Cybersemiotics and the Problems of the Information-Processing Paradigm as a Candidate for a Unified Science of Information Behind Library Information Science[1]

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Abstract

As an answer to the humanistic, socially oriented critique of the information-processing paradigms used as a conceptual frame for library information science, this article formulates a broader and less objective concept of communication than that of the information-processing paradigm. Knowledge can be seen as the mental phenomenon that documents (combining signs into text, depending on the state of knowledge of the recipient) can cause through interpretation. The examination of these "correct circumstances" is an important part of information science. This article represents the following developments in the concept of information: Information is understood as potential until somebody interprets it. The objective carriers of potential knowledge are signs. Signs need interpretation to release knowledge in the form of interpretants. Interpretation is based on the total semantic network, horizons, worldviews, and experience of the person, including the emotional and social aspects. The realm of meaning is rooted in social-historical as well as embodied evolutionary processes that go beyond computational algorithmically logic. The semantic network derives a decisive aspect of signification from a person's embodied cultural worldview, which, in turn, derives from, develops, and has its roots in undefined tacit knowledge. To theoretically encompass both the computational and the semantic aspects of document classification and retrieval, we need to combine the cybernetic functionalistic approach with the semiotic pragmatic understanding of meaning as social and embodied. For such a marriage, it is necessary to go into the constructivistic second-order cybernetics and autopoiesis theory of von Foerster, Maturana, and Luhmann, on the one hand, and the pragmatic triadic semiotics of Peirce

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in the form of the embodied Biosemiotics, on the other hand. This combination is what I call Cybersemiotics.

Introduction

Library information science (LIS) devotes itself primarily to the study of systems and methods for classification, indexing, storing, retrieval, and mediation of documents that can cause the creation of information in the user's mind. The aim is to create information in the user's mind to be understood as meeting social, cultural, or existential needs. The crucial question is that of the interpretation of the document's meaning for the individual in a given organizational or institutional connection, and in a given historical situation. Ingwersen (1996) describes the information need as built from a cognitive state (including previous knowledge), a work task, interest, and a domain. These social-pragmatic circumstances form the context for understanding our informational desires and problems. He develops a matrix with four distinct cognitive forms of information needs relevant for determining search behavior and types of polyrepresentation. But thus far, we do not have an explicit theoretical treatment of how varying forms of aboutness come into existence and function in a social context. As information, in this view, develops primarily in an individual mind in front of a document-mediating system, there are no explicit theories about how information develops in social practice. We still have difficulties with the construction of a comprehensive theoretical framework, which can improve consistency in our use of scientific concepts within LIS, guide our research and development of research methods, and finally, provide the background for the interpretation of empirical research. As in Machlup's (1983) theory of information, the cognitive viewpoint focuses on the individual.

Hjørland and Albrechtsen (1995) describe the influence of knowledge domains on concept formation and interpretation in the domain analytic paradigm. They give theoretical reasons why classification and indexing should be directed toward the ways signification is created in discourse communities related to different knowledge domains, especially within the different fields of science. This is followed up in a book by Hjørland (1997) that has an activity approach to information science. But as Blair (1990) points out in his foundational book *Language and Representation in Information Retrieval,* then we need to add a pragmatic semiotic and language game–based theory of interpretation to make the above-mentioned new developments function in a common framework and get access to the mystery of meaning in human language that goes beyond computational approaches (Fodor, 2001, points out that mystery). See also Bowker and Star's (1999) development of a pragmatic semantic embodied theory of classification.

This insight leads to the need for a general semiotic framework of communication and sign interpretation. We need to open LIS to the results and constructive thinking of a more general theory of how signs—such as words and symbols—acquire their meaning through communication, be it oral or written (Warner, 1990; Suominen, 1997; Thellefsen, Brier, & Thellefsen, 2003). Semiotics should encompass not only social and cultural communication but also should be able to address natural phenomena such as the communication of biological systems. It should have categories for technical information processing. At the same time, this transdisciplinary theory should distinguish between physical, biological, mental psychological, and social-inguistic levels and not reduce them to the same process of information.

Thus, LIS requires a theory of the cognition and communication of signification by different types of systems. Neither the objective syntactic approach of the information-processing paradigm nor the personal phenomenological approach of Machlup can deliver a framework encompassing communication processes in social, biological, and technical systems. As Buckland (1991) points out, we also must draw on systems theory and cybernetics, and I especially will point to the new second-order cybernetics and autopoiesis theory. In contrast to Suominen (1997), who builds on the French culture-centered structualistic *semiology* originating in Saussure's work, I chose to build on the American pragmatic transdisciplinary *semiotics* founded by Charles Sanders Peirce as it promises to cover nature and technology as well. More than anything LIS—and many other informational fields—needs a theory that can dissolve the mutual ignorance and hostility between Snow's two cultures. See, for instance, the work of Zadeh (1999) and Sinha et al. (2000),[2] making computing with words possible. The great conceptual and methodological differences between the computational and semantical approaches to communication divide LIS in two paradigms to a degree that one can hardly talk about one knowledge domain—a problem that psychology, computer science/informatics, and medicine, to name a few, also have.

Analyzing the Possibility of an Information Science

Science—especially natural science—has a double role as both developer of technology and worldview producer. Reliance on science as an instrument for obtaining knowledge is an important part of our faith in technology as the correct means for developing society. Science is also the foundation of "the modern worldview," indicated by rationalism and physicalism and embedded in a theory of evolution. Science is therefore an important element in the system world's strengthening of its self-conscious belief of having special access to the truth about reality and holding the key to perpetual progress based on the steadily increasing control of nature.

The ideological tendency to view the acquisition of scientific knowledge as a unique and privileged path to truth and reality is, in my opinion, one of the main problems of the modern information society. All knowledge other than the "laws of nature" determined by physics and mathematics is regarded as uncertain and subjective. Part of our cultural project is to uncover all "laws of nature" to fulfill the desire to display the ultimate safe basis for the construction of objective, true, and provable knowledge. Stone by stone, we will erect the cathedral of truth and reach the final realization and control of our own selves and surrounding nature, and with this we hope to liberate the human intellect from natural and material forces. This is the project that—according to our self-understanding—separates us from, and raises us above, other human cultures and is central to our view of ourselves as "modern." Today this idea is embraced by great scientific thinkers like Stephen Hawkins (1989) and E. O. Wilson (1999) but questioned by philosophers and sociologists of science like Thomas Kuhn (1970) and Bruno Latour (Latour, 1993). The latter argues, "we have never been modern."

One characteristic of modernity is faith in rationalism as the highest value and the associated tendency to see science as a "meta-narrative." The empirical-mathematical science, formulated by Galileo among others, has come to play a great role in our cultural self-understanding and worldview. In the mechanical physics that consequently gradually developed lies a vision that Laplace clearly articulated about the possibility of achieving a complete mathematical description of the collective expression for "The Laws of Nature," in short, a World Formula.

This belief in science and technology, where science becomes a "great story," has much in common with the myth of dogma-based cultures where myth defines true knowledge, true values, and real beauty. Instead of becoming true liberating knowledge, science is, to a certain degree, finding its limited viewpoint raised to a dogma called "the scientific worldview" that promises to uncover the algorithms behind language and intelligence and implement them in the computer.

