Reviews of Concepts in Knowledge Organization

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Domain Analysis*†

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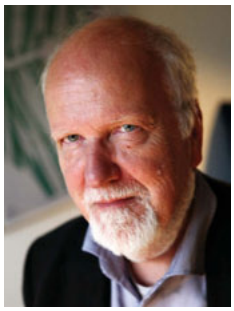

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Abstract: The domain-analytic approach to knowledge organization (KO) (and to the broader field of library and information science, LIS) is outlined. The article reviews the discussions and proposals on the definition of domains, and provides an example of a domain-analytic study in the field of art studies. Varieties of domain analysis as well as criticism and controversies are presented and discussed.

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1.0 Historical background

1.1 Definition and main characteristics

Hjørland and Albrechtsen (1995) formulated domain analysis as a new[1] approach to information science (IS) or library and information science (LIS)[2]. The article stressed the social, ecological, and content-oriented nature of knowledge as opposed to the more formal, computer-like approaches that dominated in the 1980s. The article stated that the most fruitful horizon for IS is to study knowledge domains as thought or discourse communities, which are parts of society's division of labor. These aims have since that time represented the core characteristics of domain analysis. Seven years later, Hjørland (2002a) suggested eleven ways in which information science may address a given domain in a relatively specific way:

1. Production and evaluation of literature guides and subject gateways;
2. Production and evaluation of special classifications and thesauri;

3. Research on competencies in indexing and retrieval of information in specialties;
4. Knowledge of empirical user studies in subject areas;
5. Production and interpretation of bibliometric studies;
6. Historical studies of information structures and services in domains;
7. Studies of documents and genres in knowledge domains;
8. Epistemological and critical studies of different paradigms, assumptions, and interests in domains;
9. Knowledge of terminological studies, LSP (languages for special purposes), and discourse analysis in knowledge fields;
10. Studies of structures and institutions in scientific and professional communication in a domain;
11. Knowledge of methods and results from domain-analytic studies on professional cognition, knowledge representation in computer science, and artificial intelligence.

It can be seen that these points clearly include knowledge organization (KO) as a part of the overall study of domains (e.g., indexing, classification, and thesauri). These eleven approaches emphasize that the objects of study for information researchers are social and theoretical entities rather than universal minds (which dominated the field under the label "the cognitive view" at the time). Information science is understood as the study of information infrastructures, and is one among other fields in the study of science. The eleven points are a mixture of activities performed by (or suggested for) information specialists on the one hand, and genuine approaches on the other hand (in particular, 8: epistemological approaches, and 10: sociological studies). Epistemological and critical studies are important, because that category in particular defines domain analysis in the narrow sense (cf., Section 4 below) and provides the link back to social epistemology[3] (cf., Egan and Shera 1952; Zandonade 2004). It was also stated (Hjørland 2002c) that: a) these eleven approaches should ideally be combined,[4] and b) knowledge of these approaches—and in particular their combination—provide the special competency of information specialists. Smiraglia (2015, 97) proposed a slightly revised taxonomy of the eleven approaches (leaving out the third: indexing and retrieval of information in specialties, and tenth: studies of structures and institutions in scientific and professional communication—and adding database semantics and discourse analysis). Another important suggestion for an addition to the eleven points is knowledge about provenance, as suggested by Guimarães and Tognoli (2015).

Smiraglia (2015) analyzed nearly one hundred research reports in the field of KO in which domain analysis has been used. He found (97-98) that it is clear that the knowledge organization community has embraced domain analysis as a scholarly methodological paradigm for the discovery of ontological bases and for the continuing analysis of the evolution of scholarly communities. There has been little applied research, however, reporting on the development or evolution of pathfinders or subject gateways, even in the face of expanding digital hegemony over all human activity.

Domain analysis is a theory about and an approach to LIS and KO. The objects of KO can be generalized to be, in particular, about knowledge organization systems (KOSs) and knowledge organization processes (KOPs) (for example classification systems and the process of classification). The objects of LIS include, in addition, other issues, more or less covered by the eleven plus three approaches presented above. Domain analysis approaches the issues of KOSs and KOPs from a combined sociological and epistemological perspective and emphasizes the importance of subject knowledge.

1.2 Subject knowledge and specialization

Domain analysis focuses on the importance of subject knowledge; this was an important but relatively implicit assumption for the founders of KO as well as of documentation, information science, and of the management of libraries and information institutions and services. Saracevic (1975, 333) termed this "the subject knowledge view," and suggested that it is fundamental to all other views of relevance, because subject knowledge is fundamental to the communication of knowledge. In that paper, he also mentioned the importance and urgency of work on that view.[5]

Subject knowledge has been institutionalized in libraries (particularly in research libraries) as well as in other kinds of mediating institutions by employing interdisciplinary teams of specialists. For example, the Russian State Library's Department of Systematic and Subject Catalogues was in 1990 the largest indexing unit of the world's libraries, with one hundred thirty staff specialists. Nearly one hundred of them had a subject specialty plus a second diploma in library science. All over the world, a similar model was used and is to some degree still used.[6] The tendency has been that the bigger the library, the more specialized the staff (corresponding to the educational system: the higher the level, the more specialized the teachers; no one would claim that general psychological and pedagogical knowledge can replace subject knowledge in university teaching). Of course, in small public libraries with only one librarian, that person has to cover every field, and is thus less professional in managing core information functions.

Teams involving subject specialists were also considered essential for designing and updating knowledge organization systems (KOS) such as the Universal Decimal Classification, and this is also assumed for indexing of bibliographical databases of high-standards such as MEDLINE[7] and for the construction of advanced ontologies.[8] Subject-knowledge specialists also used to be an important part of the faculty of schools of library and information science. By implication, information science (with LIS and KO) must be understood as a metascience (cf., Hjørland 2016a).

Within information science (or in adjacent fields), there exist specializations such as chemoinformatics, digital humanities, geographical information science, legal informatics, and medical informatics—often with their own journals, conferences, and so on. The Association for Information Science and Technology (ASIS&T) has (in 2017) special interest groups for, among other fields, Arts & Humanities, Health Informatics, and Scientific & Technical Information. Schools of LIS used to have specialized courses in, for example, the literature of the humanities, social science, and science[9] just as library associations were involved in providing guides for different subjects (e.g., Webb et al., 1986).

