

Toward a New Horizon in Information Science: Domain-Analysis

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This article is a programmatic article, which formulates a new approach to information science (IS): domain-analysis. This approach states that the most fruitful horizon for IS is to study the knowledge-domains as thought or discourse communities, which are parts of society's division of labor. The article is also a review article, providing a multidisciplinary description of research, illuminating this theoretical view. The first section presents contemporary research in IS, sharing the fundamental viewpoint that IS should be seen as a social rather than as a purely mental discipline. In addition, important predecessors to this view are mentioned and the possibilities as well as the limitations of their approaches are discussed. The second section describes recent transdisciplinary tendencies in the understanding of knowledge. In bordering disciplines to IS, such as educational research, psychology, linguistics, and the philosophy of science, an important new view of knowledge is appearing in the 1990s. This new view of knowledge stresses the social, ecological, and content-oriented nature of knowledge. This is opposed to the more formal, computer-like approaches that dominated in the 1980s. The third section compares domain-analysis to other major approaches in IS, such as the cognitive approach. The final section outlines important problems to be investigated, such as how different knowledge-domains affect the informational value of different subject access points in data bases.

Introduction: Domain-Analysis as a New Front in Information Science

The domain-analytic paradigm in information science (IS) states that the best way to understand information in IS is to study the knowledge-domains as thought or discourse communities, which are parts of society's division of labor. Knowledge organization, structure, cooperation patterns, language and communication forms, information systems, and relevance criteria are reflections of the objects of the work of these communities and of their role in society. The individual person's psychol-

ogy, knowledge, information needs, and subjective relevance criteria should be seen in this perspective.¹

The domain-analytic paradigm is thus firstly a social paradigm, conceiving of IS as one of the social sciences, promoting a social psychological, a sociolinguistic, a sociology of knowledge, and a sociology of science perspectives on IS. The domain-analytic paradigm is secondly a functionalist approach, attempting to understand the implicit and explicit functions of information and communication and to trace the mechanisms underlying informational behavior from this insight. Thirdly it is a philosophical-realistic approach, trying to find the basis for IS in factors that are external to the individualistic-subjective perceptions of the users as opposed to for example the behavioral and cognitive paradigms (cf. note 1).

You may ask: Is domain-analysis really new? Or is it old wine in new bottles? Is the phrase "domain-analysis" new, is it given a new meaning, and what fundamental claims in the theory behind this view are new? We will try to show that many past and contemporary approaches to IS implicitly share many of the basic assumptions in this view, but that an explicit formulation of this view and its theoretical assumptions and consequences has hitherto been absent from the contemporary scene.

In our opinion, the most important thing is not to postulate some new theory for its own sake. The really important thing is to try to build a foundation for IS that can make this field develop in a more satisfactory way. Much existing knowledge can contribute, and concepts such as Saracevic's (1975) the subject view and the subject literature view could well be seen as predecessors. Other approaches such as Taylor's (1991) "Information Use Environments" and what Mann (1993, pp. 9-14) discusses as "The Specific Subject or Discipline Model"² are contemporary approaches of a related nature.

Thus, one central point is that the view of domain-analysis, which we are trying to formulate here, is more or less latent in much contemporary research in IS as well as in earlier contributions and predecessors. It is ac-

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tually near both the heart and surface structure of IS. In spite of this, however, the domain-analytic view has neither hitherto been formulated as one theoretical approach, nor been compared and evaluated in the literature together with other views (e.g., the cognitive view). You can say that the domain-analytic viewpoint has had a kind of quasi-existence: It has both been existing and nonexisting. An important job is to make this view more explicit, to explicate its theoretical consequences, and to formulate a comprehensive research agenda. This article is an attempt to do this.

Contributors and Predecessors to Domain-Analysis in IS

Explicit and Latent Contributors to Domain-Analysis

Very few researchers have so far explicitly proposed that the unit of study in IS is the speciality/discipline/domain/environment, not the individual. Among them is Patrick Wilson, who states this point very clearly:

We have put the communication problem as one of communication among specialities rather than among individuals. This approach is meant to reflect the fact that the main way in which information from outside affects a speciality is by being recognized by the group as being impersonally, "objectively" relevant: as providing a point, supporting a hypothesis, making a theory less likely, demonstrating an effect, and so on (cf Swanson, 1986). It is not how some individual is affected but how the speciality as a whole is affected that is in question: it is the group as a whole that has to be persuaded that the information has an appropriate logical or evidential status (Wilson, 1993b, p. 379). Further:

Our efficiency hypothesis is stated in terms of the adequacy of the cognitive situation of every individual *in a speciality* to some information. . . . A realistic approach to communication efficiency must expect that large individual variations will inevitably be found. But then a particular individual's late find of information may be completely unimportant to the collective situation; it may make no significant difference. . . . It matters who is doing the failing, for contributors and contributions are not equal (Wilson, 1993b, p. 380).

Amba and Iyer have rediscovered the importance of some earlier contributors:

An early paper, the subject matter of which has found renewed interest as late as 1987 (Bates cites his work) is that of Mote (1962). He published a study on the reasons for the variations in the information needs of scientists. He, however, looked at the needs from the type of discipline point of view stating that "*the type of subject area would determine the type of need*" (Amba & Iyer, 1992, p. 98). Further:

Bates (1987) feels that not much attention has been paid in information seeking behavior studies to the variable

"information," which is a powerful variable. Basing her suggestions on the study by Mote (1962) she suggests the various strategies that could be followed in doing online searching depending on the type of subject area being searched (Amba & Iyer, 1992, p. 101).

Robert S. Taylor was first a pioneer in a more psychological approach to IS, but has recently engaged in a more domain-oriented approach. His influence on the more individualistic, intrapsychological/cognitivist approach was mediated among other works in his 1968 article, and was declared a citation classic in *Current Contents* (Taylor, 1985). As is very often the case with influential researchers, Taylor introduced a new approach (1991). This is based on the concept "Information Use Environments," and is in line with a collectivistic, domain-oriented kind of research. This latter approach inspired Rosenbaum (1993) to a further theoretical integration with modern sociological theory. Taylor's and Rosenbaum's conceptions therefore represent one contemporary line of research which is in accordance with our conception of domain-analysis and which explores some of the epistemological questions in the field.

Tefko Saracevic tries to find a foundation for the central concepts and theories in IS in a theory of knowledge:

Effectiveness of communication depends on many factors. . . . Along with the system's and the *destination's* view of relevance, we may add the *subject literature* view of relevance. This view can be built around considerations of the structure of subject literatures. The view has not been developed to any extent yet, but there is a start. It is premature to talk about the completeness of the view.

The importance of the *subject literature* view of relevance to other views and to the total knowledge communication process, especially where information systems is involved, is great. . . . (Saracevic, 1975, p. 331). Further:

The *subject knowledge* view of relevance stresses the nature, structure and extent of the subject knowledge on a topic given by a question. Subject knowledge and subject literature are obviously related, but they are not the same. . . . (Saracevic, 1975, p. 332). Further:

The subject knowledge view has not been formed as yet in any detail, although considerable material from which it can be formed exists. I wish to suggest that the *subject knowledge view of relevance is fundamental to all other views of relevance*, because subject knowledge is fundamental to communication of knowledge. In that lies the importance and urgency of the work on that view (Saracevic, 1975, p. 333).

This statement by Saracevic about the importance of theories of knowledge as an efficient background to the problems of IS is very much in line with our point of view. The subject-based approach is powerfully embodied in the operating structures and traditions of aca-

demic/research librarianship. (However, in spite of this, it is very difficult to find explicit contributors or generalized theoretical principles on this view in IS. In the third part of this article we shall see that subject-knowledge sometimes is regarded as a rival, not a partner to IS: The subject approach can represent some kind of "anti-theory" to IS.) The subject-knowledge point of view implies a domain-oriented point of view as contrasted to an individual point of view. In addition, the following statement by Rowley expresses this line of thought:

There is an alternative method for the design of subject retrieval devices, and that is to build languages or schemes which depend upon some theoretical views about the nature and structure of knowledge (Rowley, 1987, p. 168).

Recently, Thomas J. Froehlich (1989, 1994) has also reached the conclusion that the foundations of information science must be in social epistemology. In considering the concept of relevance, he thus concludes:

In sum, the ordinary language use of "relevance" is quite appropriate for making judgements about the output or success of information systems, because it can function in the many ways in which various users make relevance judgements. What does have to be clarified are the interpretive schemes or kinds of criteria that prototypical users are likely to bring to an information system with a given set of tasks or a given subject domain . . . (Froehlich, 1994, p. 132).

In information retrieval (IR) one trend has been work with intermediary expert systems. Some of these systems—especially the I³R—have incorporated modules of domain-knowledge (see Croft, 1986). We shall return to this approach later in this article.

Explicit works with theories of knowledge have for a long time been neglected in IS (as well as many other disciplines). One important and influential work of this nature is *Understanding Computers and Cognition*, by Winograd and Flores (1986/1987), which is an attack on what is called rationalism, but which could equally well have been termed positivism. Against this theory of knowledge the authors try to find a new basis in hermeneutics. Their work is one example of how theories and views of knowledge might affect problems that are central to IS. They also stress the social dimension of the design of information systems:

In order to understand how meaning is shared, we must look at the social rather than the mental dimension (Winograd & Flores, 1986/1987, p. 60). Further:
From this standpoint, the designer of a computer tool must work in the domain generated by the space of potential breakdowns (Winograd & Flores, 1986/1987, p. 72).

One of the limitations of Winograd and Flores' book is that it deals with computer science, which is of course not identical with IS, even though some important principles can be generalized. Another important problem is the evaluation of the scope and power of hermeneutics as compared to other contemporary theories of science and knowledge, such as various forms of social constructivism and scientific realism. The usefulness of the whole enterprise is of course closely related to the usefulness of the chosen theory of knowledge. We shall return to this later in this article.

We will finish this section with a report of some presentations at the 1993 ASIS meeting in Columbus, Ohio. First, there was a session on domain-analysis arranged by one of the present authors (Albrechtsen), with presentations by Hjørland (1993b) and Bates (1993). The last mentioned author is very active doing domain-studies in the humanities.

The earlier mentioned work by Rosenbaum (1993) was also presented at the conference, as well as a paper by Cool (1993), representing an attempt at solving the problem related to the status of cognition in IS by using the theory known as symbolic interaction in the study of retrieval processes. Our own attitude towards this theory can best be described by the following quotation from Ratner:

Explicitly acknowledging the *societal* basis of psychological functions distinguishes sociohistorical psychology from other variants of social constructivism. Most other variants emphasis face-to-face, dyadic influences on psychological functions, and construe these functions as interpersonally negotiated. This is true of symbolic interactionism, narrative analysis, and many contemporary social constructionists such as Kenneth Gergen. While these treatments are important correctives to intraindividual explanations, they fail to recognize the implacable, coercive impact of the broader social system on psychological activity (Ratner, p. 113).

This difference between face-to-face interaction and larger societal practices seems in particular important for IS, where the scientific knowledge is produced in the disciplines, while the transmission of information to the individual is often very indirect.

The above-mentioned presentations were the more explicit theoretical contributions to domain-analysis as an approach in IS. Besides, there were many implicit contributions: many papers on bibliometrics from special interest groups (SIGs) such as humanities or medicine.

Our impression is that domain-analysis simmered very near the surface in many papers, but that many contributions—say in the humanities—had difficulties in generalizing common principles about the domain. There was much concrete work about introducing computers to humanists, but no attempt to generalize the nature of the humanist's work and how it affects information

seeking, relevance judgements, etc. There were no theories about the nature of the humanities that could be used to deduce information needs and uses. This could be strengthened by incorporating more theoretical studies of the different kinds of sciences, such as the human sciences.

