Reviews of Concepts in Knowledge Organization

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Library and Information Science (LIS), Part 1†

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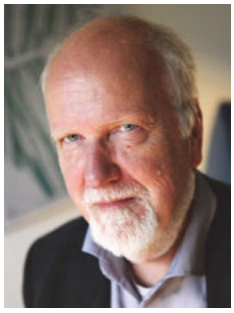

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Abstract: This article outlines the history of library and information science (LIS), from its roots in library science, information science and documentation. It considers various conceptions or "paradigms" in the field and discusses the topical content of LIS as well as the relationships between LIS and other disciplines. The main argument of the article is that answers to all such questions concerning LIS are related to conceptions of LIS. It is argued that an updated version of social epistemology (SE), which was founded by Egan and Shera in 1952, may in hindsight provide the most fruitful theoretical frame for LIS. SE is related to the domain-analytic approach, which was suggested by Hjørland and Albrechtsen in 1995.

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1.0 Introduction

This article considers library and information science (LIS) as a field of study (a discipline or an inter-discipline). It is written from the viewpoint that it is important to focus not only on the specific problems of a domain but also on its identity and organization. Researchers in fields such as LIS and knowledge organization (KO) must consider whether they fall under the aegis of computer science or of humanities and social sciences;[1] a neglect of this issue may lead to a fragmented field which does not contribute to either aspect. A discipline (or inter-discipline) is an organization that supports cooperation in achieving common goals and sharing disciplinary journals, conferences and institutions, among other things. As this article will show, questions such as "What is LIS?," "What are the topical content areas of LIS?" and "What are the related disciplines?" are rather complicated, as described by Hjørland (2017c, 1797):

> The overall situation in information science [/LIS] today is a chaos of theoretical contributions, each paying no or much too little interest in the existing ones, what Åström (2006, 20) after Whitley (1984) called a "fragmented adhocracy," a field with a low level of coordination around a diffuse set of goals.

It is important, however, that we intend to shape an identity, and, therefore, are concerned with the field in which we are working. The topic of the article is complicated and even controversial, and although the attempt is made to present many different voices, it is not possible to present all different views, much less to be completely neutral. The article is intended, however, to present a broad view of the field that may be useful for further studies and debate.

There have been voices from within KO claiming that KO is not a part of LIS, but is an independent discipline. However, the present article is written from the viewpoint that KO is a subfield of LIS, and that the history and theoretical issues of LIS are therefore important for researchers in KO to consider.

2.0. Brief history

Library and information science is, as the name implies, a combination of two fields: i) library science; and, ii) information science. The joint term is associated with schools of library and information science (SLIS). The first use of this combined term was in the School of Library Science at the University of Pittsburgh, which added information science to its name in 1964 (cf., Galvin 1977). Thereafter followed other American library schools, and by the 1990s almost all former library schools had added information science to their names. A similar development has taken place in many other parts of the world,[2] although not all institutions have made the same choice.[3] This shift in naming has generally been motivated by a growing emphasis on the application of new electronic and computer technologies.

Sometimes the plural term library and information sciences is used to underline the fact that more research areas are involved. This is, for example, the case in the *Dewey Decimal Classification* and in Bates and Maack's (2010) *Encyclopedia of Library and Information Sciences*.[4] These authors list (xiii) the following disciplines as being covered by the LIS disciplines and by their encyclopedia:[5]

- Archival science
- Bibliography
- Document and genre theory
- Informatics
- Information systems
- Knowledge management
- Library and information science
- Museum studies
- Records management
- Social studies of information

Another variation is to speak of library and information studies, in order to emphasize that the field is not necessarily scientific in its strictest sense. A new tendency in the twenty-first century is to drop the word library and to use only the terms information school, i-school or iSchool. This is not, however, solely a new name for LIS but represents a new interdisciplinary merging of various fields including LIS.[6] Whether such a merging is considered fruitful or not depends among other things on the theoretical perspective (cf. section 5). For those who primarily consider LIS to be related to computer science, it seems to be clearly a productive solution; however, for those who consider LIS to be more related to the knowledge fields (such as philosophy, social epistemology (SE) and sociology of science) it may perhaps seem less successful. For more details on iSchools, see Lopatovska and Ransom (2016) and section 4.2 of this work.

In practice, the term LIS is sometimes used for an area that is not science (or research, a scholarship or an academic discipline); by implication, the term library and information science research may be used to make the research focus explicit[7] (e.g., Stielow 1994). Some studies of the field distinguish between professional publications and research articles, such as that of Tuomaala et al. (2014, 1451):

> In total, the study sample for 2005 comprises 1,024 articles, of which 70% were research articles and 30% professional articles. In the following subsections, only research articles are analyzed.

Even if studies are limited to research articles, it has been questioned whether the literature qualifies as research. Turcios et al. (2014), for example, found that only 16% of the literature published in LIS research journals qualified as research.

The status of LIS as a science has been discussed for many years. Librarian and researcher Carl S. Petersen (1915) wrote (translated BH; emphasis added):

> Library technique is a common term for the methods used for organizing, cataloging, use, and administration etc. of a library. Particularly in Germany the term "library science" is often used for both library technique as for other related disciplines (book history, bibliography, library history and library statistics); however, this term is not well chosen, because library management is not a science, *even though scientific knowledge and qualifications are necessary.*

Despite various trends towards merging the two fields, some consider library science and information science to be separate fields or disciplines, for example Miksa (1992) and Saracevic (1992). Moreover, ProQuest Dissertations and Theses Global (2017) still uses two different classifications: 0399: library science and 0723: information science.[8] Huang and Chang (2012, 790) wrote:

> Although the discipline of IS has been incorporated into LIS, numerous recent studies still focused on IS issues but not LIS ones … This implies that some researchers regard IS as an independent discipline. In addition, some subfields, including library service activities, cataloging, and publishing are traditionally regarded as belonging to LS (Järvelin and Vakkari 1993), while some other have closer ties with IS, such as bibliometrics, information retrieval, scientific communication, webmetrics, and patent analysis.

In general, however, the tendency today is to use the terms information science and library and information science as synonyms. [9]

2.1 Library science[10]

Gabriel Naudé's (1627/1950) *Advis pour dresser une bibliothèque* (*Advice on Establishing a Library*) was an influential work; it is probably the first modern treatise on library management and put forward modern rules of librarianship. However, in order to speak of library science as an organized activity, we must go further forward in history.

The term Bibliothek-Wissenschaft was used for the first time in the title of a German textbook (Schrettinger 1829), the first issue of which was published in 1808. Martin Schrettinger (1772–1851), Friedrich Adolf Ebert (1791–1834) and Karl Dziatzko (1842–1903) were the founders of library science in Germany. The first journal in the field was *Serapeum: Zeitschrift für Bibliothekswissenshaft, Handschriftenkunde und ältere Litteratur* (*Journal of Library Science, Manuscript Information and Older Literature*), published in Leipzig by T.O. Weigel in the period 1840–1870.

Schrettinger (1829) (translated definition cited from Schrader 1983, 36) held that library science encompasses "all precepts necessary to the practical organization of a library, provided that they are based on sound principles and reducible to one supreme principle [namely, that] a library must be arranged in such a way as to render speedily accessible whatever books are required to fill every literary need." Schrettinger's book is a systematic treatise on the principles of librarianship.

In the USA, Melvil Dewey (1851–1931) founded the first School of Library Economy[11] in 1887 and received the title of professor. Although this particular school ran into difficulties, possibly because women were thereby allowed access to academia, Dewey was able to transfer the school to the New York State Library in Albany in 1889; since then, many library schools have been founded in the United States and Canada and around the world.

For both the European and the American schools, it has been discussed whether the term science is misplaced. Vakkari (1994) writes that the scientific nature of Schrettinger's book is, to say the least, debatable (if the term science is understood as a systematic body of knowledge formed by the scientific method, consisting mainly of theories), and that it was "professional literature, not science."[12] Miksa (1988, 249) found, however:

> Early library education, including Melvil Dewey's School of Library Economy at Columbia College, has traditionally been thought to have emphasized vocational-technical skills rather than substantive intellectual issues. New evidence for the first two lecture sessions of Dewey's school raises questions about that view. The schedule of the school, its faculty (including regular Columbia College professors), and the way the school's topical content of library economy and bibliography was approached strongly suggest an educational venture with unexpected intellectual substance. More evidence is needed before extrapolating these findings to early library education in general.

However, the following quote from Stielow (1994, 338) is probably more representative of the view of library research:

> The remaining questions on library services were deemed too practical and obvious to merit a scholarly distinction. Even advanced skills in cataloging and classification were not acknowledged as a potential research base. The service and applied nature of librarianship simply did not coincide with the definers or their definition of a true "scientific" discipline. In truth, the general climate of opinion and practical needs of the library pioneers may have blinded them to the full measure of Naude's vision. They may not have seen scientific research in librarianship as a mark of a profession. One can also hypothesize that the growing identification of library work with women further reinforced the male-dominated academy's denigration of any research potential for librarianship.

The term library science was also used by Lee Pierce Butler (1884–1953), a prominent educator at the University of Chicago's Graduate Library School, which was the first doctorate-granting library school in the United States. Butler authored a programmatic essay entitled "An Introduction to Library Science" (1933). Cronin (2004) considers the historic and contemporary import of Butler's book, characterizes the content of each chapter, and critically analyses the central theses. He relates Butler's positivistic premises, assumptions, and conclusions to the congeries of competing epistemological and ideological standpoints that define current thinking in LIS research, and con-

cludes, contrary to Butler's conceptualization of the field, that "There is, and can be no such thing as 'library science'" (Cronin 2004: 187), thus denying the possibility of a discipline of that name.[13] Wersig (1992, 2002), also rejected the term:

> There is little proof that specific kinds of organizations provide a sound basis for a scientific or academic discipline. As long as there are no disciplines like "hospital science" or "jailhouse science" in existence, something like "library science" is not very convincing.[14]

Reitz's (2004) online dictionary defines library science as:

> The professional knowledge and skill with which recorded information is selected, acquired, organized, stored, maintained, retrieved, and disseminated to meet the needs of a specific clientele, usually taught at a professional library school qualified to grant the postbaccalaureate degree of M.L.S. or M.L.I.S. The term is used synonymously in the United States with librarianship. Compare with information science.[15]

Note that library science and librarianship are here considered synonyms, again indicating that we are not necessarily speaking about a science or a field of research.

In schools of librarianship, the processes that librarians were supposed to master (each of these subfields has its own huge subject literature) were taught, in particular:

- Material selection;
- Collection building and collection management;
- Cataloging and classification of documents;
- Reference work, bibliography and documentation
- Subject literature of specific domains: humanities, social sciences, science and technology;
- Fiction;
- Literature for children and other special groups.

Other important subfields include:

- Library history;
- The social function of libraries.[16]

For some subfields, such as library history, library architecture, and library administration, the term library science is meaningful. However, the knowledge needed to organize document collections and search for documents and information is not specific to libraries. The term documentation (and, later, information science) therefore became influential in the field.[17]

2.2 Information science

The term information science has been traced back to Jason Farradane (1906–1989) in an article (Farradane 1955) about the education of information scientists, a term introduced by Farradane (1953), which he considered a synonym for documentalists.[18] Fields such as library science, the science of bibliography, scientific information, and documentation were predecessors of information science, as pointed out by Kline (2004, 19):

> Called bibliography, documentation, and scientific information during the first five decades of the twentieth century, the field became known as information science in the early 1960s.

One of the most important indicators of the relationship between documentation and information science is the change in name of the American Documentation Institute (founded in 1937) in 1968 to the American Society for Information Science.[19]

What then, if anything, was new in information science? Proffitt (2010) noted about the *Oxford English Dictionary*'s coverage of the word "information:"

> The Supplement's editors identified and included many of the earliest compounds evoking the sense of information as data, something to be stored, processed, or distributed electronically: information processing, information retrieval, information storage (all three dated from 1950). In quick succession came terms relating to the academic study of the phenomenon, appearing in a neatly logical sequence: first the idea (information theory, 1950), next its budding adherents (information scientist, 1953), then the established field of study (information science, 1955).