From the French Age of Enlightenment's philosophers, through Comtes's positivism, the ramifications of the Vienna Circle and logical positivism, the idea of information has been interpreted in an increasingly rationalistic and materialistic direction. Today this path has ended with the split portrayed by C. P. Snow (1993) between "the two cultures," where the modern humanities in their divided specialization and often highly refined aestheticism stand in weak opposition to financial power joined with a scientific-technological system. The humanities have difficulty finding a common basis from which to formulate their value assumptions since they wish neither to make ethics into religion or science, nor to define human nature beyond sociolinguistic material consciousness. But even the mechanical philosophy of nature's rationality is being undermined inside science itself through the so-called paradigm shift.

Here the task of formulating a new quantum mechanics has shown itself to be important. The discussions about Heisenberg's Interdeterminacy Principle, the problems of measurement, and Bohr's Complementarity Theory relate to the cognitive limitations that quantum mechanics cognition sets for the traditional sciences. Ultimately concepts such as nonlinearity, chaos, and unpredictability are establishing themselves as fundamentals in mathematics and science. In relation to its own self-understanding, science has ended in a series of situations of powerlessness that should eventually lead to a deliberation over the status of scientific knowledge in a highly industrialized society.

In spite of the increasing number of theoretical scientists and researchers who have acknowledged limitations in the scientific form of knowledge, the Laplacian ideology of science seems to nevertheless influence a large part of the system world. It is in this market-sphere that researchers must find their grants. Perhaps that is why the "World-Formula Ideology" still influences the headings of a series of larger research projects. For example, work with the united Quantum Field Theoretical formulation of all powers' and particles' basic dynamics in the common mathematical description today moves from the grand unified theory (GUT) to be formulated as "the heterotic super string theory" as well as efforts to find and manipulate "the fundamental laws of life" by uncovering "the genetic program in the human genome project."

A similar idea is the assumed connection between the laws of nature, logic and thought, and linguistic syntax. This lies behind the project that attempts to uncover and transfer "the laws behind human intelligence" to computers to create "artificial intelligence." This also pertains to the project's more sophisticated continuation in "cognitive science" and certain forms of "information science." The last project especially shows the severe limitations of the mechanistic view of knowledge, nature, language, and consciousness.

The information-processing paradigm will never succeed in describing the central problems of mediating the semantic content of a message from producer to user because it does not address the social and phenomenological aspects of cognition. Furthermore, it will fail because it is built on a rationalistic epistemology and a mechanistic worldview with an unrealistic world-formula-attitude toward science. Science can deal only with the decidable, and, as Gödel has shown, there are undecidables even within mathematics. The problem with the now-classical functionalistic information-processing paradigm is its inability to encompass the role of the observer. It is the human perceptive and cognitive ability to gain knowledge and communicate this in dialogue with others in a common language that is the foundation of science. An awareness of this will lead one to start in the middle instead of at the extremes, to start not with either subject or object, but with the process of knowing in living systems. This is precisely what second-order cybernetics and Peircian biosemiotics do.

The Cybernetic Turn

As one of the founders of second-order cybernetics, Heinz von Foerster is keenly aware of the paradoxes of objectivity, the deterministic mechanicism of classical physics, and even modern quantum physics and relativity thinking. He develops a position where he can offer dialogic theories of cognition, language, and how reality and meaning are created in society.

Von Foerster (1984) demonstrates that if an organism is modeled as a machine then it cannot be trivial (i.e., there is no deterministic mathematical description of its behavior). He therefore speaks of living systems as at least nontrivial machines. The system organizes itself and produces its own parts. The self-organizing ability and the historical dimension of living systems are important reasons why organisms are not trivial machines. They are closed, self-organized systems. But this actually only makes the whole problem more difficult. If information is not transferred from the environment to a mechanically describable system, what kind of dynamics are we dealing with?

Von Foerster answers this question of information and dynamics as follows: The organism reacts to disturbances/perturbation in its system by means of self-referential dynamics (so as to conserve the sort of system it seeks to be). The concept "outside" is not used because according to these theories the concept "outside" or (objective) "reality" has no significant objective meaning. As von Foerster explains:

> . . . I see the notion of an observer-independent "Out There," of "The Reality" fading away very much . . . (Von Foerster, 1984, Preface)

In understanding the organization and function of information systems, it is important to appreciate the role of system-regulated feedback from influential user groups of different parts of the system. This organizational structure includes retrieval systems and user-interfaces. These feedback analyses allow us to see information-storing and intermediary systems as self-organizing cybernetic systems in a constant inner interaction that includes users as causal parts of the system. Von Foerster formulates this basic insight of cybernetics as follows:

> Should one name one central concept, a first principle of cybernetics, it would be circularity. Circularity as it appears in the circular flow of signals in organizationally closed systems, or in "circular causality," that is, in processes in which ultimately a state reproduces itself. (Von Foerster, 1992a, p. 226)

Transferred to document-mediating systems, this means that these systems develop in a constant inner exchange between the producers', indexers', and users' intellectual horizons. Such an understanding is inspired by systems science and especially by the new second-order cybernetics (von Foerster, 1979, 1984, 1992a), which works intentionally with the integration of the observer's observation process into the actual system description. This promotes the understanding of the document-mediating systems and other informational systems as self-organizing processes.

Such systems cannot be controlled exclusively from within or without, and the adequacy of their behavior and cognition should be judged by their viability rather than by an objective idea of absolute truth, says another important contributor to second-order cybernetics, the radical constructivist Ernst von Glasersfeld (1992). This places second-order cybernetics in the same pragmatic as Wittgenstein's language philosophy and Peirce's semiotics. Blair (1990) makes use of a combination of these two theories in his important book. Hjørland and Albrechtsen also rely to some degree on pragmatic views of language, although not specifically on Wittgenstein (1958) and Peirce (1931–58).

Cybernetics seeks to describe and explain how the function of structural constraints influences the development of self-organizing systems that are now, due to the work of Maturana and Varela (1980), called autopoietic systems. "Auto" means self and "poietic" means creation. Maturana and Varela define an autopoietic system as one that produces its own limits and organization through the production of the elements it consists of. It is typical for second-order cyberneticians like Maturana (1988a) and von Glasersfeld (1991) to take a deeper step into biology than most humanists. Like Piaget, they descend to biology's prelinguistic creatures. With their concept of autopoiesis, Maturana and Varela (1980) show one of the reasons for this. Maturana's strength is his broad biological starting point in living systems. With the concept of autopoiesis, he shows that organisms are organizationally closed. The nervous system is also a closed circular system that does not accept outside information in any objective sense. Perturbations of the organism's vital organization produce only knowledge in relation to the domain of distinctions that the organism has developed in relation to its own domain of living. Knowledge, therefore, also has a biological foundation. The forms of distinguishing whether an organism or an observer develops are not "true" in any universal sense. They acquire, however, an operational effectiveness in relation to the life praxis of the system in question. Viable patterns of differences are then established in the domain of distinction as various kinds of objects. Along the same line of thinking, von Foerster explains this bringing forth of objects and concepts:

