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"Information Theories"

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Information theories

Abstract: This chapter describes information theory and signification in comparison to communication theory and meaning by looking at a number of definitions offered through semiotics, linguistics, and mathematics. Information theory used by machines is compared to communication theory used by humans by looking at historically evolved models. Each of these key models explain the evolving relation of information to human, animal and machine, particularly in respect to consciousness and embodiment. Finally, the essay offers some comments on the status of information in the development of what is often taken to be the pinnacle of contemporary communication technology, the internet.

Keywords: Communicology, model and theory, phenomenology, semiotics, signs, signals, signification, meaning, Roman Jakobson

1 Definitions

The concept of "information" ranges from facts we reference in conversation to the mathematical specification of electrical impulses in computers. To gain a general understanding of the varying uses of the term, we can define basic concepts and then examine some key theories of how these ideas are organized into explanations of the most basic of all human behaviors: *communication*. We communicate with one another because we surmise basic human values (decisions displayed in behavior) from the things we say and do with others. Our speech and gestures convey meanings, so the most fundamental understanding of information is the *meaning* we interpret in human comportment.

The *meaning* of human interaction is the paradigm for all theories and models of communication. Yet semantics – interpreted meaning – is irrelevant for studying information as a mathematical phenomenon – signal behavior – in electrical engineering. Unfortunately, the warning by mathematician Claude Shannon (1948, 1993a,b,c), inventor of information theory, against drawing analogies between information and communication *processes* has been ignored for decades (Gleick 2011: 242, 416). The meaning problem was suggested to Shannon by Margaret Mead during his first public lecture on the theory at the Macy Foundation Conference on Cybernetics held 22–23 March 1950 in New York City. In short, information theory studies the signifying physical properties of electrical signals, whereas communication theory studies the meaning of human interaction. Note, however, that this *signification* – *meaning* distinction is only one of 52 basic differentiations iden-

tified between information and communication (Marcus 1974). The most relevant of these distinctions are discussed in the Roman Jakobson model below.

This chapter will address information theory by looking at a number of definitions offered through semiotics, linguistics, and mathematics. It will then consider information theory and a number of information/communication models. Each of these sheds light on the relations of information to human, animal and machine, particularly in respect of consciousness and embodiment. Finally, the chapter will offers some comments on the status of information in the development of what is often taken to be the pinnacle of contemporary communication technology, the internet.

1.1 Semiotics: semantics, syntactics, pragmatics

The field pre-eminently associated with signification is semiotics (Krampen 1997). Semiotics is the science of understanding representation, i.e., how human beings express their thoughts and feelings in an external form perceptible to others. What is perceived constitutes a *sign* that stands in place of an idea or emotion. The sign codes or re-presents the original item. Charles S. Peirce (1931, 2: 247) suggests there are three basic ways to do this: (1) an i*con* is a sign that denotes the whole character of the original perception, e.g., a statue of a person; (2) an *index* is a sign that points to the original characteristics of a perception, e.g., dark clouds that suggest rain; and (3) a *symbol* is a sign that we associate, by cultural rule, with the original perception, e.g., your name reminds us of you.

One major division of semiotics is *semantics*, the interpretation of the meaning we associate with any type of sign. In communication, we cross-check all codes used and not used to preform this complex human cognition (Cherry [1957] 1978: 233). *Syntactics* is the relation or structure that articulates strings of signs into systems, e.g., words into sentences into paragraphs. Last, *pragmatics* is the way we use sign-systems for various purposes, e.g., making a statement into a question by tone of voice: “You are doing WHAT?”.

1.1.1 Signs versus signals

One fundamental difference between information theory and communication theory is the basic unit being studied, the thing perceived in its behavior. First, let’s remember that a human being is the *observer,* the source of *perception*. We use our bodies to perceive ourselves (internally and externally) and our environmental world (Merleau-Ponty 1945). What we perceive are signs. These signs are never isolated, but are part of sign-systems or *codes* (see Chapter 12, Cobley). Human codes are (1) *synergistic* (the whole is greater than the sum of its parts) and (2) embodied (all our body senses are integrated simultaneously) at three logi-

cal levels: the expression and perception of (1) *Affect* or emotion, (2) *Cognition* or thought, and (3) *Conation* or purposeful action. We have a *signal* when we perceive the presence and absence of signs, and their movement to determine if they are static or dynamic. Electrical signals are a good example. They constitute the physical system in the human brain and we use our mind to symbolically measure them, often with the mediation of machines. For example, computing machines use electrical impulses or their absence (icon) to indicate (index) a meaning assigned to them (symbol) by a human observer. Once properly programmed by a person, one machine can mediate another machine, and so on, to *simulate* simple items of human memory and action. In short, computers and similar machines manipulate meaningless signal units, whereas human beings use signs to code meaning, i.e., make information into communication by creating complex relationships among represented signs. "Signs become necessary when the circulation of information *within* an organism is replaced by communication *between* organisms" (Lotman 1990: 68). There are two fundamental ways to code such meanings: Linguistics and Mathematics.

1.1.2 Language: grammar, rhetoric, logic

The modern discursive foundations of language and mathematics were elaborated in the Middle Ages and the Renaissance with the development of the famous Seven Liberal Arts, linguistically marked in most universities today as the "College of Arts and Sciences." The Scholastics taught as primary the *human science* pedagogy of the *Trivium* (Grammar, Rhetoric, Logic) followed secondarily by the *natural science* practices of the *Quadrivium* (Arithmetic, Geometry, Music, Astronomy) in the Medieval universities, principally at L'Université de Paris.

