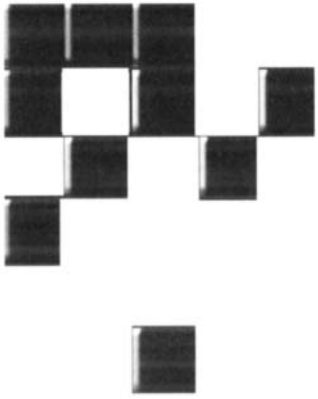

SECTION IV

Theorizing Information and Information Use

CHAPTER 8

The Concept of Information

Rafael Capurro
University of Applied Sciences, Stuttgart

Birger Hjørland
Royal School of Library and Information Science, Copenhagen

Introduction

The concept of information as we use it in everyday English, in the sense of knowledge communicated, plays a central role in contemporary society. The development and widespread use of computer networks since the end of World War II, and the emergence of information science as a discipline in the 1950s, are evidence of this focus. Although knowledge and its communication are basic phenomena of every human society, it is the rise of information technology and its global impacts that characterize ours as an information society. It is commonplace to consider information as a basic condition for economic development together with capital, labor, and raw material; but what makes information especially significant at present is its digital nature. The impact of information technology on the natural and social sciences in particular has made this everyday notion a highly controversial concept. Claude Shannon's (1948) "A Mathematical Theory of Communication" is a landmark work, referring to the common use of information with its semantic and pragmatic dimensions, while at

the same time redefining the concept within an engineering framework. The fact that the concept of knowledge communication has been designated by the word *information* seems, prima facie, a linguistic happenstance.

For a science like information science (IS), it is of course important how fundamental terms are defined; and in IS, as in other fields, the question of how to define information is often raised. This chapter is an attempt to review the status of the concept of information in IS, with reference also to interdisciplinary trends. In scientific discourse, theoretical concepts are not true or false elements or glimpses of some element of reality; rather, they are constructions designed to do a job in the best possible way. Different conceptions of fundamental terms like *information* are thus more or less fruitful, depending on the theories (and in the end, the practical actions) they are expected to support. In the opening section, we discuss the problem of defining terms from the perspective of the philosophy of science.

The history of a word provides us with anecdotes that are tangential to the concept itself. But in our case, the use of the word information points to a specific perspective from which the concept of knowledge communication has been defined. This perspective includes such characteristics as novelty and relevance; i.e., it refers to the process of knowledge transformation, and particularly to selection and interpretation within a specific context. The discussion leads to the questions of why and when this meaning was designated with the word *information*. We will explore this history, and we believe that our results may help readers better understand the complexity of the concept with regard to its scientific definitions.

Discussions about the concept of information in other disciplines are very important for IS because many theories and approaches in IS have their origins elsewhere (see the section "Information as an Interdisciplinary Concept" in this chapter). The epistemological concept of information brings into play nonhuman information processes, particularly in physics and biology. And vice versa: the psychic and sociological processes of selection and interpretation may be considered using objective parameters, leaving aside the semantic dimension, or more precisely, by considering objective or situational parameters of interpretation. This concept can be illustrated also in physical terms with regard

to release mechanisms, as we suggest. Our overview of the concept of information in the natural sciences as well as in the humanities and social sciences cannot hope to be comprehensive. In most cases, we can refer only to fragments of theories. However, the reader may wish to follow the leads provided in the bibliography.

Readers interested primarily in information science may derive most benefit from the section on "Information in Information Science," in which we offer a detailed explanation of diverse views and theories of information within our field; supplementing the recent *ARIST* chapter by Cornelius (2002). We show that the introduction of the concept of information circa 1950 to the domain of special librarianship and documentation has in itself had serious consequences for the types of knowledge and theories developed in our field. The important question is not only what meaning we give the term in IS, but also how it relates to other basic terms, such as documents, texts, and knowledge.

Starting with an objectivist view from the world of information theory and cybernetics, information science has turned to the phenomena of relevance and interpretation as basic aspects of the concept of information. This change is in no way a turn to a subjectivist theory, but an appraisal of different perspectives that may determine in a particular context what is being considered as informative, be it a "thing" (Buckland, 1991b) or a document. Different concepts of information within information science reflect tensions between a subjective and an objective approach. The concept of interpretation or selection may be considered to be the bridge between these two poles. It is important, however, to consider the different professions involved with the interpretation and selection of knowledge. The most important thing in IS (as in information policy) is to consider information as a constitutive force in society and, thus, recognize the teleological nature of information systems and services (Braman, 1989).

How to Define a Scientific Term

Definition and Meaning Theory

It is well known that definitions are not true or false, but more or less fruitful. In a way, people are free to define terms as they like, but in reality their definitions may encounter problems. In children's play, a chair

can be defined as a table and vice versa. This works as long as the children remember and obey their own decisions and do not apply their own conventions in communication with outsiders. However, when somebody defines a term in such an idiosyncratic way, that definition will be neglected and will not contribute to understanding, communication, or the advance of practice.

Knowing how different people apply the terms they use is helpful. Wittgenstein's (1958a) famous use theory of meaning emphasizes this aspect, defining terms by finding out how people actually use them (see Blair's chapter in this volume). This aspect also applies to the term *information*. Dictionaries such as *The Oxford English Dictionary* (1989) provide valuable insights about the etymology of a word and how different authors have used it throughout the centuries (see Appendix). This etymology should be supplemented by more detailed descriptions of how the word has been used in different disciplines. The actual use of terms may differ from their more formal definitions. The ordinary use of a term like *information* may carry meanings other than formal definitions, implying that conflicting theoretical views may arise between the explicit scientific definitions and the implicit definitions of ordinary use. Because of this tendency, we must not only compare different formal definitions, but also consider the meaning of a word like *information* as it is used in relation to, for example, information seeking, information systems, and information services.

Studies of how a term has been used cannot, however, help us to decide how we should define it. When we use language and terms, we perform a type of act, with the intention of accomplishing something. The different meanings of the terms we use are more or less efficient tools to help us accomplish what we want to accomplish. In this way, according to pragmatic philosophers such as Charles Sanders Peirce (1905), the meaning of a term is determined by not just the past, but also the future.

We also cite Braman (1989), pointing out how important it is for information policy to define information adequately, thus applying this pragmatic principle of definition to practical policy.

Theory Dependency of Scientific Terms

The kind of activity performed in the sciences is the production of knowledge and the development of scientific theories. In this respect, the meaning of terms must be considered in the framework of the theories they are supposed to serve. In the philosophy of science, Chalmers (1999, pp. 104–105) has provided an important analysis of the meaning of scientific concepts:

> Observation statements must be expressed in the language of some theory. Consequently, it is argued, the statements, and the concepts figuring in them, will be as precise and informative as the theory in whose language they are formed is precise and informative. For instance, I think it will be agreed that the Newtonian concept of mass has a more precise meaning than the concept of democracy, say. It is plausible to suggest that the reason for the relatively precise meaning of the former stems from the fact that the concept plays a specific, well-defined role in a precise, closely-knit theory, Newtonian mechanics. By contrast, the social theories in which the concept *democracy* occurs are vague and multifarious. If this suggested close connection between precision of meaning of a term or statement and the role played by that term or statement in a theory is valid, then the need for coherently structured theories would seem to follow directly from it.

Chalmers also considers alternative ways of defining scientific terms, by, for example, lexical or ostensive definitions. The main problem with lexical definitions is that concepts can be defined only in terms of other concepts, the meanings of which are given. If the meanings of these latter concepts are themselves established by definition, it is clear that an infinite regress will result, unless the meanings of some concepts are known by other means. A dictionary is useless unless we already know the meanings of many words. Newton could not define mass or force in terms of previously available concepts. It was necessary for him to transcend the limits of the old conceptual framework by developing a new one. The main problem with ostensive definitions is that they are difficult to sustain, even in the case of an elementary notion like *apple*.

Defining something like *mass* in mechanics, *electrical field* in electromagnetism, or *information*, *subject*, or *topicality* in information science is even more challenging. The dependence of the meaning of concepts on the structure of the theory in which they occur—and the dependence of the precision of the former on the precision and degree of coherence of the latter—is thus made plausible by noting the limitations of some of the alternative ways in which a concept might be thought to acquire meaning.

Chalmers also points out that the history of a concept, whether it be *chemical element*, *atom*, *the unconscious*, and so forth, typically involves the emergence of the concept as a vague idea, followed by its gradual clarification as the theory in which it plays a part takes on a more precise and coherent form. He argues that Galileo was in the process of making a major contribution to the building of a new mechanics that was to prove capable of supporting detailed experimentation at a later stage. It is hardly surprising that—contrary to popular myth—his efforts involved thought experiments, analogies, and illustrative metaphors rather than detailed experimentation. This situation is understandable if it is accepted that experimentation can only be carried out if one has a theory capable of yielding predictions in the form of precise observations.

Following Chalmers, we propose that the scientific definitions of terms like *information* depend on the roles we give them in our theories; in other words, the type of methodological work they must do for us. With regard to the term *information*, Spang-Hanssen (2001, online) remarks:

> In fact, we are not obliged to accept the word information as a professional term at all. It might be that this word is most useful when left without any formal definition, like e.g., the word *discussion,* or the word *difficulty,* or the word *literature.* It might be that the word information is useful in particular when we try to raise our professional status in relation to other professions; it sounds smart and imposing and gives an air of technicality. I find no moral objections to this sort of use of words; language is certainly not only for informative uses ("informative" here refers to the so-called intellectual or factual meaning of a text or an utterance). However, we must

realize that the status-raising effect of a word may depend precisely on its being used in other fields as well, preferably in fields having a high status, like engineering and nowadays sociology. The uses in such other fields actually makes [*sic*] it impossible at the same time to keep this word as a formally defined professional term in our field without some risk of confusion; the words force, energy and effect—used both generally and in physics as formally defined terms—illustrate this situation.

The word information—and combinations like information retrieval, information center—have definitely contributed to raise the public perception of library and documentation work, which is generally held to be a little dull, dusty and distant from what is actually going on in society. Maybe it would be wise to leave the word information there, were it not for the fact—already mentioned—that several attempts have been made to define information as a formal term relative to documentation and information work, and even to define it as some measurable quantity, corresponding to questions of the type: How much information was retrieved by the search?

The Danger of Applying Persuasive Definitions

Many kinds of definitions exist (Yagisawa, 1999). The tendency to use and define terms in order to impress other people has been called persuasive definition. The definition provided by Brookes (1977) $K(S) + \delta I \rightarrow K(S + \delta S)$ seems to us to serve only such a persuasive function. If we agree with Spang-Hanssen that definitions are legitimate ways to boost the status of a profession or research field, we must face the fact that such use can cause internal confusion and lack of self-respect in the discipline. Schrader, among others, has demonstrated this outcome. He studied about 700 definitions of *information science* and its antecedents from 1900 to 1981 and found that:

> [T]he literature of information science is characterized by conceptual chaos. This conceptual chaos issues from a variety of problems in the definitional literature of information

> science: uncritical citing of previous definitions; conflating of study and practice; obsessive claims to scientific status; a narrow view of technology; disregard for literature without the science or technology label; inappropriate analogies; circular definition; and, the multiplicity of vague, contradictory, and sometimes bizarre notions of the nature of the term "information." (Schrader, 1983, p. 99)

As we can see, the cost of applying persuasive definitions in IS has been extremely high; this approach should no longer be accepted by journals and authorities in the field. We have to ask more seriously: What role—if any—should the concept of information play in IS? In order to answer this question, one must clarify the role and nature of scientific theories in IS. We suggest that focusing on the concept of information may have misdirected our field, and that closer attention to concepts such as signs, texts, and knowledge may provide more satisfactory conceptual frameworks for the kind of problems that IS is trying to answer. When we use the term *information* in IS, we should always keep in mind that information is what is informative for a given person. What is informative depends on the interpretative needs and skills of the individual (although these are often shared with members of a discourse community).