According to Proffitt,[20] Shannon's (1948) so-called information theory[21] was the reason for establishing information science about seven years later. There is little doubt that: i) Shannon's theory was extremely influential in an interdisciplinary sense in the 1950s; ii) many people in fields related to library science and documentation hoped at that time that the field had finally found a fruitful theoretical basis in Shannon's theory; and, iii) later on, most of these hopes that Shannon's theory could fulfill this role in information science were greatly frustrated. In hindsight, Shannon's theory stands out as one of the least influential paradigms in the field, one that has often been described as a blind alley, although an extremely important theory in computer science, due to which Shannon has been called the father of the digital age (cf., Aftab et al. 2001).

In the years following 1955, there was much talk of the information explosion[22] and the need to apply information technology to manage this explosion. The term information storage and retrieval (ISR) was common (cf., Hjørland 2015b) and is probably derived directly from Shannon's (1948) idea that messages need to be coded, communicated, and then decoded in an information system. This is, of course, true for digital communication: the content is coded into a digital format and later decoded back. This coding is, however, a computer science issue rather than an information science issue. Similarly, however, in information science, the idea became common that documents had to be classified or indexed (using an indexing language) and later retrieved by the user by the same indexing language (e.g., classification system, thesaurus, or whatever had been used in the storage process). Following Shannon's (1948) information theory, it became common to consider libraries, journals, reference books, and the whole scientific information system as ISR systems. For example, *The International Encyclopedia of the Social Sciences* (Sills 1968, 7:301-31) contains an entry entitled "Information Storage and Retrieval" that is subdivided into five subsections: i) the field; ii) information services; iii) libraries; iv) reference materials and books; and, v) bibliographic issues in the behavioral sciences. This is a fine demonstration that, at that time, the fields of librarianship, information services, and bibliography were perceived as belonging to information storage and retrieval/information science. The entry concerning libraries was written by Shera (1968), who later wrote (Shera 1983, 383): "twenty years ago, I thought of what is now called information science as providing the intellectual and theoretical foundations of librarianship, but I am now convinced that I was wrong." (On pages 383 and 386, Shera identifies information science with Shannon's information theory).[23] If Shera is right, the influence of Shannon on information science may be considered a misunderstanding; a misunderstanding that, according to Spang-Hanssen (2001), was probably fueled by the wish of those in the field of library science/documentation to gain prestige by being associated with this field.

Eugene Eli Garfield (1925–2017) was an important information scientist. Garfield's (1962-1993) *Essays of an Information Scientist* shows what information science was all about for one of its greatest pioneers: multiple aspects of scientific and scholarly communication with an emphasis on information retrieval and knowledge organization. The focus is not primarily on libraries but on journals, citation patterns, and the whole scholarly communication system, its actors, systems, institutions, processes, and products. Garfield was also much engaged in providing practical solutions for problems in scientific communication (and is one of the few people in the field who has been economically successful by creating innovative solutions). On the other hand, Garfield's essays show a fragmented field without a theoretical frame to define it. In 2000, Garfield was president of the American Society for Information Science and took the decision to change its name to the American Society for Information Science and Technology. This change seems confusing from a theoretical point of view,[24] and adds to the picture of fragmentation in Garfield's understanding of the field.

We return to the discussion of these theoretical developments in section 3.

2.2.1 Is the term information science a homonym?

Are there more information sciences? Do people use this term for different fields? Is the term a homonym? Many researchers seem to confirm that this is the case, for example Wersig (2003, 312):

> At the beginning of the 1970s, when information science started to establish itself, it was faced with the problem that while nearly everybody used the term information, nearly everybody meant something different by it.[25] The problem was complicated by the fact that most of the users of the term thought that everybody else would understand and therefore they very often did not define which kind of meaning they had in mind.

Daniel and Mills (1975, 5) wrote, in relation to the classification of LIS:

> In particular, "information science" is a typical ambiguous term. We take it to stand for the systematic and scientific study of the problems of information dissemination and retrieval. Taken as it stands, "information science" could be constructed in a manner which, for the purpose of this scheme, would be impossibly wide, embracing an enormous range of studies, from Epistemology to Psychology, from Palaeography to Computer Science, from Public Administration to Linguistic Analysis and Information theory. Here, the field is restricted to those parts of it which contribute directly to those activities indicated above. Certain specialized topics within the vast Communication field are still given some prominence, e.g., Publishing and Bookselling which reflect the still dominant position of bookforms in information exchange.

Rayward (1996, 5-6) discusses library and information science, on the one hand, and computer and information science, on the other. It is not clear, however, whether he sees these as two different information sciences.

In a former publication, Hjørland (2013b, 223-4) wrote:

> In 2002, two different international conferences about the foundations of information science took place. One was the Fourth Conference on Conceptions of Library and Information Science (CoLIS 4) in Seattle, USA, the other was the International Conference on the Foundations of Information Science (FIS).[26] Were these conferences discussing two different fields, each of which claimed to be "information science," or were they two different scholarly meetings in the same field? Perhaps they are both forums for multidisciplinary approaches using different disciplinary outlets? Whether they represent one, two, or more kinds of information sciences can only be uncovered by theoretical analysis of the core assumptions expressed in the respective conferences and their proceedings. Inasmuch as FIS is founded on cybernetics and CoLIS is founded on something more related to social and epistemological studies of knowledge production and dissemination, different information sciences may well be at play.[27]

An encyclopedia entry on information science (Bøgh Andersen and Ingwersen 1997) reflects two different "lines," one related to the library field, and the other connected with the humanities and social sciences. Another example is the *Journal of Information Science and Technology* (ISSN 1906-9553), which appears to be somewhat different from other journals about information science. But when does a journal belong to a given field and when not? To consider a given journal, such as the *Journal of the Association for Information Science and Technology* (*JASIST*), to be representative of a field is also problematic, because, as demonstrated by Chua and Yang (2008):

> Top authors [in *JASIST*] have grown in diversity from those being affiliated predominantly with library/information-related departments to include those from information systems management, information technology, business, and the humanities.

Bibliometric maps based on *JASIST* therefore cannot simply be taken to represent the library/information field without further examination.

A study by Schneider (2010) may also illuminate the nature of information science.[28] Schneider says that information science is an "arbitrary construct," and whether or not a given journal is considered a part of the domain has important consequences for bibliometric mappings. This view of information science was formulated very sharply by Machlup and Mansfield (1983, 22), who suggested that:

> In the broad sense information science is a rather shapeless assemblage of chunks picked from a variety of disciplines that happen to talk about information in one of its many meanings.

We may therefore conclude that information science is an unclear label (a floating signifier) and that there is a great need for clarification and for improved terminological hygiene.

2.3 Documentation

The field of documentation[29] is associated with the movement founded by Paul Otlet (1868–1944) and Henri Lafontaine (1854–1943). As Otlet's foremost biographer (Rayward 1994, 238) noted:

> The term "documentation" is a neologism invented by [Paul] Otlet to designate what today we tend to call Information Storage and Retrieval. In fact, it is not too much to claim the *Traité* [*de Documentation* 1934] as one of the first information science textbooks.

The relationship between librarianship and documentation has been described in the following way (Meadows 1990, 59):

> The main differences [between library science and documentation] were identified as lying in the areas of bibliography and what came to be called "documentation." Exactly what the differences between these new "documentalists" and traditional librarians were was not altogether well defined. However, there was general agreement that documentalists were concerned not only with the physical handling of documents, but, to a much greater extent than traditional librarians, with the exploitation of the information contained in the documents. This practical thread generated some of its own theory, a noticeable example being Bradford's law of scattering.

British librarian and documentalist Samuel C. Bradford (1878–1948) wrote the first British textbook on documentation (Bradford 1948, Bradford 1953), and the *Journal of Documentation* (1945–) was and perhaps still is the leading British journal in the field.[30] An American account was Shera (1966). The field of documentation concerned subject literature, abstracting journals, special libraries, archives, classification, the application of new technologies in scientific communication (at that time, in particular, microfilm technology), the study of bibliometrics (e.g., Bradford's law of scattering), and standardization and related issues. Otlet

was even concerned with developing a new kind of encyclopedia (*The Encyclopedia Universalis Mundaneum*) and saw this as being closely linked to his bibliographical project. Documentation was thus a broad field. It was debated at the time whether documentation was a part of librarianship or vice versa (cf. Meadows 2002), but one could say, using an analogy taken from Ørom (2000), that documentation represented, at least potentially, a Copernican information universe, whereas librarianship represented a Ptolemaic universe. In the Copernican universe, traditional libraries are but planets, while knowledge production and dissemination, centralized information systems and the scientific literature form the central star. The content area of documentation was thus not very different from that mentioned in section 2.2, where the content of information science was exemplified by Garfield's broad spectrum of *Essays by an Information Scientist*, although of course, technological development has provided a changed environment and thereby new kinds of research questions.

When electronic databases became common in the 1960s and 1970s, searching was done by intermediaries referred to as (research) librarians, documentalists, or information specialists. Online intermediation was the last common job function involving documentation in relation to information work; Danish research libraries, for example, had documentation departments until about 1990. However, with the arrival of end-user searching, this function was downgraded in most places (cf., Hjørland 2000b), and the use of the term documentation disappeared almost entirely.[31]

2.3.1 Why was the term documentation abandoned and with what consequences?

Some researchers consider it unfortunate that information science replaced documentation (and that terms such as information retrieval, rather than document retrieval, became the standard). The reason for this has never[32] been defended theoretically. Why was the term abandoned? Farradane (1955, 76) said simply "The term 'documentalist' has, for various reasons, not met with favour in Britain." Lilley and Trice (1989, 1) wrote: "The architects of information science in the United States wanted to be sure that [the field] would no longer be mistaken either for the microfilm-oriented discipline that documentation had become or for the document-oriented discipline that was library science."[33] The (false) view that Shannon's information theory was found to be a productive foundation for the field has undoubtedly also played an important role for the change in name.

Some benefits of the term documentation are that it is related (both historically and logically) to the term bibliography and that it emphasizes aspects of scientific and scholarly communication that are relatively distinct from the more technical aspects of computer science and information technology; it is thus both expressive of a unique focus for LIS and provides a perspective more connected to the history and aim of the discipline.

Some researchers in information science have called for the return of document as a basic term in LIS. Buckland (1991), Frohmann (2004a), Hjørland (2000a), Lund (2004), Ørom (2007) and others have for years argued that the concept of document is the most fruitful one to consider as the core concept in LIS. The concept of document is understood as "any concrete or symbolic indication, preserved or recorded, for reconstructing or for proving a phenomenon, whether physical or mental" (Briet 1951/2006, 7; here quoted from Buckland 1991). Rayward et al. (2004) suggested replacing the term LIS with LID, that is, library, information, and documentation studies.

3.0 Paradigms and theoretical developments in LIS

The writings about theories, metatheories, and paradigms in LIS include Åström (2006),[34] Åström (2007), Bates (2005),[35] Egan and Shera (1952),[36] Ellis (1992),[37] Frohmann (1990), Frohmann (2004a),[38] Fuchs (2011),[39] Leckie et al. (2010),[40] Olaisen (1985),[41] Ørom (2000),[42] Pickard (2013),[43] Talja et al. (2005),[44] Tredinnick (2006),[45] Wersig (2003),[46] and Wilson (1983).[47]

Some of these sources, for example, Ørom (2000) and Wersig (2003), attempt to provide historical outlines of the development of information science/LIS. Before the term information science was introduced in 1955, the field had various theoretical orientations. Ørom (2000) describes prewar humanistic, historical, and social conceptions and mentions, among others, the Spanish philosopher, José Ortega y Gasset, who analyzed the development of the library profession in a social and historical context and in the Belgian and French documentation tradition. Other early researchers with a social orientation include Charles Ammi Cutter, Margaret Egan, and Jesse Shera, the first academics to use the term social epistemology.[48] There were of course many other theoretical orientations; these researchers are mentioned here, because they represent a sociologically oriented view that today represents a growing theoretical trend in the field. However, before describing this, we will consider some of the most debated theoretical positions in LIS. First of all, however, let us consider some sources that seem to claim that there has been no overall theory or theoretical development in the field.