1.3 Conflicting views

The domain-analytic view may be in opposition to the view that it is possible to educate "the complete librarian" (cf., Audunson et al. 2003). This expression implies that one person can be "complete," and can be understood as an ideology developed by schools of LIS, because public libraries have been their main target. From the point of view of the library profession, it may be an advantage to have libraries staffed with generalists rather than with information scientists representing different specialties (or teams of people with different subject degrees in addition to a degree in information science). In other words, professional interests may support tendencies towards uniformity rather than diversity. Such a uniformity may, however, lower the quality of the information services.

Many approaches to information science and KO (e.g., facet analysis, the cognitive view, and statistical taxonomy) may be understood as attempts to pass over subject knowledge (or at least not make subject knowledge explicit in their methodologies). Domain analysis, on the other hand, makes subject knowledge an explicit and important part of the methodologies of information science and knowledge organization. This makes KO and information science part of science studies in a broad sense. Just as philosophers, sociologists and historians, for example, may study a given domain (such as medicine), information specialists may also study the same domain, but with a special focus on medical information infrastructures, information retrieval, and the other areas defined above (cf., Hjørland 2016a).

Domain analysis stands in contrary to the "one size fits all" principle in information systems and services. Bates (1987) considered domains "the last variable" in information science, and Mai (2010, 629) wrote that the library literature has generally not problematized the differences and commonalities of different domains, and seems to have assumed that general laws and principles exist.[10]

1.4 Conclusion

Information science, LIS, and KO deal with mediating information, knowledge, documents, and culture. Any mediating act is always about some specific content produced by persons related to the different subject areas. To mediate subject knowledge requires a degree of subject knowledge (depending on the level of informing—higher, for example, in research libraries as compared to public libraries). Subject knowledge is not, however, the "specific" qualification of LIS professionals. The specific competencies of information specialists are information infrastructures and information retrieval, etc. (the "eleven plus three" points mentioned above). By implication, LIS is a metascience or metafield. It is about, for example, the optimization of the information infrastructures of disciplines,[11] between disciplines, and for the larger society. LIS may involve specialized services (such as MEDLINE) or general institutions and services, such as national libraries and archives, public libraries, Google, Wikipedia, and the Internet Archive. Domain analysis is the methodology of LIS that considers the optimization of information systems and services from the perspective of their "specific" contents and requirements.[12]

2.0 What is a domain?

2.1 General definitions

According to WordNet 2, the noun "domain"[13] has 5 senses:

1. sphere, domain, area, orbit, field, arena—(a particular environment or walk of life; "his social sphere is limited;" "it was a closed area of employment;" "he's out of my orbit");
2. domain, demesne, land—(territory over which rule or control is exercised; "his domain extended into Europe;" "he made it the law of the land");
3. domain—(the set of values of the independent variable for which a function is defined);

4. world, domain—(people in general; especially a distinctive group of people with some shared interest; "the Western world");
5. domain, region, realm—(a knowledge domain that you are interested in or are communicating about; "it was a limited domain of discourse;" "here we enter the region of opinion;" "the realm of the occult").

Some of these senses are related to the way the term is used in domain analysis, but WordNET does not provide criteria for distinguishing subject, discipline, and domain, for example. A domain may be a discipline, but it need not be; it can be distributed in multiple disciplines or specialties or be a non-discipline, such as a hobby. "Subject" (Hjørland 2017c) is understood as the object of subject analysis, which is also a different concept. A domain, on the other hand, is a specialization in the division of cognitive labor that is theoretically coherent or socially institutionalized. As can be seen below, domains are not ready-made divisions of the world but are dynamic, developing, and theory dependent.

Prieto-Díaz, from the field of software engineering, provided a definition of "domain analysis" (DA). He is probably the first to connect the term with library and information science ("DA/LIS"), specifically to facet analysis. He wrote (1990, 50)[14]: "In the context of software engineering it [domain analysis] is most often understood as an application area, a field for which software systems are developed. Examples include airline reservation systems, payroll systems, communication and control systems, spreadsheets, and numerical control. Domains can be broad like banking or narrow like arithmetic operations."

Domain-analysis was used as a technical term in software engineering and related fields before it was introduced in LIS. Prieto-Díaz (1990) considered it equivalent to faceted classification.[15] Writers on faceted classification in LIS did not use that term, however, and its methodology is different[16] from the approach introduced by Hjørland and Albrechtsen (1995), which may be termed "critical-hermeneutical," emphasizing different interests, perspectives, epistemologies, and "paradigms" of domains in classification (see further in Hjørland 2017b on different philosophies of classification). This last sense is here termed "DA/LIS narrow," in contrast to "DA/LIS broad," which includes faceted classification and other kinds of studies.

In addition to software engineering, the concept of "domain" has been connected to cognitive science, where the principle of domain specificity of thought is opposed to the principle of general or universal cognitive mechanisms (see, for example, Hirschfeld and Gelman 1994). Cognitive psychology, in turn, is connected to artificial intelligence and the cognitive view in information science, and may have influenced developments in computer science and software engineering.

2.2. Shapere's definition

Mai (2005, 605) stated that Hjørland and Albrechtsen (1995) did not "clearly define what they mean by 'domain.'" Mai (2008, 20) wrote that Hjørland and Albrechtsen lacked a concrete suggestion of how to operationalize the notion of a domain. At the same place he defined "domain" as "an evolving and open concept that will develop as the concept is used and applied in research and practice."[17] He also wrote (21) that the "description and designation of the particular domain to be analyzed depends on the goal and purpose of the design; there is no set way to determine domains." Mai also quoted Rasmussen et al. (1994, 35) "identification [of the domain] depends on a pragmatic choice of boundary around the object of analysis that is relevant for the actual design problem. This choice depends on the circumstances."

