

INFORMATION RETRIEVAL *I*NTERACTION

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Chapter 1

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The aims of this chapter are to outline the scientific landscape in which information science operates and to analyse its core substance.

Since the seventies, a new generation of information professionals and scientists has emerged, including the congregation of interested colleagues in the East European countries. This generation has not been trained by the pioneers of the field and thus demonstrates a keen interest in its foundation and development. In addition, R&D work in the field during the eighties seems to indicate a profound shift from focussing on the technological aspects only to viewing the human sphere in *interaction* with information technology as the main focus in information transfer.

This has implications for the interpretation of the historical dimensions leading to the present state of art in information science as well as our understanding of the function of information in society. In particular, the IR area becomes affected.

The chapter demonstrates the development of information science through three stages: its emergence prior to the Second World War, its search for identity and alliances during the sixties and seventies, and its establishment as a discipline during the period 1977–80. The scope and present state of the discipline is discussed, pointing to five major areas of concern for information science as well as a number of fundamental sub-disciplines.

1.1 The emergence of information science

Information science is a young discipline. The earliest formal use of the term information science dates back to 1958 when the Institute of Information Scientists (IIS) was formed in the UK. The use of the term information scientist may have been intended to differentiate *information* scientists from *laboratory* scientists, since the main concern of the members was with management of scientific and technological information (Farradane, 1970). The members were scientists from various disciplines, often highly distinguished, who devoted themselves to organizing and providing

scientific information to their fellow researchers in R&D institutes and industry. This fact provides us with important clues as to the understanding of the emergence and development of the discipline.

By naming themselves information scientists the members of IIS obviously wanted to stress the importance of the study of (scientific) information and the *processes* involved in *scientific communication*. Hereby their work was a continuation of previous scientific attempts to deal with problems of organisation, growth and dissemination of *recorded* knowledge, carried out before the Second World War. First H.E. Bliss (1929) published his studies in the organization of knowledge, preparatory to developing his bibliographic classification, carrying an introduction by the philosopher John Dewey.

A second area of intellectual investigation in documentation was opened up with the quantitative study of bibliographic production. S.C. Bradford (1934) first drew attention to a *bibliometric* distribution that has since been widely studied. Slightly earlier, other statistical means were applied to measure productivity in the form of publication ratios among scientists, by A.J. Lotka (1926), as well as to word frequencies in texts, by G.K. Zipf (1932).

Third, during the thirties, *social survey methods* were first applied to studying the use of books and libraries (Waples, 1932). The Indian mathematician S.R. Ranganathan initiated the formulation of his 'five laws of library science' at the same time. He himself stressed that the laws were not scientific generalizations but norms, principles, guides to good *practice*: 'every reader his book'; 'books are for use'; 'every book its reader'; 'save the time of the reader, and of the staff'; 'a library is a growing organism' (Ranganathan, 1957). The latter principles predict information management as an important aspect of information science. Recently, the original texts have been published in a collection edited by A.J. Meadows (1987).

However, the notions 'book' and 'practice' demonstrate the influence of the *current information technology* on the actual handling and accessing processes of recorded knowledge; the fact that all methods and theories applied to these processes, during approximately five millennia of clay-tablets and paper techniques, encouraged the development of principles and skills of a practical nature. Traditionally, the agents of these processes are librarians and documentalists. Their trade is librarianship (library science) and documentation. Exactly at a point where information technology went through a fundamental change with the application of computer technology, information science was born. Librarians typically organize, analyse and provide access for all kinds of users to the contents of documents. Documentalists do the same thing, but tend to exploit a wider variety of media and formats and traditionally limit their work to scientific-technical documents and users.

Information scientists emerge mainly from the ranks of documentalists, being aware of the wider aspects of scientific investigation of the processes of generation, representation, management, retrieval and use of information.

It is the increasing problems of both physical and intellectual access to a very fast growing body of (scientific) knowledge in the form of the 'document explosion' since 1945, coupled with the increase in the complexity of problem-solving at all levels throughout the world and the opportunities offered by the new information

technology, that gave birth to the discipline. Ranganathan's principle 'every reader his book' is forced to change, carrying more qualitative and specific dimensions to it: 'the most *relevant* piece of text to each reader'. The problem of relevance will never cease to be under investigation.