Studies and Sources of the Word Information

> [A] word never—well, hardly ever—shakes off its etymology and its formation. In spite of all changes in the extensions of and additions to its meanings, and indeed rather pervading and governing these, there will still persist the old idea ... Going back into the history of a word, very often into Latin, we come back pretty commonly to pictures or models of how things happen or are done. (Austin 1961, pp. 149–150)

The study of the history of a word, its etymology, is not concerned, as the word etymology itself prima facie suggests, with a true meaning (Greek, *étymon*) that apparently may be the basis of its formation and

use; but rather with the interrelation of its different uses (particularly its translation into other languages and contexts), including its metaphors and metonyms. By examining the history of word uses, we find some of the primitive forms or contexts that underlie higher-level scientific practices. This lessens the expectations we may have with regard to univocal higher-level concepts, and may help us better manage vagueness and ambiguity. To question modern terminology, to look more closely at the relation between signs, meanings, and references, and to pay attention to historic context shifts help us understand how present and future uses are interwoven.

The word *information* has Latin roots *(informatio)*. Before we explore this thread we should examine its entry in *The Oxford English Dictionary* (1989, see Appendix). We shall consider two basic contexts in which *information* is used; namely, the act of molding the mind and the act of communicating knowledge. These two activities are, obviously, intimately related. But when and how do information and molding come together? Based on studies by Seiffert (1968) and Schnelle (1976), Capurro (1978) explores the Greek origins of the Latin word *informatio* as well as its subsequent development. This historico-critical background makes possible a better understanding of the higher-level concepts of information in the Hellenistic period as well as in the Middle Ages and in modern times. Peters' (1988) view is highly supportive of these analyses.

Latin Roots and Greek Origins

The *Thesaurus Linguae Latinae*[2] (1900) gives detailed references to the uses of *informatio* and *informo* in Latin from Virgil (70–19 B.C.) until the eighth century. There are two basic contexts, namely a tangible (*corporaliter*) and an intangible (*incorporaliter*) one. The prefix *in* may have the meaning of negation as in *informis* or *informitas,* but in our case it strengthens the act of giving a form to something, as in Virgil's verses on Vulcan and the Cyclops hammering out (*informatum*) lightening bolts for Zeus (*Aen.* 8, 426) or a huge shield for Aeneas (*Aen.* 8, 447). Early references to the use of *informo* are in a biological context, for instance by Varro (116–27 B.C.) who describes how the fetus is being "informed" (*informatur*) by head and backbone (*Frg.* Gell. 3, 10, 7). The intangible or spiritual context concerns moral and pedagogical uses since the second

century A.D. that reveal not only the influence of Christianity—Tertullian (ca. 160–220 A.D.) calls Moses *populi informatory;* that is, people's educator or molder—but in several cases also an explicit reference to Greek philosophy, particularly to Plato (427–348/7 B.C.) and Aristotle (384–322 B.C.). Several Greek words were translated with *informatio* or *informo,* such as *hypotyposis* (which means *model*, especially in a moral context) and *prolepsis* (representation), but most higher-level uses are explicitly related to *eidos, idea, typos,* and *morphe;* that is, to key concepts of Greek ontology and epistemology (Capurro, 1978). This relationship is clearly the case with prominent thinkers such as, for instance, Cicero (106–43 B.C.) and Augustine (354–430 A.D.). Nevertheless, these higher-level concepts have their roots in the low-level use of these words, particularly in the primitive context of pottery as well as in the Greek experience of limitation and shining-forth of what we perceive sensually (*phainonemon*).

Cicero explicitly translates in *De Natura Deorum* Epicure's (341–270 B.C.) concept of *prolepsis*—i.e., the representations of the gods or of things impressed in our souls before any experience (a priori, as Kant would say) as *informatio rei* (*nat. deor.* 1, 43). At the same time he uses this word in a rhetorical context—for instance in *De Oratore* (2, 358) as well as in *Orator,* where he explicitly points to Plato's ideas (*orat.* 10)—in order to describe the active and a posteriori action of the mind depicting something unknown or helping memory, as part of the *ars memoriae,* to better remember a past situation through the pictorial representation of a sentence *(sententiae informatio).* Several references are to the use of *informo* in a biological as well as in a pedagogical and moral context. A particularly interesting one can be found in his speech *Pro Archia.*

In Augustine, we have the influence of Greek ontology and epistemology on the one hand, and of Christian tradition on the other. In *De Trinitate,* Augustine calls the process of visual perception *informatio sensus* (*trin.* 11, 2, 3) and he uses the famous Platonic (*Theaet.* 191d) and Aristotelian (*De an.* 424 a 17) metaphor of the impression *(imprimitur)* of a ring seal into wax (*trin.* 11, 2, 3). According to Augustine, the images or representations of the perceived objects are stored in memory. These images do not inform, following the Platonic view, the soul *(mens)* or the rational intellect *(intelligentia rationalis),* but only reflection *(cogitatio)*; that is, the faculty dealing with internal

representations *(informatio cogitationis)* (*trin.* 14, 8, 11). Augustine uses *informatio* also in a pedagogical context: Christ is God's form *(forma dei)*. His deeds instruct and educate us *(ad eruditionem informationemque nostram)* (*epist.* 12). In *De civitate dei*, he describes the process of illumination of the heavenly community *(informatio civitatis sanctae)* (*civ.* 11, 24).

Throughout the Middle Ages, *informatio* and *informo* are commonly used in the aforementioned epistemological, ontological, and pedagogical senses by several authors (see Capurro, 1978 for details). The Aristotelian influence on the higher-level philosophical concept of *informatio* is shown best in the work of Thomas Aquinas (1225–1274). Bussa (1975) lists in his *Index Thomisticus* 66 references to *informatio*—15 of them in nominative—and 454 references to *informo*. Schütz (1958) distinguishes in his *Thomas-Lexikon* between *informatio* in the sense of "providing something with a form" in an epistemological or ontological context and the pedagogical sense of education or instruction.

Modern and Postmodern Uses of Information

"The action of 'informing' with some active or essential quality" had, according to the *Oxford English Dictionary* "a quite restrictive use" not only in English, but also in other modern European languages, and references to "formation or molding of the mind or character, training, instruction, teaching" date from the 14th century. Probably the most intriguing question from the point of view of the history of ideas concerns the ontological use of *informatio*—both in the lower-level sense of "molding matter" as well as in the higher-level sense used by the Scholastics as *informatio materiae*—which became obsolete not only in modern languages that, like English, inherited the Latin word and slightly transformed it into *information*, retaining the epistemological meaning, but also, for instance, in German where the word *Information* has actually been used in the sense of education and communication since the 15th century. *Informatio* was translated literally—first in a mystical context as *in-Bildunge or in-Formunge*; later on in a general pedagogical sense, such as used by Christoph Martin Wieland (1733–1813)—with *Bildung*, a term heavily charged with higher-level meaning (Capurro 1978, p. 176). A plausible explanation for the loss of the ontological higher-level sense is the decline of

Scholastic philosophy caused by the rise of modern empirical science. As Peters (1988, p. 12) states:

> In the feverish demolition of medieval institutions in the seventeenth and eighteenth centuries, the notion that information consisted in the activity or process of endowing some material entity with form remained largely unchanged. But the notion that the universe was ordered by forms fell into disrepute, and the context of this in-forming shifted from matter to mind. Both changes inaugurated a massive inversion in the meaning of information.

This transition from Middle Ages to Modernity in the use of the concept of information—from "giving a (substantial) form to matter" to "communicating something to someone"—can be detected in the natural philosophy of René Descartes (1596–1650), who calls ideas the "forms of thought," not in the sense that these are "pictured" *("depictae")* in some part of the brain, but "as far as they inform the spirit itself oriented to this part of the brain" (Descartes, 1996, VII, p. 161). As Peters (1988, p. 13) states:

> The "doctrine of ideas," developed initially by Descartes, was central to early modern philosophy, both rationalist and empiricist. Abandoning the "direct perception" of the scholastics—the immediate communion of Intellect and Nature—Descartes interposed "ideas" between the two. An "idea" was something present to the mind, an image, copy, or representation, with a problematic relation to real things in the world. For empiricists (like Locke), the stream of ideas was the raw material from which genuine knowledge could be built; for rationalists (like Descartes), it was a veil of illusion, to be pierced by logic and reason.

Nevertheless, the concept of information ceases to be a higher-level concept until the rise of information theory in the 20th century. Philosophers such as Francis Bacon (1561–1626), John Locke (1632–1704), George Berkeley (1685–1753), David Hume (1711–1776), and Thomas Reid (1711–1796) criticize scholastic hylomorphism and

particularly the theory of abstraction. Peters (1988, p. 12) asserts that Bacon's (1967) "Great Instauration":

> criticizes the logicians of his day for receiving "as conclusive the immediate informations of the sense ..." Instead, those "informations" must be subjected, according to Bacon, to a sure plan that will sort the true from the false. Though Bacon's usage may not appear irreconcilable with our own, the inverted pluralization should tip us off that he does not completely share our prejudices (we should say "the information of the senses"). In fact, this locution exemplifies a perfectly hylomorphic notion of the workings of the senses: they are a kind of matter (wax being a favorite empiricist instance) on which objects of the world may leave their shapes or stamps. What is interesting here is that the site of information is being shifted from the world at large to the human mind and senses. This shift requires no break with scholastic notions of mind or nature.

Indeed this epistemological notion of information(s), particularly the wax metaphor, was a key higher-level concept throughout the Middle Ages. Consider Locke's (1995, p. 373) statement: "No existence of anything without us, but only of GOD, can certainly be known further than our senses inform us." Peters (1988, pp. 12–13) concludes:

> Information was readily deployed in empiricist philosophy (though it played a less important role than other words such as impression or idea) because it seemed to describe the mechanics of sensation: objects in the world in-form the senses. But sensation is entirely different from "form" —the one is sensual, the other intellectual; the one is subjective, the other objective. My sensation of things is fleeting, elusive, and idiosynchratic [*sic*]. For Hume, especially, sensory experience is a swirl of impressions cut off from any sure link to the real world ... In any case, the empiricist problematic was how the mind is informed by sensations of the world. At first informed meant shaped by; later it came to mean received reports

> from. As its site of action drifted from cosmos to consciousness, the term's sense shifted from unities (Aristotle's forms) to units (of sensation). Information came less and less to refer to internal ordering or formation, since empiricism allowed for no preexisting intellectual forms outside of sensation itself. Instead, information came to refer to the fragmentary, fluctuating, haphazard stuff of sense. Information, like the early modern worldview more generally, shifted from a divinely ordered cosmos to a system governed by the motion of corpuscles. Under the tutelage of empiricism, information gradually moved from structure to stuff, from form to substance, from intellectual order to sensory impulses.

Later developments in etymology are partly covered in the next section. Here we will conclude that the modern uses of information show a transition period in which the medieval ontological concept of "molding matter" is not just abandoned but reshaped under empirical and epistemological premises. It has been extremely interesting to observe how the concept of information is closely connected to views of knowledge. This conclusion is important when we later analyze the concept of information in information science, because it indicates a severely neglected connection between theories of information and theories of knowledge.

Information as an Interdisciplinary Concept

Almost every scientific discipline uses the concept of information within its own context and with regard to specific phenomena. Can a common meaning for this term be derived, or do we have to agree with the skeptical view expressed by Bogdan (1994, p. 53)?

> My skepticism about a definitive analysis of information acknowledges the infamous versatility of information. The notion of information has been taken to characterize a measure of physical organization (or decrease in entropy), a pattern of communication between source and receiver, a form of

> control and feedback, the probability of a message being transmitted over a communication channel, the content of a cognitive state, the meaning of a linguistic form, or the reduction of an uncertainty. These concepts of information are defined in various theories such as physics, thermodynamics, communication theory, cybernetics, statistical information theory, psychology, inductive logic, and so on. There seems to be no unique idea of information upon which these various concepts converge and hence no proprietary theory of information.[3]

A broad philosophical debate continues as to whether the concept should address a knowledge process including, as a necessary condition, a human knower or, at the very least, an interpretative system, or whether it should exclude mental states and user-related intentions (Pérez Gutiérrez, 2000; Ropohl, 2001). Between these two positions are different kinds of mediating theories, including the quest for a unified theory of information (Hofkirchner, 1999). This controversy reflects the complex history of the term.