Because Greek and Latin were the languages of literate people at this time, their characteristics and structure became the guideline for writing rules about the socially effective use of ordinary speech, whether spoken or written. Hence, social rules of usage emerged at three levels of thought (Kristeva 1989). The first level meaning rules were called *grammar* and specified what classes or types of words could be used, especially in relation to each other. Second level meaning rules of *rhetoric* concern the articulation of words into utterances or sentences for effective expression to a listener or reader (Lanigan 1984). When the phonetics of speech (tone) are employed, the articulation is a focus on *tropes of speech*. Whereas perceptual impression in writing (style) refers to *figures of language* (Lotman 1990: 49). Third level meaning rules in *logic* consist of combining the rules of grammar and rhetoric as metarules. This is to say, the articulation of words is compared (as a structural process) to the articulation of sentences. In writing, the paragraph is such a product of articulation. These metalinguistic functions are the basis of all human reasoning about choices and contexts: "Rhetoric, therefore (like logic, from another point of view), reflects a universal principle both of the individual consciousness and of the collective consciousness (culture)" (Lotman 1990: 48).

Effectively, what was taught was a concept of information as *symbolic logic*, while the logic of meaningful utterances is known as *rhetorical logic*. Where there is no meaning reference to language, but only the use of numbers or algebraic notation, it is known as *mathematical logic*.

1.2.3 Mathematics: signals, information modeling, informatics

From a mathematical point of view, information is an algorithm, i.e., a step by step procedure that solves a probability problem in a finite linear sequence of steps (Cherry [1957] 1978: 228–231). Each step is a "bit" of information that indicates a binary (either/or) choice by means of the presence or absence of an electrical signal in a machine circuit. The critical signification of such a bit is that we understand its *probable place in the sequence* of choices, not whether the choice was right or wrong, meaningful or not! Thus, a "no" (incorrect) answer gives just as much "information" as a "yes" (correct) answer. In short, signal information is merely a syntax of signals without any semantics or pragmatics that could make it equal to a human language. To make the signal into a sign with meaning and use value, a human being must code the signal by making it represent a sign, e.g., a *symbol* in the Latin alphabet like "Y" (meaning "Yes") or "N" (meaning "No"). Umberto Eco's (1976: 32–55) famous "Watergate Model" demonstrates how human beings need to convert information theory into communication theory by adding sign semantics and pragmatics to such a signal syntax.

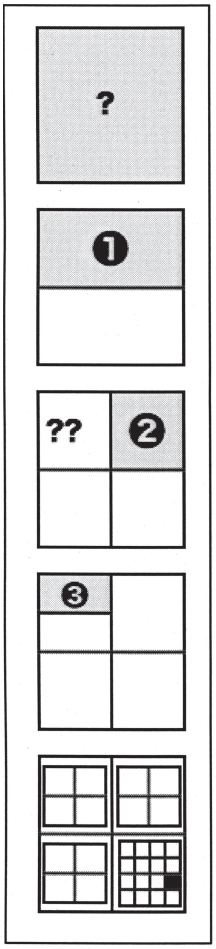
2 Theories

2.1 Information Theory (IT)

IT is technically a mathematical algorithm and specifies the constraints on a signal mediation as the number of mediations increases. This is simply a capacity problem applied to a particular physical channel, such as the capacity of a metal or fiber optic telephone line to carry multiple signals (phone calls) at the same time. In fact, Claude Shannon (1948; 1993a) was concerned with this electrical engineering problem while working at the Bell Telephone Laboratories when he formulated the advanced mathematics of IT.

For our purposes, IT is best described as an *applied logic* and is easier to understand in non-mathematical terms as the *signification* problem of making choices and understanding the context for those decisions. Simply put, IT only allows *choices in a given context*. IT is based on a discrete *Closed System of Signal Rules:* (1) Context is already given as *data;* (2) All choices are *digital* (either/or logic) and must be signaled by *either* "Yes" *or* "No"; and (3) Choices have no meaning, they just reduce uncertainty in signifying the next choice. Thus, significa-

tion "informs" how to choose, not what a choice means. The system signification rules for the operation of IT are illustrated by a conversation between Warren and Claude:



? ➔ Warren: "I'm thinking of an x in the box, can you find it?"

Claude: "Is it in the top half?"
❶ ➔Warren: "Yes"

Claude: "Is it on the right side?"
❷➔Warren: "NO."
Claude: "Ah Ha! It's in the upper left quadrant!"
??➔ Warren: "Sorry, that's not a yes or no question!"

Claude: "I see. Is the x in the top of the upper left quadrant?"
❸ ➔Warren: "Sorry, NO."

Claude: "The context is an infinite regress; I'll never really know where the x is, will I?"

Warren: "No, but your uncertainty about location is being reduced! Probability signifies, even if it is meaningless."

■ ➔ [Warren is thinking of this spot (= meaning)]

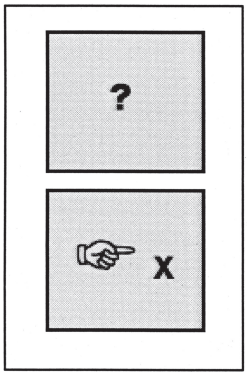
2.2 Communication Theory (CT)

Communication is technically an account of how human beings use *semiotic systems*, especially language, to symbolize their interactive thinking, speaking, and bodily practices, i.e., behavior as culture. Keep in mind that there are "verbal systems" or eidetic codes (linguistics, mathematics, and logics) as well as "non-verbal systems" or empirical codes: proxemics (space), chronemics (time), ocularics

(sight), kinesics (action), haptics (tactile), vocalics (sound), and olfactorics (smell/taste); all codes are explicated in Lanigan (2010b,c).

Following the same approach that was used for the discussion of information theory, Communication Theory is best explicated as an *applied logic* and is easier to understand in language terms as the *meaning* problem of making choices and understanding the context for those discourse decisions. Simply put, CT allows the *choice of a context*. CT is based on a discrete System of Sign Rules: (1) Context is taken by Choice made; (2) Normal analog rules (both/and logic) of discourse operate; (3) Answers have meaning, they constitute intentionality (consciousness) about *both* the choice made *and* those not made. Thus, interactive discourse communicates *what* a choice means in its context, not how to choose. Most importantly, human beings simultaneously know all the choices *not* made that are still available to make (we can *take* another choice, i.e., change our mind, reverse course, etc.). "To speak essentially is not to say yes or no, but to make something exist linguistically. To speak supposes the use of contingency and the absurd" (Merleau-Ponty 2003: 164).