During two decades, 1958–1977, information scientists as well as researchers from other fields attempted to establish the core areas of research in information science and to define its boundaries to other disciplines. They were helped by the fact that other related fields, such as information theory, the systems sciences, and computer science, emerged a short while earlier or at the same time. This may seem a paradox since these post-war disciplines all have in common the handling of data in various ways by the same new technologies. Do they leave space for information science? At a first glance independence seemed difficult. By evolving from something apparently so trivial and hence not a science, i.e. the practice of documents and the skills involved, information science gave (and still gives) cause for discussion. In contrast to the other new fields, information science did *not* emerge from a well-established major scientific domain, such as electrical engineering, mathematics or physics. This lack of an independent theoretical foundation is outlined by B.C. Brookes in his introduction to the Popperian ontology and its relevance to information science. He states (Brookes, 1980, p. 125):

Theoretical information science hardly yet exists. I discern scattered bits of theory, some neat in themselves but which resist integration into coherence. So there are no common assumptions, implicit or explicit, which can be regarded as its theoretical foundations. Information science operates busily on an ocean of commonsense practical applications, which increasingly involve the computer... and on commonsense views of language, of communication, of knowledge and information. Computer science is in little better state.

On the other hand, in most of the new computer dependent fields debates concerning the nature of 'information', 'knowledge' and epistemological issues, as well as the intermingling of theories and between fields, took place during the same period (Machlup, 1983). These discussions support an *interdisciplinary approach* to all the fields, which again provide a framework for an understanding of the theoretical and applied objectives and limits. The situation from 1958 and onwards can be illustrated by Figure 1.1.

The problems for information science with respect to its borderlines with other disciplines are mainly found at interdisciplinary level, less often at the disciplinary level. A core dimension noticed by other fields, is that information science actually is the one which studies large *text* entities containing preserved knowledge – with more interest in solving theoretical and practical problems of its organisation and representation in systems for later retrieval and use on demand, than in the technology itself; the latter being the means to the former. Consequently, important areas of common interest between information science and other disciplines may develop. One may state that its *applied level* contributes to its recognition.

More important, during this period information science starts producing research results and theories of its own. These are often of high relevance to other disciplines, for example to computer technology applications in medicine, engineering and

chemistry, in relation to text indexing, retrieval and transfer. The research efforts are carried out by applying, some may argue by leaning heavily on, a number of established theories from various fields.

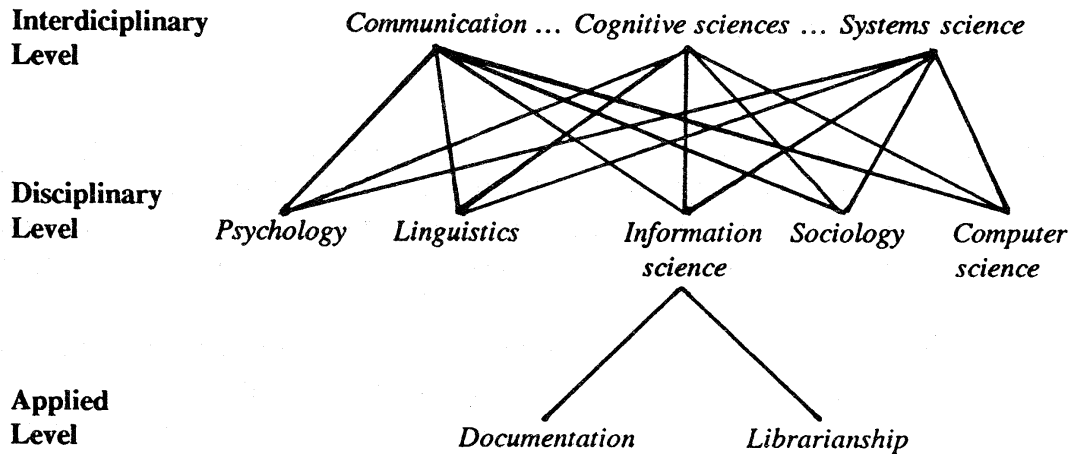


Fig. 1.1. Information science viewed as one of several sciences of information (Ingwersen, 1991, p. 3).

For instance, the behavioural sciences contribute on the methodological side, and provide a framework for understanding the use of information in the context of society (Wersig and Neveling, 1975). Slightly earlier, G. Wersig applies communication theory to model knowledge transfer (Wersig, 1971). Partly based on communication, partly on statistics, E. Garfield explores and develops his quite unique theories and techniques of citation analysis in science (1979). Linguistic theories concerning syntactics and semantics provide the bases for theories and developments of text representation and retrieval (Spark Jones and Key, 1973). C.E. Shannon and W. Weaver's quantitative formulation for the coding and transmission of signals in a message (1949) have a recognized influence on theory construction. R. Fairthorne applies it, as well as communication theory, to producing his classical Notification Hexagon consisting of the interacting elements in an information system (1967), later further developed by C.N. Mooers (1974). Its mathematical possibilities and relevance to information transfer are analysed by M.F. Lynch (1976) and reviewed by P. Zunde and J. Gehl, who concentrate on problems of aggregation of information, information decay, information measures and performance criteria, and extension of information theory (Zunde and Gehl, 1979).