IS therefore not only needs to occupy itself with general theories of knowledge such as hermeneutics, various forms of constructivism, and scientific realism, but also to incorporate more specific theories about the nature of different domains such as the humanities, applied sciences, and interdisciplinary studies.

Our conclusion from observing the contemporary scene is that even though a domain-analytic view appears very near the surface in many activities in IS and in the work of major contributors to this field, domain-analysis has not been described in any detail as one theoretical approach confronting other theories.

Predecessors to Domain-Analysis in IS

In this section, we introduce important investigations and areas in IS that can be viewed as forming parts of, or contributions to, a domain-analytic frame of reference. The contributors are not necessarily working exclusively in the context of this present approach, but may form part of other approaches as well.

Henry Evelyn Bliss (1870–1955), who published the first edition of *Bibliographic Classification* (BC) in 1940–1953, was looking for consensus in the scientific community. In so doing, he believed that it was possible to identify and map a rather permanent basic structure of a subject area (cf. Amba & Iyer, 1992). The permanence of the basic structure proved however to be wrong. Today, it is regarded as somewhat naive to think that consensus guarantees truth (the history of science shows the opposite: consider examples such as phrenology in the 19th century). This does not automatically reject consensus building as a method. In fact, an important characteristic of a subject area might actually be its degree of stability, degree of consensus among the researchers at a given time. This is related to what modern sociologists of science (Whitley, 1984) call “the strategic uncertainty” of a discipline.

The Indian mathematician and library scientist S. R. Ranganathan (1892–1972) founded a theory of facet classification based on fundamental categories. This was applied to a universal classification scheme, but the principles were further developed by the English Classification Research Group as a method for classificatory analysis of subject disciplines, i.e., one kind of domain-analysis (e.g., Mills, 1957; Hjørland, 1988). Eventually, the concept of fundamental categories is a philosophical concept, which must be analyzed in the view of basic philosophical doctrines. Up to now, only a preliminary analysis of Ranganathan’s very rationalistic approach has been provided by Hjørland (1992). This concludes

that Ranganathan’s theory is too little concerned with real, organic disciplines, their development, differentiating, integrating and mutual interaction, and too much concerned with artificial ideas that can be combined and separated like a puzzle in a mechanical fashion. The theory appears to be too much based on a rationalistic philosophy, conceiving reality as Platonic ideas, rather than organic developments in knowledge. Very few contemporary contributors have addressed the problem of classification from domain-analytic angles. Among them are Horner (1992), Prieto-Diaz (1992), and Albrechtsen (1992).

Bibliometric analysis, scientometrics, and informetrics represent large research areas in IS, covering techniques for mapping sciences, e.g., bibliographic coupling, obsolescence, scattering, ISI’s “Atlas of Science,” etc. A concise historical introduction with definitions of the central concepts is beyond the scope of the present article. Readers are referred to special introductions such as “An Introduction to Informetrics” by Tague-Sutcliffe and Sutcliffe (1992). Bibliometric techniques can offer some valuable information about a discipline and about the relations between disciplines. The classical and one of the most important contributors to this approach, combining bibliometrics with science studies, is Derek J. de Solla Price (1963, 1969). Bibliometric analysis is very popular in IS, and many studies are conducted every year, e.g., Tijssen (1992, 1993); Tijssen et al. (1990). White (1990) presents a valuable discussion in which he answers some of the most important critics of bibliometric analysis.

What, if any, are the limitations of this approach? Under the heading “pathology of theory” Buckland (1991, pp. 22–23) addresses some of the problems: “A symptom of difficulty is the enormous contrast between small sub-fields that lend themselves to quantitative techniques and surrounding areas that do not. . . . Citation analysis and document usage studies of great complexity are conducted, but little is understood about the causes or consequences of citing or using documents (Brooks, T. A., 1986, 1987). These latter topics are less easy to investigate, let alone measure or calculate.”

No doubt, bibliometric studies can describe some kind of reality: some sociological patterns in scientific communication. They can in some ways describe how things have developed, but cannot interpret this development, nor tell whether this development is useful under new circumstances, or just represents adjustments to some kind of social conditions. You can get some idea of this if you think of Patrick Wilson’s (1993b, p. 381) statement that the impact of the average scientific paper today is near zero! Or citing the words of the philosopher of science, David Hull, that “Publishing a paper is roughly equivalent to throwing it away” (Wilson, 1993a, p. 18). Also Jaenecke (1994) argues that the majority of scientific publications contain peripheral knowledge and pseudoknowledge, not core knowledge. To the degree

that these views are correct (and of course, that is a question of varying degree) this means that what bibliometrics can actually measure is tendencies in research that have to be interpreted (sometimes as important development, other times as fads or positivistic trivialism [Olaisen, 1991], or routine administration of standard procedures"). Bibliometrics can show sociological tendencies in knowledge development, but the interpretation of these tendencies must be based on broader knowledge in the sociology and philosophy of science. From the point of view of domain-analysis, bibliometrics/informetrics is only a method, and as such it must be supplemented with other methods, and it must be based on a more comprehensive methodology: the methodology of domain-analysis.

Empirical User Surveys. Thousands of empirical user studies have been carried out in IS. The American Psychological Association's (APA's) major studies of the discipline of psychology in the period 1963–1971 can be regarded as studies of information use in a domain, as a kind of domain-analysis (Garvey & Griffith, 1972). These studies brought much relevant knowledge to IS. Empirical studies are important, but should be theoretically well motivated, and be integrated with science studies and contribute more to an accumulation of knowledge in IS. The major problem of this approach is equivalent to applying the method of bibliometrics: We need an interpretation of whether the actual information seeking behavior of scientists actually represents an optimal strategy or not, which again implies an approach based on philosophical analysis/epistemology/theory of knowledge. We have too much fragmented empirical data on users and too little knowledge of the deeper forces determining their behavior. It is our feeling that many people today have come to look with suspicion upon user studies ("dry as dust empiricism"). Maybe the reason for this is that information has too seldom been viewed as an important variable—as Bates puts it.

Also in information policy and management the question about universal versus domain-specific approaches is relevant. Some developments have strengthened the development of subject-specialized information systems. These developments often give rise to increased research, which may be fruitful from a domain-specific point of view. In America, following the Sputnik crisis (in 1957) important innovations in discipline-oriented national information systems emerged, and increased the interest in domain-oriented information systems (cf., Van Cott, 1970 and the above-mentioned APA studies). In Germany, such specialized systems are named "Fachinformationssysteme," described in Bundesminister für Forschung und Technologie (1990). These systems give rise to research activities such as those of Capurro (1986).

Conclusion

The core question, is of course, in which way a focus on knowledge-domains should differ from the above-

mentioned predecessors? One point is that domain-analysis as a new approach should foster renewed attention to some of these approaches, which became neglected in the very atomistic and positivistic tradition following the IR tradition from 1950 and onwards. Studies of the larger structures of disciplines, together with theoretical and philosophical analyses in addition to empirical analyses etc., should be reintroduced and play a greater role in IS.

Transdisciplinary Tendencies in the Understanding of Knowledge: From Artificial Intelligence to Discourse Communities

IS is influenced by other fields, such as the cognitive sciences, linguistics, psychology, educational research, computer science, sociology, and philosophy. Often this influence is indirect: Important trends in computer science and artificial intelligence change IS' relation to philosophy: When more soft philosophy like hermeneutics became accepted in hard computer science (Winograd & Flores, 1986/1987), an increasing interest for hermeneutics occurred in IS. In this section, we will outline some extremely important new cross-disciplinary tendencies in cognitive sciences such as psychology, education, linguistics etc. in the 1990s. These tendencies will demonstrate that the arguments in the present article for a new horizon, domain-analysis, are in line with important new orientations in the borderline disciplines of IS.

In educational research, Alexander (1992) finds that research on domain-knowledge has given rise to several productive lines of inquiry, including research into the expert–novice distinction, the interaction of domain and strategy knowledge, and research on learner misconceptions. Alexander further tries to define domain-knowledge. In her opinion, it encompasses declarative knowledge (knowing that), procedural knowledge (knowing how), and conditional knowledge (knowing when and where). It can operate both on a tacit or an explicit level. Discipline and domain are not synonyms. A discipline has in her view three elements: a domain, a set of rules or generalizations, and a history. The opposite of the domain-specific view is called the strategy view. (The present authors prefer to talk about "domain general strategies" and "domain-specific strategies." Alexander's terminology seems to imply that the domain-specific view is opposed to a strategy. This is an apprehension which we do not share.) About the late acceptance of the domain-specific view, she writes:

It could also be that the lack of attention to the effects of domain knowledge among strategy researchers was a reaction to the emphasis on the compartmentalization and fragmentation of content knowledge in instruction. That is, educators have found it useful to teach content knowledge in discrete rather than in integrated fashion. Further, they have evidenced a tendency to center their

instruction on the easier-to-teach whats of knowledge than on the harder-to-teach hows, whys, and whens (Alexander, Kulikowich, & Pate, 1989). The downplay of domain knowledge may be due, as well, to the fact that many of the strategy researchers operated in the domain of reading and concentrated their efforts on text comprehension (e.g., Curtis & Glaser, 1983; Pressley et al., 1989). Reading, I have argued elsewhere (Alexander & Judy, 1988), is a more ill-structured domain and text comprehension a more ill-defined task. Thus, these researchers may well have given an edge to general strategy knowledge in their investigations (Alexander, 1992, p. 41).

Other papers discussing domain-specific problems in the educational field include Alexander and Kulikowich (1991); Hall, Dansereau, and Skaggs (1992); Kuhn, Schauble, and Garciamila (1992); Lawson, 1991; Matthews, 1992; and Sundre (1992).

In psychology, there was a well-known cognitive revolution initiated by the psychologist J. S. Bruner and the linguist Noam Chomsky around 1956–1957, regarding the human mind as a computer and linguistics as part of psychology, which studied the innate programs of the brain. This cognitivism has developed into becoming less and less hard: It has more and more tended to look at the individual mental states as social constructs, and today, the machinery and programs of the brain are not viewed to be as isolated from the sociocultural context as originally believed. For instance, the psychologist Ulric Neisser³ had a very important role in the development of the cognitive revolution in the 1960s, and his book *Cognitive Psychology* (1967) was seen as a standard by followers of the computer model of mind. Today Neisser has turned against his own theory and is advocating a more social and ecological theory.

It is of course dangerous to generalize about the developments in fields with many differentiated theories, but we do find evidence for a development in which modern psychology, linguistics, and the new field of compositional studies are all looking at language and other cognitive processes in the context of a sociocultural development (rather than an intrapsychological framework, in which linguistics is seen as part of cognitive psychology). The Russian psychologist L. S. Vygotsky who died in 1934 is seen as one of the classics and currently enjoys popularity in American psychology. His works (Vygotsky, 1962, 1978) represent in our view an important development from a very mechanistic and positivistic science toward a more social and realistic science. Vygotsky was predated by several decades by the American philosopher John Dewey, who described the manner in which socioeconomic relations influence psychology:

Occupations determine the fundamental modes of activity, and hence control the formation and use of habits The occupations determine the chief modes of satisfaction, the standards of success and failure. Hence

they furnish the working classifications and definitions of value; they control the desire processes. Moreover, they decide the sets of objects and relations that are important, and thereby provide the content or material of attention, and the qualities that are interestingly significant. The directions given to mental life thereby extend to emotional and intellectual characteristics. So fundamental and pervasive is the group of occupational activities that it affords the scheme or pattern of the structural organization of mental traits. Occupations integrate special elements into a functional whole (Dewey, 1902, pp. 219–220).