The system meaning rules of logic application for CT are illustrated by a conversation between Roman and Juri:



? Roman: "I'm thinking of an x in the box, can you find it?"
Juri: "Please point to it with your finger."

☞ Roman: "OK, look carefully! I'll point to it"

Juri: "That's really easy for a human being! Let's name it **X** and talk about it. I'll also remember where it was not located!

3 Models

Models are abbreviated, usually diagrammed, presentations of theories. While the pictorial presentation is a useful visual aid to comprehension, it is critical to remember there is a large body of published research that explains the conceptual content of the model. Assuming what visual models mean, as opposed to understanding the published theory, is a major problem in the diffusion of misinformation about the nature and process of human communication behavior. There are

hundreds of models of communication that specify individual formats and events of communication, many associated with the history of mass media. But, there are very few theories of communication that comprehensively explain all possibilities of communication at the intrapersonal, interpersonal, group, and cultural levels. The key historical developmental of modern *theories* is explicated in the following models.

3.1 Karl Bühler: 1934 Model

Bühler's ([1934] 1982a: 30; 1982b) *Organon Model* of human communication derives from Plato's argument in the *Cratylus* "that language is an *organum* for the one to inform the other of something about the things." Bühler's ([1934] 1982a: 13) approach builds linguistic science into the logic foundation constituted by Edmund Husserl's ([1922] 1970) intersubjective phenomenology as articulated in the *Logical Investigations* and especially in the *Cartesian Meditations*.

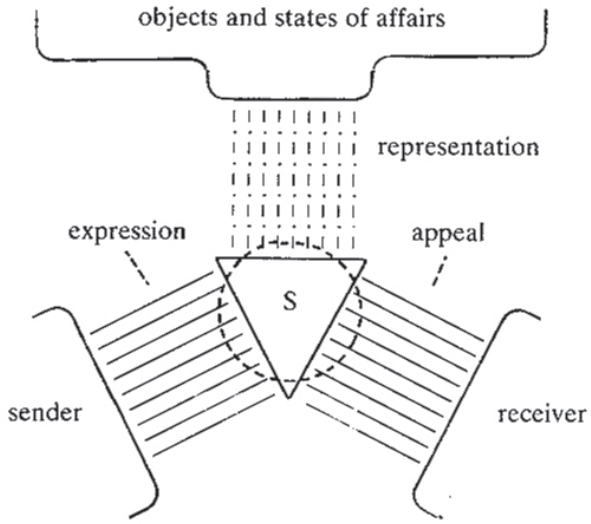


Figure 1: Bühler's *Organon Model*

Bühler (1982b: 34–37) specifies the concepts in the Fig. 1:

> The circle in the middle symbolizes the concrete acoustic phenomenon. Three variable factors in it go to give it the rank of a sign [= s] in three different manners. The sides of the inscribed triangle symbolize these three factors. In one way the triangle encloses less than the circle (thus illustrating the principle of abstractive relevance). In another way it goes beyond the

> circle to indicate that what is given to the senses always receives an apperceptive complement. The parallel lines symbolize the semantic functions of the (complex) language sign [= s]. It is a *symbol* by virtue of its coordination to objects and states of affairs, a *symptom* (*Anzeichen, indicium:* index) by virtue of its dependence on the sender, whose inner state it expresses, and a *signal* by virtue of its appeal to the hearer, whose inner or outer behaviour it directs as do other communicative signs.

The semantic relations are indicated by "the terms *expression* (*Ausdruck), appeal* (*Appell*) and *representation*." Bühler (1982b: 37–38) is describing interpersonal communication where

> each of the two participants has his own position in the make-up of the speech situation, namely the sender as the agent of the act of speaking, as the *subject* of the speech action on the one hand, and the receiver as the one spoken to, as the *addressee* of the speech action on the other hand. They are not simply a part of what the message is about, rather they are the partners in an exchange, and ultimately this is the reason why it is possible that the sound as a medial product has a specific significative relationship to each, to the one and to the other severally.

Up until 1982, the only account of Bühler's model available in English was that by Leo Zawadowski (1975). Per Durst-Andersen (2009) provides a clear linguistic explication of Bühler's model in terms of a correlation to C. S. Peirce's semiotics that expands the previous discussion of grammar, rhetoric, and logic as elements of communication theory.

3.2 Claude Elwood Shannon: 1948 model

James Gleick (2011) offers a comprehensive history of the notion of information articulated by Claude Shannon (1948, 1993a,b,c). The model we know as information theory (IT) stimulated many subsequent variations that appear in all manner of books on just about every topic of communication and media. All are variations on the following diagram that Shannon (1948: 31, 34, 35) specifies as a "schematic diagram of a general communication system" as found in "computing machines" or "telephone exchanges." Shannon's model is directed at solving the problem of "noise in the channel" when an electrical signal is transmitted from one machine to another. The small unlabeled box in the middle of the diagram represents the physical *channel*, such as a telephone line, fiber optic cable, or computer chip. By comparison in human communication (CT), "when we use the term *'medium'*, rather than *'channel'*, we are concerned not with the actual transmission of signals, but with the systematic functional and structural differences between written and spoken language" (Lyons 1977: I, 69) or network levels of language use, such as human *groups* (McFeat 1974: 22, 40).