In their seminal book *The Study of Information: Interdisciplinary Messages,* Machlup and Mansfield (1983) collected key views on the interdisciplinarity controversy in computer science, artificial intelligence, library and information science, linguistics, psychology, and physics, as well as in the social sciences. Machlup (1983, p. 660) himself disagrees with the use of the concept of information in the context of signal transmission, the basic senses of information in his view all referring "to telling something or to the something that is being told. Information is addressed to human minds and is received by human minds." All other senses, including its use with regard to nonhuman organisms as well to society as a whole, are, according to Machlup, metaphoric and, as in the case of cybernetics, anthropomorphic. The confusion started with the abstraction of meaning in information theory (Shannon & Weaver, 1972). Machlup (1983, p. 660) found that human sciences like psychology, economics, decision theory, and linguistics had adopted the basic human-related meaning, asserting it with some restrictions:

> The requirement of truth or correctness should exclude false or incorrect messages; the requirement of value or usefulness should exclude messages not helpful in decisions and actions; the requirement of novelty should exclude repeated or redundant messages; the requirement of surprise should exclude messages that the recipient expected; the requirement of uncertainty-reduction should exclude messages that leave the recipient's state of uncertainty unchanged or increased; and so forth. No exhaustive enumeration of persuasive or dictatorial restrictions is here intended.

In short, for Machlup, information is a human phenomenon. It involves individuals transmitting and receiving messages in the context of possible actions.

More than 10 years later, Kornwachs and Jacoby (1996) edited *Information. New Questions to a Multidisciplinary Concept.* This volume displays a general tendency toward what we might call the naturalization of information. In his contribution "Can Information Be Naturalized?," Zoglauer responds in the negative with regard to semantic and pragmatic information, which is different from syntactic information; that is, from any kind of mind-dependent semiotic units as well as functional information whose interpreter can be a Turing machine and/or any kind of living organism processing neural and genetic information. Also in this volume Capurro (1996) defines information as an anthropological category concerning the phenomenon of human messages, whose vertical and horizontal structures are related to the Greek concept of message *(angelia)* as well as to philosophical discourse *(logos)*. The controversy surrounding the naturalization of information goes back to the work of physicists and engineers such as L. Boltzmann, J. von Neumann, L. Szilard, H. Nyquist, N. Wiener, and particularly to R. V. L. Hartley (1928, p. 536), who in his article "Transmission of Information," argued that, because electrical transmission systems have to do with machines and not with human beings, "it is desirable therefore to eliminate the psychological factors involved and to establish a measure of information in terms of purely physical quantities."

Warren Weaver discussed the elimination of meaning from the concept of information, within the engineering context of signal transmission, in

a similar way with regard to Shannon's "Mathematical Theory of Communication:"

> The word information, in this theory, is used in a special sense that must not be confused with its ordinary usage. In particular, information must not be confused with meaning. In fact, two messages, one of which is heavily loaded with meaning and the other of which is pure nonsense, can be exactly equivalent, from the present viewpoint, as regards information. It is this, undoubtedly, that Shannon means when he says, "the semantic aspects of communication are irrelevant to the engineering aspects." But this does not mean that the engineering aspects are necessarily irrelevant to the semantic aspects. (Shannon & Weaver, 1972, p. 8)

The philosophical controversy about the concept of information in the 20th century had its origin in cybernetics, because the concepts of communication and information were conceived at a higher level of abstraction and not reduced to the communication of human knowledge as expressed by Norbert Wiener's (1961, p. 132) famous dictum: "Information is information, not matter or energy. No materialism which does not admit this can survive at the present day." This was of course a challenge to dialectical materialism. Studies of the concept of information from a materialistic point of view followed (Karpatschof, 2000; Kirschenmann, 1969; Klaus, 1963; Ursul, 1970). Wiener's idea of information as a third metaphysical principle was developed by Günther (1963), while, according to Titze (1971), information is not a substantial or metaphysical principle but expresses a tendency for order and evolution. In his seminal work, Oeser (1976) places information within the context of epistemology as a key concept concerning the creation of scientific knowledge. He explicitly refers to the Latin and Greek roots of the term *information* as well as to its central role in medieval epistemology and ontology. Weizsäcker (1974) also follows this path, as we shall show in the next section. But, with some exceptions, the concept of information is not at the core of philosophical research until the end of the century. The historical review of the concept by Schnelle (1976) refers to linguistics and cybernetics. Weizsäcker develops his views on the relationship between

language and information particularly in dialog with Heidegger (1959). In a seminar with Eugen Fink on Heraclitus, Heidegger also points to the naturalization of the concept of information in biology; that is, to genetic information (Heidegger & Fink, 1970, pp. 25–26; Capurro, 1981). Conceptions of information within the philosophy of science and analytic philosophy, particularly since the late 1970s, are related to specific sciences, particularly physics, biology, and linguistics. As a result of this development the tendency has been to re-humanize the concept of information; that is, to place it within a cultural context. But at the same time, a search continues for a higher level of reflection in which information and communication, whether human or not, are seen with their corresponding *differentia specifica* from the viewpoint of the genus of interpretation or selection. This higher level of reflection means, on the one hand, a renaissance of the ontological dimension of the Greek roots of *informatio* beyond a restrictive humanistic view, while, on the other, the modern, but now de-humanized, perspective of information as knowledge communicated, gives rise to what we could call a communicative ontology where not only living beings (other than humans) but also all kinds of systems are said to produce, process, and exchange information. This perspective may also explain the rise of information science as a science that is supposed to be related to (computer) systems as well as to human beings.

The Concept of Information in the Natural Sciences

Information is prima facie something that flows between a sender and a receiver. But Shannon's definition of information is quantitative concerning possible selections from a repertoire of physical symbols. It is, in fact, as Underwood (2001) remarks, a theory of signal or message, not of information, transmission. Shannon's model of communication (see Figure 8.1) includes six elements: a source, an encoder, a message, a channel, a decoder, and a receiver (Shannon, 1948).

Strictly speaking no information could be communicated between a sender and receiver, because this theory is not concerned with the communication of a meaningful message, but rather with the reproduction of a selection process. Shannon correlates information—that is, the number of possible choices in order to create a message—and uncertainty. The

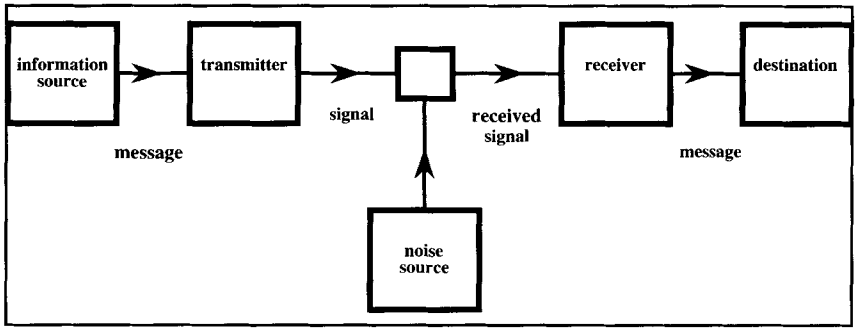

Figure 8.1 Shannon's model of communication.

greater the freedom of choice, the greater the uncertainty; that is, the information. This concept of information seems, as Weaver remarks, "disappointing and bizarre—disappointing because it has nothing to do with meaning, and bizarre because it deals not with a single message but rather with the statistical character of a whole ensemble of messages, bizarre also because in these statistical terms the two words information and uncertainty find themselves to be partners" (Shannon & Weaver, 1972, p. 27).

Völz (1982–1983) gives an overview of the different approaches to the concept of information in the natural sciences. According to Mahler (1996), information is a "contextual concept;" in other words, the question: "What is information?" cannot be stated without reference to a situation. In the case of quantum physics, this situation is a dynamic scenario in which "decisions" are carried out by a system that gives rise to an "information flow." Such decision making, although arranged by human beings, does not require conscious observers. Quantum mechanical systems are embedded within a classical environment. The theoretical model must combine system dynamics and information dynamics, which are separated within the classical world of observation, where information can be copied at will. Given the incompatibility of observables like location and impact, there is no transmission of encoded information in the individual photons between A and B, local information coming into being only after measurement. Mahler shows that this fundamental contextuality can be exploited in communication scenarios, particularly with regard to cryptography. According to Mahler (1996, p. 117), "information can only be defined within the scenario, it is not just

out there." In other words, information is not a pure observable, but a theoretical construct. It is "interpreted data." As Bennett and DiVincenzo (2000) show, an information theory based on quantum principles extends and completes classical information theory. A quantum theory of information offers benefits not only to cryptography but also to quantum information processing. A quantum bit or "qubit" is a microscopic system, such as an atom, or nuclear spin, or photon.

The physicist and philosopher Carl-Friedrich von Weizsäcker conceives of information as a twofold category: (1) information is only that which is understood; (2) information is only that which generates information (Weizsäcker, 1974). Weizsäcker points to the Aristotelian and Platonic origins of the term to show that the concept of information is related to form or structure (definition 2). Information means, at the human level, the concept; not the thinking process itself. In order for a concept to be information, two conditions are necessary; namely, it must be a linguistic entity and it must be univocal. A circular movement between language and information serves as a precondition of scientific thinking (Weizsäcker, 1974). Weizsäcker (1974, p. 347) stresses that a biological structure, or more generally, information as "a measure for the amount of form," is something that can be potentially known (definition 1). At the same time, an entire organism is the product of genetic information (definition 2). Weizsäcker (1974, p. 351) calls generating forms "objectivized semantics." Information is a property of material entities: "matter has form, consciousness knows form." (Weizsäcker, 1974, p. 167). At the level of thermodynamics, actual information means the opposite of entropy; at the level of consciousness it has syntactic, semantic, and pragmatic dimensions. Evolution is the increase of form. Weizsäcker translates the information concept within signal transmission into the context of thermodynamics and biological evolution. The macro state of, say, the Latin alphabet used to send a message, makes possible the choice of a specific letter at the micro level. The same can be said with regard to chromosomes and a DNA sequence. Thermodynamic entropy measures the distance between knowledge of the macro and ignorance at the micro level. The probability of possible events always takes place within specific conditions. No absolute concept of information exists (Weizsäcker, 1985). Contrary to Plato, information should not be conceived as a perennial form, but as changing over time (Weizsäcker, 1992).

Finally, Weizsäcker (1974, p. 60) points to the "unavoidable circle" between language and information; that is, between word plurivocity and conceptual univocity, as a characteristic of exact thinking. The reason is that we are finite observers and actors within language as well as within evolution. We cannot, in Kantian terms, understand things as they are in themselves and therefore we never have fully univocal concepts (Weizsäcker 1992). On the basis of Weizsäcker's twofold concept of information, Lyre (1998, p. 76) develops "a quantum theory of information" *(Ur-Theorie)* with "basic alternatives" *(Ur-Alternativen)* representing the information content of a yes/no decision or one bit of quantum-theoretic potential information *(Ur)*. *Urs* are potential information (Lyre, 1998). This idea of information units is prima facie similar to Stonier's theory of objective information. According to Stonier (1990, p. 21), "information exists;" that is, information exists independently of human thinking (Stonier, 1997). Stonier follows Norbert Wiener's (1961, p. 132) famous dictum:

> The mechanical brain does not secrete thought "as the liver does bile," as the earlier materialists claimed, nor does it put it out in the form of energy, as the muscle puts out its activity. Information is information, not matter or energy. No materialism which does not admit this can survive at the present day.

Structural and kinetic information is an intrinsic component of the universe. It is independent of whether or not any form of intelligence can perceive it (Stonier, 1991). Information may exist in particular form, comparable to photons, as "infons" (Stonier, 1996, 138). The term "infon" was coined by Keith Devlin (1991) and refers to parameters corresponding to individuals and locations (Israel & Perry, 1990). Stonier's view is orthogonal to Weizsäcker's twofold conception of information and Lyre's quantum theory of information with its Kantian background. *Urs* are not infons; that is, they are not particles in space and time. Finally, Stonier separates the syntactic from the semantic aspects of information, whereas Lyre (1998, pp. 155–156) looks for a "complete concept of information." Stonier's (1999) evolutionary view foresees the emergence of a global brain similar to Teilhard de Chardin's (1964) "noosphere."