Hjørland and Albrechtsen (1995), however, did include a quote from Shapere and a reference to Hjørland (1994) in which "domain" was further discussed and in which the concept of "theory" becomes important. By considering the scientific characterization of electricity in the 18th century, Shapere (1977, 518) pointed out that what we today consider the unified subject matter or domain "electricity" is by no means an obvious conclusion. He generalized this claim by pointing out that even though researchers think of science as explaining things, it is not clear that the things that science explains are really unified or have any natural unity in themselves. The range of phenomena to which an explanation can be applied is in itself controversial. He further wrote that nature does not happen to come once and for all divided into "areas" or "fields" for investigation on the basis of anything immediately experienced. Although there are certainly observable features, the sorts of entities to be studied is not a matter of anything that could be called immediate or obvious sensory characteristics (Shapere 1984, 323). Therefore, Shapere (1977, 527) stated "that a body of information constitutes a domain is itself a hypothesis that may ultimately be rejected" and he arrived at the following definition (528 emphasis original):

> *The domain is the total body of information for which, ideally, an answer to that problem is expected to account.* In particular, if the problem is one requiring a "theory" as answer, the domain constitutes the total body of information which must, ideally, be accounted for by a theory which resolves that problem.

Shapere further wrote that domains can be as broad as the subject matters of fields such as electromagnetism, genetics, or organic chemistry, or as narrow as the specialized interests of individual research workers.

Shapere's point can be illustrated by considering the domain "biology." At the time of Carl Linnaeus (1707-1778), zoology and botany were considered two different domains. What later united these two domains into biology was the cell theory—that all living organisms consist of cells (first formulated in 1839 after more than one hundred years of observation by microscopes). The domain "biology" is therefore the result of scientific theory and research. For Shapere, domains are phenomena that require careful and deep investigation simply to be defined, and may be given different theoretical perspectives.[18] This accords with Mai's understanding of domain as "an evolving and open concept that will develop as the concept is used and applied in research and practice."

2.3 Ontological, epistemological and sociological dimensions of domains

The definition of "domain" needs to consider both the social and the cognitive dimensions of domains. Hjørland and Hartel (2003) suggested that three dimensions interact in the constitution of domains:

1. Ontological theories and concepts about the objects of human activity;
2. Epistemological theories and concepts about knowledge and the ways to acquire knowledge, implying methodological principles about the ways objects are investigated; and
3. Sociological concepts about the groups of people concerned with the objects.

The relationships between these dimensions are complicated. Basic theories about these relationships are, for example, forms of philosophical realism, social epistemology and social constructivism. A broad family of theoretical positions are potentially relevant, including Bourdieuian theory on "field"[19] and the concept "epistemic community."[20] From the point of view of social constructivism, Dam Christensen (2007, 32) argued that a knowledge domain does not exist in itself, but only in relation to its frame. Domains are never unambiguous; instead of wholes, stability, and closure, domains are characterized by processuality, fragmentation, indeterminability, performativity, or other words that may today be used for dealing with this ambiguity. In other words, a domain is never frozen in time and space, but is always changing, although it may not seem so for either information producers, users, or mediators in scholarly day-to-day practice. Albrechtsen (2015, 561) also expressed a constructivist view: "'Domains' are not terrains out there, waiting to be described and analysed by the initiated few. Fundamentally, we may all create them." What does this mean? As we shall see, domains are at the same time "given" and "constructed." In the first way, (A) domains seem to be "out there, waiting to be described and analyzed," but in the second way, (B) Albrechtsen is right, we may all create them. We now consider these two perspectives a little more closely:

> (A): When a person is born, the social world is already organized, for example, with languages and their conceptual distinctions, with social division of labor, with school subjects, and with academic disciplines. We do not all have the power to change that, although some persons (e.g., deans) may have some power to change an academic discipline at their own university. In this sense, domains are terrains out there, and as such they are described and analyzed by historians, sociologists, anthropologists, and bibliometricans, among others.

> (B): At the same time, domains are nothing but the work of human beings, and if enough people decide (actively or passively) to change a domain or the system of domains, it will change (for example, if too few people work hard to make a domain successful, it may vanish). Therefore, Albrechtsen is right; we may all contribute to creating a domain. This is also true in the methodological sense to which Albrechtsen refers. When we describe a domain, e.g., bibliometrically, the methodology we use influences how that domain looks. For example, the journals selected to map a domain such as LIS will always be a choice reflecting the researcher's conception of LIS (see further in Hjørland 2016a). Albrechtsen's point is thus that mapping of domains cannot avoid the subjectivity of the researcher, and the study of domains is like the hermeneutical spiral: You start investigating domains based on your pre-understanding. During your study, your knowledge changes, and makes you change the way you study the domain in a spiral.

It is important to understand the dual nature of domains as intellectual organization on the one hand, and social organization on the other hand. Toulmin (1972/1977) differentiated between the "content-knowledge" of a science [or domain] and the "institutional aspects" of science, such as professional forums, and suggested that science is generally continuous, because either the content or the institution will remain stable while the other changes. In response, then, the former will adapt, in an iterative process of constant change and constant stability. The dual nature of

domains has been addressed in LIS by Fry (2006) and Fry and Talja (2007), inspired by Whitley (2000). The social development of domains is characterized by the findings that the language of domains tends over time to become more distinct from general language (owing to increased specialization) and the language use of individual domains tends to become increasingly distinct from that of other domains (owing to diversification, cf., Teich et al. 2016). Communication in domains may be modeled using bibliometric/altmetric methods or by considering the system of actors, systems, and processes in domains, between domains or from domains to the public sector (cf., Søndergaard et al. 2003).

In Section 5 below, other aspects of defining "domain" are discussed, including a criticism of domains as too related to academic disciplines as well as Tennis' claim that one must define the area to be studied before a domain analysis is started through the methodological application of two axes (the modulation area and degrees of specialization).

Smiraglia (2012, 114) found that:

> A domain is best understood as a unit of analysis for the construction of a KOS. That is, a domain is a group with an ontological base that reveals an underlying teleology, a set of common hypotheses, epistemological consensus on methodological approaches, and social semantics. If, after conduct of systematic analysis, no consensus on these points emerges, then neither intension nor extension can be defined, and the group thus does not constitute a domain … It is the interactions of the ontological, epistemological and sociological that define a domain and reveal its critical role in the evolution of knowledge.

This definition is close to the one suggested in the present paper, and can almost serve as the conclusion of this section. The definition highlights the consensus in the domain, which is clearly highly important to consider. In many domains (e.g., LIS), however, consensus seems not to exist, and it would seem problematic to obtain from domain analysis in those cases. In cases with no or little consensus, the role of the domain analyst in actively contributing to the creation of the domain will be more dominant (and therefore obtain a role that is less distinct in relation to researchers in the domain).