Shannon begins his technical presentation of the mathematical model with this warning:

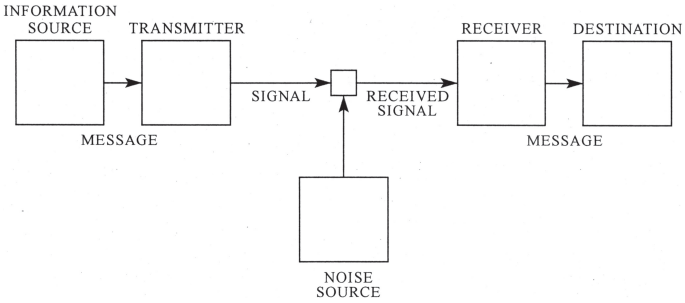


Figure 2: Claude Elwood Shannon's model

> The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point. Frequently the messages have *meaning;* that is they refer to or are correlated according to some system with certain physical or conceptual entities. These semantic aspects of communication are irrelevant to the engineering problem. The significant aspect is that the actual message is one *selected from a set* of possible messages. The system must be designed to operate for each possible selection, not just the one which will be actually chosen since this is unknown at the time of design (Shannon 1948: 31).

There are two important facts here: (1) meaning is not part of the theory and (2) the chosen message is unknown. Here, also, we must understand that "certain physical or conceptual entities" refers to *human writing/speaking or language*, the system of *meaning*. When we take the requirement for meaning into account, the diagram must be modified to account for a *human observer* who has a command of a natural language. While it is possible to have one machine monitor another machine (e.g., the internet) there will always have to be a *human observer* to build, maintain, use, and supply language to the machine (Ruesch 1953: 55). Ultimately, the "correction data" will always be a natural human language (syntactics, semantics, pragmatics) as specified in Figure 3 by Shannon (1949: 68).

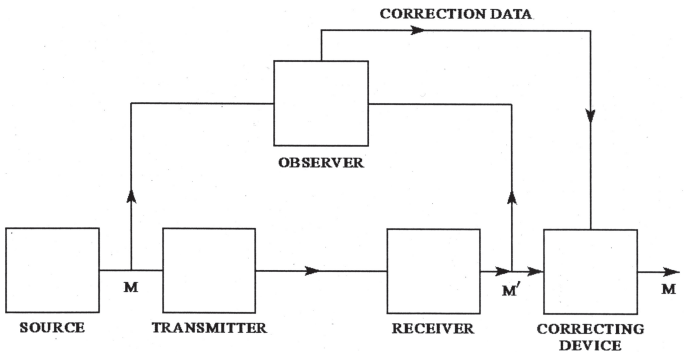


Figure 3: Shannon's "correction data"

3.3 Jürgen Ruesch and Gregory Bateson: 1951 model

The human science response to the Shannon IT model was made initially by Jürgen Ruesch and Gregory Bateson (1951), a psychiatrist and an anthropologist respectively, with an explicit CT account of the *human observer* – the language using human being. Ruesch and Bateson specify that human communication operates on four ascending embedded network levels of complexity: Level I is intrapersonal communication (embodied consciousness), Level II is interpersonal communication (dyadic interaction), Level III group communication (social interaction), and Level IV cultural communication (inter-group culture). As a direct comparison to the Shannon model, Ruesch and Bateson (1951: 277, Table D.) designate each network according to (1) Origin of the Message, (2) Sender, (3) Channels (4) Receiver, and (5) Destination of Message. The communication *process* involves (1) evaluating, (2) sending, (3) "channel" [= medium] chosen, and (4) receiving. Note that the process begins with the *observer evaluating the message* (the part external to the Shannon model). All these elements of the model are presented in Fig. 2 (1951: 275). A summary version of the theory is Ruesch (1953).

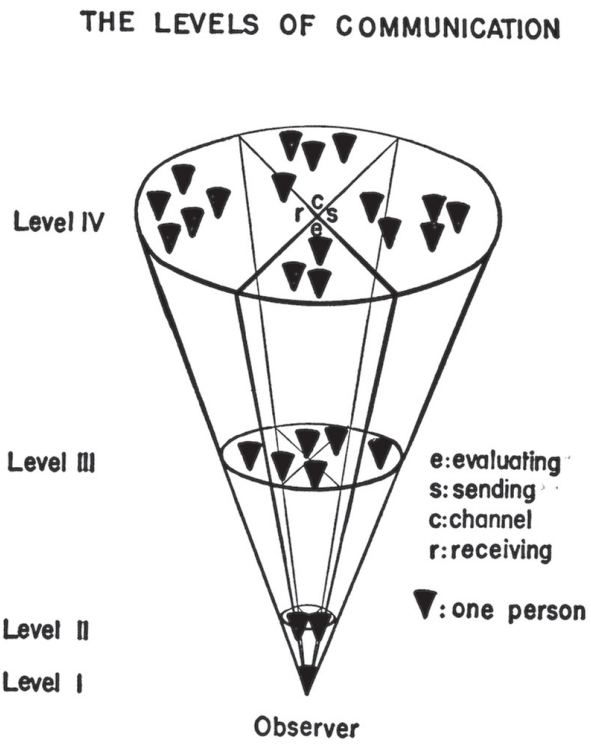


Figure 4: Jürgen Ruesch and Gregory Bateson's 1951 model

3.4 Roman Osipovîch Jakobson: 1958 model

Jakobson's communication theory is the most comprehensive ever developed, ranging from phonology in consciousness to practice in culture. The theory builds on the "rhetorical branch of linguistics" because "distinctiveness and redundancy, far from being arbitrary assumptions of the investigator [as in IT], are objectively present and delimited in language [as in CT]" and thereby "establishes a clear-cut demarcation between the theory of communication and of information" (Jakobson 1960b: 571–573). By this time, as Gleick (2011: 268) notes, "In the social sciences, the direct influence of information theorists had passed it peak. The specialized mathematics had less and less to contribute to psychology and more and more to computer science."

Jakobson's (1960a: 21–27) model of communication presents both six FUNCTIONS and six respective *elements*. Note that the Addresser – Addressee are horizontal to indicate a primary syntagmatic relationship, whereas the paradigmatic relationship is shown vertically by the Context and Message pair in opposition to the Contact and Code pair. Note that the functions and elements are also incorporated into the *Alexander Model* which is seen in Fig. 5.