These approaches to theory generation, although rather scattered and not providing one coherent foundation, support the recognition on a disciplinary level of the nature of information science and its relations to the interdisciplinary fields mentioned.

This analysis leads to the observation that *library science* is a special R&D activity within information science. Library science, in the author's opinion, is concerned with the information processes that takes place *in libraries*. As such, library science becomes a special case where for instance information retrieval is called reference

work and information management is named library management. A similar special case is ‘documentation theory’, which mainly is concerned with generation, transfer and use of scientific information.

1.1.1 *Alliances, identity or exaggeration?*

As can be expected, the flow of theories and viewpoints between the disciplines, horizontally on the disciplinary level and vertically from the interdisciplinary level downwards, Figure 1.1, creates various attempts during the period for information science to merge with other fields – or to be merged – in order to manifest a stronger scientific position.

Two major trends are visible: a vertical move towards *communication*, and an attempt horizontally to merge with *computer science* into *informatics*.

Communication theory, which concerns itself with the role of language, the nature of movement and other means for conveying meaning, is perceived by some scientists not only to contribute to, but to be the meta theory for information science. This has been suggested and discussed by T. Saracevic (1970b) and W. Goffman (1970a).

This trend does seem logical in the sense that transfer of recorded knowledge involves transactions and communication of meaning between humans, and between humans and systems containing conceptual structures. Fairthorne’s notation scheme, Wersig’s socio-communicative views, research on scientific communication and several approaches to information retrieval and indexing demonstrate this allegiance to communication. The relation seems reinforced during the eighties under the influences of a more user-oriented research view and the cognitive sciences (see Chapters 5–7). As a consequence, some US faculties of communication and library and information science did merge from the mid-eighties. Basically, the allegiance mainly suits the researchers studying the behaviour and interaction of the human elements of transfer of recorded knowledge.

In contrast, some information scientists, mainly focussing on systems and information technology applications in relation to knowledge organisation and transfer, demonstrate a drive towards *computer science*. H. Wellisch analyses this possibility (1972) and S. Gorn actually advocates a merger between the two fields into *informatics* (1983). This notion is close but not identical to the French ‘informatique’ which in general designates a wider range of information technology applications, with emphasis on their technological aspects. Very recently, Zhang Yuexiao discusses the definitions of information sciences (1988). In his analysis he states that there is “not any real justification to replace computer science by information science or informatics”, although he allows for a renaming into ‘computer and information science’ (p. 483–485). In fact, it might have been logical to join the information retrieval, representation and management elements from information science with the software and AI sides of computer science – from a computer science point of view. Certain computer departments in universities in the

UK and USA do incorporate the information retrieval elements in their curriculum and R&D activities, e.g. Amherst, Massachusetts and Glasgow.

The problems for information science would in such a case consist of maintaining its behavioural aspects and links to practice in librarianship and documentation. However, the subfields mentioned from the two disciplines increasingly cross and cooperate, e.g. as shown by Wormell (1988) and in several ESPRIT projects. For example, the KIRA (Esprit 1117) and the SIMPR projects (Esprit 2083), involving AI theories for knowledge-based systems design. The KIRA project (Knowledge-based Information Retrieval Assistant) builds on theories for intermediary performance as well as thesaurus theory; SIMPR (Structured Information Management: Processing and Retrieval) takes advantage of classification and indexing theories originating from information retrieval. The close ties between computer science and information science are mainly demonstrated by the Informatics conferences starting in 1973, and the initiation in 1978 of the yearly ACM-SIGIR conferences.

'Informatics' unfortunately also carries another meaning to it. Since 1968 the Russian key-figure in documentation, A.I. Mikhailov designates 'informatics' to the study of scientific communication and knowledge transfer, i.e. to contain the theoretical level of documentation alone (Mikhailov, Chernyi & Giliarevskii, 1968). The effect on East European information science research is notorious.