3.1 Is there an atheoretical paradigm in LIS?

Perhaps an atheoretical attitude is (or has been) a dominant view in the field? Rafael Capurro has developed a theoret-

ical position related to social epistemology, but wrote (Capurro 2017):

> According to my experience [Rafael Capurro], there was little interest in the LIS community in discussing fundamental issues in the seventies and eighties. The discipline was based on practices particularly concerning how the new technologies could and should be used (or not) in the library field. In fact, some librarians were sceptical about it. The use of computers and data bases, for instance, was considered as non-relevant for public libraries when I started teaching documentation at the School of Librarianship in Stuttgart. On the other hand, LIS was mainly conceived from the perspective of information retrieval, particularly at university level.

Supporting a skeptical view of an overall atheoretical position, Bawden (2016, 287-8) wrote:

> it is unreasonable to expect there to be "a theory" of information science specifically, or of the information sciences more generally. Rather, there will be a range of theories, dealing with different aspects of the subject, and very probably deriving from theories in cognate disciplines. We may also expect theories at different levels of scale and specificity, dealing with emergent properties of information in different contexts.

Robertson (2000, 1) wrote (emphasis original):

> I consider myself a theorist. That is, my inclination is to theoretical argument, to achieving theoretical understanding, in information retrieval as in other realms. To me, understanding is what theory is about; those other attributes of theory, prediction and application, are side-effects only, secondary to the main purpose. However, I have to admit that the field of information retrieval in which I have chosen to be a theorist is not a very theoretical one. This is true in two senses: in a negative sense, there are few strong theories in IR, and certainly no overall theory *of* IR, to which one might appeal to solve all difficulties. In a positive sense, the field is very strongly pragmatic: it is driven by practical problems and considerations and evaluated by practical criteria.

Small (2016, 49) wrote:

> As someone trained in science and the history of science, the constructivist view did not ring true. Perhaps I was stuck in my story-book version of science. In any event, the bibliometrics community ignored the new sociology and remained largely empirical and atheoretical.

These four quotations all express that overall theoretical development in information science has been weak and is difficult and perhaps impossible. Zwadlo (1997) even wrote a paper "We don't Need a Philosophy of Library and Information Science: We're Confused Enough Already." Small's sentence "the bibliometrics community … remained largely empirical and atheoretical," in particular, raises the question of whether the atheoretical view has been the most important one in the short history of the field. Should we, along with other theoretical positions, also operate with an atheoretical or antitheoretical position (which, of course, is also a theoretical position that needs to be defended). We may label the view that science and knowledge develop independently of theoretical movements as positivism (although this label is ambiguous).[49]

The opposite view is that researchers' theoretical and cultural backgrounds are important in the development of science and scholarship. This view relates to Thomas Kuhn's (1962) theory of scientific paradigms, which claims that research is guided by sets of shared assumptions in scientific communities. In opposition to the positivist view, paradigm theory is a historically and socially oriented point of view related to hermeneutics. From this theoretical position, it becomes important to consider paradigms and research traditions.

3.2 Information theory

Two seminal publications, Shannon (1948) and Shannon and Weaver (1949), developed statistical communication theory (also called the classical theory of communication or information theory), although this is often considered a misnomer for a theory of data transmission. The conceptual basis was provided by previous engineering studies of efficiency in the transmission of messages over electrical channels. This theory concerns the physical transmission of a message from a source to a receiver in an optimal way (reducing loss and noise during the transmission). Shannon's famous model is shown in Figure 1.

A basic idea in information theory is that the harder it is to guess what has been received, the more information one has obtained. For example, specifying the outcome of a fair coin flip (two equally likely outcomes) provides less information than specifying the outcome from a roll of a die (six equally likely outcomes). The theory involves concepts such as information, communication channels, bandwidth, noise, data transfer rate, storage capacity, signal-to-noise ratio, error rate, feedback, and so on (see Figure 1). The core applications are issues such as data compression

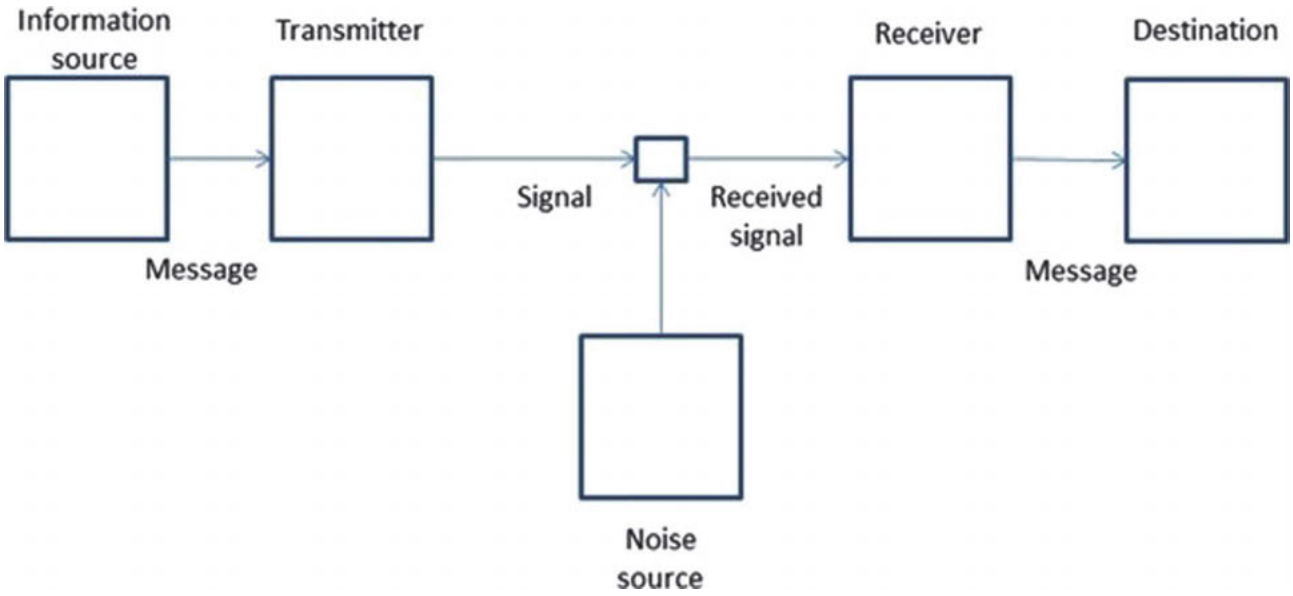

Figure 1. Schematic diagram of a general communication system (after Shannon 1948, 2).

and the reliable storage and communication of data. It has broadened since its inception, finding applications in many other areas; however, as we shall see, the applications to which information theory is relevant are a controversial topic. Information theory makes it possible to code messages, text, sounds, pictures etc. in ways that makes it possible to transmit and store them as electronic signals, and then at the receiving point to reconstruct them as texts, sounds, and pictures. In other words, information theory is the theory underlying digitalization (often involving making analog signals to discrete codes of which the digital code is one among many possible). Information theory concerns the technical optimization of such transmission and storage processes.

A simple example is the text transmitted by teletypewriters. Pressing a particular key on the sending machine causes a particular sequence of electrical signals to be sent to the receiving machine, which activates the corresponding type bar; the machine then prints out the character that corresponds to the key that was pressed. The number of keys used at the sending end (and the number of corresponding characters at the receiving end) determines how much information is involved by transmitting a given letter (or number, shift, linefeed etc.). If we assume that there is only one key, pressing this key would transmit one bit of information (corresponding to a 50% chance of guessing whether or not the key was pressed). An essential keyboard for transmitting a message of English text without punctuation and Arabic numbers needs twenty-seven symbols (including a space). These twenty-seven symbols correspond to about 4.75 binary digits; if each symbol is assigned to a five-digit binary number (e.g., 01101) then five of those numbers are not used. A typewriter with fifty keys, including shift, shift lock, carriage return, and line advance, would need a six-bit code and so on.

Shannon's theory gave rise to a new understanding of the term information, as described in the *Oxford English Dictionary* (Simpson 2010), sense 2c:

> As a mathematically defined quantity divorced from any concept of news or meaning … ; spec. one which represents the degree of choice exercised in the selection or formation of one particular symbol, message, etc., out of a number of possible ones, and which is defined logarithmically in terms of the statistical probabilities of occurrence of the symbol or the elements of the message. The latter sense (introduced by Shannon, quot. 1948, though foreshadowed earlier) is that used in information theory, where information is usually regarded as synonymous with entropy (entropy n. 2a).

Information theory is thus a mathematical theory about the technological issues involved whenever data is transmitted, stored or retrieved; this has turned out to be essential to the design of present-day communication and computational systems. "Without Shannon's information theory, there would have been no internet" (Jha 2014).

3.2.1 Reception in information science

Wersig (2003, 213) called the period between 1948 and the 1970s "The Shannon and Weaver phase" and wrote:

> One could call the developmental stage [of information science] from 1948 to the 1970s "the Shan-

> non and Weaver phase," because most of the discussions and attempts to structure the concept of information relied on the reception of Shannon via Weaver.

This view is confirmed by Bawden (2016, 284):

> In terms of theories of information, Shannon's Mathematical Theory of Communication was the only game in town [about 1978]. Its limitations in application to the concerns of the less technical end of the information sciences were well recognized, but there was interest in how it might be applied more widely.

However, it is important to emphasize that in each year or period, the literature of LIS contains a mixture of many different topics and perspectives. It is not the case that in one period all or most papers are based on or reflect a certain paradigm of that period. In other words, most views seem to co-exist at a given point in time, and it is just the meta-discussions that are dominated by a certain theoretical view in each period.

An example of how information theory has been an interesting subject in relation to information science is the concept of redundancy. For example, Shannon (1951) measured the degree of redundancy in written English (e.g., how much of a text can be arbitrarily removed and the text still be understandable?). Similar experiments have been carried out with oral languages (removing part of electronic signals carrying oral speech). It has been shown that less redundancy is needed for native speakers (Miller 1951). This may at first seem surprising, since hearing a message is one thing, and understanding it is another; the quality of the physical signal should only concern the first issue. Another interesting example, which is related to the cognitive view and applied in human-computer interaction, is Miller's (1956) finding that human beings have a limit to the information that can be processed in their short-term memory and that the number of items that can be remembered is seven, plus or minus two.

Linguist and information scientist Henning Spang-Hanssen (2001) wrote:

> "Information theory" is not concerned with documents, and not even primarily concerned with the content or meaning of documents or other symbolic representations, but concentrates on the efficient transmission of signals, which may—or may not—convey meaning. It is therefore unfortunate to confuse the term information theory with information as occurring in "information science" and "information retrieval."

Shannon's theory gave rise to the measurement of information using the unit of the "bit," which may be applied, for example, to the question of how information can be compressed and stored on a disk drive.[50] However, as pointed out by many, this measure is not particularly relevant to the field of library, information, and documentation studies. Buckland (2005, 686), for example, wrote:

> There is a valid and respectable field of formal information theory based on propositions, algorithms, uncertainty, truth statements, and the like, but its formal strengths are also its limits and make [it] inappropriate and inadequate for the concerns of LIS.