2.4 Conclusion

A domain is a body of knowledge, defined socially and theoretically as the knowledge of a group of people sharing ontological and epistemological commitments. Domains are often academic disciplines, but may also be, for example, hobbies.[21] Different theories and social interests may construe domains differently, and therefore the classifier should be explicit regarding the interests and theoretical views on which the construction is based. From the perspectives of LIS and KO, it is important to optimize information exchange in domains; therefore, domains need to have a certain level of stability and infrastructure[22] in order to be good candidates for domain analysis.

3.0 An example: domain analysis of art history

This section aims at providing a model of a domain-analytic study. Different researchers may have different views on what represents a good example. Talja (2005) provided some examples and Hourihan Jansen (2016) found that "given the growing pluralism of approaches, it appears there is no quintessential research design for domain analysis." Hjørland (1998b) provided an analysis of the domain "psychology" from the perspectives of empiricism, rationalism, historicism, and pragmatism, which formed the basis for his general understanding of classification (see Hjørland 2017b, Section 42c). In this paper, however, Ørom's domain analysis of art studies is presented as a model. Ørom (2003)[23] presented and discussed the following "paradigms" in art history and art scholarship (here with subheadings subordinated to the metastructure of the present article).

3.1 Cultural history

Ørom (2003, 134) wrote that Jacob Burckhardt (1818-97) aimed at describing the panorama of an entire age and "within this panorama he set the visual arts at or near the centre of the defining characteristics of an age."

3.2 The iconographic paradigm

Erwin Panofsky created his iconographical paradigm in the tradition of cultural history. His iconographic analysis (which included a stylistic analysis) aims at the interpretation of the intrinsic and symbolic meaning of images. The interpretation of this intrinsic meaning is based on the study of contemporary philosophy and literature.

The focus of the iconographic paradigm is allegorical and symbolic meaning. Panofsky studied the Renaissance and the Baroque period. Works of art from these periods have a privileged status for the scholars who subscribe to this paradigm. In general, the art-historical tradition for cultural history (E. H. Gombrich) and iconography have high culture in focus.

3.3 The stylistic paradigm

According to Ørom, the stylistic paradigm was established around 1870 and later developed by Heinrich Wölfflin, who "considered that laws governed the ways in which forms changed through time" (Ørom 2003, 135) and:

> Based on stylistic characteristics (for instance linear versus painterly and plane versus recession) Wölfflin grouped works into related categories. The analysis of style became the basic and defining method of the stylistic paradigm in art history and the object was the works of art belonging to high culture.
>
> The object of the stylistic paradigm is the formal aspect of the work of art (style, composition, way of painting and the like). The aim of the stylistic analysis is to describe, categorize, compare, and systematize these stylistic features in order to determine a sequence of historical styles. It means that the overriding principle in knowledge organization—whether in art exhibitions, art histories or KOS—is the historical sequence of styles.
>
> As a consequence of the focus on styles the intertextuality is limited to works of art, i.e. the history of art is conceived of as an autonomous history. The meaning of the works of art is beyond the horizon of this paradigm. The way works of art are analyzed and organized in taxonomies is similar to Linné's principles in "Systema Naturae" in which the forms of nature in the animal kingdom, the vegetable kingdom, and the mineral kingdom are analyzed systematically and grouped in families, species, and so on.

Ørom describes the iconographic and stylistic paradigms as "the traditional paradigms."

3.4 The materialistic paradigm (social history of art)

This paradigm was developed in the 1940s and 1950s by Arnold Hauser, among others. It is based on (Ørom 2003, 137; Fernie quotation in original):

> the Marxist thesis that the economic base conditions the cultural superstructure and that as a result styles vary according to the character of the dominant class" (Fernie, 1995, 18). Within this paradigm the social functions of art and the sociology of art are studied … The works of art are considered as integrated elements in the historical and social context. This materialist conception of art is diametrically opposed to the general Western idea of autonomous art. The materialist paradigm aims at analysing the meaning and the function of art in the context of material, social, political, and ideological structures (at the time when the works of art were created). This paradigm does not understand the evolution of the art as being continuous. Changes in the power and class structure cause changes in, and ruptures with, the artistic tradition.

3.5 Changes in the domain of art history and art scholarship

Ørom (2003, 139-40) wrote that in the early 1970s, "new" art historians with different theoretic orientations started criticizing the "traditional" paradigms. Criticisms included: the narrowness of the way in which art was defined and studied, the focus on individual artists, the limited scope of methods (analysis of style or iconography), and the concentration on canonical works of art. In some ways, these "new" art historians in their "new" art historical practice were inspired by the social history of art. In general, they conceive of art in a broader social context, including power structures and the relations between artists and the public. In this view, the structures of meaning have changed.

3.6 Ørom (2003, 141-42) came to the following general conclusions:

1. First, different socially and historically embedded discourses on art, including pre-paradigmatic studies and scholarly paradigms pervade knowledge organization in the art institution at three levels. These three levels are "articulated" respectively as:
   a. Art exhibitions,
   b. Primary and tertiary document types (printed, audio-visual, and multimedia documents), and
   c. Classification systems, bibliographies, thesauri (and other secondary document types).
2. Concerning the general discourse in which art is understood, there is a marked (ideological) difference between the Soviet *BBK* [*Bibliote no-Bibliografi eskaja Klassifikacija*] on the one hand, and Western classification systems (*DDC* [*Dewey Decimal Classification*], LC*C* [Library of Congress *Classification*], and UDC [Universal Decimal Classification] on the other.
3. Though the universal classification systems as such are constructed on the basis of (formal) rational and logical structures, analysis of the art classes shows that the substantial "layers" "beneath" the rational structures are constructed as "bricolage" works.
4. The systems analyzed, including the sketched analysis of UDC, show that there are significant differences

among the four systems, both regarding the understanding of art (which is a part of the discourse) and regarding the concepts of the "bricolage" work. The LC*C* system is the one that to a lesser extent includes concepts from the "traditional" paradigms—the iconographic and the stylistic paradigms. In other words, scholarly conceptions are of minor importance as compared to general formal structures in this system. The opposite is the case with UDC, in which substantial parts of the taxonomy are constructed based on "traditional" paradigms. The *DDC* system can be placed in between LC*C* and UDC.