The most coherent proposal for a merger with computer science, as well as other interdisciplinary fields, originates from the Swedish systems scientist K. Samuelson, who created a department based on these principles. Cybernetics, including communication and control, and the systems sciences are seen as closely related metadisciplines to informatics, which incorporates the information and computer sciences as well as information technology. The well argued suggestion is called SCI, Systems, Cybernetics, Informatics (1976).

In parallel to the described trend to relate closer to various fields or theories, the major part of the information science community attempts to solve the identity problem on its own. Several research conference proceedings as well as individually published studies contain titles that mirror the striving for consensus in information science, for instance: *Information science: discipline or disappearance?* (Goffman, 1970b); *Information Science: Search for Identity* (Debons, 1974); *Perspectives of Information Science* (Debons and Cameron, 1975); *The fundamental problem of information science* (Brookes, 1975); *Information: one label, several bottles* (Fairthorne, 1975); *Towards a true information science* (Farradane, 1976).

Aside from demonstrating a struggle and a wish for coherence, the cited titles cover a great number of valuable research works and contributions to the understanding of specific elements of the generation, organisation, retrieval, transfer and use of information.

In retrospective, however, this fragmentation and specificity of research interests and scientific background knowledge among scientists in reality produced effective obstacles for the achievement of an independent consensus at a disciplinary level. Debons, a leading US information scientist during the entire period may have sensed this problem very accurately when in 1977 at the 2nd IRFIS Conference in

Copenhagen he analyses the situation. In a critical essay he proposes *informatology* as a meta-science (Debons, 1980), based on suggestions put forward already (Otten & Debons, 1970).

He operates within two frames of reference concerned with issues of the foundation for information science. The first frame regards information science as that body of understanding which concerns, for instance, scientific flow of knowledge or the organisation of information for better retrieval. To Debons this formulation looks for practical (applied) solutions, mostly through the establishment of new procedures and technologies.

The second frame of reference regards information science as directed towards an understanding of the 'phenomenon of information' – discovering fundamental laws governing the experience. He calls this the 'science of information' – *informatology*. He defines it "as a process leading to a 'state of the information system'". In practice, these two frames are intermingled although their respective foundations may not be the same. Debons continues to propose a step toward resolving the confusion, also stated by Brookes previously, by viewing information science as based on three primary factors concerned with the functioning of organisms: "the creation or generation of states (*generation*); the ability to use states in the accomplishment of tasks (*utilization*); the capacity to convey to other organisms indications of our states (transfer or *communication*)".

To Debons the human organism is a model information system, and he strongly advocates that it is the *interrelationship and interaction* of the three functional factors that constitutes the system, not the three separately conceived.

In the author's opinion, he *exaggerates* the goals and value of information science. When he attempts to lift it up above the disciplinary level, Figure 1.1, he encompasses other established disciplines. Debons' first frame of reference refers clearly to the applied level. His second reference frame, however, places the 'phenomenon of information', i.e. the object of information science, at a level already occupied by other disciplines and theories that are concerned with "information as a process leading to a state of the information system". For example, the cognitive sciences, the systems sciences, and epistemology. There does not seem to be any space nor any justification for 'informatology' (or science of information) at this level. The author finds it more fruitful to apply Debons' proposal to information science at a *disciplinary level* only. The condition for a disciplinary level is to accept an understanding of the phenomenon of information, as well as the interaction of the three functional factors constituting the system, in the context of *recorded and demanded knowledge* or experience.

The reason for analysing Debons' view rather carefully is that, with this minor modification or reinterpretation, it does point towards a common understanding and provides an identity for the field. It makes visible what information science ought to study concerning the generation, communication, and utilization of information (see Figure 1.3). Also, it justifies from which other disciplines (dealing *separately* with the three fundamental factors) the field may receive or provide valuable contributions: psychology, linguistics, communication, computer science, etc. (see Figure 1.2).