Modern activity theory is closely related to Dewey's theory (which is famous for its principle "learning by doing"). But as Bauersfeld (1992, p. 22) writes, there are also important differences. It is not the doing of the individual subject alone which has the developing power, but it is the coordinated action in the form of participating in a functioning culture.

This also means that within psychology the trends have developed from more domain-general to more domain-specific theories. The development of children's thinking does not follow as abstract patterns as earlier described by Jean Piaget, but is closely related to the concrete knowledge base that the child possesses (cf. Chi, Hutchinson, & Robin, 1989; Siegler, 1989). Today human cognition is viewed as much more domain-specific than the founders of cognitive science imagined.

This focus on domain-specific cognitive functioning represents a very strong current tendency, contrasting a long period where the human mind was perceived as a universal calculator. The intense contemporary research on domain-specific cognition is documented by the following references: Andresen and Schmid (1993); Bailey (1992); Bassok (1990); Drahuschak (1992); Dunbar (1993); English (1992); Farah (1992); Hirschfeld & Gelman (1994); Klix (1992); Krems and Pfeiffer (1992); Landsmann and Karmiloffsmith (1992); Lee (1992); Leslie and Thaiss (1992); Maratsos (1992); Mayer (1993); Markman (1992); Miles (1992); Moravcsik and Kintsch (1993); Nickerson (1992); Ogilvie (1992); Reynolds (1992); Rostan (1992); Samarapungavan and Miliowski (1992); Schaie and Willis (1993); Schneider and Weinert (1990); Sharp (1991); Tardieu, Ehrlich, and Gyselinck (1992); Tobias (1992); Van Aken (1992) and Wold (1992).

Gigerenzer and Hug (1992) characterize the shift from perceiving the mind as a universal calculator to a domain-specific mechanism in this way:

What does it mean to be rational? Leibniz' vision was to reduce human reasoning to a calculus, the Universal Characteristic, which would settle all arguments in a rational way by coercing assent, once everybody accepted the rules. . . . In psychology, research on the human intellect has borne the imprint of the Enlightenment conviction that reasoning could be reduced to a general cal-

culus (on the rise and fall of this idea see Daston, 1988). For instance, when Inhelder and Piaget (1958, p. 305) asserted: "Reasoning is nothing more than the propositional calculus itself," they echoed Laplace's statement one and a half centuries earlier: probability theory is "nothing more at bottom than good sense reduced to a calculus" (Laplace, 1814/1951, p. 196).

The century-old conviction that humans reason according to some content-independent logic was shattered by a number of factors, among them research on the selection task introduced by Peter Wason (1966). In the selection task, the subject is asked to search for information that can violate or falsify a conditional rule. The main result of this research is that reasoning is guided by the *content* of the task, rather than by its formal structure. Although it was realized that "content is crucial" (Wason & Johnson-Laird, 1972, p. 245) for understanding how humans actually *do* reason, content-independent logic was retrained in the 1970s and 1980s as the yardstick for how subjects *should* reason. Subjects' judgements were examined for their *deviations* from that logic. . . . Content was not of theoretical interest in and of itself. . . . (Gigerenzer & Hug, 1992, p. 128).⁴

In biology, information seeking is studied as the behavioral ecology of finding resources (cf. Bell, 1991). In a similar way, psychological theories about domain-specific cognitive processes perceive these as adaptive, ecological mechanisms in the human mind, mechanisms adjusted to concrete (content-defined) tasks such as social contracts:

What would a theoretical framework look like that starts with content as a primary concept, rather as a modifier of logical reasoning? . . . two such proposals exist . . . Both theories hold that reasoning processes are *domain specific* as opposed to domain general. Both theories model aspects of *deontic* reason, reasoning about "must" and "may," obligation and entitlement. They contribute to two current and related debates: a normative one and a descriptive one. First, what counts as human rationality: reasoning processes that embody content-independent formal rules, such as propositional logic, or reasoning processes that are well designed for solving important adaptive problems . . . ? . . . In this article, we elaborate and test social contract theory. This theory postulates (1) that we should think of reasoning as rational as it is well designed for solving important adaptive problems, and (2) that there exist domain-specific cognitive processes for reasoning about social contracts . . . (Gigerenzer & Hug, 1992, p. 129).

Such a view is closely related to functionalism and philosophical pragmatism, which look at knowledge as an adaptive phenomenon (Figure 1).

In spite of early evidence of content-dependent reasoning in the 1970s and 1980s, the thinking in formal, rule-based, content-independent thinking was retained in the most important research program in cognitive science:

Based on large body of research on both tasks, however, it was concluded that human reasoning did not generally follow these logics [Karl Poppers' logic of falsification or the Bayesian version of scientific hypothesis testing]. . . . In both research programs, the focus shifted from the logical structure to the content of the tasks. . . . Kahneman and Tversky (1982) reached the same conclusion: "Human reasoning cannot be adequately described in terms of content-independent formal rules" (p. 499). Nevertheless, the content-independent formal rules were retained in both programs, not dropped" (Gigerenzer & Hug, 1992, p. 167).

There is neither a simple dichotomy between structure and content nor between relevant and irrelevant information. The very assumption of such a simple dichotomy has delayed the understanding of the reasoning processes:

Why has there been so little progress in understanding the reasoning processes elicited by both tasks, despite an avalanche of studies since the 1960s? We believe one major reason to be the answers given to these two questions. These answers presuppose a *simple* dichotomy between structure and content, which is subsequently used to separate good from bad reasoning. However, this presupposition holds neither for modern logics nor for modern probability theory . . . Each of these theories divides the information presented in a reasoning problem into two parts: relevant and irrelevant information. Relevant information corresponds to what is seen as the problems structure. Irrelevant information corresponds to unimportant content. Different theories, however, make different divisions . . . The general point is that there is no simple and unique division line between structure and content, or between information relevant and irrelevant to rational reasoning. What counts as the relevant structure for reasoning about a domain therefore seems to need a domain-specific theory . . . Further: If human reasoning is, to some important degree, an adaption to specific environments (where environments include social environments), then ecological analysis of reasoning mechanisms as adaptations to structures of important present environments, and evolutionary analysis of reasoning mechanisms as adaptations to structures of important past environments, are indispensable. SC [social contract] theory is one important step (Gigerenzer & Hug, 1992, pp. 168-169).

A very valuable model of the relation and matching between the cognitive development of the individual scientist and the development of a scientific field or domain is provided by Moneta (1993). Moneta's point of departure is scientific creativity, but the model could be applied to information needs and other specific IS problems as well. It can expand the cognitive approach with a social dimension.

In the literature of management, studies on the im-

"The epistemological point of departure in this study can be summarized in a few points.

1. Man is primarily an actor, living and acting in a bio-physical, a socio-cultural and a subjective world.
2. Living and acting in the three worlds constitutes the *a priori* of human knowledge.
3. Since living and acting constitutes the *a priori* of knowledge, knowledge is constructed in such a way that an application of well constructed knowledge will directly or indirectly serve living and acting.
4. When knowledge becomes part of an acting system, it functions as an internal action determinant.
5. There is a continuous interaction between knowledge and action so that knowledge is created in and through action and so that experiences that the actor acquires through action influence subsequent action.
6. Value-knowledge, factual knowledge, and procedural knowledge are three types of knowledge connected to the three types of internal action determinants. Having value-knowledge means knowing what fulfil the criteria of good values. Having factual knowledge means having true beliefs about the three worlds in which one is living. Having procedural knowledge means knowing how to carry out a specific act or act sequence.
7. Knowledge can be unarticulated or articulated. Unarticulated knowledge is, for instance, tacit knowledge, familiarity, knowledge by acquaintance. Knowledge can be articulated in everyday language, science and art." (Sarvimäki, 1988, page 58-59 unis⁵)

FIG. 1. A manifest for a pragmatic and functionalistic perception of knowledge.

portance of domain-specific knowledge can also be found, e.g., Bedard and Biggs (1991); Brown and Solomon (1991); and Frederick (1991). In linguistics and allied disciplines such as composition studies, a turn similar to that in psychology has taken place: From a very structuralistic position, culminating in the generative grammar of Noam Chomsky, to a more functionalistic and sociolinguistic approach emphasizing the use of language in discourse communities. The structuralistic position was very attractive to linguists, because it could isolate the language system from other sociocognitive phenomena, thereby making linguistics a cleaner, stronger, and more independent discipline. It was also attractive because of its supposed contributions to artificial intelligence as a formal, content-independent theory.

Even though structuralism retains a strong position in linguistics, the development of more domain-specific linguistic approaches has had a remarkable influence on research activity in the recent years, documented among others by the following references: Ackerman (1990); Barabas (1990); Bazerman (1986, 1988, 1992); Bazerman and Paradis (1991); Bergenkotter and Huckin (1992); Bracewell and Breuleux (1992); Brodkey (1987); Fish (1976, 1980); Jolliffe (1989); Myers (1985, 1990);

Nystrand and Wiemelt (1991); Porter (1986); Russel (1991); Swales (1990); and Wuthnow (1992). For a useful review of this development in composition studies, see Nystrand, Greene, and Wiemelt (1993).

While a prevailing approach in language and literature has concentrated on single texts in isolation from their social, cultural, and historical sources, recent research in the sociology of knowledge has influenced the field and emphasized that the formation of knowledge rests on a dialectical relationship between a community and its members, a dialectic that is mediated by language and influenced by the history of the specific discipline. Writers in a disciplinary community are part of a discourse tradition and are accountable to the discipline's past, to its shared concerns, and shared knowledge. In the perspective of artificial intelligence and formalist approaches to text analysis, a text is explicit to the extent that writers spell things out. This legalistic view of text meaning assumes that the more detailed a text is the more likely it is to be explicit and unambiguous. Following this argument, explicitness and textual autonomy are essentially identical and correlate directly with the extent of text elaboration. Against this view, Nystrand and Wiemelt (1991) present a new and very important understanding of the explicitness of texts.

In a study examining the difficulty of revising computer documentation for readability, Nystrand found that for any given passage of unclear documentation, computer novices require qualitatively different revisions from those that help experienced computer users: novices more often require category definition (e.g., explaining what a disk drive is), whereas experts typically require further specification (e.g., explaining which disk drive was meant). Nystrand and Wiemelt (1991) conclude that explicit texts are not texts that seek to say everything. On the contrary, explicit texts say only what is necessary. What is necessary and relevant to be said depends on more than the writer's purpose; it also depends on what readers know and do not know, and hence on what the writer may validly assume or not. In other words, explicitness should not be judged in terms of fit or match between writer intention and text representation but rather in terms of reciprocity between writer and reader as mediated by the text. Explicit meaning unfolds at the interface of highly synchronized writer-reader cognition. Also Albrechtsen (1993) finds that technical documentation is less explicit than ordinarily believed. This view of explicitness of text is closely related to a view of text meaning, in which a text has no stable, objective meaning. Following such sociolinguistic thinkers as M. M. Bakhtin, D. Brandt, M. A. K. Halliday, and R. Rommetweit, Nystrand and Wiemelt discuss the meaning potential of a text. This view of text meaning is in correspondence with a theory of subject analysis developed in IS by one of the present authors and presented in Hjørland (1992, 1993a). This theory states that the subject of a document should be defined as the epistemological potential of that document (also applicable to nontextual documents, e.g., pictures).⁶

According to Putnam, the semantic question about the meaning of words is partly determined by the division of linguistic labor in society and again by the general division of labor:

Everyone to whom gold is important for any reason has to *acquire* the word "gold"; but he does not have to acquire the *method of recognizing* if something is or is not gold. He can rely upon a special subclass of speakers. The features that are generally thought to be present in connection with a general name—necessary and sufficient conditions for membership in the extension, ways of recognizing if something is in the extension ("criteria"), etc.—are all present in the linguistic community considered as a collective body; but that collective body divides the labour of knowing and employing these various parts of the "meaning" of "gold." This division of linguistic labour rests upon the division of non-linguistic labour (Putnam, 1975, 245).