According to Stonier, it is important to distinguish between information and meaning. Information is, say, the letters of a written alphabet or the nucleotides of a strand of DNA. Two moles of sodium chloride contain twice as much information as one mole. It may yield a message if and only if it has been processed. If the nucleotide in the second sequence is identical to the first, its message is merely redundant. The message may acquire a meaning if and only if it has been information-processed by a recipient. The meaning of two identical messages would not double "although it might be increased somewhat as a result of being repeated" (Stonier, 1996, p. 137). This evolutionary approach to information within the natural (and social) sciences has been discussed at international conferences on the foundations of information science (Conrad & Marijuan, 1996; Hofkirchner, 1999). Information science is seen in this context as an interdisciplinary or multidisciplinary science:

> As a putative vertical science it creates its own spattering of subdisciplines in the overlapping with the other existing sciences: information physics, information chemistry (molecular computing), bioinformation (artificial life), informational neuroscience (artificial intelligence), and socioinformation. (Marijuan, 1996, p. 91)

Biological systems are treated as networks in which information processes at all levels participate (Loewenstein,1999). The features of this autopoietic universe are collapse, irreversibility, and self-regulation, where higher levels act downwardly on the lower levels. This circularity remains imperfect. The physics of biological life recapitulates the underlying physics of the universe (Conrad, 1996). According to Matsuno (1996), information is intrinsically ambivalent with regard to temporality. Shannon's information theory refers to synchronic information; that is, to a process existing in a finite time period and ignoring historical antecedents. Matsuno (1996, p. 111) quotes Weizsäcker: Information is only that which produces information. In evolutionary processes we are concerned only with diachronic information. The historicity of events does not allow participants to claim a global perspective in an atemporal manner. Within this internalist perspective conflicts among the participants inevitably arise as there is no possibility of attaining

simultaneous communication among the participants. The duration of time in production contrasts with the static configuration within products. Products constitute boundary conditions for subsequent production. Measurement of products by an external observer is opposed to internal measurement of production. Internal measurement remains local; external measurement is global. In other words, an external perspective is possible only with regard to what has been accomplished and frozen in the record. Matsuno's question is, then, how an external description of internal measurement is possible. The introspective and the extrospective boundary conditions must coincide "otherwise, the integrity of the notion of boundary conditions would collapse." The local-to-global activity of information becomes crystallized in a product in global time while the global-to-local activity makes synchronization skewed in locally asynchronous time. "Information is intrinsically a conceptual device connecting the local to the global." (Matsuno 1998, p. 66). Matsuno (2000) formulates this connection between local and global information in linguistic terms: How could the present progressive tense be related to the present perfect tense, and how could this relationship be addressed in the present tense?

According to Fleissner and Hofkirchner (1995), the concept of information should not be restricted to a particular level of reality. But, due to qualitative changes at different levels of reality, the concept of information may have:

- The same reference in all contexts, such that qualitative changes are not grasped.
- Similar aspects between the references. In this case a question arises about the primary or basic reference to which analogical concepts refer.
- Finally, qualitatively distinct references may exist. In this case the concepts of information are equivocal.

Fleissner and Hofkirchner call this problem "Capurro's trilemma," which is indeed an Aristotelian one (Capurro 1995; Capurro, Fleissner, & Hofkirchner 1999; Fleissner & Hofkirchner 1995). The view of evolution as self-organization offers, according to Fleissner and Hofkirchner, a paradigm for dealing with this problem. In the process of evolution, different

kinds of low structures generate higher-level structures, starting with physical systems through biological systems to social systems. Evolution is an autopoietic process in which these systems select possible ways of reaction, and forms are transformed. It is a nondeterministic process that is not merely ruled by the classic concept of causality (*actio est reactio,* or, "every action has a reaction"), but by the principle: *causa non aequat effectum, actio non est reactio,* or, "equal causes do not have equal effects, every action does not have an equal reaction" (Fleissner & Hofkirchner 1999, p. 209). This second type of self-organized causality is based on informational relations. This information concept is related to its Latin origins as *information,* meaning a dynamic process of formation and not just the meaning of a message (Fleissner & Hofkirchner, 1995). A unified theory of information should give an account of the dynamic process of evolution that embraces the whole of reality (Hofkirchner, 1999). Laszlo (1999, p. 6) asks for "invariant patterns appearing in diverse transformation" during the evolutionary process. Brier (1999) conceives of cybersemiotics as an ontological and epistemological framework for a universal information science. The evolutionary dissolution of the trilemma has, in our opinion, a metaphysical rather than a scientific status insofar as it presupposes a view of the whole of reality that is not possible for a finite observer.

Some philosophers explicitly criticize the use of the concept of information in the natural sciences. As Küppers (1996, p. 140) remarks:

> The majority of biologists, especially molecular biologists, appear to accept that biological information is indeed a natural entity, which expresses itself in the specific structures of biological macromolecules. However, this attitude has recently been the target of strong criticism from the constructivistic philosophers of science (Janich, 1992). Their main attack has been directed against the application of the concept of information in non-human areas that are governed entirely by natural laws.

According to Küppers, human language can be understood as a higher evolutionary development of the molecular-genetic language, which is the opposite of Janich's view of biological information as

analogous with human information. The use of the concept of information in the natural sciences is a redundant description of the concept of causality (Janich, 1996).

The Concept of Information in the Humanities and Social Sciences

Psychology as a field bridges the natural sciences on one hand and the humanities and social sciences on the other. In psychology, the concept of information has had a central role, with the so-called cognitive revolution from 1956 onward, also called the information-processing paradigm in psychology. (This development gave birth to a whole new interdisciplinary field, named cognitive science, from about 1975. Gärdenfors [1999] reviews the development of this field.) In spite of early disappointments with information theory (see Quastler, 1956; Rapoport, 1956), the dominant trend in psychology has been a kind of functionalism in which human cognitive processes are seen as analogous with information processing by computers. There has not been much explicit discussion of the concept of information in psychology. (Some exceptions are Golu [1981], Hamlyn [1977], Harary & Batell [1978], Harrah [1958], Miller [1953], Miller [1988], Nørretranders [1998], Peterfreund & Schwartz [1971], Rapoport [1953], and Rogers [2000].) The trend has been reductionistic in the sense that human beings are seen as extracting information from the physical and chemical properties of sensory stimuli. Such reductionism stands in contrast to more hermeneutic and historical understandings in which perception is also informed by cultural factors, and information is not defined or processed according to mechanisms in the brain, but by historically developed criteria and mechanisms. (Problems relating to psychological conceptions of information are also important for other human and social sciences, and for the proper understanding of users in library and information science. See Karpatschof [2000] for a culturally informed conception of human cognition.)

Information may refer, as Qvortrup (1993) remarks, to a change in the external world, and in this case it has been defined as "a difference which makes a difference" (Bateson 1972, p. 459); that is, an operational change brought about by the external world in an observing system. It may also refer, inverting the order of this relation, to the process of finding

differences—information as a difference which finds a difference—in which case the system is stimulated by a difference in the external world. On one hand, information is a thing, on the other, a psychic construction. Information as a difference in reality—as something existing independent of an observer—seems to be the view of information in engineering and the natural sciences, although, as we have seen, this is not always the case. This view was one implication of Shannon's exclusion of the semantic and pragmatic aspects of the everyday use of the word *information*. According to Qvortrup (1993), Shannon and Weaver are unclear as to whether they conceive information as a substance or as a sign.

Nevertheless, we note that Shannon retains a basic aspect of the modern concept of information in the sense of knowledge communication, namely selection. When dealing with the meaning of a message we discuss interpretation; that is, the selection between a message's semantic and pragmatic possibilities. To interpret a message means, in other words, to introduce the receiver's perspective—her or his beliefs and desires; to make her or him an active partner in the information process. We would like to suggest a difference between motivational (or anthropological) and causal (or natural) theories of information. Shannon develops a perspective, as we shall show, on causal theories of information with different kinds of "family resemblance" (Wittgenstein, 1958a). One important resemblance between the two kinds of theories is the role of selection in each. Even in the extreme case in which any interpretation is supposedly excluded—as in the engineering perspective of the conduit metaphor—we can still recognize a process of selection. In other words, we state a resemblance between interpreting meaning and selecting signals. The concept of information makes this resemblance possible. Bar-Hillel pointed to the "semantic traps" of Shannon's terminology, particularly with regard to the analogies between the psychological and the engineering fields. Bar-Hillel and Carnap (1953) developed a semantic theory of information in which they distinguish between information and amount of information within a linguistic framework. Dretske's (1981, p. 63–64) theory of semantic information is based on the distinction between information and meaning. Information does not require an interpretive process, although it is a necessary condition for acquiring knowledge. He states three conditions that a definition of information must satisfy, namely:

> "(A) The signal carries as much information about s as would be generated by s's being F."
>
> "(B) s is F"
>
> "(C) The quantity of information the signal carries about s is (or includes) that quantity generated by s's being F (and not, say, by s's being G)."

On one hand, information is not an absolute concept, because we can acquire varying degrees of information about a source. On the other hand, however, "the information that *s* is *F* does not come in degrees. It is an all or nothing affair" (Dretske, 1981, p. 108). According to Dretske (1981, pp. 80–81), information is always relative to "a receiver's background knowledge" (*k*); it is "something that is required for knowledge." It is indeed a "harmless fiction" to think about a number of possibilities existing at the source "independently of what anyone happened to know." There is no false information but there is meaning without truth (Dretske, 1981, pp. 171–235). Indeed, "information is what is capable of yielding knowledge, and since knowledge requires truth, information requires it also" (Dretske, 1981, p. 45). The flow of information is based on the following Xerox principle: "If *A* carries the information that *B*, and *B* carries the information that *C*, then *A* carries the information that *C*" (Dretske, 1981, p. 57). Dretske's information concept is different from meaning, but basically related to cognitive systems. The relation between knowledge and information is a recursive but not a circular one. In order to learn that *s* is *F*, a person should know about *s*, without knowing that *s* is *F*. On the other hand, the information that *s* is *F* "causes *K*'s belief that *s* is *F*." "Knowledge is information-produced belief" (Dretske, 1981, pp. 91–92). Thus, in the case of "genuine cognitive systems," as distinct from "mere processors of information," knowledge is specified with regard to information, meaning, and belief; or, in other words, with regard to interpretation during the learning process. Computers have, at least so far, no capability of using information. It means nothing to them. They can only manipulate symbols (Dretske, 1986).

Dretske's definition of information does not initially include *k* (that is, the receiver's background knowledge). This cognitivistic limitation seems illegitimate if we consider other kinds of receivers or, more precisely,

other kinds of situations. Becoming aware of this contradiction, Barwise and Perry (1983) developed situation theory and situation semantics (STASS). This theory is based on the idea of regularities between types of situations, which allow information flow to take place (Barwise & Seligman, 1997). Linguistic regularities, as considered by Dretske, are a special case of this flow.

Information is not a property of facts but it is context or constraint dependent. A difference exists between "pure information" and "incremental information." "Pure information" is illustrated as follows:

> Whenever there is a state of affairs consisting of some x-ray's having such and such a pattern at some time t, then there is a state of affairs involving a dog's leg having been the object of that x-ray and that leg's being broken at t. So the indicated proposition is that there is a dog of which this is the x-ray, and it has a broken leg. The pure information is about the x-ray, but not about Jackie, or her leg. (Israel & Perry, 1990, p. 10)

"Incremental information" concerns more specific information that may result at the terminus of "information flow architectures" (Israel & Perry, 1991). A distinction is made between "informational content" and "information": "Informational content is only information when the constraints and connecting facts are actual" (Israel & Perry, 1991, p. 147). The causal relations among the contents of an "information system" are called "architectural" (Israel & Perry, 1991, pp. 147–148).

Dretske's Xerox principle becomes a regulative one: the point is to develop information flow architectures whose signals at the terminus will contain incremental information with regard to the earlier ones (Israel & Perry, 1991). In contrast to Dretske's concept of information, the theory of situation semantics defines information within a realistic and not just cognitivistic framework. Information contents are not dependent on the knowledge of the receiver, Dretske's k, but on types of situations. Two different receivers may extract, due to different constraints and facts, different information content from the same signal. According to Pérez Gutiérrez's (2000), further development of this theory—he was inspired by the formalization of the information flow through Barwise and Seligman (1997)—the incremental information content may be defined

only with regard to "classifications" or clusters of situations connected through channels by which the information is transmitted without any reference to a receiver's interpretation. Based on Wittgenstein's (1958b) notion of language games as specified by the formal notion of situations as well as on Gregory Bateson's (1979) ecological paradigm, Rieger (1996, p. 292) analyzes the linear (or syntagmatic) and selective (or paradigmatic) constraints that natural language structure imposes on the formation of strings of linguistic entities:

> The regularities of word-usage may serve as an access to and a representational format for those elastic constraints which underlay [*sic*] and condition any word-type's meaning, the interpretations it allows within possible contexts of use, and the information its actual word-token employment on a particular occasion may convey.