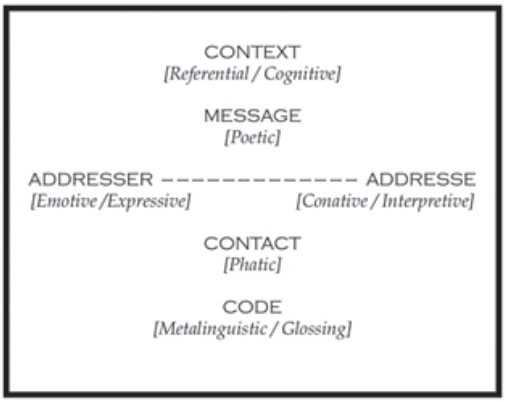


Figure 5: Jakobson's *Alexander Model*

The *Addresser* is the human, embodied origin of communication and in consequence is not a mechanical "sender" or "signal source," but the *expressive constitution of emotion*. In linguistic terms, the Addresser is the verbal 1st Person (*persona) who is speaking*. The person may be the psychic voice the Greeks called *mythos*, or the persona whose oral speaking is audible as the interpretant *logos* of a person. As such, the Addresser *gives* (data) a Message that constitutes a Code and selects a Context for Contact ("choice of context" or analogue logic). Lotman (1994: 22) provides a detailed analysis of the motivation that occurs between message and

code, code and message, in the formation of discourse as practice and communication as culture.

The *Addressee* element of communication is basically the reverse phenomenological intentionality of the Addresser. The Addressee is the human, embodied origin of culture and, in consequence, is not a mechanical "receiver" or "signal destination," but the *interpretive constitution of conation*. In linguistic terms, the Addressee is the verbal 2nd Person (persona) *who is spoken to*. The person for whom aural listening is audible (oral) becomes the interpretant *logos* (a preconscious social practice or *habitus*) for the psychic voice that the Greeks called *hexis,* or the self embodied practice of culture. As such, the Addressee *takes* (capta) a Code that constitutes a Message and selects a Contact for Context ("context of choice" or digital logic).

Context is the *referential function* of the communicative act in which signification is denotative within a cognitive system of meaning. In linguistic terms, Context is the 3rd person, *someone or something spoken of*. It is crucial to recall that Jakobson rejects Saussure's notion of an arbitrary sign (signifier in *opposition* to signified). Rather, Jakobson demonstrates that communication is a "choice of context" such that signs have a relative, but necessary, motivation to one another (signifier in *apposition* to signified). As Holenstein (1974: 157) explains Jakobson's use of Peircian semiotics, a sign's "own constitution reflects the relational structure of the thing represented," Hence we have Peirce's preferred name for the sign as a *representamen*. The notion of "representation" is a key problematic and thematic in all Postmodern discussions of intentionality in the human sciences.

Contact is the *phatic function* operating in human communication such that a physical (interpersonal) and psychological (embodied, intrapersonal) connection is established between the Addresser and the Addressee. The best eidetic/empirical example in linguistics is the concept of an *emblem*. An emblem is the anthropologist's name for a word that stands in place of a gesture, or, the gesture that replaces a verbal message (this is also an example of code switching). The emblem is a sign with a culturally known interpretant that moves from (1) physical contact (signification) between Addresser and Addressee to (2) mutual psychic sharing (meaning).

The *Message* displays the phenomenology of the *poetic function* in communication. Rather than a mundane reference to poetry, the essence of *poiesis* is the shifting of verbal elements exterior to the system of language in which case you have *rhetoric,* or, interior to the system of language in which case you have *poetic*. While there is a long, detailed phonological analysis that is relevant at this point (i.e., the nature of distinctive and redundancy phonetic features), we must be content to explain the poetic function in verbal communication as paradigmatic and syntagmatic *reversal* of words as units in sentences.

For example, once you know the words in a sentence by grammatical function, any word in that category can replace any other word. In the sentence, "The cat

ate the dog." you immediately see that if you are a dog lover the message can be reversed as "The dog ate the cat." Moreover, you immediately also know that any noun in the sentence can be replaced by a pronoun, and, any verb can substitute for any other verb. The vertical (paradigmatic) and horizontal (syntagmatic) word shifts can be remembered as a whole set, what Jakobson calls the "Prague Prism" (Holenstein 1974: 31, 139) or ever expanding matrix, hence, Ruesch and Bateson's (1951) use of "social matrix" in the subtitle of their book.

Jakobson concludes that messages are unique in language because human speaking (*parole*) consists of: (1) a linguistic utterance, (2) language as an individual, private property, and (3) the individualizing, centrifugal aspect of language (where *centrifugal* means the agency of moving from individual out to group, from person into culture). Message interpretation relies on perceiving the diachronic ("then and there" historical sequences) of verbal or nonverbal usage. Egocentric cultures, typically Western, stress the importance of messages over codes, individuals over groups (Lanigan 2011b).

The concept of a *Code* entails the understanding of the *metalinguistic, glossing, or rubric function* in communication. Every communication system, verbal or nonverbal, has both an object language (discourse about extralinguistic entities) and a metalanguage (discourse about linguistic entities) that specify synchronic relationships ("here and now" existential moments). Linguists refer to this code phenomenon as "double articulation," since an utterance or gesture refers both to itself as an entity (the *agency* function) and beyond itself to its context in a system (the *efficacy* function). Jakobson also judges that codes are unique in language because social language (*langue*) consists of (1) linguistic norm, (2) language as supraindividual, social endowment, and (3) the unifying, centripetal aspect of language (where *centripetal* means the efficacy of moving from group to individual, from culture to person). Sociocentric cultures, typically Eastern, stress the importance of codes over messages, groups over individuals (Lanigan 2011b).