This quotation shows that the structuralistic/cognitivist focusing on "the machinery of the brain" is unable to explain the individual knowledge structures. Such knowledge structures or mental maps cannot be ex-

plained primarily from the physiology and mechanics of the brain, but from the social role of the individual. The conceptual world of the individual, his or her acquisition of concepts, his or her "linguistic labor," must first and foremost be explained by the common division of labor in society. This applies not least to scientific communication.

In philosophy and the theory of science there has been a move away from fundamentalistic theories such as empiricism and rationalism, arguing that science is built of elements of absolute truth either derived from the senses (empiricism and positivism) or from thinking (rationalism). This positivistic and rationalistic view of science had a nominalistic understanding of language as labels put on the elements of perceived knowledge. In this view, language has no contributing role in the perception of reality, but is functionally limited to communicating already established knowledge in the individual. This view of knowledge emphasizes the individual perception, free from cultural traditions. It is a philosophy that emphasizes a fresh start, a detached view on things. This traditional view of epistemology and the theory of science is today replaced by a more holistic trend, recognizing the importance of language in the perception of reality, thereby introducing a historical, cultural, and social dimension in the theory of knowledge and the theory of science. Reality cannot be understood naively by the unprepared and isolated subject. It is the knowing subject, who is formed by history and culture, including the concrete development in specific knowledge-domains, who has the possibility to perceive the reality. Important modern positions include forms of hermeneutics, social constructivism, and scientific realism.

In his *Reason and the Search for Knowledge*, Shapere (1984, pp. 320–324), outlines important principles for a realistic philosophy of science. He devotes an entire chapter to "Remarks on the Concepts of Domain and Field" and puts forward a new perspective for understanding the interconnections between the developments of the sciences and their domains of knowledge:

Although in more primitive stages of science (or, perhaps better, of what will become a science), obvious sensory similarities or general presuppositions usually determine whether certain items of experience will be considered as forming a body or domain, this is less and less true as science progresses (or, as one might say, as it becomes more unambiguously scientific). As part of the growing sophistication of science, such associations of items are subjected to criticism, and are often revised on the basis of considerations which are far from obvious and naive. Differences which seemed to distinguish items from one another are concluded to be superficial; similarities which were previously unrecognized, or, if recognized, considered superficial, become fundamental. Conversely, similarities which formerly served as bases for association of items come to be considered superficial, and the items formerly associated are no longer, and

form independent groupings or come to be associated with other groups. The items themselves often, in the process, come to be redescribed, often, for scientific purposes, in very unfamiliar ways (Shapere, 1984, p. 323).

Concluding that: "... as science proceeds, the connection between knowledge-claims, domain groupings, and descriptions (and often naming) tends to become tighter and tighter" (Shapere, 1984, p. 324). This observation is of great importance for IS, because it implies that classifications of knowledge domains cannot be regarded as independent of knowledge claims. Some consequences of this insight in classification theory are further outlined in Hjørland (1994).

Conclusion: Domain-Analysis as an Alternative to Methodological Individualism

For a long time, methodological individualism (MI; or even by Fodor "methodological solipsism") has been dominant in the behavioral, cognitive, and social sciences including IS. This concept covers different meanings, for example, an ontological thesis, a thesis about the meaning of social concepts and a thesis about explanation. For a good introduction, see Little (1991). Sinha (1988) defines methodological individualism as the point of view which looks at knowledge as individual mental states rather than—or opposed to—the view of knowledge as a social or cultural process or a cultural product. That is, the study of knowledge in IS from the MI point of view consists of a study of cognitive processes isolated from the social context and the developmental history, from which these cognitive processes are created.

The opposite view of MI is sometimes named methodological collectivism (MC), other times methodological holism. We prefer the first mentioned: MC. Some philosophers, including Karl Popper, have criticized MC. It is of course essential to avoid the dangers of this viewpoint, which in particular consists of the understanding of domains as autonomous subjects with their own will and consciousness. The domain-analytic approach recognizes that discourse domains comprise actors, who have worldviews, individual knowledge structures, biases, subjective relevance criteria, particular cognitive styles, etc. In other words, there is an interplay between domain structures and individual knowledge, an interaction between the individual and the social level.

For IS our main thesis is that the point of departure is knowledge-domains, disciplines, or trades, not individuals and especially not the more biological, physiological, and psychological make-ups of individuals. The individuals should be seen as members of working groups, disciplines, thought or discourse communities, etc. IS should in other words be seen as a social science rather than as a cognitive science. (Cognitive science here un-

derstood in the mentalistic, intrapsychical tradition, not in the sociocognitive meaning.)

The transdisciplinary developments in educational research, psychology, linguistics, and philosophy of science as outlined above can be seen as a confirmation of this view. In short, there has been a transdisciplinary development where the view of human individuals, of human knowledge, etc., is seen as less formal, less mechanical, less computer-like, and more organic, contextual, sociocultural, and domain specific. It is not the isolated, abstract individual as much as it is the discourse community and its individuals, which constitute the focus of current research in disciplines allied to IS.

Domain-Analysis Compared to Other Theories in IS

It is difficult to compare domain-analysis with other theories in IS because explicit theoretical work is rare. In their review of principles and theories in IS, Boyce and Kraft (1985, p. 165) state:

Although we have found several generally accepted principles and noted considerable speculative discussion, we have found nothing like a theory of information science in the sense meant by Popper and by Carnap. Cooper (1978) represents one possible exception in his book, which seems to be more a presentation of a theory of language than of information science. We are clearly closest to theoretical information science in the area of bibliometrics and information theory. However, even here, where we can find generalizations, we find neither independent testability nor general acceptance. Our discipline has been more concerned with the facilitation of communication processes than with their explanation. . . . (Boyce & Kraft, 1985, p. 165).

Theories and paradigms in IS are also difficult to analyze because they are often implicit. Ellis (1992a & 1992b) distinguishes between the physical paradigm and the cognitive paradigm. The physical paradigm—or at least the expression: "physical paradigm" resembles what Ingwersen and Wormell (1990) call the "systems-driven paradigm," i.e., a paradigm only interested in the technical side, not in how well potential users are informed. But is this really a theory or paradigm in information science or is it a kind of anti-theory: a theory which regards IS as an unnecessary discipline? A theory which finds that all we need is information technology and computer science? The so-called information scientists are in this view just people applying information technology. This may function as long as it is difficult to apply the technology (even though the term "science" is then misplaced), but as soon as user-friendly systems are developed for the end-user, the role of information scientists becomes problematic. At best, IS in this view is the operation of another science (computer science) at a lower, less professional level. All theories in IS must, in

our opinion, incorporate some assumptions about users.⁷

Computer science is one angle that IS has to relate to and find its identity in relation to. Computer science is not a theory in IS, but a bordering science, to which IS must define itself. Therefore, in our view, a pure physical paradigm or the systems-driven paradigm cannot be regarded as theories for IS. There is another serious threat to IS, that of the content or subject disciplines. Many specialized information centers and research libraries employ people educated in different subjects such as law, chemistry, or medicine. Such domain experts are working with information problems inside the disciplines in which they are educated. Such professionals could have another (implicit or explicit) anti-theory of IS; IS is an unnecessary discipline: All you need to have is subject knowledge. From this subject knowledge you can handle the problems of relevance, of subject indexing, of information retrieval, and so on.

These two anti-theories to IS could of course be combined: You could take subject specialists, give them courses in computer science and information technology, and let them manage libraries and information systems. What more is needed? It is in the answer to this question we must find the identity of IS. This answer is about theories, approaches, and paradigms in IS. Only theories that can illuminate this identity can be regarded as core theories. The domain-specific approach to IS has an answer to what this identity might be. IS has been reluctant to address questions regarding subject matter or content because of the fear of being absorbed in concrete subject areas. In this respect IS may be similar to other disciplines such as educational research. Instead some ideologies have developed in IS: that subject matter knowledge can be avoided by either using psychological methods as in the cognitive paradigm or by using other idealistic theories of knowledge (cf. Hjørland, 1992 and 1993a).

In the rest of this section, domain-analysis will be compared to contemporary theories and approaches in IS as represented by a major conference and a major textbook in the field. As already mentioned (see note 1), there was a session at the 1993 ASIS annual meeting entitled "Debating Different Approaches to Studying the Organization of Information," where four approaches were defended:

1. The object paradigm: The path to understanding how information should be organized is to analyze the nature of common information objects themselves.
2. The communication paradigm: The best way to understand information is to study information-seeking and use communicatively, examining how people construct questions and create answers to these questions.
3. The behavioral paradigm: The best method for studying how information should be organized is to observe how people interact with potential sources.

4. The cognitive paradigm: The best way to approach the organization of information is to study how people think and to mimic those regularities of thought.

All of these four approaches are distinctly individualistic in that they consider the individual rather than the collective or domain-oriented aspects of knowledge as the focus for research.

The object paradigm has neither been described nor discussed in the literature except from a short presentation (Jeng, 1993). The approach appears to be rooted in the practice of cataloguing, and as such not anchored in broader theories from cognitive science, epistemology, or social science. It could, however, be seen as an attempt to formulate an alternative to a theory of information organization based on the users' subjective perceptions or behavior, but in our view such an alternative must be less concerned with formal attributes of information as described by Jeng, and more with subject matter.

It is not possible to build an information system on some form of naive realism, in which an objective order, independent of human knowledge interests, is postulated. The objectivity of the nature of the information objects cannot be recognized by unqualified people in many cases. The qualifications for the recognition of the objects are to be found in the scientific education, and the sciences are historical products. In the formulation of Brilliant (1988, p. 129): "... objects can exist without reference to any particular observer, but the historical fact and character of that existence need to be demonstrated by someone capable of showing a persuasive connection between *this* object and *that* time and place. Historical research, if properly done, denies the isolation of the object and posits a nexus of objective, historical associations, acceptable to others with access to the same supporting information, properly presented to them by the scholar." Therefore, it is important to distinguish between naive and qualified realism. In order to become a qualified realist, it is necessary to consider the disciplines and their findings, i.e., to consider the domain-specific approach.

The communication paradigm has been occupied with epistemological questions and is the most socially oriented of the four viewpoints presented above (cf. Dervin, 1994). Therefore, this approach has possibilities of contributing to the domain-oriented approach. But some problems remain. First, the exact consequences of the epistemological insight for IS seem somewhat unclear. It may be that some of the epistemological inspirations in this paradigm (e.g., post-modernism) are not very fruitful. Second, the focus is still rather individualistic, not oriented towards knowledge-domains. From the definitions alone, it is not easy to see how the cognitive and the communicative paradigms differ. Without question, however, this approach has described various epistemological positions and enlightened the influence

of these positions on our understanding of human communication.

The differences between the cognitive and behavioral paradigms have been intensively discussed in psychology. Behaviorism dominated American psychology from J. B. Watson's manifest for a behaviorist psychology from 1913 until the rise of cognitivism about 1956. A major cause of the decline of the behavioristic position was the criticism raised by the cognitivist Noam Chomsky in a review of a book by the leading behaviorist B. F. Skinner (Chomsky, 1959). Both approaches still have their adherents, but in general, the cognitive approach is seen as much more methodologically rewarding. Cognitivism is not as methodologically restrictive as behaviorism. It allows the same kind of methods as the behavioristic approach, and in addition it gives access to the conscious processes in the individual. In psychology, behaviorism has few adherents today compared to cognitivism or information process psychology as it is also called. A well-known introduction to psychology from the cognitivist position is human information processing by Lindsay and Norman (1972/1977), which has also been influential in IS.