> Of interest are circumstances in which the dynamics of a system transforms certain states into these very states, where the domain of states may be numerical values, arrangements (arrays, vectors, configurations, etc.), functions (polynomials, algebraic functions, etc.), functionals, behaviors, and so on. Depending on domain and context, these states are in theoretical studies referred to as "fixed points," "eigenbehaviors," "eigenoperators," and lately also as attractors, a terminology reintroducing teleology in modern dress. Pragmatically, they correspond to

> the computation of invariants, may they be object constancy, perceptual universals, cognitive invariants, identifications, namings, and so on. (Von Foerster, 1992a, p. 226)

When we look at language as a means of information, it appears clear that a word's metaphorical meaning is dependent on the organization of the living system (its body) and its context of living, as opposed to context-free computer language (Lakoff, 1987). Meanings are the result of a coupling process based on joint experiences. This is an important foundation for all languages and all semiosis. Words do not carry meaning, rather meanings are perceived on the basis of the perceiver's background experience. Percepts and words are not signals, but a perturbation whose effect depends on system cohesion. After a long period of interaction, a concept acquires a conventional meaning (eigen behavior) within a certain domain. The perception and interpretation of words force choices that give opportunities for action and meaning (Luhmann, 1990, p. 32).

This conception is complementary to "the transmission model" where one imagines packages of information sent via language from a sender to a receiver. In the cognitive view, this is modified to consider that which is sent as only potential information. In second-order cybernetics, biological and societal contexts are made explicit through the theory of autopoiesis, and there is a clear understanding of the pragmatic origins of knowledge from different knowledge domains. Von Foerster summarizes this position in the following:

> Another case of a net with circular organization that cannot be mapped onto a plane is *autopoiesis* . . . an autopoietic system consists of interactive components whose interactions produce these very same components. Autopoiesis is thus a special case of self-organizing systems, whose organization is its own *eigen-organization* . . . the notion of autopoiesis allows the phenomenon of language to emerge as a consequence, as the *eigen behavior,* of the recursive interactions of two organisms, each in need of the other for the realization of its own autopoiesis . . .
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> Because language can speak of itself having language, syntax, word, and so forth in its vocabulary, in conversations speakers can speak of themselves, thus preserving their autonomy in a social context by uttering, for example, the first-person singular pronoun in the nominative case, "I," thus generating the shortest self-referential loop . . .
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> It is precisely at this point that the perspectives of second-order cybernetics can be seen. . . . Second-order cybernetics invites you to leave Helmholtz's *locus observandi* and to step into the dynamic circularity of human give-and-take by becoming part and partner of the universe of discourse and the discourse on the universe. (Von Foerster, 1992a, p. 311)

Language is therefore a self-organized, self-reflecting circular system based on interactions of autopoietic systems that have the same kind of organization.

In this view, language emerges from a mutual coupling between humans in society (whose consciousness emerges in the self-same process) through a long historical process. Meaning and the semantic level in language are "sense created in common," and it is this understanding, and not some direct objective empirical reference, that is language's most important reference. The meaning of a word changes as a consequence of historical drift, which is largely accidental. The development occurs partly because people that communicate never have completely identical "horizons of understanding" (Gadamer, 1975). The meanings of concepts are created, maintained, or developed within discourse communities, a domain, a culture, or a society among biopsychological systems having a material body.

What are the organizational principles, if any, of the observation or cognition generating the living systems? Organisms are not only dissipative structures. They are also self-organized. As systems, they produce their own elements, internal organization, and boundaries. The system is organizationally closed, including the nervous system. All nerve cells impinge upon each other. The senses have no privileged position. Maturana and Varela claim that there is no "inside" or "outside" for the nervous system, but only a maintenance of correlations that continuously change. The nervous system thus does not "pick up information" from its surroundings. Instead it "brings forth a world." This is done by specifying which perturbations of the sensory surface will lead to changes in the system's behavior. This is determined by the system's organization. As these interactions are repeated over a period of time, the changes of states that are triggered by the interactions will be adapted by the structure of the nervous system. These repetitions will be conserved as sensory-motor correlations. The repetitions of sensory-motor correlation patterns are conserved as part of the structural dynamics of the network. Structural couplings are established. Thinking is the part of sensory-motor correlations that occurs in the relations of the observer. Thinking takes place in the interactions or relations of the observer as coordination of behavior.

The problem here is how the scientific community sees the connection between nature and mind or between the universe and the world of life, mind, and meaning. In Maturana and Varela's vision, the autopoietic system is closed in its structure-dependent organization. The environment, or a world, is only constructed by another observer. But who is this observer? Is it another autopoietic system that also only exists through the observation of another autopoietic system, observing the observing system and its surroundings? The "picture" of the environment is constructed through a society of observers making structural couplings to the environment and to each other through languaging. This leaves unanswered the question about who made the first distinction between system and environment. Maturana and Varela take biological systems, society, and language for granted, but not the environment. Instead of the usual physicalism, this is a biologistic worldview. It is an important step forward, but not a sufficient answer to the basic epistemological and ontological questions of how cognition, information, and communication are possible.

Spencer-Brown (1972), the philosopher and logician who came to mean so much to second-order cybernetics and autopoiesis theory, was aware of this question. He poses the metaphysical question differently than others in the sciences. He includes the process of observing as an important part of basic reality, which, as we shall see later, places him near Peirce, who includes feeling in his concept of (unmanifest) Firstness. In light of the developments of thermodynamics, chaos theory, and nonlinear dynamics, today there is a tendency to change metaphysics from mechanics' law-determined to a probabilistic worldview. Many researchers, however, cling to the mechanistic ideal while accepting the practical impossibility of dealing with large ensembles of atoms. These cannot be modeled except with probabilistic models. Prigogine and Stengers (1984) have shown the inconsistency in this approach that rejects chance as something real and only as a subjective lack of knowledge. Their point is that objective chance is the source of irreversibility and evolution, and therefore its products, such as scientists themselves. There is a true metaphysical dilemma in modern physics and information science. If one is a mechanicist and believes that everything—including our brain and cognitive apparatus—is governed by mathematical laws, then all we are is the expression of a world formula in search of itself.

Alternatively, we are the products of chaos and chance, what Richard Dawkins (1987) calls the blind watchmaker of evolution working through selfish genes. No matter what theories one holds, in this metaphysics they will, in the end, only be a product of pure coincidence. Something is epistemologically wrong with this framework and its concepts. This is what second-order cybernetics attempts to solve by developing sociobiological constructivism. But it then fails to answer the question of how the first observation that distinguished between system and nonsystem was possible. How did the first distinction between the marked and the unmarked state, as stated by Spencer-Brown in "The Laws of Form," come about in a world of structure-dependent systems? Varela (1975) points to self-reference as the crucial factor in his development of a calculus based on Spencer-Brown's work. But from where can it arise? Constructivism cannot avoid ontological problems. Some believe that the special quality of constructivism as a scientific paradigm is its avoidance of ontological questions. But in my view, even constructivism cannot avoid stating its preconditions. Of course, I speak of a constructivism that goes beyond the social constructivism that takes nature for granted and as objective and therefore is not able to incorporate a natural history of observing systems. Even if one has a "cookie-cutter-constructivist viewpoint," where one's perception and concept cuts out the form of some basic "world stuff," one would have to say something about the minimal requirement in order for this "stuff" to become conscious linguistic systems. As we saw in the above quote from Spencer-Brown, he actually suggests a basic self-referent quality in the world/universe as the process that started evolution.