5. The taxonomy of the *BBK* is based on the Marxist conception of art and has a less "bricolage" like structure, because the "deep" structure is more rational than that of the other classifications, as a result of an overriding theoretically-based construction. On the other hand, this "firm" construction creates "blindness" in the sense that non-Marxist concepts tend to be excluded or negated.
6. In simple terms, it can be concluded that the UDC, in particular, is well suited for representation of knowledge produced in the contexts of pre-paradigmatic, iconological, and stylistic studies.
7. During the recent three decades, the so-called "new" art history or the "new" art scholarship, has developed interdisciplinary approaches, or paradigms, that break with both the general discourse on art and the "traditional" paradigms. This means that the "new" art history, by introducing new contexts and new theoretical positions, breaks with the principles (and practice) of knowledge organization at the three levels noted above. From a library and information science (LIS/KO) point of view, the challenge is to be able to represent the documents produced by the "new" art scholars in (theoretically) adequate ways, in addition to the representation of the entire historical corpus of documents on art.
8. The central problem is that a hierarchical system based on "traditional" discourse combined with concepts from the "traditional" paradigms, is "conceptually closed." At a pragmatic level, a "polyhierarchical" thesaurus, such as the *Art & Architecture Thesaurus*, seems to be a step towards a solution of some problems raised by the approaches of the "new" art history. Because the *Art & Architecture Thesaurus* is a more "open" and more expanded work of "bricolage" than universal classification systems, it is easier to integrate new aspects of art studies into the facet structure.
9. At a theoretical level, however, the eclecticism and the "additive" view of conceptual relations mean that the *Art & Architecture Thesaurus* has a problematic epistemological foundation.

3.7 Conclusion

This summary of Ørom (2003) demonstrates that:

1. Organization of art exhibitions, and of knowledge recorded in comprehensive works on art and in LIS classification are influenced by the same paradigms. In other words, LIS classification is not independent and cannot ignore paradigms in the domains with which it deals.
2. LIS classification schemes more or less reflect and support certain paradigms in a domain, and some paradigms may be badly served by existing classifications.
3. The construction of a classification needs to identify the basic paradigms in the domain and make a choice or a compromise between (or among) them.

It seems clear that information specialists who have understood Ørom (2003) are in a better position to organize knowledge, as well as to use existing KOSs for retrieving information in the domain of art. One could ask whether information specialists who have acquired this knowledge have also learned something that can be generalized to other domains. The answer is yes, on an abstract level; information specialists will be prepared to look for different "paradigms" (and their associated criteria of relevance). In addition, there are certain similarities between paradigms in different domains. Because of this, knowledge of a philosophical nature (e.g., positivism, hermeneutics, and critical theory) can be generalized.

4.0 Varieties of domain analysis

Disciplines other than information science and knowledge organization use the term "domain analysis." As mentioned above, the term was used in the field of computer science before its introduction in the literature of information science at the beginning of the 1990s. In this section, a preliminary classification of the various types of domain analysis is presented.

4.1 Domain driven design

In software engineering, "domain analysis" is the process of analyzing related software systems in a domain to find their common and variable parts. Neighbors (1980) coined the term. This field, also known as "domain-driven design" (DDD) is huge. Here we apply the term DDD to this kind of domain analysis in order to distinguish it from other kinds. Among the works on DDD are Arango (1994), Evans (2003), Lisboa et al. (2010), Millett and Tune (2015), Prieto-Diaz (1990), Prieto-Diaz (1991), Vernon (2013 and 2016).

Albrechtsen (2015, 558), citing Prieto-Diaz (1991), presented facet classification as a kind of domain analysis in the DDD meaning:

> From the point of view of classification research, Prieto-Diaz's approach is especially interesting because its main theoretical basis is Ranganathan's theory of faceted classification. Prieto-Diaz developed a faceted scheme for classification of software components and introduced the term "domain analysis" for the analytic-synthetic approach that he suggested.

This passage is somewhat confusing, however. Facet-classification has never used the term "domain analysis" (but employs the term "special classification") and has never applied a methodology related to DDD (but it is mainly based on logical division, cf., Mills 2004). Facet classification does not share the "critical-hermeneutical" approach view of Albrechtsen.[24] Domain-analysis in the sense introduced by Hjørland and Albrechtsen (1995) is therefore considered to be different from DDD.

4.2 Domain-specific modeling

A second approach is termed "domain-specific modeling" (DSM) or "ontology-driven domain-specific modeling." It seems to be a framework related to DDD. See, for example, Banerjee and Sarkar (2016), Kelly and Tolvanen (2008), Tairas et al. (2008), and Walter et al. (2014).

4.3 Work domain analysis as a part of cognitive work analysis

A third approach is termed "work domain analysis." This term has been used in relation to problems corresponding to the approach considered in KO and LIS. Work domain analysis is part of cognitive work analysis (CWA), a methodology and conceptual framework developed by Jens Rasmussen and Annelise Mark Pejtersen, from the Risø National Laboratory in Denmark (see Rasmussen et al. 1994).[25] The focus of the CWA framework is analysis of the interactions between humans and their cognitive processes, technology (information systems) and work domains (work environments and tasks). Mattsson's thesis (2016) (in Danish) is about the use of CWA in the design of controlled vocabularies. The author examined an approach for the design of classification systems based on CWA that was described by Albrechtsen and Pejtersen (2003). Using a national film-research archive as a case, they articulated a methodology for developing a classification system intended to support the decision-making of the actors during information retrieval. Mattsson found (2016, 41ff.; the following four quotations are here translated from Danish):

- The classification itself (the semantic structure) was not a product of the CWA, but of the dialog between the user and staff.
- Another premise for generalizing the implication of this cooperation is that the structures represent prototypical user needs (Albrechtsen and Pejtersen 2003, 223). It is not discussed or explained why they should be considered prototypic.
- Absent from the article is an analysis of different epistemological positions in the domain. This is important because domain analysis without epistemological analyses tends to be superficial because epistemology provides insight into the assumptions of theories about user behavior. Epistemology thus provides a foundation for evaluating present systems (Hjørland 2002a).
- The facets are, in my reading of the article, to a large extent derived from the staff of the archive on the basis of their experience and background knowledge applied to the specific problems of the users …. What seems to be missing in this investigation is a discussion of the validity of the staff's "expert knowledge." The domain "film archives" is not defined or delimited, and it is therefore unclear whether it represents the three film archives investigated or film archives in general. There is no discussion of the theories or assumptions underlying the decisions of the actors. To construe a classification ought to mean that one knows about, and takes a stand on, the assumptions, which underlie the production of knowledge. Such assumptions influence how an actor classifies something (and thereby have an influence on the semantic structures studied in this investigation). The aspects of the information needs that the expert identifies must depend on assumptions related to film studies as well as to studies of information searching. The designer of classification systems in the domain needs to know about the different theories and paradigms in film studies [see, e.g., Stam 2000]. It may be problematic to take "the expert's" (i.e., archive staff's) guidance of users as the measure for understanding their information needs. It is as if the applied method leave the analysis of user needs to a "black box" in the form of an expert.