In this paper we do not find it of great importance to distinguish between the behavioristic approach and the cognitivist approach. We find it much more important to describe the similarities in these two approaches and to confront them with newer approaches such as socio-cognitive and domain-analytic approaches. We have previously outlined modern post-cognitive developments in some disciplines bordering IS (Section 2 of this paper). Inside psychology Still and Costall (1991) and Resnick, Levine, and Teasley (1991)⁸ are examples of critical analysis and search for alternatives. In computer science we have already presented the criticism by Winograd and Flores (1986/1987).⁹ It came as a surprise to us that N.J. Belkin, whose name is closely associated with cognitive modeling and the cognitive view in IS, did not advocate the cognitive, but the behavioristic position at the 1993 ASIS conference (cf. note 1). He may have had good reasons for doing this, but it indicates to us clearly a need for a more thorough description, comparison, and debate about these approaches in the literature presented by the adherents of those views.

For IS the domination of intrapsychological frameworks raises some fundamental problems about philosophical realism. As criticized by Frohmann (1990) and Hjørland (1991) these mentalistic approaches assume that by studying the users' behavior or thinking, IS can discover some hidden laws, principles, or regularities which can be used in designing information systems. In the opinion of these authors, IS should not discover these principles from studying the behavior of users, but rather construct such principles as instruments for optimizing certain social practices of an informative nature. Users' knowledge about information sources, information search strategies, etc., is often defective. It is the informa-

tion scientists, not the users, who should deliver the principles for constructing information systems. Of course it is useful to study and understand such more or less defective behavior in order to help the users increase the quality of that behavior, but that presumes that IS possesses some principles that are more advanced against which the defective behavior can be judged. The application of psychological knowledge about users presumes some objective knowledge, i.e., knowledge that is not just a reflection of the users' subjective perception, but a knowledge that is prior to this. This problem is not just a problem for IS, but also a problem for psychology. A recent article about the psychology of problem-solving treats this as a methodological problem in the field of psychology (Fillbrandt, 1992).

The application of mentalistic, intrapsychological approaches to IS seems to imply that the information system should reflect the users' subjective perception of knowledge and information, not some objective reality¹⁰ (which could contribute to the development of the users' knowledge). If you are going to design an information system for, say, Scandinavian geography, the obvious approach would be to design it according to how Scandinavia really is (and probably to use geographers as cognitive authorities), not the way the users think it is. Perhaps mentalistic approaches can defend themselves by saying that the objective content of the information systems can be taken for granted. What the cognitivist approach cares about is making the systems user friendly. The cognitivist position would then imply that the principles that it can supply to IS do not relate to the content of the database nor to the primary classification of its objects etc., but to the user interface of the information system. Clearly, this point of view is of greatest relevance in systems functioning as intermediaries toward some specific kinds of users, e.g., children. If the mentalistic and cognitivist approaches take this stand, they clearly must admit that some other, more basic approaches are needed, from which they can take over. For instance, you have to know to what degree the objectivity of knowledge can be taken for granted. To what degree is there consensus in a field? Are different viewpoints related to different goals and political priorities? It follows that problems in the theory of knowledge are more fundamental than knowledge about the users of information systems: The users cannot express needs that they have no ideas about.

We are here facing an interesting paradox. It is customary to regard positivism as objective and hard and as the methods of the natural sciences. Hermeneutics, on the contrary, is viewed as subjective, soft, and the methods of the human sciences. So in order to strengthen their impact as sciences, the humanities and social sciences have sometimes adopted hard theories of knowledge. However, by isolating the organism and mind from their environments, to which they must be seen as adaptations, the positivistic and rationalistic methods have great difficulty grasping reality; consequently, they be-

"Cognitivism"	"The Domain-Specific View"
Priority is given to the understanding of isolated user needs and intrapsychological analysis. Intermediating between producers and users emphasises psychological understanding.	Priority is given to the understanding of user needs from a social perspective and the functions of information systems in trades or disciplines.
Focus on the single user. Typically looks at the disciplinary context as a part of the cognitive structure of an individual - if at all.	Focus on either one knowledge domain or the comparative study of different knowledge domains. Looks at the single user in the context of the discipline.
Mainly inspired by AI (Artificial Intelligence) and cognitive psychology.	Mainly inspired by knowledge about the information structures in domains, by the sociology of knowledge and the theory of knowledge ("Science studies").
The psychological theory emphasizes the role of cognitive strategies in performance.	The psychological theory emphasizes the interaction among aptitudes, strategies, and knowledge in cognitive performance.
Central concepts are individual knowledge structures, individual information processing, short- and long term memory, categorical versus situational classification.	Central concepts are: scientific and professional communication, documents (including bibliographies), disciplines, subjects, information structures, paradigms etc.
Methodology characterized by an individualistic approach. (Methodological individualism has some connection to a general individualistic view, but the difference between "cognitivism" and "the domain-specific view" is <u>not</u> a different political perception of the role of information systems, but a different theoretical and methodological approach to the study and optimization of information systems).	Methodology characterized by an collectivistic approach. (Methodological collectivism has some connection to a general collectivistic view, but the difference between "cognitivism" and "the domain-specific view" is <u>not</u> a different political perception of the role of information systems, but a different theoretical and methodological approach to the study and optimization of information systems).
Best examples of application: User interfaces (the outer side of information systems).	Best examples of application: subject-representation/classification (the inner side of information systems).
Implicit theory of knowledge: mainly "rationalistic"/"positivistic", tendencies toward hermeneutics.	Theory of knowledge: Scientific realism/forms of social constructivism with tendencies towards hermeneutics.
Implicit ontological position: Subjective idealism.	Ontological position: realism.

FIG. 2. Some differences between "cognitivism" and the domain-specific viewpoint.

come very subjective, which is in fact the opposite of what they were originally meant to be. By excluding knowledge about the world where the people live, and by excluding values from scientific methodology and restricting itself to studying the minds of isolated and abstracted subjects, psychological science has been much less objective and less realistic than more soft approaches. So, in trying to become hard sciences, fields like psychology and IS are in fact avoiding reality, thereby becoming more subjective. In our opinion, therefore, there is a need in IS (as in other social sciences) to leave what we earlier described as the fundamentalistic epistemologies and enter into investigations of more holistic theories, incorporating knowledge about the cul-

tures in which the information systems are functioning. In our view, this implies giving up (or at least supplementing) behavioristic and cognitivistic positions in IS.

Of course, there have been important internal developments inside cognitivism pointing towards more sociocognitive or domain-specific approaches. Some researchers would like to keep the same label cognitive research and just modify the content of the research. Other researchers may wish to use a new label, but one that comes close to the old label. In this way, Ingwersen (1992) distinguishes between cognitivism and the cognitive view, the latter being less AI-like, more inspired from hermeneutics. Now we are discussing labeling problems, which are problems of another kind or at another level

than the methodological problems themselves. It is important, however, to have good labels. It is important for science to have a clear picture of its own intellectual history, to know which approaches turned out to be fruitful, and which turned out to be less fertile. The domain-specific viewpoint, which we are advocating, is more related to American pragmatism and functionalism in the beginning of the 20th century than to the very positivistic/rationalistic approaches in both behaviorism and cognitivism. Therefore, we prefer a new label, not a label that is easily mistaken for cognitivism.

In the session on domain-analysis at the ASIS conference held on October 25, 1993, Marcia Bates—as a reaction to one of the present author's presentation (Hjørland, 1993b)—said that in her opinion, IS needs both more cognitive studies and more domain studies. Is there a theoretical conflict between these two kinds of studies? The answer to this question is both yes and no, depending on the underlying conceptions. Human cognition is of course extremely important, and studies of thought processes during online searching and other studies of human cognition are undoubtedly important for IS. Whether you call such studies cognitive studies, or you call them bibliometric studies of disciplines or studies of terminology, database use, etc., domain studies, both kinds of studies are indispensable, as pointed out by Bates.

But when you do cognitive studies, you can have very different theories about which factors influence the thinking processes and their outcomes. Not all theoretical views on cognition are equally valid in IS, and the approaches prevailing until recently have failed to recognize very important features about human thinking, such as its dependence on the content of thinking and its relation to the knowledge-producing communities.

When we advocate domain studies as a new approach in IS, we are suggesting a theoretical integration of two contemporary lines of research in IS, which lacks such an integration: cognitive studies and such studies as bibliometric studies, which we have labeled predecessors to domain studies. This integration is partly achieved by changing the theoretical presumptions about cognition. In this way, domain-analysis—building on more socio-cultural, pragmatic, and realistic theories of cognition—represents an alternative theory to the cognitive phenomena, and in this respect, domain-analysis and cognitivism are not two supplementary points of view, but two mutually exclusive theoretical viewpoints. Some of the differences in these two views are shown in Figure 2.

After having compared domain-analysis to approaches discussed at the ASIS conference, we will now compare this approach with theories discussed in a modern textbook about IR, *New Horizons in Information Retrieval* (Ellis, 1990). An overview of the approaches to be briefly discussed is shown in Figure 3. Our own presentation of these viewpoints has of course to be very short,

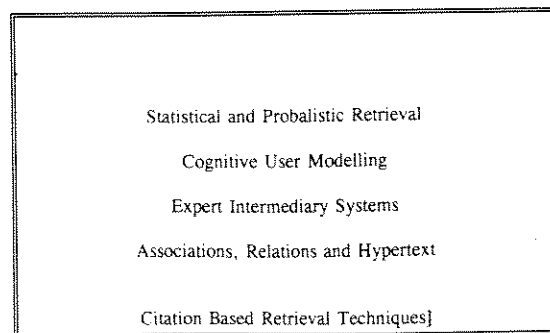


FIG. 3. Contemporary horizons in IR.

and the readers are referred to Ellis' book for fine introductions.

Statistical and Probabilistic Retrieval

A lot of experimental research has been carried out examining the distributions of terms in single documents and in document collections aimed at constructing algorithms for ranking documents according to degree of relevance, for clustering documents according to (relevance) similarity, etc. This approach can be expanded with computational linguistic techniques (natural language processing), i.e., supplement term distributions based on statistical text analysis with analysis of syntactic structures and lexical information. In all this research however, concepts like domain and discipline seem almost completely lacking. A term is seen as something concrete, as independent of the knowledge-domain in which it appears. We are of course aware of the fact that a parser may rely on lexical information from a domain-specific dictionary, or be supplemented with rules for disambiguation of homonyms. This latter approach, however, faces the problem of interpreting pragmatic aspects of language, since a given utterance (e.g., a clause) cannot be analyzed fully without a thorough understanding of the overall message and purpose of a particular text. Compare the discussion of the explicitness of texts provided by Nystrand and Wiemelt (1991), which we presented earlier in this paper.

According to the domain-analytic framework, the meaning of a term can only be understood from the context in which it appears. The meaning of a term such as gold can only be understood by an interpretation of the discourse in which that term appears. Gold has at least one chemical meaning (a heavy metal, difficult to dissolve by acids, electrical leading, etc.), one economic meaning (conventional economic measurement and reserve), one fictional meaning (related to wealth, happiness, the half kingdom and princess), etc. What other terms would be related to gold in a thesaurus depends entirely on the function served by a particular thesaurus. Whether documents retrieved by that term in an algo-

rithm would be relevant to a question depends entirely upon whether that term has one or another of its possible meanings. The approach of statistical and probabilistic retrieval seems to be blind with regard to these problems of interpretation and to the contextual, dialogical, and historical character of knowledge and meaning.