Spang-Hanssen (2001) explained why Shannon's theory does not apply to information science:

> The amount of information is here [in Shannon's information theory] measured by the decrease of uncertainty resulting from the choice of a particular message among a set of possible messages … I shall only mention a few points to show the limitation of this measure to our conception of information.
> – In Shannon's sense, the amount of information is proportional to the length of the message (in a given code). This obviously does not apply to the utilization of literature as information. Among other things, an abstract may be as informative as the complete paper.
> – Shannon's amount of information presupposes a measure of the uncertainty on behalf of the receiver. By the utilization of literature as information no measurable uncertainty can be defined generally.
> – Shannon's amount of information applies to some explicit coding and cannot in the case of normal writing (or speech) account for semantic relations that are not shown by similarities of expression. E.g. the synonyms "serials" and "periodicals" would be treated as different messages (or parts of messages) having different "amounts of information."

As late as 2011, it was claimed that information science is based on information theory (Milojevic et al. 2011, 1933):

> Miksa (1985, 1992) argues that the field has two distinct paradigms—librarianship, which is focused on libraries as institutions, and information science, which is focused on information and its communication. They are informed by different research traditions: librarianship from social science, and IS from mathematical communication theory.

The general view is, however, that Shannon's information theory failed as a theoretical frame of reference for LIS, not just in the "soft" field, but also in information retrieval research in computer science. Stock and Stock (2013, 22), for example, wrote: "Shannon's information theory is of historical interest for us but it has only little significance in information science." Some authors go even further; Fugmann (2007; 2008) called it "the bluff of the century" that had caused a great deal of damage in information science. However, despite the overall view that it failed to fulfill expectations, there are still a few information scientists working on the basis of Shannon's theory, e.g., Leydesdorff (2016).

As we shall see below, the cognitive view is also partly based on Shannon's theory, which thus also influenced another paradigm in information science.

3.3 The Cranfield tradition

The Cranfield tradition is often described in the literature as "the systems-oriented view" (e.g., by Saracevic 1999) or as "the physical paradigm"[51] (e.g., by Ellis 1992)[52]. Experiments at the Cranfield Institute of Technology in the 1960s are often cited as the beginning of the modern area of testing and evaluation of computer-based information retrieval systems (Cleverdon et al. 1966). In the Cranfield studies, retrieval experiments were conducted on a variety of test databases in a controlled, laboratory-like setting. In the second series of experiments, known as Cranfield II, alternative indexing languages constituted the performance variable under investigation. The aim of the research was to find ways to improve the relative retrieval effectiveness of IR systems through better indexing languages and methods (Cleverdon 1970). The components of the Cranfield experiments were: a small test collection of documents; a set of test queries; and a set of relevance judgments, that is, a set of documents judged to be relevant to each query. For the purposes of performance comparison, it was necessary to select quantitative measures of relevant documents output by the system under various controlled conditions. The famous recall and precision measures (derivatives of the concept of relevance) were first used in the Cranfield II experiments.

Hjørland (2010, 220) formerly wrote:

> Cleverdon (1970) reanalyzed some results from the Cranfield II experiments. The types of search questions discussed were both "realistic" or "real-life questions" and "prepared questions" (which is surprising, given the description of this view from the user-oriented community). Relevance assessments were made by people with different backgrounds, mostly scientists in the field. Each assessor evaluated each document (in full text) on a five-point scale and made qualitative notes about the assessment. Most important is that relevance was evaluated in relation to its possible function for the user because this is directly opposed to how the systems view is mostly being described. The paper further discussed how relevance assessments vary greatly among different assessors. Appendix 1 in Cleverdon (1970) lists the test-questions and the real documents used in the test. This seems important because it makes interpretations of the relevance-assessments possible. This procedure seems different from how it is described by the user-oriented researchers.

Table 1 shows some results of the relative recall of four different indexing languages. It was a shock to the LIS community that a high-quality classification system like the UDC (which demands highly qualified indexers) seems to be less effective than the low-tech Uniterm system (a system mainly based on uncontrolled, single words extracted from the text of a document). Despite criticism, these results have since influenced the attitude of main-stream information retrieval researchers, not just in relation to UDC, but to all kinds of controlled vocabularies.

	Original test	Supplementary test
Facet	73.8 ± 2.5 %	83 %
UDC	75.6 ± 2.5 %	-
Alphabetical	81.5 ± 2.5 %	-
Uniterm	82.0 ± 2.5 %	-

Table 1. Aslib Cranfield Research Project (Warburton and Cleverdon 1961; after Vickery 1966, 86-87).

Among the criticisms raised against this tradition are that human searchers, their interaction with the system, their interpretation of the query, and their process-formed relevance judgments were factors excluded from these experiments. Ørom (2000, 16) wrote about this approach:

> The physical paradigm represents a nomothetic type of research and it is based on a realistic view of science. According to the realistic model scientific knowledge is absolute true knowledge. That means that scientific knowledge is considered to have a privileged position, it is universal and neutral, and it is not influenced by social and cognitive processes.

It is likely that Ørom's criticism can be understood as a just criticism of the positivist view underlying the Cranfield tradition. Parts of Cleverson's research seem strongly positivist, for example the claimed "law of the inverse relation between recall and precision" (which has been rejected most clearly by Fugmann 1994). The Cranfield tradition

has not raised the question of whether different indexing languages best serve different kinds of communities or interests (as did Ørom 2003). That said, there seems to be much misplaced criticism of this tradition (and by implication a misplaced trust in what has mainly been understood as its alternative: the cognitive view). Firstly, the very dichotomy between systems-based and user-based approaches is problematic because neither can be understood without the other (cf. Hjørland 2010; Talja and Nyce 2015, 61; Warner 2010).

Warner found that the Cranfield tradition and the cognitive tradition shares important characteristics and therefore (2010, 4-5): "For the purposes of discussion … they can be considered as a single heterogeneous paradigm, linked but not united." This paradigm has not always been explicit about its own values, nor have its own basic assumptions always been examined. In Warner's analysis, the basic assumption in this tradition may broadly be termed query transformation, which implies that a user's verbal query, formulated before the start of the search, is transformed by an information system into a set of documents or bibliographical records. According to Warner, these records have been evaluated according to their relevance (using measures such as recall and precision) in relation to the query. Warner (2010) finds that the underlying methodology tends to reify the concept of relevance and that the underlying indexing philosophy in the searched material is neglected and taken as given. Finally, he finds that this approach contains an implicit teleology aimed at the construction of a perfect system. Contrary to the dominant paradigm of the computer/information-oriented tradition, Warner presents a tradition that is based more on library science and the practice of indexing. This tradition is far older, but less influential today. In his opinion, there are two especially valuable elements in this tradition. The first is the explicit priority of selection power, that is, the user's ability to make relevant distinctions during a search; the second is the recognition of the need for human labor to create this selection power (see further in Hjørland 2015a).

The conclusion can be drawn that the Cranfield tradition remains strong in information science; it was continued by the Text REtrieval Conferences (TREC) and today still represents the most important contribution to the development of search engines and other IR systems (although it has mostly migrated from information science to computer science). In information science, it has been met with criticism. Although Warner's criticism seems justified and important, much other criticism of it is problematic. An important characteristic of the Cranfield tradition is the view that subject expertise is needed in evaluating information retrieval and knowledge organization (and not just user satisfaction). However, at the time the tradition was established, Kuhn (1962) had not yet influenced the philosophy of science, and Ørom (2000) seems to be correct overall in his characterization of its epistemological assumptions.

Notes

1. It has been claimed that LIS and KO have provided the basis for the modern information structure: "In the contemporary digital information society almost all communication and interaction is shaped and guided by structures designed and constructed information professionals trained in knowledge organization" (Andersen, 2015, slide 4). However, Google, for example, was not developed using the application of knowledge developed in LIS or KO, and the quote is therefore wrong. LIS and KO have played a much more modest role. What Andersen probably intended to write was that LIS and KO have potential for developing important new perspectives on those infrastructures.
2. For example, in 1997 the Royal School of Librarianship in Copenhagen changed the English version of its name to the Royal School of Library and Information Science, RSLIS.
3. Exceptions include Tromsø, Norway, where the term documentation science is the preferred name of the field; France, where information science and communication studies form one interdiscipline (Mucchielli 2000); and Uppsala, Sweden, where the fields of archival science, library science, and museology have been integrated as archival, library, and museum studies.
4. The plural form is also used for information science alone, e.g., in Sonnenwald, ed. (2016) *Theory Development in the Information Sciences*. This also goes for the tendency to replace science with studies, as Duke University began in 2001 a program called Information Science and Studies.
5. Note that Bates and Maack consider LIS in the singular, as one subdiscipline of LIS in the plural. LIS in the plural is also referred to as the information disciplines (xiv) and characterized in this way: "The information disciplines collect, organize, store, preserve, retrieve, transfer, display, and make available the cultural record in all its manifestations. These activities are essential for maintenance of and access to all kinds of cultural records, whether they are produced as a result of business, government, education, creative endeavors, or daily life." What holds these disciplines together is, according to Bates and Maack (2010, xii) "[T]heir interest in recorded information and culturally meaningful artifacts and specimens."
   Winter (2010, 4890) wrote about this classification of disciplines:

> This entry draws attention to librarianship, archivistics, records management, bibliography and textual studies, document-type studies, social studies of information use, and museum studies, all sharing a broad, human-centered orientation, with quantitative methods making some inroads. The distinction between archivistics and records management is essential because, even though in North America the contrast between the two is not particularly sharp, it has for some time in Western Europe referred to two clearly distinguished fields.[Ketelaar 2000] To these we must add a newer, closely affiliated yet more quantitative and technical group: information science, information systems design, knowledge management, and informatics, where humanistic, historical, and interpretive approaches on the other hand are less prominent, though growing in importance. This rough classification follows Bates, who has also identified the more human-centered information fields as "disciplines of the cultural record" and the more scientific group as "sciences of information"; we also adopt that typification here. [Bates 2007]

Note also that today there is an increasing tendency to combine some of these disciplines (archives, libraries, and museums studies (ALM)) into one educational program (cf., Urban et al. 2014).

Absent in Bates' and Maack's list of disciplines are, for example, communication studies, computer science, human-computer interaction, management, cultural studies, language and literature studies, educational studies, media studies, science studies, and textual scholarship, which are often combined with LIS. These are probably better understood as adjacent fields or cognate disciplines (which may, however, also be the case with some of the disciplines included by Bates and Maack, 2010, xiii). Other fields to consider are bibliometrics, research on databases and search engines, social media and internet studies, which are interdisciplinary fields with a strong LIS component. Fields such as medical informatics, legal informatics, geographical information science, digital humanities, etc. can on the one hand be considered special subfields of information science, and on the other as subfields related to medicine, legal studies, geography, and humanities.