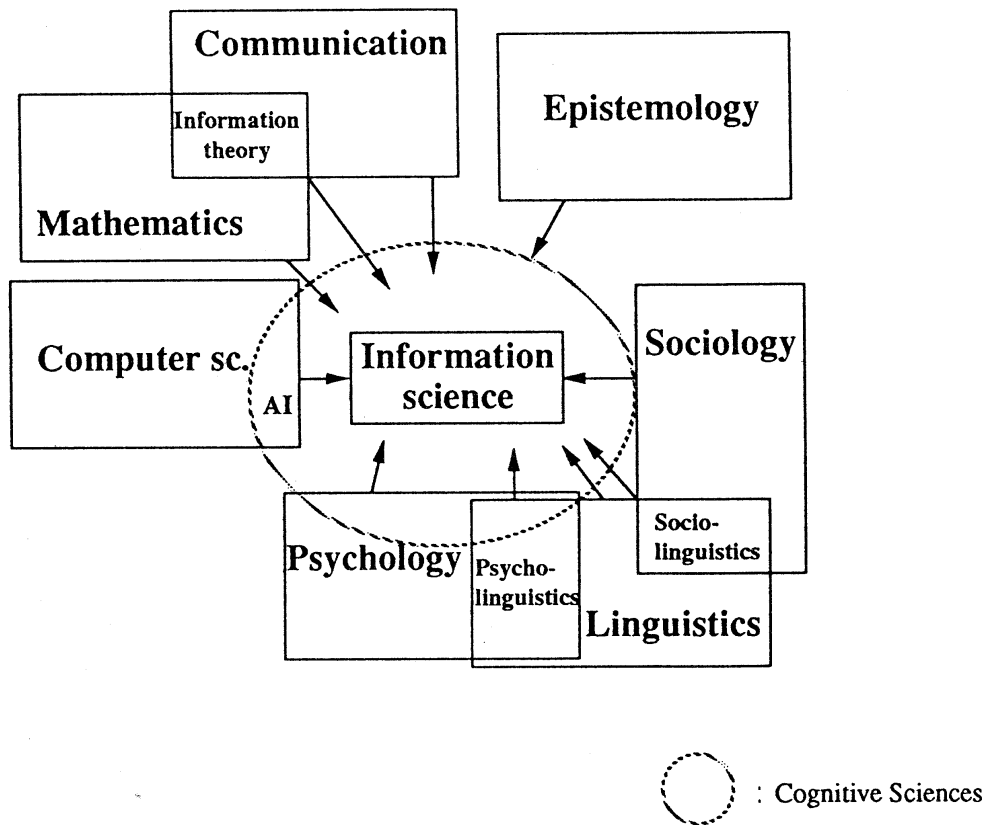


Figure 1.2. Scientific disciplines influencing (->) information science (Ingwersen, 1991, p. 7).

This tendency to *exaggeration* has made information science more vulnerable than the fragmented and incoherent theory developments mentioned earlier – and it still is. For example, it makes little sense when B.C. and A. Vickery very recently widen the scope of information science to be “the scientific study of the communication of information in society” (Vickery and Vickery, 1987, p. 11), thereby postulating an umbrella-role, for example covering mass-communication, which it cannot fulfil.

Previously, Figure 1.2 has been published in slightly different versions (Ingwersen, 1984c, p. 84; 1986, p. 208). The arrows designate from where information science mainly obtains inspiration and theoretical input as discussed above. Disciplines like AI, becoming influential in the eighties, are included. The reason for exhibiting the cognitive sciences, understood as the intersection of linguistics, artificial intelligence (AI) and psychology, as stated by Shank and Abelson (1977), is to stress a direct influence of these fields mainly in relation to information retrieval (IR). In this respect information science can be seen basically as a cognitive science, as outlined in Chapter 2.3.

1.1.2 *The turning-point 1977–1980*

What seems to emerge between 1977 and 1980 is an identity, and the scope which was searched for during previous decades. Several significant publications on the matter provide profound analyses that indicate the turning-point for information science as a discipline. It becomes more mature and well-defined.

The first to appear was an analysis of the understanding and use of the concept of information as seen from an information science point of view, by Belkin (1978). As can be expected, the interpretation and different use of the concept is rather scattered, depending on the scientific viewpoint and the research area in which the concept is applied. The paper suggests a scheme for the requirements of an information concept for information science. In addition, it outlines a framework for information science which is discussed and elaborated in greater detail in Chapter 1.2.

A second publication is the introduction of Karl Popper's ontology as well as the cognitive view, by B.C. Brookes (1977, 1980). Brookes argues that Popper's 'Three-world model' provides a framework for understanding the nature of information science. In the Three-world model World 1 consists of nature and human, physical artefacts, such as buildings, books or computers. World 2 is 'subjective knowledge' within the mind of individuals, and World 3 consists of 'objective knowledge', i.e. recorded knowledge, mainly generated by humans (Popper, 1973). The difference between World 1 and World 3 can be illustrated by the sentence "this was really a heavy book". Brookes claims that the world of 'Objective knowledge' in particular, World 3, consists of characteristics of major interest to information science. He relates the cognitive view to the Popperian model in order to admit the concept of information and its relation to subjective and objective knowledge. Brookes' contribution – his Fundamental Equation – is discussed in Chapter 2.2.1.