Although the theories and concepts of von Foerster and Maturana led to a much better grasp of the basic situation of observing and cognition, they seem, in their radicalism, to have removed too much when they neglect even "das Ding an sich." The problem is that they have attempted to find a scientific solution to a basically philosophical problem. Many social constructivistics, on the other hand, avoid these basic questions.

On the other hand, both von Foerster's second-order cybernetics and Maturana's "bring-forth-ism" are correct to focus our attention on creative processes in perception and cognition. As I have already attempted to demonstrate, one cannot resolve the problem of mind and intentionality in an evolutionary philosophy through either mechanical materialism or physical indeterminism. Nor do I believe that this can be accomplished through pure phenomenalistic idealism, subjective constructivism, or mentalism, all of which underestimate the importance of the relative stability of the "outside" world to the possibility of knowledge, communication, and meaning.

In the discussion of differences and similarities in cognition and problem-solving in people and computers, the Dreyfus brothers (1986) and Winograd and Flores (1987) have used Heidegger's concepts such as "das ein," which underlines the "thrownness" of humans in the world. They use this concept to show that a person's relationship to the world is fundamentally different from that of the digital computer. Winograd and Flores use Maturana's theory of autopoiesis and the closure of the nervous system to show that this basic condition is common to both people and animals. The basic situation toward the environment is not objective and separated. The "domain of living," a basic concept from Maturana, is rather an integrated part of the structure of the system predating any cognitive separation between self and nonself.

This epistemological foundation of second-order cybernetics connects it to important points in Heidegger's phenomenology. The important point from Heidegger is that as observers we are always already a part of the world when we start to describe it. When we start to describe it, we, to a certain degree, separate ourselves from the wholeness of the world of our living praxis. This is an important development of the second-order cybernetic and system thinking.

Niklas Luhmann (1990, p. 3) continues this development when he summarizes how cybernetics and the concept of autopoiesis in Maturana's definition provide a new way of looking at things, while he simultaneously maintains a sophisticated realism:

> . . . autopoietic systems "are systems that are defined as unities as networks of productions of components that recursively, through their interactions, generate and realize the network that produces them and constitute, in the space in which they exist, the boundaries of the network as components that participate in the realization of the network." Autopoietic systems then are not only self-organizing systems, they not only produce and eventually change their own *structures;* their self-reference applies to the production of other *components* as well. This is the decisive conceptual innovation. It adds a turbocharger to the already powerful engine of self-referential machines. Even *elements,* that is, last components (in-dividuals) that are, at least for the system itself, undecomposable, are produced by the system itself. Thus, everything that is used as a unit by the system is produced as a unit by the system itself. This applies to elements, processes, boundaries, and other structures and, last but not least, to the unity of the system itself. Autopoietic systems, then, are sovereign with respect to the constitution of identities and differences. They, of course, do not create a material world of their own. They presuppose other levels of reality, as for example human life presupposes the small span of temperature in which water is liquid. But whatever they use as identities and as differences is of their own making. In other words, they cannot import identities and differences from the outer world; these are forms about which they have to decide themselves. (Luhmann, 1990, p. 3)

Hence, we need a more sophisticated theory of how these identities and differences develop, rather than resorting to the usual materialistic mechanism, eliminative materialistic theories, or functionalistic theories of mind. But it must be supplemented by a theory of signs and signification, as well as theories about those biological and social systems to which the difference can make a difference, as cybernetics largely addresses the circularity of differences in self-organized systems. To go deeper into an understanding of the process, one must analyze the whole process of sign making, as C. S. Peirce does in his semiotics, and discuss the functionality of meaning, which is an important aspect of Luhmann's theories.

My concern here has been the function of the concept of "outside reality" in the analysis of behaviors of autopoietic or "observing systems." Although one has rightly abandoned the notion of "objective reality" in second-order cybernetics, one should not give up the notion of a partly independent "outside reality." There is something lacking in the phenomenalistic or idealistic constructivist position that is not corrected by repeatedly referring to "experienced reality." We cannot avoid ontological considerations, but they must, of course, be constantly developed through critical epistemological discussions and analysis. We need to develop a more refined and complex understanding of the role of the concepts of reality in relation to our understanding of our own processes of knowing.

Since we cannot avoid speaking of the nature of aspects of reality as a prerequisite for various scientific paradigms, I suggest it would be more fruitful to regard it not just as complex, but also as hypercomplex. Reality, both in its entirety and its local manifestations, cannot be reduced to something simple, deterministic or random, material or spiritual, or be contained in a linguistic or mathematical formulation. The spontaneous, intentional, anticipatory mind is an irreducible part of that same reality. We never will be able to completely separate subject and object, for our own science nor for the intentional systems we study.

For at least two hundred years, science has recognized that living beings are an intrinsic part of physical and chemical realities. For more than one hundred years, it has been recognized that humans and their culture are an intrinsic part of the biological aspect of reality. Whereas physical and chemical aspects have been considered basic for the universe, it is only within the last thirty years that it has been realized how deeply connected our biological aspect is to the whole development of the universe. We are now on the brink of discovering how the psyche penetrates the basic levels of our reality as Bateson (1972), Bohm (1983), and Peirce (1931–58) have posited.

Because of reality's hypercomplexity, there will always be "noise" in all measurements that will affect our results unpredictably. We always "cut" in an arbitrary way between the observed system and ourselves and between the observed system and its "environment" as we define it through our own experiences and our attempts to explain the "reactions" of observed system(s).

Galilean science has dominated us for over three hundred years. It has shown that reality has aspects amenable to exact mathematical analysis. This has been an enormously productive insight. We must admit that even mind has its "sluggish" sides, especially in a primitive nervous system, which may be partially describable by functional laws. This does not mean, however, that the content of all behavior and language can be transferred to computers, as some eliminative materialists and functionalists believe. There is a hypercomplex "background problem" of individual and historical origin. In both physics and psychology (especially the latter) that which can be described formally has its background in that which is not formally describable: the hypercomplex phenomena, which besides the predictable, and regular, are also comprised of the spontaneous, unpredictable (chaotic), intentional, and unconscious.

In evolutionary philosophy—which does not deny that reality can possess "deep" but formally indescribable absolute features—we may see the development of even more complex and selectively unstable, "far from equilibrium" individual environment systems. Maturana and Varela's autopoietic systems are one example of nature's ability to reflect in ever-increasing degrees the spontaneous, unpredictable, and intentional sides of reality. This ability allows these systems to be centers of their own and to draw a line between themselves as systems and their environment. Through the use of language in society, systems can finally represent themselves socially and by such means establish an individual, curious point of view from which to reflect on knowledge, existence, and meaning.