6. Perhaps LIS itself should also be considered a merging or combination of different fields, but as such a more established combination. Tengström (1993, 12) expresses the view that social fields are dynamic and changing. LIS, for example, can be viewed as a field that started as a multidisciplinary field based on literature, children's culture studies, psychology, sociology, management, computer science, etc., and that is developing towards a monodiscipline in its own right.
7. The term library and information science research seems to be a pleonasm since anything termed science should, by definition, be research. However, the jour*nal Library and Information Science Research* is focused on methodology in LIS, and in this case, the term seems, therefore, adequate. Regarding the use of this pleonasm, see also the quote from Wilson (2015) below.
8. The editor of *Information Research* recommends the following use of the terms: "An additional point about LIS—this is much over-used and people are rarely writing about research directly related to libraries when they use it: if you are writing about research in libraries, use 'library research,' if you are writing about information research, use 'information research' or 'information science research.' If you really intend both, use 'research in librarianship and information science.'" (Wilson 2015).
9. In Readmond-Neal and Hlava (2005) LIS is considered synonymous with information science (68), whereas librarianship is considered a related term (150-1).
10. The term library research has two different meanings: 1) the study of libraries, their operation, history, social impact, etc. (what we here have called library science); and, 2) research based on library collections (in a broad sense, including reference tools and online databases), and partly the opposite of laboratory research and field studies. See Abbott (2011) and Mann (2005) for this second meaning. Perhaps we could say that the ultimate goal of library research in the first sense is to facilitate library research in the second sense.
11. *Dewey Decimal Classification* (*DDC*) used the term library economy for class nineteen in its first edition from 1876. In the second edition (and all subsequent editions), it was moved to class twenty. The term library economy was used until (and including) the fourteenth edition (1942). From the fifteenth edition (1951), class twenty was termed library science, which was used until (and including) the seventeenth edition (1965); it was then replaced by library and information sciences (LIS) from eighteenth ed. (1971) and forward.
12. Vakkari (1994) found, however, that the development of library science as a science in the strictest sense was under way by the time that Hessey (1902) published his handbook on librarianship.
13. Stock and Stock (2013, 15) wrote "The object of library science is the empirical and theoretical analysis of specific activities; among these are the collection, conservation, provision and evaluation of documents and the knowledge fixed therein. Its tools are elaborate systems for the formal and content-oriented processing of information. Topics like the creation of

classification systems or information dissemination were common property of this discipline even before the term 'information science' existed. This close link facilitates—especially in the United States—the development of approaches toward treating information science and library science as a single aggregate discipline, called 'LIS' (Library and Information Science)." Stock and Stock are right in their claim that topics such as the creation of classification systems or information dissemination were common properties of this discipline even before the term information science existed. However, it is still the question when work about, for example, the creation of classification systems is a research-based activity. Melville Dewey's creation of the *DCC* system in 1876 was not the result of a research project. Henry Bliss's creation of the BC was based on comprehensive scholarly studies by one man. Real systematic research programs came with, for example, the Classification Research Group in the UK (about 1952-1992) and with the so-called Cranfield tradition (from the 1960s), the first mostly connected with library science, the last with information science (but with overlapping figures, e.g., Jack Mills). Still, we may ask whether Cronin's (2004: 187) denial of the possibility of a discipline of the name library science is justified. The classification research of Bliss and the Classification Research Group is not about libraries (although it was applied mainly in libraries). The term documentation seems to be a better choice.

14. Consider that we have today fields like archival science, museum studies, and theatre studies.
15. This definition is almost identical with one quoted by Floridi (2002, 41) from the online ALA Glossary (the link to this source is no longer available): "The professional knowledge and skill by which recorded information is selected, acquired, organized, and utilized in meeting the information demands and needs of a community of users."
16. Shera (1983, 387) wrote: "Administration, management, architecture, and many other disciplines can contribute to the effectiveness of the library, but they are not librarianship."
17. It should also be said that the terms documentation and information science were not limited to libraries, but included the study of archives, museums, databases, and other memory institutions. However, when LIS was taught, the focus has often been on library cataloging rules and classification systems at the expense of, for example, archives and museums. In a way, the term LIS has therefore not lived up to its name.
18. Even if the term information science only goes back to 1955, the field may be older; it may be retrospectively constructed in the minds of some people. For example, Lilley and Trice (1989) has the title *A History of Information Science 1945-1985*. This book considers five individuals to be the visionaries who formed information science: Vannevar Busch (1890), Norbert Wiener (1894-1964), Claude E. Shannon (1916-2001), S.C. Bradford (1978-1948) and Arthur C. Clarke (1917–2008). However, to claim that these people formed information science as a discipline is problematic. Busch is much cited in information science today for his Memex, but whether this idea laid the ground for a research field is another issue (just as the analogy between Memex and the internet is probably a retrograde construction). Wiener is known as the father of cybernetics, but he (or cybernetics) has had no direct influence on the development of information science. Shannon is the father of the so-called information theory, which many in the beginning saw as probably the theoretical foundation for information science, but which in hindsight turned out not to be. Bradford was an important documentalist, and it is well known that documentation changed its name to information science. Finally, Clarke was mainly a science fiction writer, best known for the screenplay for the 1968 film *2001: A Space Odyssey*. He was also a science writer, and Lilley and Trice (1989) attribute to him the idea of communication satellites in space around the world to facilitate radio and television transmission. Although this turned out to be an important technology for information science, it is not a contribution to information science, and is neither a theoretical contribution nor a contribution to information science as an organized community.

    Other examples of talking about information science before 1955 include Rayward (1994, 238), who considered the first information science textbook to be Otlet's (1934) *Traité de Documentation*; Stockwell's (2001) *A History of Information Storage and Retrieval* considers such things as the history of encyclopedias to belong to the history of information storage and retrieval (ISR). From this perspective, information science and ISR are retronyms (new words for things formerly known under other names).
19. The American Society for Information Science again changed its name in 2000 to the American Society for Information Science and Technology, and in 2013 to the Association for Information Science & Technology, ASIS&T.
20. It is questionable whether Proffitt (2010) is right. The way information has been understood in information science seems to go further back in time (cf., Capurro and Hjørland 2003). Fugmann (2007, 449) wrote: "The scope of the theory was soon extended and it was postulated that it was valid for the entire communication process. This was done by renaming the theory as 'in-

formation theory,' despite various objections from the information profession," indicating that "the information profession" was based on an understanding of information that preceded Shannon's information theory.

21. Shannon's (1948) theory was originally called "a mathematical theory of communication" and is a theory of the optimization of physical data transmission but has been known as "the information theory," which is a misnomer. Spang-Hanssen (2001) wrote about this: "Information theory is an unfortunate–but since 20 years well established–designation for the statistical theory of communication developed in the teleengineering field by Nyquist, Shannon a.o. This field is not concerned with documents, and not even primarily concerned with the content or meaning of documents or other symbolic representations, but concentrates on the efficient transmission of signals, which may–or may not–convey meaning. It is therefore unfortunate to confuse the term information theory with information as occurring in information science and information retrieval." Since Shannon's theory turned out to be an unfruitful theory for LIS, we may be dealing with a double misnomer if Proffitt (2010) is right.
22. According to Spang-Hanssen (2001), information explosion is a problematic term. He wrote: "What is called the information explosion can in the first place be termed only the publication explosion, or even the paper explosion: the number of printed pages in professional journals and books is increasing at a rate that can be described by an exponential function, like explosions. This, however, does not form an explosion of information, unless the number of printed pages is proportional to the amount of information resulting from the production and the distribution of these pages. In other words, when using the expression 'the information explosion' we tacitly assume that professional papers contain information to a constant degree, regardless of their number, and regardless of their being utilized by informee(s).

    The underlying conception of information is not particularly useful. It might be, e.g., that the users are able only to utilize a limited amount of literature, regardless of how much literature is produced; in that case the total outcome of information processes cannot exceed the limit set by the informees, and no information explosion can take place. One might even imagine that an explosion-like growth of produced literature would have a lowering effect on the total utilization of the literature, i.e., would tend to decrease the total outcome of information processes: people could react as if they were being choked."
23. In Shera (1983) there are some points of view with which I believe we have to disagree. He writes, for example (1983, 387): "In summary, we who are librarians must constantly remind ourselves that information science is an area of inquiry, of research. It is not, as is librarianship, a service or a practice." However, many kinds of research and service are based on research (e.g., medicine, social work, and pedagogics). Whether it is labeled as library science, LIS, information science or whatever, it is about construing a relevant research field aimed at supporting library and information service and practices. Shera's own theoretical frame of social epistemology must serve the same purpose. It is strange that Shera claims that librarianship should not be based on research. Another point, as already indicated, is that Shera conflates information science with information theory (although information theory was influential at the beginning). Also, Shera (1983, 386) concludes, that "Information science," insofar as it rests purely on technological foundations, "cannot qualify as a theoretical base for librarianship, and calling it bibliometrics or informatics does not alter the situation." However, bibliometrics is not based on Shannon's theory, and while Shera is right that a purely technological understanding of bibliometrics is problematic, what is needed is a better theoretical understanding of that field. Again, social epistemology, in hindsight, may turn out to be the best theoretical frame also for that subfield.
24. Garfield's field was citation indexing and bibliometrics. Theories of bibliometrics are about a scientist citing scientists, i.e., first of all about science, knowledge, and the sociology of science. Information technology is about producing computer equipment. The inclusion of "and technology" in the name of the field therefore seems to go in a wrong direction. Of course, information retrieval is also about producing search engines and algorithms, which are part of information technology. Firstly, it should be considered that the main part of research in information retrieval has migrated from information science to computer science. Secondly, criteria for calibrating search engines and algorithms must be based on a theory that cannot be technological. Again, in hindsight Shera's idea of a social epistemology as the foundation of the field looks like the best solution.
25. Wersig's claim is supported by Wellish's (1972) study, where "[Thirty-nine] definitions of IS [information science] are compared in order to find the common concepts of this science and its central topic of investigation. The comparison shows that no consensus exists among the practitioners of IS about what it is or should do."

26. "The first FIS conference was held in Madrid in 1994; the second in 1996 in Vienna (Hofkirchner 1999), and an electronic conference was held in 2002; the third FIS conference was held in 2005 in Paris and the Fourth International Conference on the Foundations of Information Science was in Beijing in August 2010. The list of authors presenting at FIS 2010 may be found at the following URL: http://www.sciforum.net/conf/fis2010/authors; Interestingly, there appears to have been no overlap between this roster of authors and those who participated in CoLIS 7 in London in 2010."
27. Hofkirchner (1999) is the *Proceedings of the Second FIS Conference*, and this book displays a different kind of information science compared to, for example, the one represented by ASIS&T.
28. Schneider (2010, 257) wrote: "The highly specialized character of Scientometrics compared to the other journals in this set, i.e., a larger share of publications and the large number of unique authors that only publish in the journal, obviously exacerbates the influence of this journal to the arbitrary construct named IS. This raises some important questions on how fields ought to be delimited if at all and how publications should be selected for mapping purposes. It is first of all a sampling problem rather than a normalization problem. It is not a question of right or wrong. It is the simple fact stemming from the phenomena of skewed distributions. Very few mapping studies address this issue."
29. Documentation may also be termed documentation science or documentation studies. Scientific documentation may be considered a subfield. The documentation movement is closely related to bibliography (cf. Shera Egan 1953). Otlet thus published a paper on the science of bibliography (1903).
30. In opposition to *American Documentation* (1950-), which, in 1970, changed its name to *Journal of the American Society for Information Science*, *Journal of Documentation* has retained its original name.
31. Exceptions from the rule that information science replaced documentation as the name for the field is, in addition to *Journal of Documentation*, that international standards uses the term information and documentation, for example, ISO 5127:2017 Information and Documentation: Foundations and Vocabulary. It is described in this way: "ISO 5127:2017 provides a concept system and general vocabulary for the field of documentation within the whole information field. It has been created with a balanced representation of major work areas in mind: documentation, libraries, archives, media, museums, records management, conservation as well as legal aspects of documentation. The scope of the vocabulary provided in this document corresponds to that of ISO/TC 46: standardization of practices relating to libraries, documentation and information centres, publishing, archives, records management, museum documentation, indexing and abstracting services, and information science" (https://www.iso.org/standard/59743.html).
32. With one exception: van Rijsbergen and Lalmas (1996, 386), who wrote: "In the early days of Information Retrieval (van Rijsbergen, 1979), people used to qualify their statements about information retrieval (IR) by saying that really they were working on document retrieval. It was denied strenuously that information was being retrieved.

    As Lancaster (1968) wrote, "An information retrieval system does not inform (i.e., change the knowledge of) the user on the subject of his inquiry. It merely informs on the existence (or non-existence) and whereabouts of documents relating to his request."

    The situation has changed. We believe that the purpose of an information retrieval system is to provide information about a request and that a request is a representation of an information need that an IR system attempts to satisfy. Hence, a fundamental problem is how to compute the information contained in one object (e.g. a document) about another (e.g., a query). Thus, if a user states a query then it behooves the IR system to find the objects that contain information about that query. Let us see how this was done in the past and what role information played, if any."