Work domain analysis in CWA (like DDD) differs from domain analysis as understood in the present article, by avoiding theoretical involvement with the domain, for ex-

ample, by not considering ways of "classifying" films,[26] by genres (Bondebjerg 2001). Work domain analysis (CWA) has not provided an example of a classification system constructed on the basis of the suggested methodology.[27] At most, CWA has been able to demonstrate the need for classification systems.

4.4 Domain analysis as a "knowledge elicitation" technique

A fourth sense of domain analysis is used by Lykke-Nielsen (2000) in the paper "Domain Analysis, an Important Part of Thesaurus Construction," of which was written (Hjørland 2002b, 259-60):

> The methodology for thesaurus construction described in Lykke Nielsen (2000) is a combination of group interviews and word association tests to collect data and content analysis and "discourse analysis" to analyze data. The "domain" or "discourse community" is a specific Danish pharmaceutical company. Given the purpose and conditions of this research, I have no serious objections to the methods used. On the contrary, I welcome this initiative as talented and relevant. We need very much this kind of information research that goes into foreign fields and develops tools for their optimal information gathering. I wonder, however, if the term domain analysis is well chosen and whether it is in accordance with my and with other people's use of this concept.
>
> The data collection methods described in Lykke Nielsen (2000) are well known in AI (artificial intelligence) as techniques or methods of knowledge elicitation. If you are going to build an expert system, you have to get the expert knowledge from somebody or somewhere. An obvious solution is to elicit the needed knowledge from somebody considered an expert on the task or issue. Cooke (1994), for example, presents a variety of such knowledge elicitation techniques, including group discussions and free associations. Such methods have primarily been considered of a psychological nature, while the domain-analytic methods that I have been a spokesman for have mainly been of a sociological and epistemological nature.

Lykke Nielsen's use of the term "domain analysis" thus seems misplaced for two reasons: 1)what was analyzed was a company rather than a domain; and, 2)the technique used is known as "knowledge elicitation" and is associated with cognitive views rather than with epistemological-sociological views.

4.5. Domain analysis in LIS (broad sense)

A fifth sense of domain analysis in knowledge organization may be termed "the broad meaning of domain analysis" (DA/LIS broad). In the broader sense, domain analysis includes bibliometric mappings and facet analysis (or any of the 11 points considered separately) of disciplines or other domains. Smiraglia (2015) may be classified as one of the documents belonging to this broader interpretation of domain analysis. As stated by Albrechtsen (2015, 559), however, "it needs to be highlighted that the development of knowledge organization systems for specific domains is not, in and of itself, a domain analysis." (The same applies to bibliometric mapping, for example).

4.6. Domain analysis in LIS (narrow sense)

In the sixth and narrow sense (DA/LIS narrow), studies are therefore considered domain analysis only if they consider different theories, "paradigms," or traditions in the domains. The reason is that a domain is not "given" to the domain analyst, but is something that involves the consideration of perspectives, goals, values, and interests in the constitution of a given domain (cf., Hjørland 2016a).

4.7. Conclusion

This section provided a preliminary classification and evaluation of different domain-analytic approaches. The section thus uncovered different interpretations of domain analysis, including those within the field of knowledge organization. Six different senses of domain analysis were discussed. The sixth sense corresponds to the one originally suggested by Hjørland and Albrechtsen (1995) and to the methodology used by Hjørland (1998b) and by Ørom (2003), which was presented in Section 3 above; this methodology may be considered a social epistemological approach.

There seems to be a tension, also within KO, between approaching domain analysis from more positivist ideals or from more critical-hermeneutical ideals, as we shall now observe in Section 5.

5.0 Criticism and controversies

5.1 The need for an *a priori* operationalization of domains

Not all researchers find the hermeneutic spiral in domain analysis satisfactory. Castanha et al. (2016, 219) wrote:

> According to Tennis (2003[28]; 2012), before starting any Domain Analysis, one must define the area to

> be studied, specify the scope of this analysis by the two axes and establish the ultimate purpose of the analysis.

The two axes suggested by Tennis (2003, 193) are: 1) areas of modulation; and, 2) degrees of specialization[29]:

- The Areas of Modulation, axis one, is an explicit statement of the name and extension of the domain examined. It states what is included, what is not included, and what the domain is called.
- Degrees of Specialization qualify and set the intension of a domain. It may be neither desirable, nor feasible, to describe an entire domain. The whole domain may have a name and an extension that can be defined, but it may not easily lend itself to analysis. Thus, the domain must be qualified. By qualifying a domain, its extension is diminished and its intension in increased. For example, to study Hinduism is not to study all of Religion. The qualified domain is Hinduism.[30]

Tennis posited that these axes should serve as analytical devices for the domain analyst to delineate what is and what is not being studied as a domain analysis. He considered that both are necessary for setting the parameters of a domain. Khalidi (2013, 120-122) also introduced two dimensions of a domain—the spatiotemporal and the aspectual—but he found that there may be no way of fully specifying the latter without circularity, that is, without referring to the laws, causal processes, entities, properties, and kinds that are characteristic of that level. Khalidi's circularity seems to correspond well with Hjørland's critical and hermeneutical methodology on how to analyze domains.

Tennis is obviously right that some decisions must be made before a domain analysis is started, in particular, the goal of the analysis is highly important. The quote by Castanha et al. (2016) and others seem, however, to suggest an *a priori* determination of a domain that is simply impossible from the hermeneutic point of view. As argued by Khalidi (2013, 122):

> For any given domain, *D*, there may be no way of specifying necessary and sufficient conditions to single out the purview of *D* in terms not derived from the theory or theories that apply to *D*, since even the individuals identified in a domain are generally picked out against the background of the theory or theories prevalent in that domain. And: Domains are both spatiotemporal and aspectual, but they may not be capable of being individuated noncircularly without recourse to the theories, properties, and kinds that occur in those domains.