A productive point of departure is to assume that none of these knowledge systems should be placed in a position of authority where it does not need to answer to critiques from the others. It is dangerous to claim that one of them can provide all necessary information. Let me give some examples of how this has been done in several moments in history.

In the classical period of Greece, general philosophy tried to dominate empirical science. Most philosophers were skeptical about the value of empirical knowledge and the development of technology.

In the Middle Ages, Catholic scholastics had the same position as Islam has today in Iran. Revealed knowledge was true knowledge and determined the limits and influence of other kinds of knowledge.

In the Soviet Union up until the 1970s, dialectical materialism held the same position, banning and destroying routes of investigation that were leading in directions other than the basic ideology.

Right now the major problem in our culture seems to be that for a long period a certain kind of mechanistic science had the major authority and reduced the influence of other areas of knowledge. Ethical and aesthetical knowledge, for example, has been reduced to subjective emotional opinions to which no general value can be ascribed, and semantic content has been neglected in linguistics.

The scientific endeavor in the postmodern age is becoming increasingly complex and transdisciplinary. Researchers and practitioners within the fields of the arts and natural, medical, and social sciences have been forced together by new developments in communication and knowledge technologies that broke the traditional limits of professional knowledge. They are further forced together by problems arising from the limitation of the kinds of knowledge that we have cherished so far.

The shortcoming of traditional information and communication analysis based on data or information-flow theories is raising fundamental problems with respect to the construction and organization of knowledge systems. New concepts of communication can help us understand and develop social systems such as self-organizing and self-producing networks, and we need a deeper understanding of the ethics and aesthetics foundational to the existence of these new systems. Instead of communication of information, we might speak of a jointly actualized meaning.

It is important to find a genuinely nonreductionist interdisciplinary view of knowledge that allows different kinds of knowledge to interact in a nonideological way. Only then may we develop a new view of cognition, signification, information, and communication and the relation between culture, nature, and our own bodies. It is difficult to change the way we think of the world, of our society, and of our own lives. But as Bateson (1972) has pointed out, this is the major key to change, and many things point to the need for such a change if we are to survive and make the leap to a new global culture.

At the present time, two nonmechanistic transdisciplinary frameworks have drawn attention to their attempt to form a fruitful dialogue between Snow's two possible cultures. These are the second-order cybernetics and autopoiesis theory of von Foerster, H. Maturana, F. Varela, and N. Luhmann and C. S. Peirce's triadic semiotics in the form of biosemiotics, especially as developed by Thomas Sebeok (1976), Jesper Hoffmeyer (1997), and Claus Emmeche (1998).

The theory of autopoiesis solves some of Bateson's problems about for whom the difference makes a difference, even though the relation between mind and matter is still unclear. Maturana and Varela's concepts of autopoiesis and multiversa are invoked. But where deriving information from the concept of neg-entropy is too physicalistic, Maturana's idea of a multiverse is too close to constructivistic idealism. To develop a more fruitful nonreductionist worldview, it is shown that a more pragmatic understanding of physics, such as Prigogine and Stengers, where thermodynamics is understood as the basic discipline and mechanics as an idealization, opens the space for a nonreductionist conceptualization of chaos. This is not fully developed in their theory. Attention is drawn to C. S. Peirce's conception of pure chance as living spontaneity with a tendency to make habits as a realistic but nonreductionist theory that comprises a solution to the worldview problems of Bateson, Maturana, Prigogine, and Stengers and the ethologists. A fruitful connection between second-order cybernetics and semiotics will then be possible through the new biosemiotics, Hoffmeyer (1997), and until and with Emmeche, and a bridge between the technical-scientific and the humanistic-social parts of cybernetics can be developed as Cybersemiotics.

Let me briefly sketch how I see Peirce's work and its value as a transdisciplinary framework for information, communication, and cognitive sciences before I attempt a more detailed analysis.

Following Peirce, I believe that our problem is that we view chaos as the absence of law, which is a negative definition. It's closer to the original Greek definition of "Chaos" as the origin of the world of time, space, energy, and information (Gaia), where Eros is the creative evolutionary force and mathematics only a way to bond back to the source, not the answer in itself. Abraham (1993) points this out in his attempt to resurrect the Orphic tradition to encompass the knowledge of modern science and chaos theory. Peirce already has done important work on this construction of a new framework, and even more importantly he integrates it with both a transdisciplinary theory of signification in his semiotics and an evolutionary theory of logic through his concept of vagueness.

An important difference between modern physics and Peirce's theory lies in the conception of chaos and Peirce's unique triadic theory of basic categories. I will not describe or discuss the triadic theory of signification and semiosis at any length here. Instead, I offer a central quotation from the Monist-paper, “The Architecture of Theories,” which clearly states the direction and possibilities of the theory of his three metaphysical categories: Firstness, Secondness, and Thirdness (see also Christiansen, 1995).

> Three conceptions are perpetually turning up at every point in every theory of logic, and in the most rounded systems they occur in connection with one another. They are conceptions so very broad and consequently indefinite that they are hard to seize and may be easily overlooked. I call them the conception of First, Second, Third. First is the conception of being or existing independent of anything else. Second is the conception of being relative to, the conception of reaction with, something else. Third is the conception of mediation, whereby a first and a second are brought into relation. . . . The origin of things, considered not as leading to anything, but in itself, contains the idea of First, the end of things that of Second, the process of mediating between them that of Third. . . . In psychology Feeling is First, Sense of reaction Second, General conception Third, . . . In biology, the idea of arbitrary sporting is First, heredity is Second, the process whereby the accidental characters become fixed is Third. Chance is First, Law is second, the tendency to take habits is Third. Mind is First, Matter is Second, Evolution is Third.
>
> Such are the materials out of which chiefly a philosophical theory ought to be built, in order to represent the state of knowledge . . . it would be a Cosmogenic Philosophy. It would suppose that in the beginning—infinitely remote—there was a chaos of unpersonalized feeling, which being without connection or regularity would properly be without existence. This feeling, sporting here and there in pure arbitrariness, would have started the germ of a generalizing tendency. Its other sportings would be evanescent, but this would have a growing virtue. Thus, the tendency to take habits would be started; and from this, with the other principles of evolution, all regularities of the universe would be evolved. At any time, however, an element of pure chance survives and will remain until the world becomes an absolutely perfect, rational, and symmetrical system, in which mind is at last crystallized in the infinitely distant future. (Peirce, 1955, pp. 322–323)

Translated into second-order cybernetic concepts, Secondness is the first distinction made by an observer marked by a primary sign, the Representamen. The observer is Peirce’s Interpretant that belongs to Thirdness. Only through this triadic semiosis can cognition be created. To become information, differences must be seen as signs for the observer. This happens when they become internally developed Interpretants. Peirce writes about this in his famous definition of the sign process:

> A *Sign,* or *Representamen,* is a First which stands in a genuine triadic relation to a Second, called its *Object,* as to be capable of determining a Third, called its *Interpretant,* to assume the same triadic relation to its Object in which it stands itself to the same Object. . . . A *Sign* is a Representamen with a mental Interpretant. (Peirce, 1955, pp. 99–100)

The object here is that aspect of reality that the Representamen signifies. In a way, Peirce’s Object is also a sign. Peirce’s semiotic philosophy develops cognitive science beyond the limitations of rationalistic and mechanistic information, as I—and many others—have pointed out. It is an Aristotelian, golden middle between the mechanicist at one extreme and the pure (nonontological) constructivist at the other. Like Aristotle, Peirce is a synechist ("matter" is continuous) and a hylozoist ("matter" has an internal cognitive-emotional aspect). From this we get a non-Cartesian cognitive formulation for science with no absolute predistinction between mind and matter and a field view of "substance" that is compatible with modern quantum field theory and general relativity theory. Most forces are described today by fields, as are subatomic "particles." These fields are not actually "matter" as classical physics perceived it in atomistic mechanics. The development of thermodynamics as one of the most fundamental physical theories deploys time and evolution at the basis of physical theory in a way clearly beyond classical mechanistic physics.