    However, this argument is not convincing, and seems to be based on an individualistic epistemology. Scholars often, for example, search documents that cite a given document in order to evaluate its status within the scholarly community. Information retrieval should be termed document retrieval, because, as Spang-Hanssen (2001) wrote: "Information about some physical property of a material is actually incomplete without information about the precision of the data and about the conditions under which these data were obtained. Moreover, various investigations of a property have often led to different results that cannot be compared and evaluated apart from information about their background. An empirical fact always has a history and a perhaps not too certain future. This history and future can be known only through information from particular documents, i.e. by document retrieval."
33. One gets the impression that different kinds of professionals related to librarianship and documentation with different backgrounds and different working context were often in conflict and chose different labels, because they did not wish to be identified with each other. In order to solve this conflict, neutral terms have been suggested and used, for example library, information, and documentation, LID (Rayward et al. 2004)

34. Åström (2006, 20) wrote: "In e.g., fields with strong connections to professional practices, disciplines do not necessarily develop out of research areas or scholarly interest groups, but out of professions or schools for professional practices. LIS is one example, but there are others as well. One is management research, described by Whitley (1984) as a 'fragmented adhocracy,' a field with a low level of coordination around a diffuse set of goals and a non-specialized terminology; but with strong connections to the practice in the business sector."
35. Bates (2005) briefly presented the following approaches:

    – A historical approach
    – A constructivist approach
    – A constructionist or discourse-analytic approach
    – A philosophical-analytical approach
    – A critical theory approach
    – An ethnographic approach
    – A socio-cognitive approach
    – A cognitive approach
    – A bibliometric approach
    – A physical approach
    – An engineering approach
    – A user-centered design approach
    – An evolutionary approach

36. Egan and Shera (1952) introduced the term social epistemology, which today has become important in, for example, philosophy and sociology. For a long time, this view had been neglected in LIS, but now seems to be undergoing a renaissance; in retrospect, an updated version of social epistemology may be the most important theoretical contribution to LIS.
37. Ellis in (1992) and other papers analyzed the physical paradigm and the cognitive paradigm in information retrieval.
38. Frohmann's work is mainly influenced by the philosopher Ludwig Wittgenstein, and contains many important implications for LIS, including indexing theory and the understanding of the concept of information.
39. Fuchs (2011, 81) is a book written from a Marxist perspective. He wrote: "If the turn from information theory towards cognitivism is characterized as the first turn in formation science and the turn from cognitivism towards society as the second turn in information science, then we can argue what is now needed is a third turn in information science from considering information in society towards considering the power structures of information in society."
40. Leckie et al. (2010) present twenty-six critical theorists in twenty-three chapters and aim to illuminate their importance for LIS.
41. Olaisen (2003) is critical about the dominant paradigm in library science (functionalism, logical empiricism) and suggests more focus on criticism and constructivism. He found (130) that "The broadening of library research, or the wish to broaden it, can be seen clearly in the works of Buckland (1982), Wilson (1983), Swanson (1979) and others."
42. Ørom (2000) discussed the following paradigms:

    – a pre-war paradigm viewing the library as a social institution;
    – the physical paradigm;
    – the cognitive view;
    – alternative perspectives in the nineties representing a new tendency towards an integration of the social dimension of the discipline.

43. Pickard (2013) is a textbook on research methods in information studies. In chapter one, it presents three major research paradigms: positivist research, postpositivism, and interpretivism.
44. Talja et al. (2005) describe the basic premises of three metatheories that represent important or emerging perspectives on information seeking, retrieval, and knowledge formation in information science: 1) constructivism; 2) collectivism; and, 3) constructionism.
45. Tredinnick (2006) briefly introduces the physical paradigm and the cognitive shift in information science and then, in the following chapters:

    4. Digital information and computer science
    5. Digital information, language and representation
    6. Digital information and semiotics
    7. Digital information and post-structuralism
    8. Digital information and post-modernism
    9. Digital information and complexity

46. Wersig (2003) provided the following overall outline:

    – 1948-1970s: The Shannon and Weaver phase
    – 1970-: The cognitive view
    – 1980s-: New theoretical directions (including constructivism, systems theory, action theory, modernization theory.) "The common core is complexity" (316).

47. Wilson (1983) argues that social epistemology is important for LIS. He connects this view to skepticism (Pyrrhonian skepticism): "One might argue (this book [Wilson, 1983] is in effect such an argument) that skepticism is a highly appropriate attitude toward the productions of the knowledge industry" (195) and he concludes his book with the words: "Skeptic, world watcher,

librarian: all take the same attitude toward the world of ideas" (196).

48. The term social epistemology (SE) originated in library science in an article about classification by library scientist Jesse Shera (1951, 82): "any attempt to organize knowledge is conditioned by the social epistemology of the age in which it was produced … Here, then, is an implicit denial of Bliss' faith in the existence of a 'fundamental order of nature,' a rejection of the belief that there is a single, universal, logically divided classification of knowledge."
49. Regarding positivism, see Hjørland (2016, 23-28).
50. Not to be confused with the number of binary digits that may be stored on a given drive, which are not "bits" in Shannon's sense. Only when optimally compressed may hardware digits carrying capacity approach Shannon information.
51. Ellis (1992, 174-175) terms it the physical paradigm and finds that its basic assumptions are:

    – "Mechanical,
    – Based on abstract generalizations about information retrieval languages,
    – Reductionist ('...the assumption that index languages consisted of amalgams of index language devices meant that index language performance (in terms of the measures of recall and precision) could be directly explained by reference to the combination of use of the different index language device, just as the performance of a mechanical system can be explained with reference to the contributions of the different elements of the system')."

52. Sometimes there is no clear differentiation between Shannon's theory and the Cranfield tradition in the research literature, and both are sometimes subsumed under the label of the physical paradigm (e.g., Tredinnick 2006). Sometimes bibliometric studies and other kinds of studies of scientific literatures are also included in this label. Other texts may just mention one of these two traditions. Ørom (2000), for example, only presents the Cranfield tradition, while Wersig (2003) only mentions Shannon's theory. It seems as if many people see these traditions as related. However, there are, for example, no references to Shannon in the core texts of the Cranfield experiments.

References

Åström, Fredrik. 2002. "Visualizing Library and Information Science Concept Spaces through Keyword and Citation Based Maps and Clusters." In *Emerging Frameworks and Methods: CoLIS4; Proceedings of the Fourth International Conference on Conceptions of Library and Information Science, Seattle, WA, USA, July 21-25, 2002*, ed. Harry Bruce, Raya Fidel, Peter Ingwersen, and Pertti Vakkari. Greenwood Village, CO: Libraries Unlimited, 185-97.

Åström, Fredrik. 2007. "Changes in the LIS Research Front: Time-Sliced Co-Citation Analyses of LIS Journal Articles, 1990–2004." *Journal of the American Society for Information Science and Technology* 58: 947-57.

Abbott, Andrew. 2011. "Library Research Infrastructure for Humanistic and Social Scientific Scholarship in the Twentieth Century." In *Social Knowledge in the Making,* eds. Charles Camic, Neil Gross, and Michèle Lamont. Chicago: University of Chicago Press, 43-87.

Aftab, Omar, Pearlin Cheung, Austin Kim, Sneha Thakkar, and Neelima Yeddanapudi. 2001. "Information Theory and the Digital Age." Final paper, Massachusetts Institute of Technology. http://web.mit.edu/6.933/www/Fall2001/Shannon2.pdf

Andersen, Jack. 2015. "Meaning-Making in Global and Local Information Infrastructures: An Argument Coming from Genre Theory." Paper presented at the Global and Local Knowledge Organization Conference, Copenhagen August 12, 2015.

Bates, Marcia J. 2005. "An Introduction to Metatheories, Theories, and Models." In *Theories of Information Behavior,* ed. Karen E. Fisher, Sanda Erdelez, and Lynne (E. F.) McKechnie. ASIST Monograph Series. Medford, NJ: Information Today, 1-24.

Bates, Marcia J. 2007. "Defining the Information Disciplines in Encyclopedia Development." *Information Research* 12, no. 4: paper colis29. http://InformationR.net/ir/12-4/colis/colis29.html

Bates, Marcia J. and Mary Niles Maack, eds. 2010. *Encyclopedia of Library and Information Sciences*, 3rd ed. 7 vol. Boca Raton, FL: CRC Press.

Bawden, David. 2016. "The Noblest Pleasure: Theories of Understanding in the Information Sciences." In *Theory Development in the Information Sciences*, ed. Diane H. Sonnenwald. Austin, TX: University of Texas Press, 283-99.

Bøgh Andersen, Peter and Peter Ingwersen. 1997. "Informationsvidenskab." In *Den Store Danske Encyklopædi.* Copenhagen: Gyldendal, 9: 382.

Bradford, S. C. 1948. *Documentation*. London: Crosby Lockwood.

Bradford, S. C. 1953. *Documentation*, 2nd ed., with an introduction by Jesse H. Shera and Margaret E. Egan. London: Crosby Lockwood.

Briet, Suzanne. (1951) 2006. *What is Documentation?* Trans. and ed. by Ronald E. Day and Laurent Martinet with Hermina G.B. Anghelescu. Lanham, MD: Scarecrow. Translation of *Qu'est-ce que la Documentation?* Paris: Documentaires Industrielles et Techniques, 1951.

Brookes, Bertram C. 1980. "The Foundations of Information Science. Part I: Philosophical Aspects." *Journal of Information Science* 2: 125-33.

Buckland, Michael K. 1983. *Library Services in Theory and Context*. Pergamon International Library of Science, Technology, Engineering and Social Studies. New York: Pergamon.

Buckland, Michael K. 1991. *Information and Information Systems*. New Directions in Information Management 25. New York: Greenwood.

Buckland, Michael K. 2005. Review of *The Philosophy of Information,* ed. Ken Herold. *Journal of Documentation* 61: 684-86.

Butler, Pierce. 1933. *An Introduction to Library Science*. Chicago: University of Chicago Press.

Capurro, Rafael. 2017. "Information Cultures in the Digital Age: Thanks and Responses." *Rafael Capurro* (blog), March 16, 2017. http://www.capurro.de/thanksandresponses.html

Capurro, Rafael and Birger Hjørland. 2003. "The Concept of Information." *Annual Review of Information Science and Technology*, 37: 343-411.

Chua, Alton Y. K. and Christopher C. Yang. 2008. "The Shift towards Multi-Disciplinarity in Information Science." *Journal of the American Society for Information Science and Technology* 59: 2156-70.

Cleverdon, Cyril W. 1970. *The Effect of Variations in Relevance Assessments in Comparative Experimental Tests of Index Languages*. Cranfield Library Report no. 3. [Cranfield?]: Cranfield Institute of Technology. https://dspace.lib.cranfield.ac.uk/handle/1826/967

Cleverdon, Cyril W., Jack Mills, and E. Michael Keen. 1966. *Factors Determining the Performance of Indexing Systems*. Aslib Cranfield Research Project. Wharley End, Bedfor: Cyril Cleverdon.

Cronin, Blaise. 2004. "Pierce Butler's 'An Introduction to Library Science': A Tract for our Times?; A Review Article." *Journal of Librarianship and Information Science* 36: 183-8.

Daniel, Ruth and Jack Mills. 1975. *A Classification of Library and Information Science*, with the assistance of R. Selwood and Pirkko Elliott. Library Association Research Publications 15. London: Library Association.

Egan, Margaret E. and Jesse H. Shera. 1952. "Foundations of a Theory of Bibliography." *The Library Quarterly* 22: 125-37.

Ellis, David. 1992. "The Physical and Cognitive Paradigms in Information Retrieval Research." *Journal of Documentation* 48: 45-64.

Farradane, Jason E. L. 1955. "Professional Education of the Information Scientist." In *Congrès international des bibliothèques et des centres de documentation, Bruxelles, 11-18 septembre 1955*. La Haye: Martin Nijhoff, 2B: 76-81.

Floridi, Luciano. 2002. "On Defining Library and Information Science as Applied Philosophy of Information." *Social Epistemology* 16: 37-49.