Tennis (2012) illustrates this with a narrow and well-defined domain: Shakerism.[31] In knowledge organization, however, we often have to construe classifications in a top-down fashion, starting with the total universe of knowledge or with disciplines such as biology, chemistry, psychology or religion (e.g., designing a universal classification or a thesaurus for a given discipline). From this perspective, Tennis' example seems unusual in that it suggests a bottom-up strategy. Let us also examine Tennis' criticism (2003, 193) of Hjørland's domain analysis of psychology:

> Hjørland (1998[b]) has offered a rigorous analysis of Psychology from an epistemic point of view. He reviews the many ways Psychology might be described as a domain. Because "classification of a subject field is theory-laden and thus cannot be neutral or ahistorical," (Hjørland, 1998[b], p. 162) Hjørland seeks to show "how basic epistemological assumptions have formed the different approaches to psychology during the 20th century" (Hjørland, 1998[b] p. 162). And precisely because the classification of a subject field (its domain analysis) is theory-laden, the basic question arises: whose psychology does Hjørland analyze? What is its extension? Is Hjørland's psychology, an academic psychology, the same psychology as Naropa University's Transpersonal Psychology? …
>
> He [Hjørland] provides the reader with an introduction to a variety of psychologies in his 1998 article. One example is psychoanalysis. Yet, when taken as a whole these psychologies are called "traditional mainstream psychology" (Hjørland, 1998[b] p. 176). We are left unsure of the scope, the extension and intension of the domain under study. The reader is provided with an open concept of psychology, rather than an operationalized concept of psychology.

This example illustrates very well the problem of the hermeneutic spiral (see also Hjørland 2016a). In order to examine a domain, you must know something about that domain, and this knowledge determines what you do and influences the results of your research. There is simply no way to escape this hermeneutic spiral, but that does not mean that there are no criteria for what counts as good research. For example, a mapping of psychology may

a. Take as its point of departure a literature[32] in which transpersonal psychology is relatively well represented; or,

b. Take as its point of departure a literature in which transpersonal psychology is not well represented (or not represented at all).

The selection of (a) or (b) must be considered a methodological and theoretical choice made by the domain analyst that needs justification (although it is often implicit, unconscious, and influenced by the domain analyst's (sub)culture and training, or by the availability of sources, and therefore not considered a theory).

Some views on psychology (and on all other domains) are more established and influential than others. The most influential views are often represented by prestigious universities,[33] journals, and publishers (the institutionalized aspect of a domain). People may, however—rightfully or wrongly—disbelieve mainstream views or ruling ideas (the content or cognitive aspect), and may fight to get alternative views accepted and made influential. For domain analysis, this means that choices should be well informed; domain analysts should have broad and deep knowledge about theories of the domain (in case psychology) with which they work. It also means that domain analysis cannot be neutral, but it will always support some views at the expense of other. Therefore, if Tennis wants to make "Naropa University's transpersonal psychology" an important part of his domain analysis of psychology, he should provide an argument (in this case in particular, because it is not generally recognized as an important view of psychology). The suggestion made here is that we have to take the mainstream view as the point of departure, and examine its implications and philosophical assumptions, including the social interests that have formed modern psychology. Such work often leads to a minority view (and could lead to the view that "Naropa University's transpersonal psychology" is the most important psychological view). We should not be afraid of defending minority views, for, as Kierkegaard ([1850] 2015) said, "the minority is always right."[34] Again, to describe or model a domain requires a theory of that domain,[35] and to make domain analysis is to participate in the construction of the domain.

5.2 The need for universal classifications

5.2.1 Universalism

Szostak et al. (2016) is probably the most recent and comprehensive discussion[36] of universalism in classification and a more focused presentation of this view is Gnoli and Szostak (2014, [1]):

> Supporters of domain analysis claim that the only solution to these challenges [cultural biases implied in universal systems] is to develop a plethora of systems explicitly biased, each representing the perspective of a different community. However, the current evolution of information systems brings a further need in front of us that domain analysis alone cannot solve: that of interoperability.

Let us consider this quote. In recent years, there has been a revolution in biological classification, for example, in the classification of birds (see, e.g., Fjeldså 2013). The point of view of domain-analysis (and common sense?) is that this new classification, when firmly established, should be used both in special biological classifications and in universal classifications (if these are not to be obsolete), just as we should expect this new knowledge to be recorded in books about birds and taught in public schools, etc. In other words, a universal classification should be considered the sum of a number of domain-specific systems (birds, cars, countries, religions, sciences, etc.). In order to classify birds (or in order to classify documents about birds), we do not need a universal classification (although Mills 2004 claimed this[37]), but in order to develop a universal classification, we need to know how to classify living organisms, including birds. Advanced classification systems such as the UDC have therefore relied on domain-specific knowledge and subject specialists. Whether or not there is one "best" classification of birds, or what kinds of classification are needed for different purposes, constitute other questions.[38] These questions, however, can be addressed only by people involving themselves with bird classification and its methodology. It is problematic to believe that *a priori* principles (learned in schools of LIS or in philosophy or elsewhere) provide a satisfactory solution.[39] In other words, domain-specific knowledge is always needed in classification. This is the first answer to the issue raised by Gnoli and Szostak (2014). Other issues are discussed below.

Fox (2016, 379) has put forward another argument for general classifications:

> Domain analysis (Hjørland 2004, 18), which treats users as "belonging to different cultures, social structures and ... communities that share common languages, genres and other typified communication practices" is another proposed option that has met with acceptance in the field. However, by definition, domain analysis caters to prescribed domains, and thus has limited effectiveness for general collections, and moreover, identity categories such as gender and race relate to many human activities and have relevance across collections and domains.

As has already been argued, general collections can be seen as sets of more specific domains (e.g., birds) that need to be classified. "Gender" and "race" play a double role in classification: 1) they are subjects that need to be classified by knowledgeable people in those domains; and, 2) they have given birth to critical epistemologies (feminist, Marxist, and postcolonial epistemologies[40]) and, thus, classification criteria that "have relevance across collections and domains." Fox's reservations about domain analysis therefore seem misplaced.