When we create deep scientific theories such as information science, we cannot avoid reflecting on the nature of reality as a prerequisite for our various scientific paradigms. It is far too presumptuous to claim that basic knowledge is expressible in one unified and precise form. There are no "ideas" or mathematical "world formulas" waiting to be uncovered in basic reality. Like Peirce, I believe that basic reality or Firstness starts as vagueness and only later develops into distinct forms. No doubt, mathematics has a lot to say about the possibilities and limits of our epistemological situation and is able to connect us back to reality as Abraham (1993) suggests. Nor can we a priori expect words to fully describe "the universe" or "basic reality," because our investigations show that signs and concepts work on differences in local contexts. There does appear to be intrinsic order in reality, although it may be partly created by the process of cognition itself.

In ethology one says that ritualized instinctive behavior becomes sign stimuli in the coordination of behavior between, for instance, the two sexes of a species in their mating play. So—as it is already in the language of ethology—a piece of behavior or coloration of plumage in movement, for instance, becomes a sign for the coordination of a specific behavior. It is the mood and context that determine the biological meaning of these signs, which are true triadic signs. Ethology presents a fundamental ecological and evolutionary view on cognition and behavior that dovetails with how Peirce conceives the construction of meaning. We see here the aptness of Peirce's sign definitions. It is from Collected Papers 1–339 and is an unidentified fragment (he wrote about 100,000 pages), but it is still commonly recognized:

> The easiest of those, which are of philosophical interest, is the idea of a sign, or representation. A sign stands for something to the idea, which it produces, or modifies. Or, it is a vehicle conveying into the mind something from without. That for which it stands is called its object; that which it conveys, its meaning; and the idea to which it gives rise, its interpretant. The object of representation can be nothing but a representation of which the first representation is the interpretant. But

> an endless series of representations, each representing the one behind it, may be conceived to have an absolute object at its limit. The meaning of a representation can be nothing but a representation. In fact, it is nothing but the representation itself conceived as stripped of irrelevant clothing. But this clothing never can be completely stripped off; it is only changed for something more diaphanous. So there is an infinite regression here. Finally, the interpretant is nothing but another representation to which the torch of truth is handed along; and as representation, it has its interpretant again. Lo, another infinite series. (Peirce, CP, 1–339)

There is no final and true object and representation. Both are under constant evolution. The meaning of a sign (a Representamen) is determined by the context, christened "life form" by Wittgenstein, that makes the concept usable in biological contexts. For instance, the red belly of a female stickleback is the Representamen for a male autopoietic system languaging with the female—because it is in a sexual mood—creating in him the Interpretant that she is worth mating with. Mating or reproduction is the Object, which is a biosocial construct. It is a context for the play of signs that in this specific mood of mating attains shared meanings based on an evolutionary established habit:

> In the first place, a "Representamen," like a word,—indeed, most words are representamens—, is not a single thing, but is of the nature of a mental habit, it consists in the fact that, something would be. (Peirce, 1911)

Peirce changed Kant's categories of pure reason—with their awe for mechanical science and classical logic—to three natural categories bridging mind and nature. As mentioned above, he called them Firstness, Secondness, and Thirdness. In Peirce's semiotics, everything in nature is a potential sign. This is a meeting point with Bateson from cybernetics, where information is a difference that makes a difference, if one chooses to view every difference as potential information that becomes informative through semiosis. With Peirce we can say that differences become information when an interpreter sees them as signs.

The implication of this is that qualia and "the inner life" are potentially there from the beginning, but they need a nervous system to achieve full manifestation. Peirce speaks of the potential qualities of Firstness. The point is that organisms and their nervous systems do not create mind and qualia. The qualia of mind develop through interaction with nervous systems, which living bodies develop into still more manifested forms. Peirce's point is that this manifestation happens through the development of sign process.

Second-order cybernetics sees information as an internal creation of an autopoietic system in response to a perturbation. Only in established structural couplings can signs acquire meaning. Second-order cybernetics brings to semiotics the ideas of closeness, structural couplings, and languaging.

The suggestive value is always working in the context of a life form, both in biology and in human cultural life. The key to the understanding of understanding and communication is that both animals and humans live in self-organized Umwelts that they not only project around themselves, but also project deep inside their systems. The organization of signs and the meanings they attain through habits of the mind and body follow from the principles of second-order cybernetics, in that they produce their own eigen values of signs and meanings, and thereby their own internal mental organization that is then projected onto the environment.

In humans, these signs are organized into language through social self-conscious communication, and accordingly our universe is organized as and through texts. But that is, of course, not an explanation of meaning. It is an attempt to describe the dynamics of meaning-generating and sharing systems and how they are organized.

Peirce's reflexive or cybernetic definition of the interpretant points to culture, history, and the never-ending search for truth and knowledge. It considers habits and historical drift—as Maturana and Varela (1980) do—as the social constructors of meaning. Evolutionary science attempts to find relatively stable patterns and dynamic modes (habits); it is not a science of eternal laws (a grand narration). As it is dealing with living systems in an empirical manner, it cannot adopt the dualistic ontological view of mechanistic materialism. A more comprehensive view must be found.

The Necessity of an Alternative Epistemology in LIS Context

I have not created a brand-new theory of LIS that reveals the correct way to design, maintain, run, and mediate document-mediating systems to different domains and user-groups on worldwide, connected computer systems. My task has been to create a theoretical framework that encompasses the problematique that librarians and documentalists have struggled with for centuries. No comprehensive, theoretical framework in LIS encompasses all interdisciplinary aspects of the subject, although the field is becoming increasingly scientific and technical.

A science must at least have a reflected metatheory of the subject area over which it claims cognitive authority. Without that, the science cannot compete and discuss with other sciences what "true" LIS is, or what is unique about the work of librarians and documentalists such that the subject deserves to be recognized as a science with cognitive authority by other fields, such as computer science and AI. Few computer scientists recognize that DR (document retrieval) is as complex as the other many areas for which computer science has tried to create automated expert systems, and that DR attempts to form a new logic for the field of LIS. Keith van Rijsbergen, for instance, proposed a "logic of uncertainty" (1996, pp. 1–10) that seems to have impacted fields outside of LIS.