According to Ellis (1990) dissatisfaction with the limitations of the statistical approach has recently become more widespread. Although much good work has been done employing this approach, little further improvement in retrieval effectiveness can be expected from it.

Cognitive User Modeling

The basic assumption concerning cognitive user modeling is that the information system should have a model of the users (or their information need) and that the documents should be identified according to such a model. Such modeling is of course possible in certain cases. In some cases, it is possible to describe some specific presuppositions in knowledge and to rank knowledge with respect to such presumed presuppositions. A typical schoolboy does not have the presuppositions to acquire advanced scientific knowledge in many fields. An information retrieval system for students, describing the supposed level of difficulty, should in theory be possible and has been implemented in such systems as "Choice" (which however has never claimed to build on principles such as cognitive modeling).

A Danish system, "The Book House" (Pejtersen, 1991, 1993) is an icon-based Online Public Access Catalogue for fiction retrieval. The interface of this system, as well as the subject analysis of the literature, is based on intensive research in user preferences and psychology in order to optimize the application of icons for organizing and representing domain-knowledge.

However, the typical domain of IR is that of identifying relevant documents for problem-solving in science and professional activities such as law and medicine. It is a strange thought to build a professional information system on medicine on the cognitive structures of its users! It is the users who have to acquire the necessary knowledge about medicine, medical theories, medical terminology, etc., in order to use a medical information system. Users are not stereotypes, they have changing knowledge and hypotheses, which are an integrated part of the highly synchronized writer-reader cognition in the domain. The main problem for information systems therefore is to reflect the domain, not the individual users.

Earlier in this article we described this tendency in IR research to be based on a mentalistic, subjective-idealistic philosophy of knowledge and being in contradiction to modern forms of social constructivism and scientific realism. It is therefore understandable that research on cognitive user modeling has not been able to go beyond the prototype stage.

Expert Intermediary Systems

Artificial intelligence and expert systems are subdomains and approaches within computer science which have also inspired many researchers in IS, and which therefore have also become an approach in IS. It is our opinion that the general AI and expert systems program have been over optimistic and based upon some rather primitive perceptions of knowledge. Some of the premises on which AI has operated have been criticized in Section 2 of this article. The general programs of AI, expert systems, Fifth-generation computers, and the like have from the late 1980s gotten into great difficulties and have been dramatically turned down (but not given up). It is however outside the scope of this article to discuss this general program.

In addition to the difficulties within the general program of AI is the fact that IR seems to be particularly ill-suited for this kind of systems. H. M. Brooks (1987) concludes that "For several reasons, IR does not seem to be an ideal problem domain for an expert system application. It is a domain that is neither well bounded nor narrow nor homogeneous (p. 378) . . . It seems that it is not feasible at present to think of building an expert system that carries out intelligent retrieval (p. 379)." Researchers in IS such as Fugmann (1992) and Swanson (1988) find that IS in following this approach has started a search for illusionary goals.

Inside the general AI program as well as in the expert intermediary approach to IR there has also been some interest in domain-knowledge, e.g., the IR system I³R incorporates a kind of user-specified domain-knowledge (cf. Croft, 1986; Croft & Thompson, 1987). Also Fu (1993); Paton et al. (1991); Vanginneken (1993); Vanjoolingen and Dejong (1992); and Vlissides and Linton (1990) discuss how to model domain-knowledge. In I³R the users are asked about concepts and relations in the domain, and gradually a thesaurus is being compiled on the basis of the users' knowledge. Ellis (1990, p. 88) says that "This represents an incrementalist and pragmatic approach to constructing a thesaurus for a particular subject domain which does not involve the specification of all conceptual relationships in the knowledge base at the time the system is set up—although it is probably useful to specify some to provide the system with at least a rudimentary Domain Knowledge facility prior to any interaction with users."

In the AI approach to domain-knowledge there has been very little interest in the philosophy or sociology of knowledge or language. One exception is Ramoni, Stefanelli, Magnani, and Barosi (1992). In general, some domain-knowledge is included if it seems feasible. Broader theories about how best to represent domain-knowledge are lacking. Very often a single user or a single textbook are regarded as cognitive authority. That this can be dangerous is shown in the following quotation about sociology textbooks:

Before plunging into the topic itself, a word on textbooks is in order. Firstly, there is no one single adequate textbook. Massive as they often are, they tend to be written from the point of view of a particular practitioner and to omit whole areas of research activity. Thus the standard text from an interactionist viewpoint (Denzin, 1979) is weak on problems of measurement and statistical techniques of analysis. Other authors (for instance, Blalock, 1970) might leave the beginning student with the impression that causal modelling and explanation are all that sociology is about, for participant observation figures little and whole areas of modern sociology go unmentioned. Secondly, both these and other such texts are *resource-books*—things to be *used*—to be consulted and dropped into as needed, not riveting “reads” to be consumed at one sitting. Thirdly, and most importantly, all such texts, on the whole, present an *unreal and idealized* account of research (Worsley, 1992, p. 79).

This tendency to take one user or one textbook to be authoritative displays a difference between computer science and library and information science (LIS). Computer Science is mainly concerned with finding problems that can be automated. It will look at textbooks in medicine in order to make a knowledge-based program that can perform a diagnosis as well as a medical analyst. The focus is on consensus. Differences between textbooks have to be ignored. Knowledge has to be safe even at the risk of being commonplace. On the other hand, LIS is concerned with the communication of the most relevant and adequate knowledge to potential users. From this perspective, it is very important to consider the uniqueness of textbooks and the limitation of every single textbook. The basic interest is not how to automate some more or less commonplace tasks, but to offer highly selective and relevant knowledge that is to provide users with as complete a view as possible of theories, topics, and approaches to a given subject and make it possible for them to be informed and to select according to their needs. Knowledge should not be safe and easily formalized, but well documented and many faceted. While mathematics is among the most important borderline disciplines for computer science, the history and philosophy of science, providing more general knowledge, are among the most important borderline disciplines to LIS. Therefore, the focus of computer science and LIS on a given domain is very different from the starting point.

In the existing expert intermediary systems such as I³R, domain-knowledge is included as one element, as one expert between many other experts such as user model builder, request model builder, and browsing expert, etc. (cf. Croft, 1986; Croft & Thompson, 1987). But the question is, to what degree such other experts can be designed without special considerations to the domain in which they will be functioning? Very little research until now has illuminated the question of the interaction between domain-knowledge and general IR knowledge in IS. But the expert intermediate approach has been a

stimulation for this kind of questions, which is in itself a worthy achievement.

Associations, Relations, and Hypertext (with Citation-Based Retrieval Techniques)

From reading Ellis' book about contemporary horizon's in IR one gets the impression that Ellis' own interest is primarily associated with hypertext and that he favors this approach. Although stated rather implicitly by Ellis, the clear impression is that hypertext is viewed as being the most fruitful approach by one of the most important books trying to evaluate the different trends in IS. The theoretical foundations of hypertext dates—according to most authors—go back to 1945 when Vannevar Busch put forward the idea of a machine “MEMEX” based on associative links between documents or items. This idea was delayed as an approach in IR until it became a major trend in the 1980s.

We share Ellis' opinion that hypertext is a fascinating research area and a promising technology. It is however only a technology, and as such cannot substitute for a theoretical approach such as domain analysis. But a theoretical approach can illuminate a technology and its possibilities. Rayward and Boyd (1994) present a most important analysis of some theoretical viewpoints which is able to put hypertext into a theoretical frame closely related to the assumptions in this article. Contrary to most authors, they find that the ideas go even further back than 1945. In their opinion the ideas behind hypertext can be traced to Paul Otlet, one of the founders of the documentation movement and hence of IS. Some of Paul Otlet's basic ideas are described by Rayward and Boyd as “An outmoded paradigm: 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*. . . . At first sight there is a startling contrast between what Otlet was writing about and what Landow and others who are interested in understanding hypertext in terms of modern critical theory are describing. But when posed in this way, the difference makes us look a little more closely at what some of the accounts of modern hypertext systems, especially in their grandiose, theoretical, “macrotext” manifestations, are actually saying. Is it possible that, despite the rhetorical flourishes, there is, deeply embedded in the accounts of some of these systems, what might be described as a “remainder” of nineteenth-century positivism?

. . . 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," Otllet's own. They suggest an atavistic positivist perspective that takes one by surprise (Rayward & Boyd, 1994, pp. 247-248).

The question of modularity of knowledge playing a crucial role in hypertext is also raised by Hofstadter:

Another question which comes up in the representation of knowledge is modularity. How easy is it to insert new knowledge? How easy is it to revise old knowledge? How modular are books? It all depends. If from a tightly structured book with many cross-references a single chapter is removed, the rest of the book may become virtually incomprehensible. It is like trying to pull a single strand out of a spider web—you ruin the whole in doing so. On the other hand, some books are quite modular, having independent chapters. . . (Hofstadter, 1980, p. 617).

The positivist view of knowledge as consisting of isolated chunks or modules is contrasted by other views such as the dialectical tradition and the theory of scientific paradigms by Thomas Kuhn. McGarry expresses it in this way:

Knowledge is a cultural entity and keeps shifting its pattern like a kaleidoscope. An emergence of the new knowledge modifies the structure of the whole. Contrary to H. E. Bliss (1870-1955) there is no permanent order in knowledge. "Pattern is new every moment" said T. S. Eliot (1888-1965), with a poetic vision (McGarry, 1991).

The domain-analytic approach is concerned with the nature of knowledge, its possible modularity, and the autonomy and explicitness of texts in discourse. The above citations have demonstrated that theories about knowledge (e.g., positivism) do have a great influence upon the design of information systems, such as hypertext systems. Of course, it is not enough to maintain that knowledge either is or is not modular. Some research must be done in order to establish some qualities and quantities of modularity in different domains or in different kinds of knowledge (for example, empirical knowledge versus theoretical knowledge). Experimentation with hypertext systems in different domains and with different types of knowledge should be able to establish more concrete knowledge about the relative modularity of knowledge, on the assumption that the researchers are conscious of such problems and not just following in purely technological lines of thought.

Despite the fact that a hypertext database can allow new kinds of opportunities, many of the classical problems of IR remain in this new technology. You still have the problem concerning whether to use controlled versus

uncontrolled vocabulary, whether to have hierarchical structures between concepts, what priority should be given to citation-based relations versus other kinds of relations such as descriptors, free text relations, etc. Hypertext is hence a new technology, allowing new ways to organize documents and their parts. But it is not a theoretical approach towards the classical problems in IR such as the informational value of different subject access points. In a way, it is therefore misleading to regard hypertext as a new theoretical approach in IS. Hypertext is a technology, which is fertile soil for remedies to classical problems in IS.

One kind of relations which have stimulated much research in IR, is citation-based retrieval techniques. Citation-based retrieval utilizes a kind of network relations between texts: where authors or references that are similar in different texts function as nodes, which are interlinked dynamically to text networks during retrieval. The core problem of IS is to provide some theoretical background from which to make priorities between all such possible connections and relations. The possibilities are infinite. If the users are provided with a system with too many possibilities without giving priority to the essential connections, the user is overloaded, and the system is ineffective. In the last part of this article, we shall argue that it is exactly the domain-approach to IS that seems to be able to provide such a theoretical framework.