We conclude this analysis of the semantic concept of information by stating that even if information is seen as something existing independently of a receiver's knowledge, this does not necessarily imply that information is something absolute. The situation theory conceives information in relation to situations with their constraints and contingencies. Oeser (1976) remarks that the objectivity of scientific knowledge is not attained through the elimination of the knower, but on the basis of the intersubjective information process. Information is a "system-relative concept" (Oeser, 1976, II, p. 86). Some classical theories of information define it with regard to the change in the receiver's model of reality; that is, as a pragmatic concept (MacKay, 1969; Morris, 1955). This is particularly the case with definitions based on system theory, second-order cybernetics, and semiotics (Qvortrup, 1993). Kornwachs (1996) defines pragmatic information as an impinging entity, one that is able to change the structure and the behavior of systems. According to biologists like Humberto Maturana and Francisco Varela (1980), as well as cyberneticians like Heinz von Foerster (1980, 1984), information is the observer's construction of a mental difference that makes and/or finds a difference in the external world. For Flückiger (1999), information is an individual's brain construct. According to Qvortrup (1993, p. 12), the conception of information as a mental difference "doesn't necessarily imply that the difference

in reality that triggered the mental difference called information is a mental construction." The German sociologist Niklas Luhmann has developed an information concept based on the theory of self-referential systems. Luhmann (1987) distinguishes between biological and social (and psychic) systems. Social (and psychic) systems are constituted by meaning (*Sinn*). In the case of biological systems, self-reference means self-reproduction. Meaning is produced through processing differences, and this is possible because there is a meaning offer (*Mitteilung*) out of which a selection can be made. Information (*Information*) is, then, an event that produces a connection between differences or—Luhmann cites Bateson's (1972, p. 459) famous definition—"a difference that makes a difference." "Understanding" (*Verstehen*) is the difference between "meaning offer" (*Mitteilung*) and "selection" (*Information*). Communication is the unity of meaning offer, information, and understanding. According to this theory, no transmission of information occurs between a sender and a receiver. This thing-oriented metaphor implies that there is something the sender has and loses when she or he sends it. The sender, in fact, makes a suggestion for selection. Information is not something identical for both sender and receiver, but it has to be constituted through the communication process (Luhmann 1987, pp. 193–194). Janich (1998) develops a theory of information that is exclusively related to purpose-oriented human actions. Information is defined as a predicate that qualifies standard request dialogues where linguistic utterances are speaker-, listener-, and form-invariant. Such invariances make it possible to reproduce these situations on the basis of anthropomorphic artificial devices.

Information is a key concept in sociology, political science, and the economics of the so-called information society. According to Webster (1995, 1996), definitions of information society can be analyzed with regard to five criteria: technological, economic, occupational, spatial, and cultural (Webster, 1995, p. 6). The technological definition is concerned with applications of information technologies in society. The economic definition goes back to the pioneering work of Machlup (1962), Boulding (1966), Arrow (1979), and Porat (1977). The occupational definition is at the heart of Porat's (1977) and Bell's (1973) theories. The spatial definition concerns information networks and the emergence of a "network marketplace" (Castells, 1989). The cultural definition is related to the influence

of media in society. Classic theoreticians of the information society are, according to Webster: Bell, Giddens, Schiller, Habermas, Baudrillard, Vattimo, Poster, Lyotard, and Castells.

According to Bougnoux (1993, 1995) the concepts of information and communication are inversely related: Communication is concerned with forecasting and redundancy; information with the new and the unforeseen. There is no pure information or "information-in-itself" (that is, information is always related to some kind of redundancy or "noise"). To inform (others or oneself) means to select and to evaluate. This concept is particularly relevant in the field of journalism and mass media, but also, of course, in information science. The action of bringing a message and the message itself were designated in Greek by the terms *angellein* and *angelia* (Capurro, 1978). The modern concept of information as knowledge communication is not related just to a secular view of messages and messengers but includes also a modern view of empirical knowledge shared by a (scientific) community. Postmodernity opens this concept to all kinds of messages, particularly within the perspective of a digital environment. We may call a science of knowledge (better: message) communication information science or *angeletics* (Capurro, 2000). Flusser (1996) has developed a "communicology" in which "discursive media" are concerned with the distribution of information whereas "dialogical media" deal with the creation of new information. Flusser fears that mass media may swallow up dialogical media into a hierarchical model. He did not foresee the Internet as a communication structure in which both media would merge beyond a central or panoptic power. It is, of course, an open question how far this is, or will be, the case. Krippendorff (1994) has explored different information and communication metaphors such as message transmission, the container metaphor, the metaphor of sharing common views, the argument metaphor, the canal metaphor, and the control metaphor. These metaphors originate within different cultural environments. The phenomena they address are intimately related to the metaphors themselves. We must learn to use them creatively; that is, to see their limits and to learn how to apply them accurately in different theoretical and practical situations.

Braman (1989) provides an important discussion of approaches to defining information for policy makers. Four major views are identified: (1) information as a resource, (2) information as a commodity, (3) information

as a perception of patterns, and (4) information as a constitutive force in society. The relative benefits and problems with each of these four conceptions are discussed. Her article points out that the selection of one definition over another has important consequences, and also that the tendency to neglect this problem results in conflicts rather than cooperation. Defining information is thus also a political decision.

The information age is also called "the age of access" (Rifkin, 2000). Information production, distribution, and access are at the heart of the new economy. The terminological shift from information society to knowledge society signals that content, and not information technology, is the main challenge for the economy as well as for society in general. From the perspective of knowledge management, information is used to designate isolated pieces of meaningful data that, when integrated within a context, constitute knowledge (Gundry 2001; Probst, Raub, & Romhard, 1999). This semantic concept of information, located between data and knowledge, is not consistent with the view that equates information (management) with information technology. According to Nonaka and Takeuchi (1995)—who follow Polanyi's (1966) distinction between tacit and explicit knowledge—only explicit knowledge (information) can be managed. Correctly speaking, knowledge cannot be managed, only enabled (von Krogh, Ichijo, & Nonaka, 2000). For Cornella (2000), companies are information. Castells (1996–1998) gives a comprehensive and critical analysis of the information age, including its social, economic, and cultural dimensions. For Hobart and Schiffman (2000), information is not a phenomenon that appears with modern technology but rather the product of complex interactions between technology and culture. They distinguish among classical, modern, and contemporary information ages, the meaning of information being specific to each age.

> The fundamental fact of information's historicity liberates us from the conceit that ours is the information age, a conceit that underlies Kauffmanesque inferences from "computer-simulation movies" to history. It allows us to stand outside our contemporary information idiom, to see where it comes from, what it does, and how it shapes our thought. (Hobart & Schiffman, 2000, p. 264)

Brown and Duguid (2000) question "the myth of information" and information technologies that would be able to shape social organization by themselves. For it is not shared information but shared interpretation that binds people together. Borgmann's (1999, p. 57) critical appraisal of the nature of information is a plea for a new cultural and ethical balance between what he calls technological, natural, and cultural information: "Natural information pivots on natural signs—clouds, smoke, tracks. Cultural information centers on conventional signs—letters and texts, lines and graphs, notes and scores."

Borgmann (1999, pp. 218–219) sees technological information as the product of developments that began a century ago:

> Based on information technology, our omniscience and omnipotence have achieved such transparency and control of information that there are not things any more to be discovered beyond the signs. Nothing is any longer buried beneath information. Behind the virtual self-representations there are no real persons left to be acknowledged.

We close this by no means exhaustive analysis of the concept of information in the humanities and social sciences with Eliot's (1969, p. 147) famous quotation:

> Where is the Life we have lost in living?
> Where is the wisdom we have lost in knowledge?
> Where is the knowledge we have lost in information?

We started this presentation of interdisciplinary theories by asking whether a common core can be found in the concept of information. According to Karpatschof (2000, pp. 131–132):

> Information
> The quality of a certain *signal* in relation to a *certain release mechanism*, the signal being a low-energy phenomenon fulfilling some release specifications.

> The *signal* is thus the indirect cause, and the process of the *release mechanism* the direct cause of the resulting high-energy reaction.

The release mechanism itself is, of course, an emergent entity, when it is seen from a cosmological position. This is the precise agenda, for biogony and biogenesis to furnish theories with an analysis of this emergence. We can thus more precisely define:

> Release Mechanisms
> Systems having at their disposal a store of potential energy, the system being "designed" to let this energy out in a specific way, whenever trigged by a signal fulfilling the specifications of the release mechanism

It is now clear why there has been this tendency to consider information to be an obscure category that is in addition to the classical categories of physics. Information is indeed a new category, but it cannot be placed, eclectically, beside the prior physical categories. Information is a category, not beside, but indeed above the classical categories of physics. Therefore, information is neither directly reducible to these classical categories, nor is it a radically different category of another nature than mass and energy. Information is, in fact, the causal result of existing physical components and processes. Moreover, it is an *emergent* result of such physical entities. This is revealed in the systemic definition of information. It is a relational concept that includes the *source,* the *signal,* the *release mechanism* and the reaction as its relatants. One might ask where I place the category of *information* in my system of ontology.

> Should it be placed in the object field of cosmology, just as mass, energy and causality? Or, should it be placed in the object field of biology? My answer to this question will be the latter position. (all emphasis in original)

In our opinion, Karpatschof's explanation identifies a key perspective of the concept of information that most interdisciplinary discussions can agree upon. It seems to be a reductionistic and indeed mechanical perspective, antithetical to a humanistic understanding. However, this is not the case. Karpatschof does not explain psychological or sociological phenomena by physical or biological principles. He does not consider information as a thing or as something objective. He forces us to look at the many different kinds of mechanisms at different levels in evolution and culture that have evolved to discriminate certain kinds of signals. In other words, he forces us to shift the perspective from information as an object to the subjective mechanisms that account for discrimination, interpretation, or selection. What distinguishes different theories of information is, thus, not so much the concept of information itself. It is, to a much higher degree, the nature of the "release mechanism" (or "information processing mechanisms"), the selectors or interpreters. To ask about the nature of this mechanism means, for instance, to ask about the nature of living organisms, the nature of human beings, human language, society, and technology. Because there are many kinds of release mechanisms developed in biology, in the human mind, in cultures, and in technologies, different sciences tend to work with different concepts and theoretical frames of reference. Information can and should thus be studied within a network of different disciplines, not just by "information science" (Capurro, 2001). No wonder, then, that the mechanisms of information—and information itself—have been so difficult to tackle.

Information in Information Science

Relationship with Librarianship and Scientific Documentation

As we have seen, the word *information* has a much richer history than the fields of inquiry known as library science, documentation, and information science, which are largely products of the 20th century. Tracing the

influence of this term and the very complex net of disciplines connected with it is indeed difficult. Machlup and Mansfield (1983, p. 22) suggested that "in the broad sense information science is a rather shapeless assemblage of chunks picked from a variety of disciplines that happen to talk about information in one of its many meanings." In this chapter only a few important points will be illuminated.

Some key events can be taken as signposts for our orientation in this complex area.

> Information desk appeared as an alternate to reference desk by 1891. Information bureau was in use by 1909 to denote an office where reference service was provided; in 1924 the Association of Special Libraries and Information Bureaux (Aslib) was founded in Britain. In the *Aslib Proceedings* for 1932, information work was introduced to describe reference assistance. Use of information as an equivalent of reference began to give way, under the influence of developments in computing, to more sophisticated usage. (Shapiro, 1995, p. 384)

The term *information* was also used in 1915 by the American special librarian, Ethel Johnson, who noted, "before everything else, it [the special library] is an information bureau. The main function of the general library is to make books available. The function of the special library is to make information available" (quoted by Williams, 1998, p. 174).

According to Williams (1998), special librarians were the first documentalists in the U.S.; and, according to Rayward (1998), documentalists can be seen as the first information scientists. We are thus able to trace one line of development from special librarianship via documentation to information science in both the U.K. and the U.S. The line of development from Paul Otlet (1934) and Suzanne Briet (1951) is discussed by Day (2001) in critical fashion.