Most people experience the complexity of the metalinguistic function when they look up a word (message) in a dictionary (code) only to find themselves referred to other words (message in the same code), thus acting to no avail in an unknown code. With an encyclopedia, the name (code) of a concept, person, place is described in a narrative (message) where the sought after name becomes a concept among related ideas. The *Dictionary* or *IT Model* of the message-to-code processing is often compared to the *Encyclopedia* or *CT Model* of code-to-message processing (Eco 1976: 98–100).

3.5 Hubert Griggs Alexander: 1967 model

Alexander's ([1967] 1988;Alexander's ([1967] 1968; 1969) communication model is philosophic in orientation with the goal of explicating how human thinking oper-

ates as *rationality* through the agency of language and logic as suggested by leading Western philosophers and linguists. At Yale University for his Ph.D., his teachers were Wilbur Urban, Edward Sapir (1931), and Ernst Cassirer ([1957] 1995) and he was a classmate of Benjamin Lee Whorf (1952) which helps explain this orientation (Lanigan 2011a). The model is formalized with notation to show all the complex semiotic relationships being considered, especially the connection between *symbol* and *referent*. The diagram, Fig. 6, is modified to show the corresponding elements and functions of the *Roman Jakobson Model* which are indicated as *[bracketed terms]*.

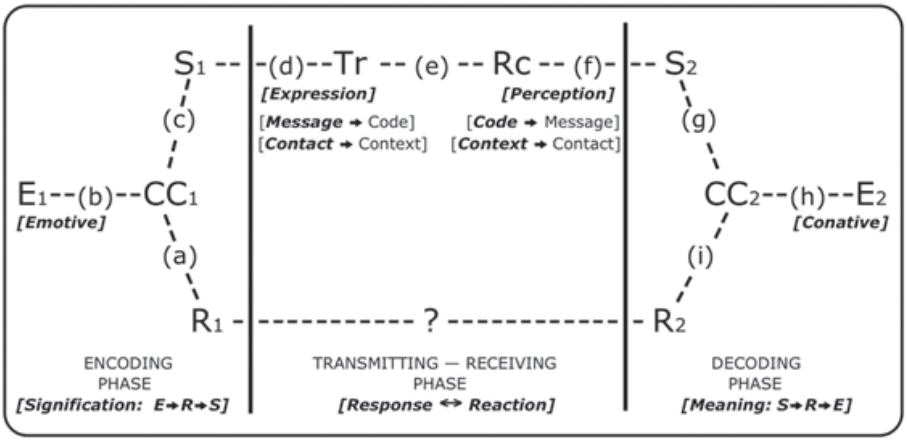


Figure 6: Hubert Griggs Alexander's model

Symbolic Notation:

E1 = The Background Experience and Attitude of the Communicator.
CC1 = The Concept of the Communicator.
S1 = The Symbol(s) used by the Communicator.
R1 = The Referent(s) as Perceived or Imagined by the Communicator.
S2 = The Symbol(s) as Understood by the Communicatee
R2 = The Referent(s) as Perceived or Imagined by the Communicatee.
CC2 = The Concept of the Communicatee.
E2 = The Background Experience and Attitude of the Communicatee.
Tr = The Transmitting Device, Mechanism, Medium of Expression.
Rc = The Receiving Device, Mechanism, Medium of Perception.
? = The Mediation Possibility of a Relationship as Response (Verbal), Reaction (Nonverbal).
a – i = Specific Boundary Relationships that are Necessary (validity) and Sufficient (reliability) Conditions in the Communicological Process.
---- = Space/Place and Time/Moment Link, Connection, Relationship.

Alexander focuses on the *communication concept* that is a complex semiotic relationship moving from human *experience* (awareness) to *referents* for that experi-

ence (awareness of awareness) on to the *symbols* (representation of awareness of awareness) *used* as a *signification* of the experience. A special focus of the model is the fact, first noted by Jakobson, that the Communicator *encoding* process is *reversed* in *decoding* by the Communicatee. Decoding involves moving from symbol to referent to experience as the constitution of *meaning*. This reversal (poetic function) is a key component of Jakobson's idea of motivated redundancy in which the symbol is *psychologically distinct* in every usage (CT) for a human being as opposed to *physically identical* repetition that is arbitrary (IT) for a machine. Jakobson's new definition of redundancy also resolves many classic philosophical paradoxes based on the hypostatization of ideal referents.

The explanatory power of Alexander's model is best understood by an examination of the key relations points marked (a) through (i) in the Encoding, Transmitting, and Decoding phases. These are points at which a *functional failure* in human communication can take place which we recognize as misunderstanding – the failure of proper concept formation. The failure points are examined in order together with suggestive examples.

3.5.1 Failures in communicator conceiving and encoding

Encoding is primarily the *process* of creating a *signification* in the language system and contextual nonverbal behavior where a personal *message* is constructed using synergistic parts of the cultural *code*. The signification is often referred to as a *denotation* or extensional term (Alexander [1967] 1988: 85–88).

(a) Referent: Epistemic-Pragmatic Failure occurs by the Communicator forming the *wrong idea* which maybe due to [1] unclear perceptions (e.g., mistaking a "cat" for a "dog"), [2] improper conceptualizing (e.g., mistaking a cardinal ["1"] for an ordinal ["first"] number), or [3] the wrong application of a properly conceived Idea (e.g., taking the planet Earth to be a perfect sphere).
(b) Experience: Epistemic-Emotive Failure because of *preconceptions* on the part of the Communicator that may be due to [1] a lack of appropriate background experience or [2] an inadequate education.
(c) Symbol: Semiotic-Semantic Failure in Encoding (using the *wrong symbols*) may be due to: [1] an inadequate knowledge of the symbol system (e.g., saying "dog" when one means "cat") or [2] using ambiguous symbols, or symbols that are apt to be unfamiliar to the Communicatee, either intentionally (deception) or not (mistake).

3.5.2 Failures due to expression (Transmitting) and perception (Receiving)

(d) Physiological Failures of the Communicator (e.g., mis-articulation, stuttering).
(e) Mechanical Failures in Transmitting and Receiving (e.g., mispronunciation, aberrant sounds, background noise, static).