Summary

In this third part of the article, we have discussed the domain approach in the light of other contemporary theories, paradigms, and approaches in IS. None of the traditional approaches in IR research regard the differences in various knowledge domains, nor do concepts such as discipline, research community, discourse community, historical-cultural perspective, etc. seem to play any role at all. The theories are empty with regard to these concepts and problems. They implicitly regard this as either nonrelevant or perhaps as intangible. This lack of concepts about knowledge, development of knowledge, and research communities has a connection to a certain view of knowledge. Knowledge is perceived as independent modules together with tendencies to epistemological atomism and fundamentalism. This is a kind of positivism or rationalism. The opposite of rationalism is not anti-rationalism, but a view of epistemology based on more ecological, holistic, and subjective theories.

Many people, including Winograd and Flores (1986/1987), are looking at hermeneutics for an answer. There is no doubt in our opinion that hermeneutics can offer a new valuable perspective to the problems of IS. The question is whether hermeneutics is enough and perhaps whether it is too relativistic. Possibilities between fundamentalism and relativism such as scientific realism (e.g., represented by Bhaskar, 1975; Harré, 1972; Greenwood, 1991), social constructivism (e.g., Collin, 1993), and

what Olaisen (1991) has called "clarified subjectivism" should also be investigated in light of the problems in IS. Such philosophical distinctions constitute in our opinion a core problem for a domain-analytic research program.

Examples and Content of Domain-Analytic Problems with Proposals for a Comprehensive Research Program

We have now demonstrated that there are important reasons both within IS and within the theory of science/theory of knowledge to try to formulate a new approach in IS and IR. It is important for IS to formulate a research program that will change the status of the area in a positive direction. In other words: that IS is able to formulate some of its own information needs! As information scientists, our professionalism depends on a collective body of respected knowledge. It is very important that we all try to relate to the different approaches in IS and work hard to improve both the theoretical and the empirical basis in an approach with which we feel confident.

A core problem in IS is the relation between domain-general and domain-specific principles and strategies in IR. Very little research exists on this question. The problem of the relative informational value of different subject access points such as titles, abstracts, citations, descriptors, or words from full-text records is perhaps the most central problem in IS. Some fine research does exist on this topic (e.g., Pao, 1993; Tibbo, 1992), but mainly in specific disciplines. (Comparison with different disciplines is done by Tibbo (1992), but such investigations are rare.) The use of language in titles and documents differs from subject area to subject area. The social sciences use much more metaphorical words in titles compared to the natural sciences. A title such as "The Conflict between Egypt and Israel is a Nightmare in Modern Politics" creates much noise for the psychologist trying to identify information about nightmares in the Social Sciences Citation Index®. In the same way the citation patterns of authors vary from one area to another. The act of citing is a human choice, governed by the purpose of writing and the practices (or culture) in disciplines, which again reflect the objects/area of study of the disciplines. Therefore, the obvious hypothesis is that the informational value of different subject access points varies from hard disciplines to soft disciplines and along other dimensions in the subject area. This hypothesis is also strongly supported by Bates (1987). But we need to have much more concrete knowledge about such questions.

Research done from the cognitive point of view/cognitive user modeling (by Belkin (1984), Ingwersen (1992), and many others) has produced a lot of papers about the users' and the intermediary's cognitive processes and interaction during the IR process. Only few concrete examples of user cognition in realistic settings exist and not much substantial evidence can be found about the interaction between domain-general and do-

main-specific knowledge and strategies in this literature (e.g., Debliek et al., 1992; Marchionini et al., 1993). Most people, including librarians and information scientists, intuitively perceive that domain-specific knowledge plays a major role in the IR process. In most real search situations there exists a very strong interaction between domain-general and domain-specific strategies. Shute and Smith (1993) demonstrate that even intermediaries without specific domain-knowledge have a great need to use the little domain-specific knowledge they might have intercepted by chance. Without this, they are not able to use the domain-independent strategies in a useful way.

Philosophical Perspectives

One important and obvious new approach is to analyze implicit theories of knowledge and discuss explicit theories of knowledge in the foundation of IS and its major concepts. Concepts such as modularity of knowledge, atomism, epistemological fundamentalism, positivism, rationalism, empiricism, holism, objectivism and subjectivism, hermeneutics, historicism, relativism, scientific realism, and clarified subjectivism should be explored both in a more general way (leading to textbooks in theories of knowledge especially written for the information profession) and in relation to specific concepts and theories, as has recently been the case with the concept of relevance (Saracevic, 1975; Schamber, Eisenberg, & Nilan, 1990) and our own research in the concept of subject (Hjørland, 1992, 1993a) and overload (Hjørland, in press).

Of course, this is not easy. It is not enough to have some knowledge about theories of science. The problem is to contribute to solving problems, that is to show how some specific theories have unfruitful consequences and should be replaced by better theories. As already mentioned it is also important to consider more specific theories about the nature of different domains such as the humanities, the social sciences, applied sciences, and interdisciplinary studies in order to be able to generalize some principles of relevance to information seeking and organization. The difficulty for information professionals undertaking domain-analysis as an approach is that some kind of subject knowledge is required. This problem is not unique to information scientists. Philosophers, educational researchers, sociologists of knowledge, linguistics for special purposes (LSP), etc. are facing the same kind of difficulties.

The major challenge for information scientists is in our opinion the need to contribute value added information to records in electronic information systems. Here we face the dilemma between becoming a subject specialist like the producers of the information at one end at a continuum and to become a computer expert with no subject knowledge at all at the other end of the continuum. The best solution which we can see is to become more like philosophers and sociologists of knowledge

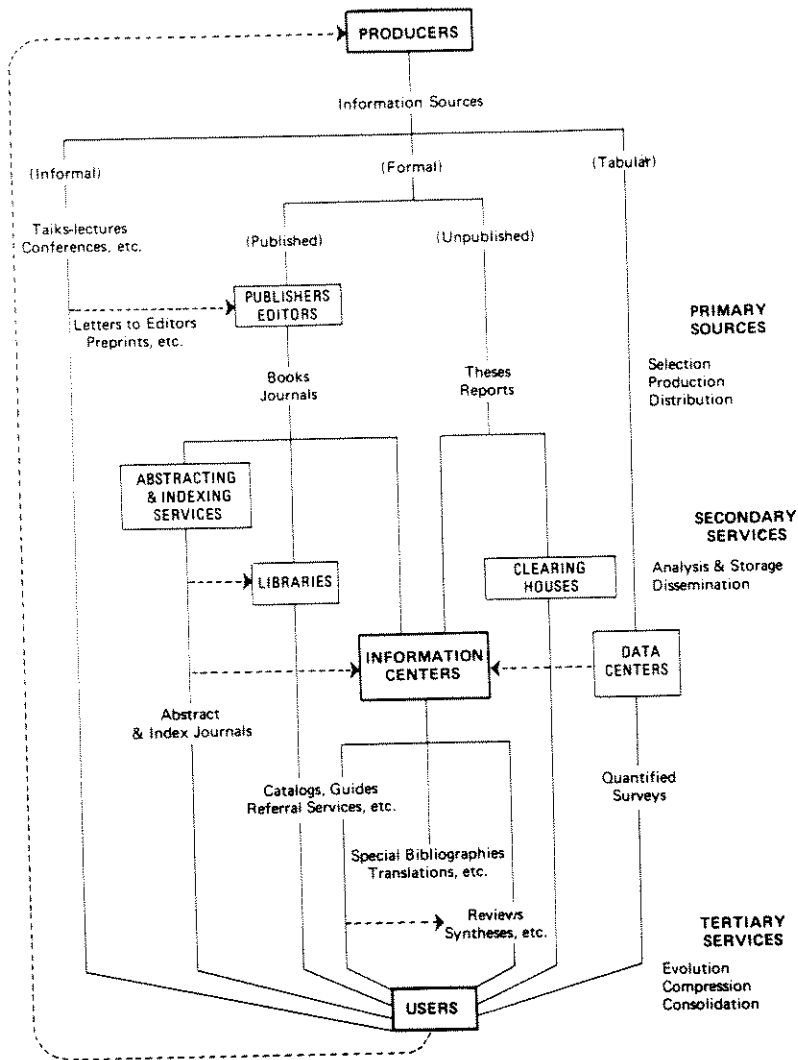


FIG. 4. Communication channels between producers and users of information. Reproduced by permission of UNESCO.

and science. That provides a more general perspective than the ordinary subject specialists can provide. IS as a discipline should provide such generalized knowledge about paradigms, methodologies, tendencies in knowledge production, knowledge in its larger historical, social, organizational, political context, etc. Such knowledge is of great value in itself, and it is also the best background for further specialization after a basic IS curriculum.¹¹

Sociological Perspectives

Philosophical analysis cannot replace empirical studies, but should be a guide to the interpretation of empirical studies and to the design of further studies. Information science could use some research done in the sociology of knowledge/science as inspiration, for example, Whitley (1984). (In Denmark, the research by Aabo, Lone, and Andersen [1987] follows this tradition.) Figure 4 shows one model of the communication channels

between producers and users of scientific knowledge. A lot of interesting research could take off from this figure. The communication structure in many different disciplines could be investigated: Who (and how many) are the producers who are the typical user groups? What communication channels exist in the domain, and how large a part of the overall communication goes through the different channels? When were the channels established? Can patterns in development be recognized?

Another line of research could compare the communication patterns between different knowledge domains and try to explore why different patterns exist. Also the borrowing of information tools from one domain to other domains such as Roberts' (1985) study of how retrieval in the social sciences was influenced by the natural sciences. If different schools or tendencies could be identified in a domain or across domains (such as positivism, structuralism, and hermeneutics), how would these different approaches then imply different demands to the information system?

The growth, organization, and publication trends of the sciences are of direct interest to any theory of information seeking and representation. So are problems of interdisciplinarity and the problems of interdisciplinary borrowing (cf. Klein, 1990) and the overlapping between different disciplines. The question of different patterns between hard and soft disciplines has been raised in IS. However, is this a fruitful classification? Could better typologies of knowledge domains and disciplines be constructed? In the sociology of science Whitley (1984) has proposed a classification of the sciences, based upon degree of consensus in a field, and the relative freedom of the individual researcher to choose problems; the strategic and technical uncertainty in different disciplines and the mutual dependence between disciplines. Such research seems to be very relevant for IS theory and practice about information seeking, as well as for classification research.

One line of research should occupy itself with the use of language in different domains. What kind of culture exists concerning the form of titles, the pattern of citations, etc.? What are the consequences for the informational value of titles, subject terminology, descriptors, and citations in IR? What important transdisciplinary tendencies and concepts exist in the disciplines?

If you made a description of the most important theoretical developments in the self-understanding of a discipline in say a 10-year period (such as a development from AI approach to discourse communities), could you then point out some important consequences that such changes would imply regarding information seeking and organizing? Different classifications could be analyzed from their implicit theoretical views, e.g., the view of humans, view of language, etc.

Ideally, IS should produce domain-specific handbooks and journals in all major domains of such a quality, relevance and visibility that the researchers, students, and users in the domains would find these handbooks of high importance and would depend on Research and Development in IS. We do have a tradition for publishing "guide to information sources in field x" and in some fields like law and medicine domain-specific IS journals. But such a program should be strengthened and combined with courses on information seeking, knowledge organization, and utilization for the end-users or teachers in the discipline. If such a course in itself has too little to offer, it could be combined with elements of information technology, theory of knowledge, and scientific methodology. If information specialists do not feel they have enough domain-specific knowledge, they should try to acquire this and at the same time cooperate with subject specialists. It is far more important for everybody that the field grows than recruiting people with one specific educational background as IS professionals.