In 1968, the American Documentation Institute (founded in 1937) changed its name to the American Society for Information Science. From that time, "information" gradually replaced "documentation" as a name for a profession and field of study (at least until a recent tendency to reintroduce the concept of documents by Buckland, 1997; Hjørland, 2000; Lund, 1997; White & McCain, 1998; and others). Only a few institutions

have preserved the term *documentation* (e.g., *Journal of Documentation;* Féderation Internationale de Documentation). One notable exception is in Tromsø, Norway, where "Documentation Science" has recently been chosen as the name for a newly founded institute. It is far more common to do as the Royal School of Library and Information Science in Copenhagen did in 1997: namely, add *information* to its name (although only to the English version). The important question is, of course, what kinds of theoretical influences lie behind such choices? How is the term *information* theoretically related to what is studied (if at all)?

According to Hjørland (2000) the increasing trend toward using the term *information* in institutions of librarianship and documentation is mainly related to: (1) an increasing interest in computer applications (or "information technology"), and (2) an indirect, theoretical influence from information theory (Shannon & Weaver, 1972) and the paradigm of information processing in the cognitive sciences.

The same paper also argues that this tendency has serious drawbacks. Theories that are appropriate for computer science are not necessarily adequate for library science, documentation, and scientific communication. A serious risk arises such that concepts and theories related to information theory tend to reduce the study of documentary communication to computer science and cognitive science, thus removing the basis of the field in its own right.

Library science as taught in schools of librarianship has always had public libraries as a major focus simply because public libraries have constituted an important market for professionally trained librarians. This situation has influenced both the focus of the field and its underlying assumptions, preferences, and "paradigms" (for example, the predilection for universal classifications systems and the relative neglect of domain-specific knowledge). Special librarianship and documentation (and later information science), on the other hand, were much more concerned with research libraries, databases, and with activities connected to the seeking and dissemination of scientific literature—and also the application of information technologies. Documentation/information science was originally based more on specific subject knowledge (chemistry has played an especially important role in information science), whereas special librarianship relied more on education and training in schools of librarianship. According to Williams (1998, p. 177) special librarians in the U.S. lost

ground to documentalists and information scientists because they lacked the specific subject knowledge to handle complex information (for example, in chemical indexing and retrieval).

> These changes, particularly when confronted with the insistence of the documentalists that a new profession different from librarianship, even special librarianship, needed to be developed, had the effect of making them [the special librarians] more general library oriented and less special library oriented. The overall effect on special librarianship and SLA [Special Libraries Association] is a decline in their domination of new developments in information management. As will be shown in the next section, one of the major reasons special librarians had lost this dominance was because they emphasized general education in librarianship to the neglect of the scientific fields they had to serve. They were now librarians first and foremost, and only knowledgeable about their subject areas second, if at all.

However, since about 1975, information science has been foregrounded in schools of library science. This may be due in part to an increasing interest in being associated with such important fields as computer-based information retrieval and other areas of information science. Although schools of library science are major contributors in the field, as reflected in their contributions to the leading journals in IS; they have also faced challenges, particularly in the U.S. This situation may be connected to what they teach, including the old problem concerning the lack of specific subject knowledge. It may be, however, that the neglect of subject knowledge reflects a privileging of research into users rather than information, and, by implication, a tendency toward psychologism, subjective idealism, and methodological individualism.[4] The terms information and IS became institutionalized in, among other places, schools of library science, which in the process often changed their names and their curricula. The question is how well we have succeeded in developing information science as a healthy field of inquiry.

Information Retrieval and the Concept of Information

The term information retrieval (IR) is possibly one of the most important terms in the field known as information science. A critical question

is, thus, why, and in what sense, IR uses the term information. IR can be seen both as a field of study and as one among several research traditions concerned with information storage and retrieval.[5] Although the field is much older, the tradition goes back to the early 1960s and the Cranfield experiments, which introduced measures of recall and precision. Those experiments rank among the most famous in IS and continue today in the TREC experiments (Text REtrieval Conference). This tradition has always been closely connected to document/text retrieval, as stated by van Rijsbergen (1979, p. 1):

> Information retrieval is a wide, often loosely-defined term, but in these pages I shall be concerned only with automatic information retrieval systems. Automatic as opposed to manual and information as opposed to data or fact. Unfortunately the word information can be very misleading. In the context of information retrieval (IR), information, in the technical meaning given in Shannon's theory of communication, is not readily measured (Shannon and Weaver). In fact, in many cases one can adequately describe the kind of retrieval by simply substituting "document" for "information." Nevertheless, "information retrieval" has become accepted as a description of the kind of work published by Cleverdon, Salton, Sparck Jones, Lancaster and others. A perfectly straightforward definition along these lines is given by Lancaster: "Information retrieval is the term conventionally, though somewhat inaccurately, applied to the type of activity discussed in this volume. An information retrieval system does not inform (i.e. change the knowledge of) the user on the subject of his inquiry. It merely informs on the existence (or non-existence) and whereabouts of documents relating to his request." This specifically excludes Question-Answering systems as typified by Winograd and those described by Minsky. It also excludes data retrieval systems such as used by, say, the stock exchange for on-line quotations. [Notes to references omitted].

In 1996, van Rijsbergen and Lalmas (p. 386), however, declared that the situation had changed and that the purpose of an information

retrieval system was to provide information about a request. Although some researchers have fantasized about eliminating the concept of document/text and simply storing or retrieving the facts or "information" contained therein, it is our opinion that IR usually means document retrieval and not fact retrieval.[6] We shall return to the difference between documents and facts later, but here we want to show why information (and not, for example, document, text, or literature) was chosen as a central term in this core area.

Ellis (1996, pp. 187–188) describes "an anomaly" in IS:

> Brookes noted the anomaly could be resolved if information retrieval theory were named document retrieval theory which would then be part of library science. However, he commented that those working in the field of information retrieval were making the explicit claim to be working with information not documentation.

What Brookes (1981, p. 2) stated was,

> From an information science point of view, research on IR systems offers only a theoretical cul-de-sac. It leads nowhere. The anomaly I have noted is this: the information-handling processes of the computers used for IR systems, their storage capacities, their input, and internal information transmissions, are measured in terms of *Shannon* theory measures—in bits, megabits per second, and so forth. On the other hand, in the theories of information retrieval effectiveness, information is measured in what I call *physical* measures—that is, the documents (or document surrogates) are counted as relevant or non-relevant and simple ratios of these numbers are used. The subsequent probabilistic calculations are made as though the documents were physical things (as, of course, they are in part), yet the whole enterprise is called information retrieval theory. So why, I ask, are *logarithmic* measures of information used in the theory of the machine and *linear* or physical measures of information in IR theory?

> If *information* retrieval theory were called document retrieval theory, the anomaly would disappear. And document retrieval theory would fall into place as a component of *library* science, which is similarly concerned with documents. But that is too simple an idea. Those who work on IR theory explicitly claim to be working on *information,* not *documentation.* I therefore abandon the simple explanation of a misuse of terminology. I have to assume that IR theorists mean what they say—that they are contributing to *information science.* But are they? [emphasis in original]

Ellis and Brookes should not refer to the opinions of researchers in their attempts to solve this problem. Only arguments count. In our view, it is not too simple an idea to claim that information retrieval theory is in reality document retrieval theory and thus closely associated with library science. It is not difficult to disprove Brookes's statement that information retrieval does not deal with documents. A short examination of the literature demonstrates this, and even if the Cranfield experiments spoke about "information retrieval," their modern counterpart, the TREC experiments, speak about "text retrieval." "Text retrieval" and "document retrieval" are often used as synonyms for IR.

If one reads Brookes's statement in the light of the relationship between the early documentalists and information scientists, it becomes clear that information scientists wanted to forge a distinct identity to be both more information technology-oriented and more subject-knowledge oriented. One reason for information scientists to prefer not to be linked to library science might be that important technological improvements were carried out not by people associated with librarianship, but by those affiliated with computer science. This preference is most probably the reason they claimed to work with "information, not documentation." Nevertheless Brookes's statement is flawed, and it has provoked endless speculation about the nature of information, which has not contributed to an understanding of the problems of IR. (Compare the quotation by Schrader, 1983, p. 99, cited earlier.)

The worst thing may be that information scientists have overlooked some of the most important theoretical problems in the field. Van Rijsbergen (1986, p. 194) has pointed out that the concept of meaning

has been overlooked in IS. The fundamental basis of all previous work—including his own—is in his opinion wrong because it has been based on the assumption that a formal notion of meaning is not required to solve IR problems. For us it is reasonable to suggest a link between the neglect of the concepts of text and documents on one hand and meaning (or semantics) on the other. Semantics, meaning, text, and documents are much more related to theories about language and literature, whereas information is much more related to theories about computation and control. We do not claim, however, that the statistical methods used in IR have not been efficient. We do claim, however, that semantics and pragmatics, among other things, are essential to better theoretical development in IR, and in the long run also to the improvement of operational systems.

Information and Assemblages of Facts

In spite of our claim that IR is actually document retrieval, there has been throughout the history of the field a problematic tendency to regard information as assemblages of facts or opinions freed from the documents.

In the literature of IS a distinction is made between document retrieval and fact retrieval. As a response to a query, a document retrieval system provides a list of references about the subject, which with a certain probability is supposed to contain the answer to the query, or rather to reveal the present documented knowledge about the problem. Fact retrieval systems, on the other hand, are supposed to provide concrete answers to queries. If the query is: "What is the definition of information science?" a document retrieval system such as *Library and Information Science Abstracts (LISA)* produces a long list of papers discussing this issue, whereas a fact retrieval system provides you with one selected definition.

Some distinguished IS researchers have regarded the creation of fact retrieval systems as the ultimate goal of information science. Karen Sparck Jones (1987, p. 9), for instance, claims that "we are concerned with access and, more materially, indirect access to the information the user wants: he wants the information in the documents, but the system only gives him the documents." This statement represents a rather narrow view with roots back to the foundation of documentation and information science:

Some of Paul Otlet's basic ideas are described by Rayward (1994, p. 247) as "the outmoded paradigm of nineteenth-century positivism:"

> Otlet's concern was for the objective knowledge that was both contained in and hidden by documents. His view of knowledge was authoritarian, reductionist, positivist, simplistic—and optimistic! ... It is merely a question of institutionalizing certain processes for analyzing and organizing the content of documents. For him that aspect of the content of documents with which we must be concerned is facts. He speaks almost everywhere of facts.

Rayward (1994, pp. 247–248) finds the same view represented in modern IS:

> In describing the Xanadu Project, Nelson (1987) for example, in capital letters, says that it is "just one thing: a new form of interconnection for computer files—CORRESPONDING TO THE TRUE INTERCONNECTION OF IDEAS which can be refined and elaborated into a shared network" (p. 143). These words and the sentiments that they both express and seem to imply could be, except for the term "computer files," Otlet's own. They suggest an atavistic positivist perspective that takes one by surprise.

In practice, document retrieval systems coexist with systems that provide concrete answers. Directories, dictionaries, handbooks of chemical and physical constants, and many other kinds of reference works are examples of factographic works and databases that have important functions and exist side-by-side with bibliographic databases. However, we find it important to argue against the view that bibliographical databases or full-text databases should be less than ideal because "[the user] wants the information in the documents, but the system only gives him the documents" (Sparck Jones, 1987, p. 9).

The idea that bibliographic information systems should be reduced to fact retrieval systems is a problematic assumption. We agree with Rayward that this view is related to a kind of obsolete positivism. We also see this view as one reason for the use of the terms *information* and *information science*. Because it is often desirable to know the source (e.g., in

order to compare it with other sources or to evaluate its cognitive authority), document retrieval should not be reduced to fact retrieval systems.

We let Spang-Hanssen (1970/2001, online) have the final word on this issue:

> Moreover, these terms are not seldom confused with a more or less obscure use of the word information to mean something factual or real as opposed to representations of such facts; what is found written in documents—or what is said in a lecture—are according to this view only disguises or at best surrogates of facts. This more or less vague conception seems to be the basis of the distinction sometimes made between "fact retrieval" and "document retrieval."
>
> This distinction I find philosophically unbased; we here touch upon the fundamental problem of the meaning of meaning and of the nature of signs and symbols. What is more essential to us, this distinction seems unhappy in actual documentation work. There will, admittedly, be cases in which a document or information center is set up with the exclusive function of providing information concerning physical data, or statistical figures, or exchange rates of currencies, or stock market prices. But even in such cases it applies that neither the person who requests such information nor the person to deliver it should ignore the reliability of data and forget about the general setting in which the data are acquired. An information about some physical property of a material is actually incomplete without information about the precision of some figure and about the conditions under which this figure was obtained. Moreover, various investigations of a property have often led to different results that cannot be compared and evaluated apart from information about their background. An empirical fact always has a history and a perhaps not too certain future. This history and future can be known only by information from particular documents, i.e. by document retrieval.