The computer has seduced us into framing our questions within its algorithms, so that we have forgotten to maintain and develop a theoretical framework for our subject area that allows us to see beyond the horizon of the computer and to make demands of those researchers developing computer systems. If we do not provide a metatheoretical description of our own area, it becomes difficult for others, such as computer scientists and software developers, to understand that they have entered a new territory with different rules. We must provide a strong theoretical understanding of the difference between physical and intellectual access. The growth of the Internet makes this knowledge more important every day.

What is new in the Cybersemiotic approach is the knitting together of a theoretical framework for LIS from recognized theories of cybernetics, systems, semiotics, communication, and language that span the gap between technical, scientific, social scientific, and humanistic approaches to the design and development of DR-systems in LIS. This transdisciplinary framework will make communication between the different approaches and theories of these processes possible, without reducing everything to mere information processing, as was done in the textbook *Information Science in Theory and Practice.* (Vickery & Vickery, 1989).

One of the most important theoretical moves within LIS, coined by Belkin and Ingwersen as "The Cognitive Viewpoint," was to change the concept of information from Vickery and Vickery's objectivistic-mechanistic view where the observer plays no vital role, to a more semiotic and process-oriented view where the observer is foundational. Belkin and Ingwersen posit that what are objectively exchanged between living communicators, or between documents and users, are signs and not information. Signs are potential information. They depend on the interpretation of the receiver. There is no information without an interpreter. This theory is in accordance with the practice in LIS of beginning a search for semantic relationships between concepts used in documents, and indexing in the human social realm of discourse communities and knowledge domains, rather than in an objective universal classification schema.

It is clear that the document is a sign of the domain and further that its meaning is anchored in the ground of the domain. There is a semantic/semiotic exchange of meaning between the domain and the document. This semantic exchange makes it possible to index while maintaining a contextual understanding of the descriptor. What we (Thellefsen, Brier, & Thellefsen, 2003) call the *significance-level concepts* of the domain is an expression of self-understanding within the domain. It is a concept inspired by Rosch's (1973, 75, 78)work on basic level use of classification in ordinary language.

In specialized knowledge systems such as the sciences, there is a semantic/semiotic relation between document and domain, and therefore the context of the documents appears in the descriptors as a metaphorical displacement that maintains their meanings through the ground of the domain. Indexing theory is capable of maintaining the context of the documents in the indexing, provided that it is possible to identify the basic level use in that given knowledge domain. This is what we call the significance-level concepts of the domain.

The words Rosch uses as examples of basic-level concepts are all everyday words—oak, chair, table, lamp—not words that are part of a scientific domain. Is it possible, within a knowledge domain, to identify basic-level terms at a scientific level?

If we posit that basic-level concepts are signs, we must expect that these signs can alter their (information) nature according to the knowledge-level of a single user, so that the basic-level theory also will apply to specialized knowledge domains. We (Thellefsen, Brier, & Thellefsen, 2003) have chosen to call this level the significance-level, and to call the fact that the concepts at this level submit the most information to certain users the significance-effect of the concepts.

As signs, the words *oak, fugue,* or *autopoiesis* are similar. As nouns (Rhemes), they all refer to a certain idea on a basic-level. However, it is decisive that the user of the sign is able to understand and thus conceptualize the sign. Therefore signs, which are analogous to basic-levelness, appear to work as a conceptualizing function at all levels of cognition. This argues solidly for the possibility of understanding terms within specialized knowledge domains as signs of conceptualization at the significance-level. By indexing with the identified concepts at the significance-level, is it possible to signal the ground of the domain in the descriptors. On this basis, there is good reason to believe that the sign-function of the concepts at the significance-level has the greatest information value and strength of reference to the interpreter. That is why indexing with significance-level concepts specific to a defined user group submits the most information to this group. Embodied cognitive semantics and pragmatic semiotics are excellent tools for analyzing the ground of a knowledge domain and are regarded as the best way to index documents within a knowledge domain.

Summarizing the conceptual changes suggested by the above analysis, I underline that knowledge is not just a lexically, logically organized, and truth-oriented cognitive structure; it is also a historically and culturally determined preunderstanding, as hermeneutics suggest, and a bodily-biological evolutionary preunderstanding of the autopoietic system, as second-order cyberneticians and cognitive semantics suggest. It is through body, culture, and awareness that we create feelings, meaning, and rationality. Knowledge is therefore both logical-rational-structural and meaning-emotional-processual. One overlooks something decisively important about human intelligence and cognitive ability if, as logical positivists attempted, one separates these two aspects.

To accept a social pragmatic theory is to acknowledge that semantics springs from a sociolinguistic context, not from referential truth conditions.

One must adapt the system, or at least the mediation of it through human or machine intermediaries, to both the domain of knowledge and to how the organization actually uses that domain based on its interests and language games. Liebenau and Backhouse (1990) have already seen this in MIS (management information systems), of which document-mediating systems are an integral part. They offer practical business examples of why it is necessary to analyze the work task of the company, its knowledge domain, and the practical meaning of concepts before attempting to implement an information system.

Liebenau and Backhouse (1990) outline a research strategy for MIS that also applies to bibliographic systems that fit into an organization. One should start with a pragmatic analysis of the informal communication system. This is the most powerful semiotic force to which any information system must adapt, and as Lakoff (1987) demonstrates, its semantic patterns are neither logical nor random—they are motivated. This accords with the cybernetic view of information as generated within an autopoietic system, and language communication as occurring within generalized media. Motivation stems from the type of media, but the actual language game chosen within the media determines a large part of the motivation for the relationship between concepts. If there is no proper feedback between producers, indexers, and users, the system will not produce information—it will not fulfill our expectations. We all participate in several language games simultaneously, but professionally we must consciously select and maintain one at a time whenever possible. As information is only potential when there is no interpretant, the only information in our systems is relevant retrieved documents. This further supports much of Bates's work on the sense-making approach (1989).

The pragmatic approach generally means, as previously mentioned, that a philosophy of science analysis of the domains/subject area/work tasks and paradigms in science, as well as a knowledge sociological analysis of communication patterns such as the discourse analysis of written text, are important for describing the decisive context of the use of our systems. They must be adjusted to our context, work task, and the budget allotted the research. These methods should be supplemented by questionnaires, association tests, and registration methods. The expense of this research is a challenge, but the willingness to pay for basic research is connected to the users' awareness of how central insights into the sociopragmatic linguistic framework are to the performance of the designed systems. We are moving past the phase of unreflective fascination with electronic systems and into a more realistic evaluation of how they can help us mediate communications between humans via documents. If one considers Ingwersen's (1992) analysis of what a mediator system must do to function properly, one realizes we cannot expect machines to solve the complexity of human communication without human mediation.

This knowledge also tells us that there is limited utility to the enormous scientific and technical bibliographic bases where many millions of documents have been categorized into Boolean systems by trained documentalists. Here, the users are the documentalists themselves, and the trained researchers from part of the domain search bases that have not been made generally accessible through the Internet. New digital libraries based on the same outdated principles and word-to-word matches are constantly being established. A bibliographic system such as BIOSIS, based on the present theory, will only truly function within a community of biologists. This means that both the producers and the users must be biologists—and so must the indexers. Even then there will be difficulties, because the producers and the users of the bibliographic database also will be researchers. This is a life form that follows a language game different from that of indexers. But if indexers maintain contact with both users and producers, solicit their feedback, attend their conferences, and investigate their ways of utilizing literature and scientific concepts, the system will holistically produce information. One should not understand document-mediating systems as merely information keepers and deliverers. They are information producers, once we include interactions with users as part of the system!