Foskett, Douglas John. 1975. "Main Lines of Training in Library Science and Informatics: An Analysis of Textbooks by R.S. Giljarevskij." *International Forum on Information and Documentation* 1, no. 1: 40-1.

Frické, Martin 2009. "The Knowledge Pyramid: A Critique of the DIKW Hierarchy." *Journal of Information Science* 35: 131-42.

Frohmann, Bernd. 1990. "Rules of Indexing: A Critique of Mentalism in Information Retrieval Theory." *Journal of Documentation* 46: 81-101.

Frohmann, Bernd. 2004b. "Documentation Redux: Prolegomenon to (Another) Philosophy of Information." *Library Trends* 52, no. 3: 387-407.

Fuchs, Christian. 2011. *Foundations of Critical Media and Information Studies*. Routledge Advances in Sociology 52. Milton Park, Abington, Oxon: Routledge.

Fugmann, Robert. 1994. "Representational Predictability: Key to the Solution of Several Pending Issues in Indexing and Information Supply." In *Knowledge Organization and Quality Management: Proceedings of the Third International ISKO Conference, Copenhagen, Denmark, June 20-24, 1994*, ed. Hanne Albrechtsen and Susanne Oernager. Advances in Knowledge Organization 4. Frankfurt/Main: Indeks Verlag, 414-22.

Fugmann, Robert. 2007. "Informationstheorie: Der Jahrhundertbluff; Eine zeitkritische Betrachtung. Teil 1." *Information Wissenschaft und Praxis* 58: 449-58.

Fugmann, Robert. 2008. "Informationstheorie: Der Jahrhundertbluff; Eine zeitkritische Betrachtung. Teil 2." *Information Wissenschaft und Praxis* 59: 159-64.

Galvin, Thomas J. 1977. "Pittsburgh. University of Pittsburgh Graduate School of Library and Information Sciences." In *Encyclopedia of Library and Information Science*, ed. Allen Kent, Harold Lancour, and Jay E. Daily. New York: Marcel Dekker, 22: 280-91.

Garfield, Eugene 1962-1993. *Essays of an Information Scientist*: *Volumes 1-15*. http://www.garfield.library.upenn.edu/essays.html

Graesel, Arnim. 1902. *Handbuch der Bibliothekslehre*, 2nd ed. Leipzig: Weber.

Hessey, Rachel and Peter Willett. 2013. "Quantifying the Value of Knowledge Exports from Librarianship and Information Science Research." *Journal of Information Science* 39: 141-50.

Hjørland, Birger. 2000a. "Documents, Memory Institutions, and Information Science." *Journal of Documentation* 56: 27-41.

Hjørland, Birger. 2000b. "*Hvad blev der af Videnskabelig Dokumentation?" DF-Revy* 23, no. 7: 191–4.

Hjørland, Birger. 2010. "The Foundation of the Concept of Relevance." *Journal of the American Society for Information Science and Technology* 61: 217-37.

Hjørland, Birger. 2013b. "Information Science and its Core Concepts: Levels of Disagreement." In *Theories of Information Communication and Knowledge: A Multidisciplinary Appproach*, ed. Fidelia lbekwe-SanJuan and Thomas M. Dousa. Studies in History and Philosophy of Science 34. Dordrecht: Springer, 205-35.

Hjørland, Birger. 2015a. "Classical Databases and Knowledge Organization: A Case for Boolean Retrieval and Human Decision-making During Searches." *Journal of the Association for Information Science and Technology* 66: 1559-75.

Hjørland, Birger. 2015b. "The Phrase 'Information Storage and Retrieval' (IS&R): An Historical Note." *Journal of the Association for Information Science and Technology* 66: 1299-302.

Hjørland, Birger. 2016. "Informetrics Needs a Foundation in the Theory of Science." In *Theories of Informetrics and Scholarly Communication: A Festschrift in Honor of Blaise Cronin*, ed. Cassidy Sugimoto. Berlin: Walter de Gruyter, 20-46.

Hjørland, Birger. 2017c. Review of *Theory Development in the Information Sciences,* ed. by Dianne H. Sonnenwald. *Journal of the Association for Information Science and Technology* 68: 1796-801.

Hofkirchner, Wolfgang, ed. 1999. *The Quest for a Unified Theory of Information: Proceedings of the Second International Conference on the Foundations of Information Science*. World Futures General Evolution Studies 13. Amsterdam: Gordon and Breach Publishers.

Huang, Mu-Hsuan and Yu-Wei Chang. 2012. "A Comparative Study of Interdisciplinary Changes between Information Science and Library Science." *Scientometrics* 91: 789-803.

International Organization for Standardization (ISO). 2017. ISO 5127:2017 *Information and Documentation: Foundations and Vocabulary*, 2nd ed. ISO 5127:2017. Geneva: International Organization for Standardization.

Jha, Alok. 2014. "A Short History of Equations: Without Shannon's Information Theory There Would Have Been No Internet." *The Guardian*, June 22, 2014 https://www.theguardian.com/science/2014/jun/22/shannon-information-theory

Järvelin, Kalervo and Pertti Vakkari. 1993. "The Evolution of Library and Information Science 1965-1985: A Content Analysis of Journal Articles." *Information Processing & Management* 29: 129-44.

Ketelaar, Eric. 2000. "Archivistics Research: Saving the Profession." *American Archivist* 63: 322-40

Kline, Ronald R. 2004. "What Is Information Theory a Theory of?: Boundary Work among Information Theorists and Information Scientists in the United States and Britain during the Cold War." In *The History and Heritage of Scientific and Technological Information Systems: Proceedings of the 2002 Conference*, ed. W. Boyd Rayward and Mary Ellen Bowden. ASIS & T Monograph Series. Medford, NJ: Information Today, 15-28.

Kuhn, Thomas S. 1962. *The Structure of Scientific Revolutions*. Chicago, IL: University of Chicago Press.

Lancaster. F. Wilfrid. 1968. *Information Retrieval Systems: Characteristics, Testing and Evolution*. Information Sciences Series. New York: Wiley.

Larivière, Vincent, Cassidy R. Sugimoto, and Blaise Cronin. 2012. "A Bibliometric Chronicling of Library and Information Science's First Hundred Years." *Journal of the American Society for Information Science and Technology* 63: 997-1016.

Leckie, Gloria J., Lisa M. Given, and John E. Buschman, eds. 2010. *Critical Theory for Library and Information Science: Exploring the Social from Across the Disciplines*. Santa Barbara, Calif.: Libraries Unlimited.

Leydesdorff, Loet. 2016. "Information, Meaning, and Intellectual Organization in Networks of Inter-Human Communication." In *Theories of Informetrics and Scholarly Communication: A Festschrift in Honor of Blaise Cronin*, ed. Cassidy Sugimoto. Berlin: Walter de Gruyter, 280-303.

Lilley, Dorothy B. and Ronald W. Trice. 1989. *A History of Information Science 1945-1985*. San Diego: Academic Press.

Lopatovska, Irene and Ellie Ransom. 2016. "The State of L-Schools: Intellectual Diversity and Faculty Composition." *Journal of Librarianship and Information Science* 48: 18-35.

Lund, Niels Windfeld. 2004. "Documentation in a Complementary Perspective." In *Aware and Responsible!: Papers of the 2001 Nordic-International Colloquium on Social and Cultural Awareness and Responsibility in Library, Information and Documentation Studies*, ed. W. Boyd Rayward. Lanham, MD: Scarecrow, 93-102

Machlup, Fritz and Una Mansfield. 1983. "Cultural Diversity in Studies of Information." In *The Study of Information: Interdisciplinary Messages* ed. Fritz Machlup and Una Mansfield. New York: Wiley, 3-59.

Mann, Thomas. 2005. *The Oxford Guide to Library Research*, 3rd ed. New York: Oxford University Press.

Meadows, Jack. 2002. "S. C. Bradford and Documentation: A Review Article." *Journal of Librarianship and Information Science* 34: 171-4.

Miksa, Francis L. 1985. "Machlup's Categories of Knowledge as a Framework for Viewing Library and Information Science History." *The Journal of Library History* 20: 157-72.

Miksa, Francis L. 1988. "The Columbia School of Library Economy, 1887-1888." *Libraries & Culture* 23: 249-80.

Miksa, Francis L. 1992. "Library and Information Science: Two Paradigms." In *Conceptions of Library and Information*

Science: Historical, Empirical and Theoretical Perspectives; Proceedings of the International Conference Held for The Celebration of 20th Anniversary of the Department of Information Studies, University of Tampere, Finland, 26-28 August 1991, ed. Pertti Vakkari and Blaise Cronin. London: Taylor Graham, 229-52.

Miller, Carolyn R. 1984. "Genre as Social Action." *Quarterly Journal of Speech* 70: 151-67.

Miller, George A. 1951. *Language and Communication*. McGraw-Hill Publications in Psychology. New York: McGraw-Hill.

Miller, George A. 1956. "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information." *Psychological Review* 63: 81-97.

Milojević, Staša, Cassidy R. Sugimoto, Erjia Yan, and Ying Ding. 2011. "The Cognitive Structure of Library and Information Science: Analysis of Article Title Words." *Journal of the American Society for Information Science and Technology* 62: 1933-53.

Mucchielli, Alex. 2000. *La nouvelle communication: Épistémologie des sciences de l'information-communication*. Paris: Armand Colin.

Naudé, Gabriel. (1627) 1950. *Advice on Establishing a Library*, with an introd. by Archer Taylor. Berkeley: University of California Press. Translation of *Advis pour dresser une bibliothèque*.

Olaisen, Johan L. 1985. "Alternative Paradigms in Library Science: The Case for Paradigmatic Tolerance and Pluralism." *Libri* 35: 129-50.

Ørom, Anders. 2000. "Information Science, Historical Changes and Social Aspects: A Nordic Outlook." *Journal of Documentation* 56: 12-26.

Ørom, Anders. 2007. "The Concept of Information versus the Concept of Document." In *Document (Re)turn: Contributions from a Research Field in Transition*, ed. Roswitha Skare, Niels Windfeld Lund, and Andreas Vaarheim. Frankfurt am Main: Peter Lang, 53-72.

Otlet, Paul. 1903. "Les Sciences Bibliographiques et la Documentation," *IIB Bulletin* 8: 125-47.

Otlet, Paul. 1934. *Traité de documentation: Le livre sur le livre; Théorie et pratique*. Bruxelles: Editiones Mundaneum; Edit. Et Imprim. D. van Keerberghen et fils.

Petersen, Carl S. 1915-30. "Biblioteksteknik." In *Salmonsens Konversationsleksikon*, 2nd ed. 26 vols. Copenhagen: Schultz, 3: 196-97.

Pickard, Alison Jane. 2013. "Major Research Paradigms." Chap. 1 in *Research Methods in Information*. 2nd. ed. London: Facet.

Proffitt, Michael. 2010. "Information." Blogpost in Word Stories, *Oxford English Dictionary*. Oxford: Oxford University Press. http://public.oed.com/aspects-of-english/word-stories/information/

Rayward, W. Boyd. 1994. "Visions of Xanadu: Paul Otlet (1868-1944) and Hypertext." *Journal of the American Society for Information Science* 45: 235-50.

Rayward, W. Boyd. 1996. "The History and Historiography of Information Science: Some Reflections." *Information Processing & Management* 32: 3-17.

Rayward, W. Boyd, ed. 2004. *Aware and Responsible!: Papers of the 2001 Nordic-International Colloquium on Social and Cultural Awareness and Responsibility in Library, Information and Documentation Studies*. Lanham, MD: Scarecrow.

Reitz, Joan M. 2004. *Dictionary for Library and Information Science*. Westport, CT: Libraries Unlimited.