> The so-called fact retrieval centers seem to me to be just information centers that keep their information sources—i.e. their documents—exclusively to themselves.

Romm (1997) shows that serious ethical implications are involved in defining something as factual as opposed to meaningful. To the extent that information is seen or presented and legitimized in terms of its supposed factual content, it authorizes a picture of the world—rather than inviting debate on the construction and relevance of the picture. Conversely, insofar as information is treated as a product of specific world-constructing activities, it invites discursive inquiry as to its meaning and relevance.

Information and the Scientific Division of Labor

Are information scientists the only professionals who are working with the "generation, collection, organization, interpretation, storage, retrieval, dissemination, transformation, and use of information"? (This quote is part of the official definition of information science given by the American Society for Information Science and Technology [Borko, 1968; Griffith, 1980] quoted in full later in this chapter.) We often assume this to be the case. If this is not the case, it seems important to try to specify the special role of information scientists in handling information.

In one sense of the word *information*, astronomers can be seen as experts who identify, process, and interpret information from the universe. The byproducts of their activities they keep as observations in one form or another. They may make photographs of parts of the universe and of single stars, planets, and galaxies. They also publish their empirical and theoretical findings in journals and other publications. Both the photographs and the publications are examples of documents. The library, documentation, and information profession is interested in all kind of documents. Its core interest and expertise is, however, related to the communication of published documents. Our point is that in the sense of the word *information* as it is used about astronomers' activities, information scientists are not experts in interpreting the information from the stars, but at most are experts in handling information documented by astronomers (e.g., indexing and retrieving astronomical documents). In

this example, information is defined in a broader sense than is usually implied in information science.

Just as astronomers can be said to handle information professionally, so it is with other groups. Publishers, researchers, historians, lawyers, and teachers can be said to be professional information handlers in some fashion. Defining information in a way other than implied here can solve this problem. Belkin (1978, p. 60) explicitly seeks to solve this problem by demanding that, "in general, any information concept for information science must refer to at least the specific domain of information science, as indicated by its problem. This means purposeful, meaningful, human communication, with the specific requirements as noted above."

But this solution has some disadvantages. In information science we are sometimes interested in studying the researcher's selection of an information channel, including whether he or she prefers to go the library or to make an observation for himself or herself.

This distinction was made in Taylor's (1968) study of question negotiation and information seeking in libraries. If we define *information* in the narrow sense, as something belonging solely to information science (as proposed by Belkin), we are not able to make comparative studies of this sort. Because we find Taylor's questions relevant and consider that he uses the concept of information in a fruitful way, we see a dilemma in using Belkin's (1978) definition in information science.[7]

The role of information specialists may be relatively clear when the target group is, for example, astronomers: information specialists are experts on forms of publications, databases, reference tools, and so forth. In the case of, for example, historians or lawyers, the borders are much less clear because the information that these professions are seeking, interpreting, and using is itself contained in publications and documents. The historian, not the librarian or information specialist, is the expert in seeking, organizing, interpreting, and utilizing the documents needed in his or her professional work. Still, an information specialist has more professional expertise regarding specific matters such as databases and cataloging.

One of the most frequently used definitions of information science is as follows:

> Information science is concerned with the generation, collection, organization, interpretation, storage, retrieval, dissemination, transformation, and use of information, with particular emphasis on the applications of modern technologies in these areas.
>
> As a discipline, it seeks to create and structure a body of scientific, technological, and systems knowledge related to the transfer of information. It has both pure science (theoretical) components, which inquire into the subject without regard to application, and applied science (practical) components, which develop services and products. (Griffith, 1980, p. 5)[8]

In our view, this definition does not contain a good identification of the special focus of information science. No science should be defined by its tools (e.g., modern technologies). All fields are supposed to utilize the most appropriate tools available. A science should be defined by its object of study. As such, the study of information is a better one. We need, however, to identify the specific role of information science in relation to "the generation, collection, organization, interpretation, storage, retrieval, dissemination, transformation and use of information" as distinct from the activities in which other professionals are more qualified. In our view, information professionals usually have a broad overview of information sources, sociological patterns in knowledge production, document types, and so on. They should also have a broader knowledge of the philosophy of science (e.g., paradigms and epistemology), and of the principles of language use for special purposes. We believe that the focus of information professionals (as distinct from the professional groups they are serving) implies a sociological and epistemological approach to "the generation, collection, organization, interpretation, storage, retrieval, dissemination, transformation and use of information."[9] Information scientists—by the very nature of their field—must work in a top-down mode, from the general field of knowledge and information sources to the specific, whereas domain experts must work in a bottom-up mode, from the specific to the general.

With regard to the concept of information, the implication is that what counts as information—what is informative—depends on the question to be answered. The same representation of an object (e.g., a stone in a field)

contains different information for, say, an archaeologist or a geologist. The same matter should therefore be represented differently in different subject databases. The concept of information itself can be defined universalistically (e.g., Bateson, 1972). Information is anything that is of importance in answering a question. Anything can be information. In practice, however, information must be defined in relation to the needs of the target groups served by information specialists, not in a universalistic or individualistic, but rather in a collectivist or particularistic fashion. Information is what can answer important questions related to the activities of the target group. The generation, collection, organization, interpretation, storage, retrieval, dissemination, and transformation of information must therefore be based on views/theories about the problems, questions, and goals that the information is going to satisfy. In public libraries, those goals are related to the democratic role of the public library in society. In medicine, they are related to the solving of health problems. In women's studies, they are related to the understanding and emancipation of women. In commercial systems, they are linked to business strategy.

Diverse Views and Theories of Information in IS

Information Theory

Outside documentation and library science, in 1948, important developments occurred in so-called information theory, in cybernetics, and in technological theories as well as in communication (Shannon & Weaver, 1972; Wiener, 1961). These fields built the foundations for subsequent developments in computer science (or information technology).[10] It is widely recognized that information theory is a problematic term, and that even the term *information technology* may be a misleading label for data technology or computer technology. A consequence of Shannon's theory was that the word *information* became extremely influential in all areas of society, and fashionable in English and other languages.

Shannon's information theory has had an impact on many fields, including library and information science and documentation. The history of this impact or reception has yet to be written. There is no doubt, however, that in the 1950s many people found that this theory could be used as a strong conceptual model for research in numerous fields,

including psychology, the social sciences, and documentation. Problems with this approach soon appeared (Rapoport, 1953), and the initial optimism disappeared, leaving many fields without an adequate theoretical frame. From an information-theoretical point of view, information can be precisely defined and measured. For example, in February 1999, Lawrence and Giles (1999) found about 15 terabytes of information on the Internet. This is not, however, the same concept of information as that used by information specialists when seeking, selecting, or indexing information sources. These activities relate to the content and meaning of messages, not just to their physical storage and transmission.

Wersig (1996, p. 221) concluded his presentation of information theory with the following remark:

> This was not so in human contexts, where neither the assumption of coherent sets of signs nor the assumption of the identity of original message, signs, and reconstructed message were applicable. The very notion of semiotics, which in fact became one of the most important critiques of too simple an application of information theory to human communication, led to the insight that Shannon's mathematical theory was only a theory on the syntactical level (relation of signs to signs), but with no reference to the semantic (relations of signs to meanings) and pragmatic (relation of signs to humans) levels. In consequence, some attempts were made to develop out of Shannon's theory a semantic (e.g., Bar-Hillel & Carnap, 1953) or pragmatic (e.g., Yovits, 1975) information theory. But they remained in the literature with no great success.

In spite of the overall tendency to regard Shannon's information theory as a blind alley in information science, studies are still published from this perspective (e.g., Wong & Yao, 1992; Zachary, Iyengar, & Barhen, 2001).

Dretske's theory originates from philosophy and was outlined earlier. It has been cited 15 times in the literature of library and information science.[11] Patrick Wilson (1983, p. 62) has provided a short but useful review of Dretske (1981). He concludes:

> How relevant is all of this to information science? I suspect that most information scientists are not much concerned with information in Dretske's sense of the word; they are concerned with meaning, not information. The documents whose storage and retrieval interests them may or may not carry any information, but they do have semantic content or meaning, which is the main thing. If that is so, and if Dretske's notion of information is the "right" one, then information science is perhaps misnamed. Dretske's idea of information is clearly closer to the "ordinary" idea of information than is the usual information scientist's idea of information; in the ordinary sense, information is contrasted with misinformation, but not so for the information scientist. It would, I think, be beneficial if some information scientists would take the trouble to read this book, with this question in mind: is information science really concerned with information? And if it is not now, could it be in the future?

Wilson's proposal has been heeded. Van Rijsbergen and Lalmas (1996) are the most prominent followers of Dretske's approach. Together with Barwise (1993) and Devlin (1991), van Rijsbergen and Lalmas (1996, p. 385) call their approach DBD: Dretske, Barwise and Devlin. Van Rijsbergen withdraws his former conclusion that information retrieval is actually document retrieval and tries to develop a theory that bases IR on an objective conception of information. The other references to Dretske's theory in IS (e.g., Bonnevie, 2001; Losee, 1997; Mingers, 1995) seem rather unrelated to one another.

The Cognitive View

We have already discussed core definitions of information connected with the cognitive view in information science: Brookes's (1977) pseudo-mathematical expression: $K(S) + \delta I \rightarrow K(S + \delta S)$ and Belkin's (1978, p. 60) definition, which managed to define information as a phenomenon relatively specific to information science by viewing information as a communicated and transformed knowledge state in the form of a structure.

Through the work of Brookes (1980), Karl Popper's metaphysical pluralism has been connected to the cognitive view. As is well known, Popper's ontology consists of three worlds:

World 1: physical objects or states,
World 2: consciousness or psychical states,
World 3. intellectual contents such as books, documents, scientific theories, etc.

Popper uses the words "knowledge" and "information" interchangeably. In Popper (1974, p. 1051), World 3 explicitly encompasses information:

> In my way of looking at World 3, its theories contain essentially the information content which is conveyed by them. And two books which may differ widely as World 1 objects may be identical insofar as they are World 3 objects—say, if they contain the same coded information.

Popper's World 3 has been compared to the concept of signs in the (monist) semiotic tradition from Charles Peirce onward (see Skagestad, 1993):

> While Freeman and Skolimowski discuss both Peirce's doctrine of signs and Popper's World 3 epistemology, they do not note that the entities comprising Popper's World 3 are signs in the Peircean sense, or that Peirce's doctrine of signs represents a World 3 epistemology that in many respects is more detailed and developed than Popper's; nor has this been noted by any other writer that we are aware of. Again, we do not mean simply that World 3 consists of objects which Peirce would have classified as signs—that would be a rather trivial observation, given the ambitious scope of Peirce's doctrine of signs. Rather, as we have already seen, Popper's own statement that a World 3 object, such as a book, is constituted by its "dispositional character of being understood or interpreted," is what recapitulates Peirce's definition of a sign as whatever is capable of being interpreted.

The tendency within and beyond IS has been to favor Peirce's semiotic view over Popper's metaphysical pluralism. It makes sense to consider informative objects as signs (as World 1 phenomena) that for some subjects (or "release mechanisms," which are also World 1 phenomena)

trigger some responses (interpretation, selection), and thus introduce teleological principles into the material world (World 1). According to Rudd (1983), we simply do not need Popper's World 3 in order to explain informational processes.

The most recent description of the cognitive view is presented by Borlund (2000, p. 16), who is a student of Peter Ingwersen. She finds that Ingwersen adds the concepts of potential information and data "and in a way the modified model becomes the trademark of Ingwersen, as he, in several cases, uses it to present an overview of IR interactions." We see the cognitive view as taking a position between the objective concept of information in both information theory and Dretske's theory on one hand, and the subjective or interpretative view taken by information scientists inspired by hermeneutics, semiotics, domain analysis, and so forth, on the other hand.

Information-as-Thing

Buckland (1991a) analyzes various uses of the term *information* in information science. It can be used in relation to things, processes, and knowledge (see Table 8.1).