We are aware that this program will be difficult and will require much hard work and thinking. But what is the alternative? The recent development in IS demands

a renewed focus on the basic problems. It is very important, however, to state that the approach domain-analysis has a continuum of problems from very simple problems that are easy to explore empirically to very complex theoretical problems. Every time you use information as the variable, i.e., every time you look at the problems of IR or knowledge organization from some kind of hypothesis about the knowledge domain as an important factor, you are contributing to this approach.^{1,2}

Acknowledgments

We would like to thank two anonymous referees for valuable comments, which have improved this paper.

Notes

¹ This formulation was inspired by four formulations in a session entitled "Debating Different Approaches to Studying the Organization of Information" at the ASIS 56th annual meeting October 27, 1993. The formulations were:

Ling Hwey Jeng, UCLA: The object paradigm: the path to understanding how information should be organized is to analyze the nature of common information objects themselves.

Donald Case, UCLA: The cognitive paradigm: the best way to approach the organization of information is to study how people think and to mimic those regularities of thought.

Nicholas Belkin, Rutgers University: The behavioral paradigm: the best method for studying how information should be organized is to observe how people interact with potential sources.

Brenda Dervin, Ohio State University: The communication paradigm: The best way to understand information is to study information seeking and use communicatively, examining how people construct questions and create answers to these questions.

(Cited from the conference program, page 22).

² Mann's (1993) book is called *Library Research Models*. It does not, however, deal with the paradigms or theories of library and/or is as such (e.g., bibliometric or cognitive approaches). Library research is understood as the part of a research process in any discipline such as history, psychology or chemistry that uses libraries as tools. His book could be seen as a discussion about different ways to teach information seeking to researchers.

One of Mann's models is "the specific subject or discipline model." Mann (1993, p. 9) says: "Graduate courses on how to do library research are almost always taught along disciplinary lines: anthropology learn the indexes, databases, and bibliographies appropriate to anthropology; prospective MBAs learn the sources specific

to business and economics; psychologists learn the ones appropriate to their subject; and so on.

The advantage of any conceptual model that categorizes sources by subject or discipline is that of depth. . . .

As good as it is, however—and it is indeed necessary for advanced research—the subject/discipline model has major disadvantages in addition to its obvious strengths. The first difficulty is that it must be taught from a specific list of sources appropriate to the discipline. The problem here is that even students who become masters of that list (of subject-specific reference tools) are left helpless in other subjects not covered by it. In other words, they have not learned how to use the library as a whole. . . .” (p. 14): “Second, in concentrating on a particular list of sources within a discipline, it blinds researchers to the existence of cross-disciplinary coverage of the same subject from the perspective of a wide range of sources in other fields. And third, the dependence of this model on lists of particular references leaves researchers at a loss as those lists inevitably become outdated.

Unlike lists of particular sources, principles of searching endure; but the subject/discipline conceptual model is singularly deficient in principles and rules. It leaves people with no “fall-back” procedures to employ when the specific sources they know about fail them. . . .”

It is our view (the domain-analytic viewpoint), that it is necessary to teach *both* discipline-specific and interdisciplinary reference tools, retrieval methods (e.g. citation indexing), and so on. No student, researcher, or user can learn all potentially relevant sources. The ultimate criterion to judge the relevance of reference sources is their relevance from a subject point of view. In disciplines with few or inadequate databases and reference sources, the interdisciplinary sources have a much greater importance than in disciplines with appropriate disciplinary sources.

The “Social Sciences Citation Index^R has greater importance in anthropology compared to sociology because anthropology has not a database such as *Sociological Abstracts*. Of course the Social Sciences Citation Index^R is extremely important also to sociologists. Moreover, studies of the interdisciplinary connections between sociology and psychology are of such great importance that *Psychological Abstracts* tends to be used even more than *Sociological Abstracts* by sociologists. (This may be related to current tendencies of MI in American Sociology.) This is an important thing to know, but this knowledge presupposes the domain-analytic viewpoint: The degree of disciplinarity or interdisciplinarity is different in different domains.

It's our opinion that Mann's discussion of different models is indeed important and useful. However, when you are doing library and information science research, you have to use some theories and approaches as a guide. The domain-analytic viewpoint is necessary to evaluate the contributions, strengths, and weaknesses of all models. But it is also very difficult and demanding.

³ Ulrich Neisser is a professor at Emory University in Atlanta and a member of the American National Academy of Sciences. His shift from a cognitive, information processing paradigm in psychology to an interpersonal and “self”-psychology has come as a big surprise.

⁴ The quotations from Gigerenzer and Hug (1992, pp. 128, 129, 167, 168, & 169) are brought with kind permission from the publisher, Elsevier Science B.V., Amsterdam.

⁵ The quotation from Sarvimäki (1988) is brought with kind permission from the author.

⁶ The trend toward discourse communities should not however be mistaken as research in languages for special purposes. The Danish linguist Carol Henriksen (1990) states:

In a previous paper (Henriksen, 1989) I have questioned the validity and usefulness of the Danish concept of fagsprog as distinguished from almensprog, the former referred to in the literature in English most frequently as Language for Special Purposes (LSP), the latter as Language for General Purposes (LGP). In this paper I argued against making such a distinction and against the type of linguistic analysis which relies solely on structuralist methods and limits its investigation to the formal elements of a text, be they terminological, syntactic or compositional, arguing instead in favor of an approach which views language as communication in a socio-cultural context, as a dynamic activity taking place between real people in time and space, an activity involving more than the text itself, spoken or written, and including phenomena like the psychological make-up of the sender, the prior knowledge of the receiver, the sender's intentions, pre-established social and textual conventions, etc. Every time you use language it is for a special purpose, regardless of whether you are telling your children to go brush their teeth or discussing the advantages and disadvantages of phosphoric acid as an electrolyte with an electro-chemical engineer. . . .” (Henriksen, 1990, p. 28).

We can see that Henriksen does not recognize the existence of a special kind of LSP (which would be a kind of domain-specific language) though this is a rather comprehensive research area internationally. Her main argument is that all languages are always used for special purposes. We will interpret her attitude as a kind of realism: The language system should not primarily be understood as something self-dependent and isolated, but as a tool for human interaction in the material, social, and psychological world. It is the understanding (or rather lack of understanding) of these worlds which causes most—but not all—problems in comprehension by the users, not a kind of linguistic ability. Henriksen does however recognize the importance of specific subject knowledge for (scientific) communication.

⁷ Watters and Shepherd (1994, p. 457) have suggested a definition of a user-centered paradigm in IS: “By a user-centered paradigm, we refer to information access

driven not by the structure of the database in the system, but rather by views of the databases needed to satisfy an information need as perceived by the user. Thus, the user defines dynamically the type, amount, and structure of the data required to satisfy an information need. This implies not just the user definition of the view, but the user selection of the model in which the view is framed."

⁸ Resnick et al. (1991) present themselves as "an emerging revolution in cognitive theory" and the book is announced with the words: "Do humans do their thinking alone? Is thought confined within the boundaries of each individual mind? Today, psychologists are pioneering a new alternative to this classic view, claiming that our thinking is shaped by others in a process known as socially shared cognition."

⁹ Both behaviorism and cognitivism are in our view too positivistic/rationalistic and limited for the reasons discussed earlier. The users are seen as abstract mechanisms, isolated from the sociocultural sphere, not as adaptive mechanisms closely integrated in specific niches. Winograd and Flores (1986/1987) follow the biologist Maturana and talk about consensual domains and autopoiesis, about the coupling of the organism to its ecological surroundings. Also language is seen as such a consensual domain. Language is *not* a collection of mechanisms in a language user or a semantic coupling between linguistic behavior and those nonlinguistic stimuli which an organism is meeting. Language is a system for developing cooperation in a domain of interactions between individuals.

¹⁰ Obviously, the concept of objectivity is difficult. In the theory of knowledge there is a debate between social constructivism and scientific realism among others about the objectivity of scientific knowledge. However, even if you subscribe to some theory of scientific knowledge not being objective, but a reflection of human knowledge interests, you are still facing the problem, that the users of information systems may have their own subjective perception that is not in line with the contemporary scientific perception. The question is: When you are designing information systems, who are going to be the cognitive authorities, and what principles would guarantee the most qualified and unbiased content and representation of the information.

¹¹ A concrete analysis of a knowledge domain, conducted by one of the present authors under such a perspective, has resulted in a proposal for a faceted classification scheme for software which can serve different knowledge interests in computing (Albrechtsen, 1992).

¹² One of the anonymous referees asked for a more concrete research agenda. "I value theoretical work, such as this paper, to the extent that theoretical work leads directly to experimentation. . . . Tell us precisely what you mean by a 'discourse community' so that I can locate one of them in the 'real' world and measure it. I challenge the authors to add to their paper an example of some empirical research where they clearly identify the

Independent variable, the Dependent variable, the Moderating variable, the Control variable and any Intervening variables. . . ."

Well, we do hope that the formulation of the domain-analytic approach will stimulate further research.

First, we hope that researchers will consider which approach in IS they feel most satisfied with. If they feel more satisfied with another approach, we hope they will argue for it and write articles about it. For us, it has been difficult not only to formulate the domain-approach, but to find high qualified papers arguing for any coherent approach against which to present our own view.

Second, we hope that this paper will help establish an international and interdisciplinary network of researchers who want to use this approach as a platform for further studies in IS. The researchers in such a network should—as a collective body—apply many different methods ranging from further theoretical analysis and philosophical studies over historical and interpretative studies to survey methods and experimental studies.

It is not our job alone to give the final definition of a concept such as discourse community. IS must relate to definitions made in other sciences, e.g., linguistics. Without doubt, some researchers use this concept in one way, and make empirical studies from that definition. Other scientists then criticize the concept for having unfruitful consequences and propose a new definition, etc. In this way research is a process which does not only build on given definitions, prepositions, and theories, but also tries to strengthen the foundation on which it is building. (This is the holistic principle advanced by the American philosopher William V. O. Quine. According to his theory, science is like a ship in a storm, which is being repaired during the sailing: You cannot take the ship on land and start from bottom.)

We have suggested some ideas to try to formulate a program that can measure the informational value of different subject access points (dependent variable) such as titles, abstracts, descriptors, references, etc. using knowledge domains as the independent variable. Moderating variable could perhaps be the professionalism of the author/originator (e.g., from junior to senior researchers) or the theoretical approach applied.

It seems clear however that such experimental work must be attended by qualitative research, e.g., tracking how specific theories, concepts etc. from one domain are penetrating other domains. Qualitative and quantitative studies, conceptual analysis, historical studies, and experimental work can hopefully inspire and supplement each other. An example can be given. If you are interested in the effectiveness of citation searching, you must have some theory about the act of citing: How do authors select those specific references, they have in their papers? Both statistical information about citation patterns in and across different domains and qualitative studies of citations are of interest.

Modern norms of citing behavior can be studied in

their historical development. The Swedish researcher Mustelin (1988) shows how researchers before 1500 were extremely lenient with their references, and often used text from other sources without indicating this. From the latter part of the 16th century, authors of scientific works tried to give their documents a greater evidential weight. This was partly achieved in the notes and references which authors added to their descriptions to make them look more reliable. This was first done by philologists and text publishers, who argued for warrant and references. Later followed historians and others. The application of references in scientific documents is an expression of what in the study of history is known as an important part of methodology: "criticism of the sources"/ "historical criticism."

Of course, on the most elementary level the principles of source criticism have today spread to all human, social, and natural sciences. This weakens the differences between different domains. But still important differences between attitudes and behavior toward the use and citation of sources can exist in different domains and determine the effectiveness of references as subject access points.

We hope that this example can illustrate the importance of the interplay between qualitative methods and theories developed by scholarly insight on the one hand, and more traditional statistical and experimental research in IR on the other.

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