(f) Physiological Failures of the Communicatee (e.g., being hard of hearing, confused by an unfamiliar accent, contradiction between word and gesture).

3.5.3 Failures in Decoding and discovering the correct Referent

Decoding is primarily the Communicatee *process* of creating a *meaning* in the language system and contextual nonverbal behavior where the cultural *code* is used to construct a personal *message*. The meaning is typically referred to as a *connotation* or intensional term (Alexander [1967] 1988: 85–88). Among human beings, this open system process is curvilinear, while in machines the closed system process is linear (Ruesch 1953: 50). Hence, encoding as a *channel code signification* is never an equivalent process to decoding *medium message meaning* – as Margaret Mead and Claude Shannon warned!

(g) Symbol: Semiotic-Semantic Failure in Decoding (using the *wrong concept* for the symbols received) may be due to: [1] Inadequate knowledge of the symbol system used by the Communicator (e.g., hearing a foreign or unfamiliar language); or, [2] Not recognizing all of the implications of the symbols used (e.g., not detecting irony in the speaker's tone of voice).
(h) Experience: Epistemic-Emotive Failure because of *preconceptions* on the part of the Communicatee (e.g., having a misconception of geographical orientation, which leads to a failure to understand directions; or, having no experience with an object which is being described to one).
(i) Referent: Epistemic-Pragmatic Failure in Finding the Correct Referent (e.g., failure to get from the correct, but too general, concept to a *specific referent* such as not knowing that "Betty" refers to a pet dog, not a person).

4 Communication

Communication science is fundamentally the study of organisms and their environment. On that premise, a distinction is made on the basis of systems complexity among humans, animal, and machines. The complexity levels are best characterized semiotically in the sense that human beings synergistically embody iconic, indexical, and symbolic systems in both time and space (Merleau-Ponty 2003). Animals and machines do not (Dreyfus [1972] 1992).

4.1 Human

Throughout history there has been an enduring consensus about human communication that is captured by Jurgen Ruesch (1972: 127):

> The word 'communication' will be used here in a very broad sense to include all the procedures by which one mind affects another. This, of course, involves not only written and oral speech, but also music, the pictorial arts, the theatre, the ballet, and in fact, all human behavior.

The unique human ability to use symbols to hold meaning in consciousness is referred to as "time binding" and our parallel ability to locate that same meaning in language (speech and writing) is called "space binding" (Korzybski 1926; Lanigan 1997b).

4.2 Animal

Research on animal communication is generally known as *zoosemiotics*. (Sebeok 1977). In the case of animals, various species display a range of specific capacities to use iconic or indexical signs, but not both. None have symbol capacity, primarily because of the inability to pass specific signs from one generation to the next. While there is evidence of passing a general biological capacity for sign production/recognition from one to a second generation only, there is no intergenerational learning and no *doutero learning* (the symbol capacity of learning how to learn). Thus Margaret Mead (1970: 2) specifies "that the continuity of all cultures depends on the living presence of at least three generations."

4.3 Machine

Machine communication is usually associated with current technologies for manipulating indexical signs. Beginning first with the primitive technology of drum beats, then hand held flags, and then the electrical signals of Morse Code on the telegraph or sound simulation on the telephone, human technology is now at the computer stage with "wireless" signal connections on a global scale. While technology forms continue to evolve and integrate (e.g., iMac computer, iPhone, and iTablet synchronized as Mobile.me in the iCloud), the major contribution of machine communication to human users is the increased opportunity for technologically extended interaction using existing symbol systems (i.e., language and audio-visual records).

5 Communicology

Communicology is the science of human communication (DeVito 1978: v; Lanigan 1988, 1992, 2008a,b; Flusser 1996, 2002). This theoretical and applied approach to the study of human communication uses the combination of semiotics (cultural codes) and phenomenology (embodied consciousness) to explicate communication

theory (CT) and information theory (IT) as logics of verbal and nonverbal interaction (Lanigan 1997a,b). The approach stresses the priority of CT as the logical context for IT. This is to say as a theorem of logic, (1) a Choice of Context as a *combinatory analog apposition* always precedes (2) a Context of Choice as a *disjunctive digital opposition* is the distinguishing characteristic of human thought and speech (Wilden [1972] 1980Wilden [1972], 1987).

Communicology can be summarized easily as a semiotic logic of discourse and practice:

> IF the *formation rules* are DISCOURSE:
> *Rule 1:* Things included in the system (Both—And analog logic).
> *Rule 2:* Things excluded from the system (Either—Or digital logic).
> THEN the *transformation rules* are PRACTICE:
> *Rule 3:* Things excluded from the system can be Things included in the system (Paradigmatic Axis of poetic function).
> *Rule 4:* Things included in the system can be Things excluded from the system. (Syntagmatic axis of poetic function) (cf. Lanigan (2005: 421–435).

Note that discourse and practice constitute an *open curvilinear system* in human thought, whereas a closed machine memory system must always be *linear,* hence cannot simultaneously process an analog and digital logic in *apposition* – which is what human cognition does (Lanigan 1988: 184–193; Ruesch 1953: 50).

It is a fact that only the human mind can engage this theorem in which *both the* chosen *and* not chosen are the binary boundary condition (analog logic) for choosing to *either* choose *or* not choose (digital logic) as the choice made. In CT the binary combination choice is an *apposition* of meaning that constitutes the context, whereas the binary disjunction context is an *opposition* that constitutes the choice as a signification (Durst-Andersen 2009: 59). Bühler ([1934] 1982a: 438–451) defines the linguistic *apposition* as *anaphoric deixis*: a continuous structure of relationship in which the sign presence (*words* in a sentence) projects a combination with the sign absence (words not used, but in paradigmatic and syntagmatic relation) in a synergism which we reduce to the concept of "contexts" (words in *specific possible sentences* that are recognized as *intended* by the speaker).