Robertson, Stephen. 2000. "Salton Award Lecture: On Theoretical Arguments in Information Retrieval." Paper presented at SIGIR 2000, Athens, July 2000. *ACM SIGIR Forum* 34, no. 1: 1-10. http://www.staff.city.ac.uk/~sb317/papers/salton_lecture_web.pdf

Saracevic, Tefko. 1992. "Information Science: Origin, Evolution and Relations." In *Conceptions of Library and Information Science: Historical, Empirical and Theoretical Perspectives; Proceedings of the International Conference Held for The Celebration of 20th Anniversary of the Department of Information Studies, University of Tampere, Finland, 26-28 August 1991*, ed. Pertti Vakkari and Blaise Cronin. London: Taylor Graham, 5-27.

Saracevic, Tefko. 1999. "Information Science." *Journal of the American Society for Information Science* 50: 1051-63.

Schneider, Jesper W. 2010. "Critical Issues in Science Mapping: Delimiting Fields by Journals and the Influence of their Publication Activity." In *Eleventh International Conference on Science and Technology Indicators. Leiden, the Netherlands, 9-11 September 2010: Book of Abstracts,* 255-57. http://cwts.nl/pdf/BookofAbstracts2010_version_15072010.pdf#page=255

Schrader, Alvin M. 1983. "Toward a Theory of Library and Information Science." PhD diss., Indiana University.

Schrettinger, Martin. 1829. *Versuch eines vollständigen Lehrbuchs der Bibliothek-Wissenschaft: Oder, Anleitung zur vollkommenen Geschäftsführung eines Bibliothekars, In wissenschaftlicher Form abgefasst*. 2 vols. München: J. Lindauer 1829.

Shannon, Claude E. 1948. "A Mathematical Theory of Communication." *The Bell System Technical Journal 27, no.* 3: 379-423, 623-56.

Shannon, Claude E. 1951. "Prediction and Entropy of Printed English." *The Bell System Technical Journal* 30, no. 1: 50-64.

Shannon, Claude E. and Warren Weaver. 1949. *The Mathematical Theory of Communication*. Urbana, IL: University of Illinois Press.

Shera, Jesse H. 1951. "Classification as the Basis of Bibliographic Organization." In *Bibliographic Organization: Papers Presented Before the Fifteenth Annual Conference of the Graduate Library School July 24-29, 1950,* ed. Jesse H.

Shera and Margaret E. Egan. The University of Chicago Studies in Library Science. Chicago: University of Chicago Press, 72-93.

Shera, Jesse H. 1966. *Documentation and the Organization of Knowledge*. Hamden, CT: Archon Books.

Shera, Jesse H. 1968. "Information Storage and Retrieval. III: Libraries." In *International Encyclopedia of the Social Sciences,* ed. David L. Sills. New York, NY: The Macmillan Company, 7: 314-8.

Shera, Jesse H. 1983. "Librarianship and Information Science." In *The Study of Information: Interdisciplinary Messages*, ed. Fritz Machlup and Una Mansfield. New York: John Wiley and Sons, 379-88.

Shera, Jesse H. and Margaret E. Egan 1953. "A Review of the Present State of Librarianship and Documentation." In Bradford, S. C. *Documentation,* 2nd ed. London: Crosby Lockwood & Son, 11-46.

Sills, David L., ed. 1968-91. *International Encyclopedia of the Social Sciences.* 19 vols. New York, NY: Macmillan.

Simpson, John, ed. 2010. *Oxford English Dictionary,* 3rd ed. Oxford: Oxford University Press.

Slife, Brent D. and Richard N. Williams 1995. *What's Behind the Research? Discovering Hidden Assumptions in the Behavioral Sciences*. Thousand Oaks, CA: SAGE Publications.

Small, Henry. 2016. "Referencing as Cooperation or Competition." In *Theories of Informetrics and Scholarly Communication: A Festschrift in Honor of Blaise Cronin*, ed. Cassidy Sugimoto. Berlin: Walter de Gruyter, 49-71.

Sonnenwald, Diane, ed. 2016. *Theory Development in the Information Sciences*. Austin, TX: University of Texas Press.

Spang-Hanssen, Henning. 2001. "How to Teach about Information as related to Documentation." *Human IT* 5, no. 1. https://humanit.hb.se/article/view/168/186

Stielow, Frederick J. 1994. "Library and Information Science Research." In *Encyclopedia of Library History*, eds. Wayne A. Wiegand and Donald G. Davis. Garland Reference Library of Social Science 503. New York: Garland, 338-42.

Stock, Wolfgang G. and Mechtild Stock. 2013. *Handbook of Information Science*, translated by Paul Becker. Berlin: de Gruyter.

Stockwell, Foster. 2001. *A History of Information Storage and Retrieval*. Jefferson, NC: McFarland.

Swanson, Don R. 1979. "Libraries and the Growth of Knowledge." *Library Quarterly* 49: 3-25.

Talja, Sanna, Kimmo Tuominen, and Reijo Savolainen. 2005. "'Isms' in Information Science: Constructivism, Collectivism and Constructionism." *Journal of Documentation* 61: 79-101.

Talja, Sanna and James M. Nyce. 2015. "The Problem with Problematic Situations: Differences between Practices, Tasks, and Situations as Units of Analysis." *Library & Information Science Research* 37: 61-7.

Tang, Rong. 2004. "Evolution of the Interdisciplinary Characteristics of Information and Library Science." In *ASIST 2004: Managing and Enhancing Information; Cultures and Conflicts; Proceedings of the 67th ASIST Annual Meeting, November 12-17, 2004, Providence, RI*, ed. Linda Schamber and Carol L. Barry. Proceedings of the American Society for Information Science and Technology 41. Medford, NJ: Information Today, 54-63.

Tengström, Emin. 1993. "Biblioteks- och informationsvetenskapen: Ett fler- eller tvärvetenskapligt område?" *Svensk Biblioteksforskning* 1: 9-20.

Tredinnick, Luke. 2006. *Digital Information Contexts: Theoretical Approaches to Understanding Digital Information*. Chandos Information Professional Series. Oxford: Chandos.

Tuomaala, Otto, Kalervo Järvelin, and Pertti Vakkari. 2014. "Evolution of Library and Information Science, 1965–2005: Content Analysis of Journal Articles." *Journal of the Association for Information Science and Technology* 65: 1446-62.

Turcios, Mirna E., Naresh Kumar Agarwal, and Linda Watkins. 2014. "How Much of Library and Information Science Literature Qualifies as Research?" *The Journal of Academic Librarianship* 40: 473-9.

Urban, Richard J., Laura-Edythe Coleman, and Paul F. Marty. 2014. "Libraries, Archives, and Museums: Connecting Educational Communities and Cultures." In *ASIST 2014: Proceedings of the 77th ASIS&T Annual Meeting Volume 51 2014 Connecting Collections, Cultures, and Communities,* ed. Andrew Grove. doi: 10.1002/meet.2014.14505101009

Vakkari, Pertti. 1994. "The Roots of Library Science in the Internal and External Discourse of *Historia Literaria* in Germany." *Bibliothek: Praxis und Forschung* 18: 68-76.

Vakkari, Pertti. 1996. "Library and Information Science: Content and Scope." In *Information Science: From the Development of the Discipline to Social Interaction*, eds. Johan Olaisen, Erland Munch-Petersen and Patrick Wilson. Oslo, Copenhagen, Stockholm, Boston: Scandinavian University Press, 169-231.

Van Rijsbergen, C. J. 1979. *Information Retrieval*, 2nd ed. London: Butterworths.

Van Rijsbergen, C. J. and M. Lalmas. 1996. "Information Calculus for Information Retrieval." *Journal of the American Society for Information Science* 47: 385-98.

Vickery, Brian C. 1966. *Faceted Classification Schemes*. Rutgers series on systems for the Intellectual Organization of Information 5. New Brunswick, NJ: Graduate School of Library Science Rutgers.

Warburton, B. and Cyril W. Cleverdon. 1961. *Report on the First Stage of a Test on the Library Catalogue of the English Electric Co. Ltd., Whetstone*. Cranfield.

Warner, Julian. 2010. *Human Information Retrieval*. History and Foundations of Information Science. Cambridge, MA: MIT Press.

Wellisch, Hans. 1972. "From Information Science to Informatics: A Terminological Investigation." *Journal of Librarianship* 4: 157-87.

Wersig, Gernot. 1992. "Information Science and Theory: A Weaver Bird's Perspective." In *Conceptions of Library and Information Science: Historical, Empirical and Theoretical Perspectives; Proceedings of the International Conference Held for The Celebration of 20th Anniversary of the Department of Information Studies, University of Tampere, Finland, 26-28 August 1991*, ed. Pertti Vakkari and Blaise Cronin. London: Taylor Graham, 201-17.

Wersig, Gernot. 2003. "Information Theory." In *International Encyclopedia of Library and Information Science*, eds. John Feather and Paul Sturges. 2nd ed. London: Routledge, 310-19.

White, Howard D. and Katherine W. McCain. 1998. "Visualizing a Discipline: An Author Co-Citation Analysis of Information Science, 1972-1995." *Journal of the American Society for Information Science* 49: 327-55.

Whitley, Richard. 1984. *The Intellectual and Social Organization of the Sciences*. Oxford: Clarendon.

Wiggins, Andrea and Steven Sawyer. 2012. "Intellectual Diversity and the Faculty Composition of iSchools." *Journal of the American Society for Information Science and Technology* 63: 8-21.

Wikgren, Marianne. 1998. *Att förklara vetenskap: Forskningsinformation ur ett informationsvetenskapligt perspektiv*. Finnish Information Studies 10. Åbo: Aabo Akademi.

Wilson, Patrick. 1968. *Two Kinds of Power: An Essay on Bibliographic Control*. University of California Publications: Librarianship 5. Berkeley, CA: University of California Press.

Wilson, Patrick. 1983. *Second-hand Knowledge: An Inquiry into Cognitive Authority*. Contributions in Librarianship and Information Science 44. Westport, CT: Greenwood.

Wilson, T. D. 2015. "Instructions on the Submission of Papers to Information Research." *Information Research* 2017-05-07. http://www.webcitation.org/6qI2eQjJR)

Winograd, Terry and Fernando Flores. 1987. *Understanding Computers and Cognition: A New Foundation for Design*. Reading, MA: Addison-Wesley.

Winter, Michael F. 2010. "Sociology of the Information Disciplines." In *Encyclopedia of Library and Information Sciences*, ed. Marcia J. Bates and Mary Niles Maack, 3rd ed. Boca Raton, FL: CRC Press, 6: 4888-98.

Yang, Siluo and Feifei Wang. 2015. "Visualizing Information Science: Author Direct Citation Analysis in China and around the World." *Journal of Informetrics* 9: 208-25.

Yang, Siluo, Ruizhen Han, Dietmar Wolfram, and Yuehua Zhao. 2016. "Visualizing the Intellectual Structure of Information Science (2006-2015): Introducing Author Keyword Coupling Analysis." *Journal of Informetrics* 10: 132-50.

Zhao, Dangzhi and Andreas Strotmann. 2008a. "Evolution of Research Activities and Intellectual Influences in Information Science 1996–2005: Introducing Author Bibliographic-Coupling Analysis." *Journal of the American Society for Information Science and Technology* 59: 2070-86.

Zhao, Dangzhi and Andreas Strotmann. 2008b. "Information Science During the First Decade of the Web: An Enriched Author Co-Citation Analysis." *Journal of the American Society for Information Science and Technology* 59: 916-37.

Zhao, Dangzhi and Andreas Strotmann. 2014. "The Knowledge Base and Research Front of Information Science 2006-2010: An Author Co-Citation and Bibliographic Coupling Analysis." *Journal of the Association for Information Science and Technology* 65: 995-1006.

Zunshine, Lisa, ed. 2015. *The Oxford Handbook of Cognitive Literary Studies*. New York, NY: Oxford University Press.

Zwadlo, Jim. 1997. "We don't Need a Philosophy of Library and Information Science: We're Confused Enough Already." *The Library Quarterly* 67: 103–21.