In his view, the "theoretical task [for information scientists] is to study the interactions between Worlds 2 and 3, to describe and explain them if they can and so to help in organizing knowledge rather than documents for more effective use" (Brookes, 1980, p. 128). This observation is obviously correct and useful in the sense that it may explain what information science and librarianship *should do*, but have not yet achieved. It is with respect to knowledge accessibility, acquisition and representation that Popper's ideas seem most relevant. Concerning these aspects Ingwersen points out (1984c, p. 89–90):

... that hitherto we have seldom succeeded in allowing for *direct intellectual access* to the potential information or objective knowledge. Most information retrieval systems point to documents or parts of documents, giving *physical access*, or at maximum *bibliographic access* via representations, to World 1 objects, i.e. to artefacts like articles, books, reports, etc. placed in remote archives.

This so-called 'tri-partite conception of accessibility' and the serious problems involved are further discussed by Wormell (1985).

Brookes goes further in using the Popperian ontology and rather exaggerates the potentiality of information science, by claiming World 3 forms "a territory which no

other discipline has already claimed” (1980, p. 128). For many decades, however, both in psychology, history, history of science, and literature, researchers have analysed World 3 and the specific phenomena of interaction with World 2. Its uniqueness for information science lies in the theoretical way of *organizing* the world of objective knowledge *for intellectual use* by World 2 – well aware that World 3 almost totally originates from individual, subjective knowledge. Brookes’ interpretation of Popper’s ontology gave rise to discussions among information scientists for several years (Neil, 1982, 1987).

Another valuable and well known interdisciplinary contribution, mainly from information scientists themselves, is the proceedings, edited by A. Debons, of the Third NATO Advanced Study Institute held at Crete 1978. The title: *Information Science in Action: System Design* (Debons, 1983) indicated the progress achieved to that date in the field. The conference viewed information systems and their design in a context of information science. There were essentially four major focal points: 1. examination of the understanding of the meaning when talking about the design of information systems; 2. ideas about the knowledge about information systems and their effectiveness; 3. examination of the systems’ impact on people and institutions, e.g. regarding issues of privacy, copyright, censorship; 4. problems concerned with the human resources that are critical to the design of information systems. The collection of papers includes reports of empirical investigations pointing to future developments up through the eighties. At the same time, but with a wider scope, C. B. Griffith edited a collection of key-papers in information science (1980).

Finally, the author wishes to point to a significant publication, edited by F. Machlup and U. Mansfield (1983): *The Study of Information*. It provides in-depth interdisciplinary analyses of approaches to information, as well as foci and scopes with respect to various disciplines, such as cognitive science, computer science, library and information science, linguistics, cybernetics, information theory and systems theory. Further, each discipline attempts to relate to information science. This highly communicatively designed publication, produced from 1980–83, put information science into perspective.

The publication includes two contributions on what information science should do and should not do, by J.H. Shera and M. Kochen, both highly distinguished scholars. Shera’s analyses focus on information science from a librarian’s point of view, whilst Kochen discusses the field from an information science approach. Shera advocates the establishment of a scientific discipline mainly dealing with ‘symbolic interaction’, also called social interaction. He outlines a scenario in which information science operates at theory-level, seen as the theoretical foundation to librarianship (Shera, 1983). He looks upon the field with the *social role* of the library profession clearly in mind, denouncing both the “marking and parking” syndrome typical of document retrieval in libraries, and the computer and data-driven nature of information science in that period. However, Shera does not talk about ‘information’. His idealistic view, or hope for the survival of the profession, is hardly operational – more associated with library science than information science.

Kochen, from his point of view, is more straightforward. He finds it fruitless to engage in semantic disputes over when the discipline of information is not

epistemology, psychology, biopsychology, and so forth. “What matters is that investigators who identify with the information disciplines, formulate researchable problems and make discoveries, and contribute insights that clarify the nature and dynamics of information and knowledge” (Kochen, 1983, p. 371). Like Shera, he disapproves of librarianship, library science, documentation, and information science understood in a narrow sense, i.e. focussing solely on written records and the physical documents and processes. From a more psychological view he defines information science in a broader sense, concerned with information, knowledge, and understanding, i.e. essentially with *meaning* as perceived by a receiving mind and embedded in such physical entities. This definition by Kochen leads directly to the present conception of information science.

