seriously, many young people have the informational world as their proverbial oyster. They have quicker, faster access, and, despite the amount of information available, many remain crippled by their inability to commit to goals.

Think for a moment of an artist sculpting a statue out of marble. The marble has little relevant information until the artist has an image, an intended form, of the end result. Even if the desired final outcome changes as the sculpting proceeds, the final statue must be guided all along by an image of an end goal. Without the envisioned goal, portions of the stone cannot disclose themselves as “not part” of the final sculpture. Without the artist’s ends, such information is literally not there.

No information can disclose itself as vital to me or to my functioning if I am goalless. For example, what is a decision? When have you made one? How many are you making right now? What information

is bearing upon those decisions? How much clearer could it be that those who have no goals nor any real sense of what they want out of life or who they want be or what specifically they want to do, cannot distinguish relevant or vital information even it were all at their finger tips. What would one need to know in order to know that some information is relevant or not? What information do people need in order to keep themselves from doing what they know they ought not do? And, why can people fail to act upon relevant information? Might it be that the “information” most people ought to be acting upon cannot be found “in” the environment independent of their goals and values? Said quite otherwise, perhaps the more information accessed and registered but which is not acted upon (or perhaps cannot be acted upon), the more irrelevance, uncertainty, and disorder that persons allow into their lives. Many forms of human malaise and strife can be successfully managed only by understanding the nature of goals, context, and how they relates to changing informational value (*cf.* [27]).

So much of Thayer’s work calls people to recognize their need to contextualize their performances in terms of ideal goals. I close this section with a brief example. Sometimes students will ask a rather trivial question about an upcoming paper, suggesting that they do not yet have enough information in order to proceed (e.g., “Exactly how many pages are required?” or “Does it need to be stapled?” or “What font should it be in?” *etc.*) To such questions, Thayer would say, “Anytime you have such a question, simply ask yourself, what would the greatest student of all time do, and then do that as best you can. Use the ideal as your measure”. Many students did not act upon that advice, despite its clarity. They seemed unable to take his words seriously; they perhaps wanted to think that he was kidding, you know, “having them on”. If and when some cocky or rebellious student would say that people surely disagree about the nature of the ideal, Thayer would reply, “Oh, so agreed. That means whatever you hand in, I will take to be your honest-to-goodness best attempt at your definition of the ideal. I look forward to seeing it”. This is also why Thayer, in class, would also use the provocation: “What you know will be constrained and enabled by your purposes for knowing”. Too many college students have it all backward. They first want to get as much information as possible and from that develop some workable goals. It happens, in fact, in the other direction. Goal-seeking makes information what it is.

The main implication is that information only becomes communication in a particular context, and the particular persons involved are essential elements within that context. Goals contextualize the variety and generate strategic information accordingly; the information is literally imperceptible without those people seeking those goals. This means that goals are not best understood as a function of information so much as information is a function of goals. The most important information about us may not be where we came from but where we currently are heading. Moreover, systems having no self-reflexive capacity to re-contextualize messages and whose basic operating values are not subject to revision or reassessment can at best deal with data or information.

5. Information as Negative Entropy?

A pernicious literalism starts to infect people when they assume a bioenergetic view, oust form from its indigenous relationship with matter, and think that they will be able to understand all of reality—and even life—as if it occurred on a single-level: A unidirectional flow of deterministic energy-matter ([1], p. 88). Not only do many people fail to comprehend the natural emergence of dependent, dissipative structures, higher orders of complexity, but they also fail to grasp the degree to

which humans' myriad goals structure information and give form to meaning. Too many people seem not to recognize that not everything moves in the direction of disorder. But this does not mean, on the other hand, that everything is moving toward order. It's more complex than that. As Campbell suggests, "... the arrow of history and the thermodynamic arrow are complementary, not in conflict" ([15], p. 86). Nevertheless, a fair amount of confusion has been created and persists by the popular idea that information, generally construed, is "negative entropy", as if some kind of substance in the known universe could avoid or escape the second law of thermodynamics. That is, living systems seem, if only for the duration of early development or early lifespan, to fend off entropy (disorder) for a while by creating disorder around them. So why, then, is there confusion about the notion of "negative entropy"?