Buckland's analysis seems to have two important consequences: On one hand, it reintroduces the concept of document ("information-as-thing"), and on the other hand, it points out the subjective nature of

Table 8.1 Four aspects of information (after Buckland, 1991a. p. 6).

	INTANGIBLE	TANGIBLE
ENTITY	Information-as-knowledge Knowledge	Information-as-thing Data, document, recorded knowledge
PROCESS	Information-as-process Becoming informed	Information processing Data processing, document processing, knowledge engineering ["Fluxed information": telephone calls, TV broadcast hours, etc.]

information. A stump of a tree contains information about its age as well as about the climate during the tree's lifetime. In similar fashion, anything might in some imaginable circumstances be informative: "We conclude that we are unable to say confidently of anything that it could not be information" (Buckland, 1991a, p. 50., underlining in original). Just as anything could/might be symbolic, Buckland maintains that *any* thing could/might be informative/information.

Domain Analysis, Socio-Cognitivism, Hermeneutics, Semiotics, and Related Views

The cognitive view takes a step toward a subjective understanding of information. Buckland goes another step. The domain analytic view sees different objects as being informative relative to the social division of labor in society. In this way, information is a subjective concept, but not primarily in an individual sense. Criteria for what counts as information are formed by sociocultural and scientific processes. Users should be seen as individuals in concrete situations within social organizations and domains of knowledge. A stone in a field could contain different information for different people. It is not possible for information systems to map all possible information values. Nor is any one mapping the only "true" situation. People have different educational backgrounds and play different roles in the division of labor in society. A stone in a field (or, of course, a document about a stone in a field such as a photograph) represents one kind of information for the geologist and another for the archaeologist. The information from the stone can be mapped onto the different collective knowledge structures produced by geology and archaeology. Information can be identified, described, and represented in information systems for different domains of knowledge. Of course, problems arise in determining whether a thing is informative or not for a domain. Some domains have a high degree of consensus and explicit relevance criteria. Other domains have different, conflicting paradigms, each containing its own more or less implicit view of the informativeness of different kinds of information sources.

The domain-analytic view is related to a hermeneutic view because the understanding is determined by the pre-understanding of the observer. An explicit "information hermeneutics" has been developed by

Capurro (e.g., 1986). It is also related to semiotic approaches (e.g., Brier, 1992, 1999) and to the approach known as social constructivism (e.g., Frohmann 1990, 1994; Savolainen, 2000).

Conclusion

We should be aware that library and information science is only one discipline among a network of disciplines and metadisciplines dealing with communication, technology, systems, and related processes. We should try to further clarify our identity and our specific goals, and to strengthen historical continuity in the field. We should not consider the concept of information in isolation, but see it in relation to other concepts such as, for example, documents and media. The concept of information may indeed have had a positive effect as a status booster for professions primarily working with documents. However, this positive effect has had the unfortunate consequence of raising the level of confusion in the discipline. It is worth noting that important books can be written in the field without using the concept of information (e.g., Lancaster, 1998). Thus, researchers should be explicit about how they define this and other theoretical terms. It should either be used for the sake of theoretical clarification, or—as Fairthorne (1965) recommended—not at all.

There are many concepts of information, and they are embedded in more or less explicit theoretical structures. In studying information it is easy to lose one's orientation. Therefore, it is important to state the pragmatic question: "What difference does it make if we use one or another theory, or concept, of information?" This task is difficult because many approaches involve implicit or vague concepts, which must be clarified. (Such a clarification may provoke resistance because information is so often used as a status-enhancing term with little theoretical ambition.) We should also ask ourselves what more we need to know about the concept of information in order to contribute to the further development of information science.

In our view, the most important distinction is that between information as an object or a thing (e.g., number of bits) and information as a subjective concept, information as a sign; that is, as depending on the interpretation of a cognitive agent. The interpretative view shifts attention from the attributes of things to the "release mechanisms" for which

those attributes are of importance. This shift may cause frustration because it is inherently difficult and because it implies teleological principles that are foreign to the positivist principles of science. It is relatively easy to count the number of words in a document or describe it in other ways; it is much more difficult to try to figure out for whom that document is of importance, and what the important questions are that the document can answer. Questions of interpretation are also difficult because we often confuse interpretation with an individualist approach. Meaning is, however, determined in social and cultural contexts.

Finally, we want to emphasize the need to explicate the foundations of knowledge claims. When we represent data in our information systems, we do so in order to support certain human activities. We should not simply regard our representations as objective, because that implies that we never fully specify the theoretical, social, and historical assumptions on which we act. All kinds of information systems have policies and more or less explicit goals. What we regard as information should also be a reflection of the social role of the information system.

As information systems become more global and interconnected, implicit information is often lost. This situation challenges information science to be more receptive to the social and cultural impacts of interpretative processes and also the qualitative differences between different contexts and media. This change means including interpretative processes as a *conditio sine qua non* of information processes. As we have shown, this task is an essentially multidisciplinary and interdisciplinary one. Building networks is basically an interpretation process. Building a scientific network as a self-reflective activity presupposes the clarification of common concepts. One such concept is information.

Appendix

The Oxford English Dictionary (1989). Lists the following meanings for "information" [references omitted]:

Information. Forms: a. 4-6 enformacion, (-ioun, -ione, -yon), 6-7 enformation. b. 4-6 informacion, (-ioun, -yon), 6- information. [a. OF. enformacion, informacion (mod. F. information), ad. L. information-em outline, concept, idea, in med.Schol.L.the action of 'informing' matter, n. of action from informare to INFORM. Conformed to the L. spelling in 16th c. The

L. sb. had a very restricted use; the Eng. senses represent all the senses of the verb; but the chronological appearance of these does not accord with the logical order.]

I.1.a. The action of informing (in sense 4 of the verb); formation or moulding of the mind or character, training, instruction, teaching; communication of instructive knowledge. Now rare or Obs. b. with an and pl. An item of training; an instruction. Obs. c. Divine instruction, inspiration. Obs. 2. The action of informing (in sense 5 of the verb); communication of the knowledge or 'news' of some fact or occurrence; the action of telling or fact of being told of something. 3.a. Knowledge communicated concerning some particular fact, subject, or event; that of which one is apprised or told; intelligence, news. spec. contrasted with data. b. with an and pl. An item of information or intelligence; a fact or circumstance of which one is told. In earlier use, An account, relation, narrative (of something). Obs. c. Separated from, or without the implication of, reference to a person informed: that which inheres in one or two or more alternative sequences, arrangements, etc., that produce different responses in something, and which is capable of being stored in, transferred by, and communicated to inanimate things. d. As a mathematically defined quantity (see quots.); now esp. One which represents the degree of choice exercised in the selection or formation of one particular symbol, sequence, message, etc. out of a number of possible ones, and which is defined logarithmically in terms of the statistical probabilities of occurrence of the symbol or the elements of the message. 4. The action of informing against, charging, or accusing (a person). (Originally the general sense whence 5 arises; now Obs., exc. as transf. from 5; cf. also 6). 5. spec. in Eng. Law. a. A complaint or charge against a person lodged with or presented to a court or magistrate, in order to the institution of criminal proceedings without formal indictment. b. A complaint of the Crown in respect of some civil claim, in the form of a statement of the facts by the attorney general or other proper officer, either ex officio, or on the relation or report of a private individual. c. information quo warranto (superseding the ancient Writ of Quo warranto): the step by which proceedings are commenced to remedy the usurpation of an office or franchise. 6. In other legal systems. a. In Civil Law. b. In Scots Law. (a) in Civil Procedure: A written argument upon a case ordered either by a Lord Ordinary in the Court of Session when reporting the case to the

Inner House (obs.), or by the Court of Justiciary in a case where difficult questions of law or relevancy are raised before it (now rare), (b) in Criminal Procedure: A statement or complaint in writing in which a person is specifically charged with a criminal offence, upon which a warrant of commitment to gaol (*sic*) for trial may proceed. c. Applied also to similar proceedings in foreign systems of judicature, ancient or modern.

II. 7. The action of 'informing' with some active or essential quality (see INFORM v. 3); the giving of a form or character to something; inspiration, animation (e.g. of the body by the soul)

III. 8. attrib. and Comb., as information content, desk, explosion [EXPLOSION 4 b], flow, gap [GAP sb. 1 6a], office, service, storage, system, transfer, work; information-carrying, -gathering (so gatherer), -giving, -seeking vbl. Sbs. And ppl. adjs.; information bureau, an office where information is given and questions are answered; also fig.; information officer, a person engaged in the provision of specialized information; information processing, the processing of information so as to yield new or more useful information; data processing; information retrieval, the tracing of information stored in books, computers, or other collections of reference material; information revolution, the increase in the availability of information and the changes in the ways it is stored and disseminated that have occurred through the use of computers; information room (see quot. 1958); information science, (that branch of knowledge which is concerned with) the procedures by which information, esp. that relating to technical or scientific subjects, is stored, retrieved, and disseminated; hence information scientist, a person employed in providing an information service, or one who studies the methods used to do so; information technology, the branch of technology concerned with the dissemination, processing, and storage of information, esp. by means of computers. Also INFORMATION THEORY.

Endnotes

1. The authors have equal responsibility for this chapter.
2. References to Greek and Latin sources are not given in this chapter, but may be found in Capurro (1978).
3. Actually, Bogdan himself develops a general view of information that stands in contrast to this skeptical quotation.
4. Of course, library schools can have a strong focus on subject knowledge. One example is the University of Sheffield's Department of Information Studies

(http://www.shef.ac.uk/uni/academic/I-M/is/home.html), in which strong programs are offered in Chemoinformatics, among other fields. The tendencies within IS are to overcome this problem, for example, by the development of the domain-analytic approach (Hjørland & Albrechtsen, 1995).

5. Other traditions are, for example, the facet analytic tradition founded by S. R. Ranganathan, the cognitive tradition, and the natural language processing (NLP) tradition. Stockwell (2000) in *A History of Information Storage and Retrieval* has a much wider view of the field than the tradition in IS. This book includes, for example, the history of encyclopedias under this concept.
6. Frei (1996, p. 3) express a similar view on this issue: "For years on end, academic researchers studied how to index, store, and retrieve bibliographic references, calling their discipline information retrieval rather than reference retrieval. Thus, for a long time, IR was concerned with finding a very restricted kind of information and the term information retrieval was a real misnomer. Retrieving relevant bibliographic references is certainly a valid problem useful to some people. But it clearly does not reflect the majority of the problems that have to be solved facing today's information explosion. Business analysts, journalists, and scientists hardly ever need bibliographic references for their work. Most of the time they need facts; that is, direct information about the problem area they are working in; oftentimes they have neither the interest nor the time to follow up references, get articles from the library, and read papers."
7. The tendency to define information as an object of study of only one group of experts has an additional disadvantage. Information science is supposed to support the delivery of services to different groups, including astronomers. Of importance to IS is how such groups conceptualize and classify their objects, how their language is designed, what they regard as important and relevant, and so forth. If information scientists isolate themselves from the work of their target groups, they risk becoming superfluous in the eyes of that group. Therefore, we find it very important that information science does not isolate activities such as indexing and retrieving documents from the knowledge-producing activities in discourse communities. These communities produce the knowledge that is to be organized in the information systems, and may be the most important users of the information scientists' services.
8. This definition quoted from Griffith, 1980, is quite similar to a definition given by Borko, 1968. This last reference was explicitly motivated by the name shift ADI made to ASIS in 1968.
9. In our view, the computational aspects of "the generation, collection, organization, interpretation, storage, retrieval, dissemination, transformation, and use of information" are not specific to information science, but are to a large degree part of computer science; but, of course, these two fields overlap.
10. "In Shannon, Weaver, and Wiener's texts the terms 'communication' and 'information' are often used interchangeably, although the term 'information' is also used to signify the content of communication. The relative synonymy of these two terms continues a tendency that was prevalent before the Second World War, as well e.g., in the texts of Paul Otlet and other European documentalists

and social theorists. From a contemporary perspective, we may object that these two terms now signify different events and research fields. This article proposes, however, that they share a common heritage in an epistemological model that is still in use today. Further, the ease by which information technologies converge with communication technologies and visa [sic] versa, today—e.g., in the case of the Internet, which is understood as both a communicational and an informational medium—suggests that the issue of defining the 'real' difference between these two terms is less important than that of accounting for their historical congruence in theory and in practice." (Day, 2000, p. 805).

11. According to the *Social Sciences Citation Index*, July 2001.

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