In enormous, outdated, domain-specific systems, we have to accept a centrally organized knowledge system. We can simplify through menu-driven systems only at the cost of speed and precision. We can help users understand what kind of system they are working with by providing thesauri to consult and work from directly. We can remind them to consider specific vital details by asking them to answer questions as part of an obligatory procedure. All this is now done in new types of interfaces. Blair (1990) suggests offering users the opportunity to view extracts of papers that the use of specific index terms will access, and what other users have accessed using similar searches. Any technique that helps users understand the language game they are participating in, how it is structured, and how words work within it is fruitful when combined with opportunities to navigate, explore, and learn the system by oneself.

In these cases we cannot bring the system to the user, so we must bring the user to the system. This will not happen if we simply install a natural language processing interface that tells users that this system will do most of the thinking for them. We should clarify that these systems only help users who do not have the time or ability for other types of search process, because users will have practically no control over the processes by which papers are accessed. This might nevertheless be useful if these users want only a few documents on a subject of interest. The same can be said for the automatic indexing of full-text documents (Blair, 1990), unless it is in a sharply delineated and rigidly formalized subject area. Automated procedures give users little insight into what occurs within a system. Users have very little opportunity to control the language game they are participating in. This does not even broach the issues that arise when index terms from one language game are used to seek documents in another.

The problem of intellectual access cannot be resolved by intelligent user-interfaces in the preexisting Boolean system. Nor will the addition of automated indexing, including natural or knowledge-domain specific language manipulation, or including full-text systems (Blair, 1990). Undoubtedly each is useful within limited contexts. In currently existing large scientific bibliographic databases, considerable efforts have been made to deliver interfaces that obligate users to pay attention to how the base is structured and remember its most relevant aspects. By reading manuals, one can acquire a simplified theoretical impression of how the controlled index terms are used. Blair's strategy permits users to gain experience about how words function within the language game of the classification system and through this learn their meanings. The BIOSIS Previews manual, for example, gives theoretical examples of this kind. It is also important to allow as much opportunity for exploring as possible.

When we contemplate designing a new document-mediating system from the bottom up, the suggestion is to specialize document-mediating systems for specific knowledge domains, knowledge levels, and points of interest, and to consider the size of the system. This means constructing bases entirely from users' needs and conceptual worlds. We must supplement current methods with pragmatic analysis of discourse communities with various knowledge domains, both scientific and nonscientific.

Most current bibliographic databases contain documents produced by different paradigms, specialties, and subject areas, all of which have different language games even when they share a vocabulary. I only need mention how data-engineers, cognitive psychologists, and information scientists use the concept of information, or how Newtonian physics and Einstein's general relativity use the concept of space. Each subject area with interest in the documents of a database should have these documents indexed according to their own language game to make precise searches possible. As is already acknowledged in BIOSIS, for example, chemists, physicians, and biologists each have specific terms for chemicals, illnesses, and classifications of plants and animals that are respected by the BIOSIS indexing procedure. But under current indexes, as a biologist, I must use chemical notation searching for a chemical, and chemists must use the correct biological name for a plant to find articles about a chemical substance it produces. What is not addressed are those words common to all three subject areas but that have different meanings because they are part of different language games. We must develop methods to more fully analyze the discourse communities in various knowledge domains, both scientific and nonscientific, theoretical and practical. We must get a firmer grasp on the social-pragmatic connotations of words and concepts to integrate them into the semantics of semiotic nets as a basis for thesaurus building.

As a result, one of the large research areas of LIS is how to integrate bibliographic databases and full-text databases into different domains, organizations, interests, and levels in organization. This demands one to distinguish and characterize different domains, levels, and language games in, for instance, an organization. In addition to the methods already employed by LIS, these analyses will benefit from methods derived from discourse and conversation analysis, as well as from socio- and ethno-linguistic empirical analysis of cultural communication.

Most fields today are, at least to some degree, interdisciplinary—BIOSIS is a good example, as it is relevant to medicine, chemistry, and the behavioral sciences—and one could imagine that eventually interest groups from different domains would develop their own systems for indexing documents so they can choose their own point of entry to these systems. In addition, there will be various offers to visualize systems and their language games aimed at searchers who lack domain knowledge or technical search knowledge, combined with many possibilities for navigation. As Blair (1990) suggested, one of the major problems of subject searching is that indexers and searchers do not participate in the same language games. Their work and social environments are different, and therefore their uses of words will be different. Blair makes an interesting attempt to integrate Wittgenstein's language-game theory, aspects of Peirce's semiotics, later developments such as the speech act theory of Searle, and elements of Lakoff's cognitive linguistics into a theory of indexing and DR that connects information science retrieval perspectives to social and cultural dynamics within a pragmatic framework (Blair, 1990, p. 169).

Conclusions

To summarize, our major challenge in LIS now is how to map semantic fields of concepts and their signifying contexts into our systems in ways that move beyond the logical and statistical approaches that until now seemed the only realistic strategies given available technology. We need a deeper theory of both computation and interpretation. In summary, here are seven basic steps to move in that direction:

1. Information is differences and patterns and is therefore only potential knowledge until somebody interprets it as a sign. To develop Bateson's definition that "information is a difference that makes a difference," then it first happens when it becomes a sign.
2. The objective carriers of potential knowledge are signs.
3. Signs need interpretation to release knowledge in the form of Interpretants.
4. Interpretation is based on the total semantic network, horizons, worldviews, and experience of the person including the emotional and social aspects.

5. The realm of meaning is rooted in social-historical as well as embodied evolutionary processes that go beyond computational algorithmically logic.
6. The semantic network derives a decisive aspect of signification from a person's embodied cultural worldview, which in turn derives from, develops, and has its roots in undefined tacit knowledge.
7. To theoretically encompass both the computational and the semantic aspects of document classification and retrieval, we need to combine the cybernetic functionalistic approach with the semiotic pragmatic understanding of meaning as social and embodied.

A transdisciplinary (second-order) framework acknowledging the multidisciplinary character of knowledge organization seems a more fruitful theoretical groundwork than the algorithmic rationalism of the information-processing paradigm for including differences in knowledge organization between domains. For further argumentation and developments of the framework outside LIS, please see Brier (1997, 1998, 1999, 2000a, 2000b, 2001, 2002, 2003a,b,c). The book *The Cybersemiotic Framework,* describing the whole new framework including LIS, is in the publication process.

Notes

1. The present paper is a follow up on my 1996 articles in *Journal of Documentation* (Brier, 1996a) and *Cybernetica* (Brier, 1996b). Theoretical development of the field I am here describing can be found in *Cybernetics & Human Knowing,* of which I am the editor.
2. The BISC program (The Berkeley Initiative in Soft Computing) at Berkeley University, http://www-bisc.cs.berkeley.edu/.

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