Three broad but interrelated factors seem to account for the confusion. First, any information more complex than analogic indexicality (e.g., digital icons, symbols, words, *etc.*), introduces an experience of *transcendence* beyond the here and now. Language, and especially the denotative word, offers a sense of ideas and concepts that seem invulnerable to rot or decay and which hold different properties than matter. Because words are principles of repeatability or not words at all, they seem to exist beyond their mere matter-energy carrier or medium. For more direct illustration, consider a green banana, fresh from the market. In a little time it turns yellow, then black, and then, soon enough, it is compost; it ages, rots, decays. The word "Banana", on the contrary, has none of those properties; it does not grow old or change its shape or color. Also, if I have a banana, and I want to share it with a friend, we can divide it in half. If a couple of additional friends arrive and want to share in the banana, the portions will need to be divided by the number of people, but not so with the word "banana". It need not be "divided" equally between and among the listeners in the ways that an actual physical banana is; each of us can have all of the word. For an even more dramatic example, imagine someone saying, "Please don't eat any bananas; there's a shortage". Depending upon the context, that may make some sense, but if the person were to say, "Shh Don't use the word 'banana'; there's a shortage", we might well suggest that the person seek medical help. There cannot be a shortage of a word! Part of the reason that people give to information some kind of occult status, deeming it to be outside the confines of a particular space-time is because of all of these features. In fact, if I have a room full of 18 students, all of different ages, backgrounds, ethnicities, places of origin, sex, *etc.*, and I ask each student, one right after the other, to say the word "banana", there are, for everyone present, 18 different space-time events. Each one has a slightly different duration, rate, volume, pitch, timbre, order in the sequence, and yet, despite all of these differences, the "same word" was said. What, exactly, is the nature of such sameness? Very carefully consider the differences between the following two expressions: "Bananas are my favorite fruit" and "Bananas is a word in English". Why do we switch to the singular when talking about the word "bananas"? Clearly countless people have uttered this word, and their utterances exhibit nearly as much variety as the supposed referent to the word "Bananas", and yet, the word as word remains singular (also see [6,28]).

Second, in addition to the forms of transcendence just mentioned, many forms of iconic information and symbolic information enable an articulate representation of endless oscillations as well as "timeless" paradoxes. That is, information occurs on various levels, and, at the level of icons and symbols, it lends increasing intelligibility to notions of transcendence and perpetual motion. Recall that the second law of thermodynamics clarifies why a perpetual motion machine is impossible, and yet,

the kinds of information (iconic and symbolic) that humans deal with introduce visual and verbal paradoxes and oscillations (cf. [29]).

Some of the best examples, on the visual plane, include Escher's well-known "Waterfall", which depicts an endless waterfall, an iconic image of a perpetual motion machine (see Figure 2), and Roger Penrose's impossible triangle (see Figure 3), which seems to shift perspectives, change dimensions, and give the appearance of indefinite on-going motion.

Figure 2. Escher's "Waterfall".



Figure 3. Penrose's "Impossible Triangle".



On the verbal level, the best examples are varieties of paradoxical injunctions such as, "*Make sure you don't read this*", and species of the liar's paradox such as "*This sentence is false*" [7,29]. In these cases, multileveled information can seem to provide endless movement, generate oscillations between

propositional states, propose what would be physically impossible, and even offer tastes of orders that transcend the unidirectional arrow of matter-energy.