A simple conversation example of anaphoric deixis is a person (listener) who *finishes* the sentences of another person (deixis) after only the first few words (anaphora) are spoken by the speaker. Edmund Husserl ([1922] 1970: 18) refers to this communicological phenomenon as a case of "transcendental sociological [intersubjective] phenomenology having reference to a manifest multiplicity of conscious subjects communicating with one another." Roman Jakobson (1962–2002; Holenstein [1974] 1976: 138–139) specifies these same communicological characteristics of all human discourse, that he calls *poetic function*, as the *reversibility* potential of (1) vertical *paradigmatic* distinctive features (selection, substitution, similarity, metaphor) and (2) horizontal *syntagmatic* redundancy features (combination, contexture, contiguity, metonymy).

In Western cultures this communicology logic of apposition prior to opposition is described as *non-Aristotelian* or postmodern logic (Lanigan 2008a) and in Asia it is known as *correlation logic* (Chang 1938, 1946; Jiang 2002; Lanigan 2011b; Nisbett 2003). To summarize, human symbolic capacity (represented empirically in spoken language) is the ability to make time and space binding logics by *combining an analog and digital logic at the same time in the same place* – a physical impossibility for an animal or machine because an electrical signal cannot both be and not be at the same time and place, but that is the very definition of a *symbol!* And, symbolic capacity is the very definition of being human (Urban [1939] 1971: 21).

5.1 Consciousness

The human mind has consciousness as a product of pre-consciousness, which we have discussed as time and space binding in verbal and nonverbal communication. Human beings, unlike animals and machines, function on three simultaneous levels of consciousness that integrate *both expression and perception* of (1) *Affect* or emotion, (2) *Cognition* or thought, and (3) *Conation* or purposeful action. The scholastic philosophers in the Middle Ages designated the three levels by the respective Latin terms: (1) *Capta*, (2) *Data*, and (3) *Acta,* which today are still in use to varying extents. In the specific context of communication, human consciousness thus functions as a simultaneous integration of (1) Awareness, or Preconsciousness, (2) Awareness of Awareness, or Consciousness, and (3) Representation of Awareness of Awareness, or variously, Nonconsciousness, Subconsciousness, Unconsciousness. Charles S. Peirce (1931–1958: 1.530–544) provides a useful reference system for these three levels by referring to them as *Firstness, Secondness,* and *Thirdness*. Thus from the perspective of the cultural development of speech as language, human Awareness becomes the syntactic code of "grammar" in verbal communication expressing iconic signs of expression-perception. In turn, Awareness of Awareness becomes the semantic code of "rhetoric" illustrating indexical signs of expression-perception. Last, the Representation of Awareness of Awareness becomes the pragmatic code of the "logic" expression of the symbolic signs of perception. Peirce (1931–1958: 7.585) provides a simple, but explicit summary": "A man has consciousness; a word has not."

5.2 Embodiment

Following the proofs offered by Merleau-Ponty (1945) for human embodiment as the source of human expression and perception, Hubert Dreyfus ([1972] 1992 : 236) reminds us that communication interaction and meaning is founded on our understanding of the *practical activity* of the human body: "what distinguishes persons

from machines, no matter how cleverly constructed, is not a detached, universal immaterial soul but an involved, situated, material body." Consciousness as the human mind in the synergistic body is the source and context for communication (Lanigan 2010a; Weiss and Haber 1999).

5.3 Information, Communication, and the Future of 'Intelligent' Machines

Machines can be programmed by creating artificial "languages" (mathematical algorithms) to match *closed system signals* to the *symbol open systems* that we know as human languages (Ruesch 1953: 49–50). This is *information modeling*. Once such a model is in place (e.g., a machine version of "English"), another model can be constructed for "French." Then a third model can be constructed to translate the machine "English" into machine "French." This process is known as primary, secondary, and tertiary modeling in *general systems theory* (Kull 2010; Lanigan 1988: 184).

Once you start to create models for "searching" specific terms in the combined models, you need a complex hierarchy and network of computers to store, sort, classify, and retrieve bits. *Complexity studies* is concerned with how to do this and is most familiar to us as the *Internet* system of models called the World Wide Web. Of course, we can do the same thing with internets that we do with models and this level of metacoding is called *Informatics*. We are presently at the point of developing Internet 2.0 to work with Internet 1.0. If we can continue to develop high order complex systems in this way to achieve an even higher level of complexity, then it will be called "Internet 3.0." Whether or not this level of development is possible at all is a matter of great controversy and is referred to as the problem of the *Semantic Web*. So far, basic negative critiques of the attempt to move from machine syntax to the level of human semantics (by computers) and pragmatics (by robotics) dominate the debate by demonstrating that the key requirements of synergism and embodiment cannot be represented in machines (Dreyfus [1972] 1992: 165, 237, 2001; Searle 1983, 1984, 1995). As Merleau-Ponty (2003: 163) summarizes: "The enumeration of possible combinations does nothing to help us understand the very act by which language takes on a meaning."

The Semantic Web is still confronting the original problems faced by information theory: "Level A. How accurately can the symbols of communication be transmitted? (The technical problem). Level B. How precisely do the transmitted symbols convey the desired meaning? (The semantic problem). Level C. How effectively does the received meaning affect conduct in the desired way? (The effectiveness problem)." (Weaver 1949: 4). In semiotic terms, (A) is the *signal transmission* problem as a matter of Syntactics, (B) is the *sign meaning* problem of Semantics, and (C) is the *symbol expression and perception* effectiveness problem of Pragmatics.

Despite the extraordinary advances that have been made in computer technology in terms of storage capacity and signal transmission efficiency, computer science and the associated "cognitive sciences" are still working at Level A on fundamental issues of signal accuracy. By comparison, the paradigm discussed in this essay is the one we are currently using: *human language* (verbal and nonverbal communication) that already functions at Levels A, B, and C with an embodied, synergistic, analog logic base that simply cannot be duplicated by a machine or an animal.

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