1.2 The scope of information science

The formulation of the problem and the phenomena which information science hopes to solve is of basic significance. It is through the establishment of this problem that the precise area of systematic, scientific investigation can be specified, and the assumptions governing that activity developed. Drawing upon previous statements by Wersig and Neveling (1975) and Belkin and Robertson (1976), N. Belkin formulates that problem to be (1977, p. 22; 1978, p. 58):

Facilitating the effective communication of desired information between human generator and human user.

In the author’s opinion, the crucial notion is *desired information*. We are here explicitly speaking of a purposeful wish for information. The emphasis is on the quality of the interaction between generators and users of recorded information.

The statement implies the study of the users’ *reasons* for acquiring information, recorded in systems of various kinds, the processes of *providing* desired information to users *qualitatively*, and the processes of *use* and *further generation* of information. We are dealing with *all kinds* of users as well as knowledge levels in these processes which basically involve all types of means of recording. Hence, information science is limited to studying specific phenomena of communication, not all communicative processes, as suggested by Debons and Vickery. Neither should it concentrate solely on the means of recording and communication, e.g. IT applications.

Belkin outlines five areas of concern for information science, based on the problem statement formulated above (Belkin, 1978, p. 58):

1. [transfer of] information in human, cognitive communication systems;
2. the idea of desired information;
3. the effectiveness of information [systems] and information transfer;
4. the relationship between information and generator;
5. the relationship between information and user.

Ingwersen (1986) points to these five major areas of study, and develops their substantial impact on information science (Ingwersen and Wormell, 1990b):

The first area deals mainly with formal and informal transfer of information, for instance scientific communication or information flow within institutions. The second area seeks to understand the generation and development of needs for information, within society, among specific groupings of people or individually. It is the nature of and reasons for desired information which is the focus of attention, *those reasons being problem solving or fulfilment of cultural, affective or factual goals.*

The third area studies methods and technologies that may improve the performance and quality of information in information systems. Further, this area is concerned with the development of theories and ways to ease the transfer processes of information between generators and users. The area is closely linked to the fourth area of concern, which deals with generated knowledge and forms of its analysis and representation in (text) information systems. Here we find theoretical and empirical approaches to indexing and classification, as well as theories concerned with measurements and distribution of R&D production. The fifth major area of study has its focus on the relevance, use and value of information.

Belkin's problem formulation and areas for study are attractive, exactly because of the explicit statement of foci for present and future research, demonstrating both sociological and individual psychological dimensions. Debon's suggestions of interactivity between generation, communication and use of 'states', Kochen's psychological dimensions, as well as Shera's much more social approach to information interaction and transfer, are made operational.

The five major areas, illustrated in the two-dimensional Figure 1.3, may be studied separately or in combinations. In the author's opinion they form a framework within which information science develops important sub-disciplines:

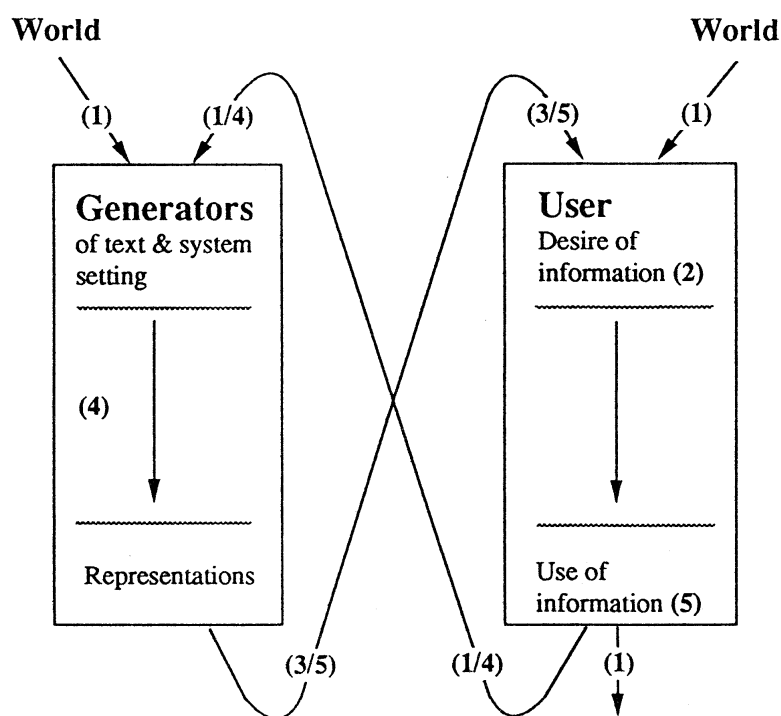
Informetrics, i.e. the quantitative study of the processes of communication of information, such as co-citation, is mainly concerned with the areas 1 and 4.