Third, and finally, the highly abstract word “entropy”, which is based upon a concept of “probability”, challenges any separation of information from context, memory, and goal-seeking. Hence, the scientific study of probability raises critical questions about the nature of order and disorder within open and closed systems. “Entropy”, it should be underscored, is not the name of some kind of substance. It is the name for a probability statistic that had been thought applicable only to physical and chemical systems. Part of the problem, though, is that probability, as far as *life* is concerned, is impossible without context and memory, and so, everyday notions of probability challenge any overdrawn distinction between the “structure out in the world” and “structure inside the individual”. Consider an almost too simple example: If someone is about to flip a penny, there is a 50% chance of either a head or a tail coming up, but notice how this probability seems to change if we learn that the person has just flipped nineteen heads in a row and now will be flipping the coin for 20 heads in a row. For this single event flip of the penny, the probability of it coming up heads remains 50% and yet the probability for *that exact same flip* being the twentieth head in a row is radically lower. Hence, a gambling man (or a statistician) would likely bet on tails even though the odds are still 50%, simply given that anything that reduces uncertainty regarding probable outcomes, in this case context and memory, serves as negative entropy.

People can reduce entropy in their world by becoming more knowledgeable and by putting items of concern into adequate context. The degree to which probability and information run together basically means that one cannot trust an overdrawn separation between objective information “out in the world” and the subjective information held “within” the perceiver or receiver. Information helps to reduce entropy when it carries enough redundancy in the message and when the structure of information corresponds in some way to how some material state of affairs is structured (either now here or at some other place and time). There is, though, a somewhat suspicious literalism within some accounts of entropy as mere “missing information” rather than a measure of uncertainty. The difficulty is that, within open systems, the very information that disambiguates one issue can create new forms of uncertainty elsewhere in the system. As Thayer observes, “... we are seemingly convinced that as our information about things increases, our ignorance of those things decreases” ([26], p. 53). Obviously, it is not the sheer production of information that reduces uncertainty and minimizes entropy. Organisms exposed to endless streams of conflicting information experience disorder and unpredictability, and this is magnified by the degree to which those organisms are not secure in their goals and values. “Serious difficulties arise”, Campbell suggests, “when scientists try to separate the idea of probability from the idea of information, because the first cannot be defined without the help of the second... entropy is also a measure of what the person perceiving a message does *not* know about it before it arrives. Entropy is an index of his uncertainty as to what to expect. If the entropy is a maximum, that is to say, if all the possible messages are equally probable, then his ignorance is also a maximum” ([15], p. 63). Hence, the clearer our purposes, the more articulate our goals, the more knowledgeable we are, the greater reserves of information we hold within ourselves, *etc.*, the more that probabilities can be anticipated and the less that uncertainty and disorder rule our lives.

In this relatively brief paper, I tried to outline a few key terms for talking about information and communication. My main goal was to address how information and communication relate to

matter-energy. An additional goal, perhaps obvious throughout the paper, was to problematize—and hopefully safeguard against—overly simplistic understandings of language, information, communication, and human life more generally. It would seem that far too many people, both inside and outside the academy, believe (or basically act as if) language were nothing but a symbol system, something best understood as wholly arbitrary, with nothing more than convention motivating the relationships between and among relevant elements. On the contrary, more people need to reckon with the multileveled nature of signs and reality. They need to appreciate the different properties implied by different kinds of coding, and they ought to understand the vital role that contexts, goals, and values play in interpretation and interaction, as well as in the generation of information and in communication. And, finally, more people would greatly benefit from trying to comprehend how symbolic communication provides humanity with a genuine taste of transcendence, even if such transcendence—because reality itself is multileveled—never completely disentangles from the world of matter-energy [30].

Acknowledgements

I wish to express thanks to the people who have helped greatly in this paper: Robert K. Logan for his original inspiration and invitation, Valerie V. Peterson for her continued support, encouragement and editorial assistance, and finally, Chad Hansen for valuable discussion and guidance in the final stages. I also need to acknowledge and thank Grand Valley State University for the generous sabbatical release that greatly aided in the production of this manuscript.

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