Information management, incl. evaluation and quality of textual and other media-based IR systems, is basically concerned with the areas 3 and 4.

Information (retrieval) systems design which belongs to areas 3, 4 and 5.

Information retrieval interaction is fundamentally concerned with the study of information processes in areas 2 through 5.

In Figure 1.3 the arrows refer to relations between or within generators and user associated with the processing and transfer of information. Numbers in brackets refer to the study areas described above. To the left there are the generators of texts, graphics, etc. as well as system features and their forms of representation in (text) information systems (4), e.g. in the form of database structures and indexing terms. To the right the user may transform his desire for information (2) into a solution and use (5) by obtaining relevant information from a system (3/5). Below to the right the user may decide to become generator and communicate something to the world (1), for example as author of text or as painter (1/4). The user and generators may communicate with, and be influenced by, the world around them (1).



text = text, graphics, pictures, sound

Fig. 1.3. Major areas of study in information science. Numbers in () refer to Belkin's (1978) five areas (Ingwersen, 1991, p. 10).

In the author's opinion, research and development work carried out since the end of the seventies in information science demonstrates the validity and actuality of these major study areas as well as the outlined sub-disciplines.

1.2.1 Current and future trends

To summarize what seems to form the kernel around which information science currently is developing and to demonstrate its new challenges one may point to certain trends, made visible during the very recent CoLIS Conference on Conceptions of Library and Information Science (Vakkari and Cronin, 1992). They are all in strong connection to a more *human-driven approach* to information transfer, i.e. the transfer processes associated with the right hand side, Figure 1.3. A strong overall trend seems characterised by a move of research interest from access-orientation towards accessibility *and* use of stored knowledge or knowledge representations (Ingwersen, 1992a). This may reinforce a rather *holistic* approach to all the areas (Figure 1.3), in particular the areas 1, 3 and 5, i.e. communication, management, and evaluation as well as the use of information.

The scope of information science expands at present into society, and the discipline is reaching a critical junction in its evolution, in line with related fields such as computer science, informatics and the cognitive sciences (Saracevic, 1992). This move thus entails far more interest in the use and transformation of information into knowledge on both individual and societal level, i.e. the areas 1 and 5. A similar trend concerns the quantitative study of the communication of information, *informetrics*, recently defined as the meta-concept for bibliometrics and scientometrics (Tague-Sutcliffe, 1992). A central challenge ahead is to develop and make operational new *qualitative evaluation criteria*. This implies the replacement, or at least the extension, of relevance and utility measures by functional use, quality and value, selectivity and strategic importance assessments, i.e. the areas 3 and 5.

The following specific trends are demonstrated in the information science R&D literature as well as during recent conferences and workshops, pointing to the future:

1. a strong requirement for making the technology fit the human;
2. a shift from focussing on 'documents' and 'text' to aiming at 'information' transformed into 'knowledge' by means of all conceivable media;
3. a shift from understanding information as purely scientific towards 'information' understood in a broad sense, as a critical and strategic asset to individuals and society;

The background for these changes is recently argued by Wersig, by introducing the concept of *knowledge for action* by actors (Wersig, 1992). Knowledge for action follows up Saracevic's historical views (1992) and signifies an extension of Wersig's earlier work on the reasons for desire for information (1971, 1973), further discussed in Chapter 2.2.

By placing the focus on the human sphere (trend 1) as well as on transformations of information into knowledge via a multitude of media (trend 2), and dealing with a wide range of information types (trend 3), the *intentionality* behind and use of such transformations becomes increasingly important to information science. Evidently, reasons for a desire for information cannot be confined to problem solving issues alone, but must eventually also involve cultural and emotional goals or interests.

These trends walk hand in hand with the focus on 'accessibility *and* use'. This issue clearly involves research areas that are under rapid development at present: the problems related to technology applications; and the modelling of information processing and retrieval. The challenge is that one now has to deal with such rational matters in a holistic fashion, achieving a realistic balance between technology and man. Hence, the recent expression *information ecology* (Capurro, 1992).

This highly complex scenario introduces a certain degree of *uncertainty*. It becomes profoundly uncertain which elements of various types of information inherent in a both highly structured and virtually unstructured world of stored potential information may be of most strategic importance to often vaguely defined intentionality underlying often ill-defined requests for information – information that finally is supposed to become usable knowledge in a given situation. Hence, present and future theory building in information science will have to introduce and consider ways that allow for *cognitive dynamics of information* in order to meet the demands from a rapidly changing world of actors.