5.2.2 Ontology and epistemology

There is a related difference between domain analysis and the view of Szostak et al. (2016, 72-73, notes omitted) concerning the role of epistemology in classification:

> Gnoli (2007) argued that classification systems are best grounded in both ontology (an understanding of what things exist in the world and how these are related) and epistemology (an understanding of how scholars study things). The domain-specific approach leans heavily on epistemology: it seeks to ground classifications in an understanding of how scholars in that domain operate. Comprehensive classifications can and should have an ontological base. Yet most comprehensive classifications rely on disciplines as a classificatory device and are thus to a considerable extent largely epistemological in approach. The sort of classification advocated in this book is grounded in ontology, for it is grounded in the phenomena (things) that exist in the world. Yet as noted above the details of such a system are worked out with careful attention to how scholars study things.

Szostak et al. (2016) recognized the need for domain analysis and López-Huertas (2015) addressed the application of domain analysis to interdisciplinary fields. In the quote above the point of view seems to be that we have direct access to things in the world and may distinguish and describe them independently of our concepts and theories. This is the opposite of the domain-analytic view that any ontology is based on epistemological assumptions. Szostak and his coauthors need to defend their view.[41] Although they claim that classification systems are best grounded in both ontology and epistemology, they need to explain how ontological analysis can be done independently. Again, taking birds as an example, we may perhaps agree that the new classification proposed by Fjeldså (2013) should be preferred; however, the argument regarding why it should be preferred must always be based on a consideration of the scientific basis of the classification and thereby its epistemology. It is simply not possible to make advances in bird classification independently of research and theory. This can easily be seen by considering the history of bird classification (e.g., Bruce 2003).

The quote above from Szostak et al. (2016) connects epistemology with discipline-based classification, and ontology with phenomena-based classification; however, rather than disciplines, "theories" are what is behind different ontologies (A discipline may contain several theoretical views, as demonstrated by Ørom in Section 3, above, just as a given theory may be distributed in different disciplines). Influenced by the philosophy of Kuhn (1962) and many others, it is an important thesis in the contemporary philosophy of science that our observations and classifications are theory-laden. The idea of describing things in the world in an atheoretical way is therefore naïve. All classification depends on the methodology used, which is again connected to epistemology (see further in Hjørland 2017b). Epistemology is therefore not just a requisite for discipline-based classifications, but also for phenomena-based classifications.

5.2.3 Interoperability, standardization and the needs of interdisciplinary research

Szostak has emphasized in many publications that we need classifications that serve interdisciplinary research (and thus are not tied to single disciplines). He has argued (Szostak 2010 and 2013) for the complementary pursuit of domain analysis and a universal classification, which would at least ensure that the concepts of a domain's literature are well captured in the universal classification. He also finds it advantageous to have domain-specific classifications that are translatable into the universal.

As described above, however, a universal classification cannot be made without considering the specific contents (e.g., birds) and the problem of different meanings seems not to be associated with disciplines as much as with theories. Given that we have different theories in which terms have different meanings and which implies different classification, how can we obtain interoperability and satisfy the needs of interdisciplinary research?

In papers such as Gnoli and Szostak (2014), the need for standardized classification and interoperability seems to influence the authors in a way that drives out the understanding of the theory-dependency of meanings and classifications. It is argued that universal classification systems "are necessary in an era that values interoperability. Such systems have numerous other advantages." The arguments, however, seem more like wishful thinking than an academic investigation of the conditions and implications of establishing such universal systems (or standardized systems[42]). If different theories imply different classifications, then a standardized classification makes one theoretical

view authoritative (and if this is not made explicit, then it is to make a subjective choice disguised as objectivity).

Another issue is also related to interdisciplinary research: the dynamics of specialties and disciplines. This is addressed by Tengström (1993, 12), who emphasizes that cross-disciplinary research is a process, not a state or structure. He differentiates three levels of ambition for cross-disciplinary research:

- The pluridisciplinarity or multidisciplinarity level;
- The genuine cross-disciplinary level: interdisciplinarity; and,
- The discipline-forming level: transdisciplinarity.

Tengström suggested that library and information science started as a pluridisciplinary activity, and is on the way to becoming a discipline. By implication, interdisciplinary research may not need standardized classifications, that are common for all disciplines, but is in the process towards developing a new classification that accords with its own special needs (this is a model of how new scholarly fields develop).

Hjørland (2016b, 320) discussed the best solution for creating interoperability, and found that the solution for a classification to serve as a "boundary object" or "epistemological hub" for defining and classifying objects should probably be outlining the most important alternative theories, their conceptions, and classifications. Then a conversion table or "crosswalk" should be established.

5.3 Resistance to study scholarly domains

In the field of KO there seems to be a certain skepticism considering scholarly disciplines. We saw above in Section 4 that Albrechtsen and Pejtersen (2003) did not consider film genre or research in film studies when they were involved in designing of a classification system for a national film-research archive. Far too few papers in LIS and KO study domains from the perspective of philosophy of science and science studies. López-Huertas (2015) also failed to illustrate her discussion with concrete examples. In LIS and KO there seems to be resistance to the study of concrete domains, whether they are disciplines or interdisciplinary fields. After all, it is an important part of our historical heritage to classify all knowledge domains, disciplines, interdisciplinary fields, or phenomena, expert groups for the UDC, for example.

5.4 Critique of the idea of a common theoretical framework for LIS/information science

Some critiques focus on the attempt to develop information science (or LIS or information studies) as a field of study with some kind of identity. Limberg (2017), for example, said:

> Domain analysis (Hjørland and Albrechtsen 1995; Hjørland 2002[a]) was developed by Birger Hjørland from the mid 90's as a competing theoretical approach [to the cognitive viewpoint], not acknowledging cognitive psychology as a relevant framework, and instead suggesting social aspects of information science as foundational. However, domain analysis was based in a similar ambition to create a common theoretical framework for the discipline of information science.

It is difficult to understand this criticism. Limberg's speech (2017) quoted a definition that reflects her own view of the field (FRN [Forskningsrådsnämnden] 1989, 85, Limberg's translation):

> The discipline [LIS] takes its point of departure in problems related to the mediation of information or culture, stored in some form of document. The objects of study are processes such as information provision or the mediation of culture, as well as libraries and other institutions with similar functions, involved in this process. The discipline has connections to a range of other disciplines within the social sciences, the humanities and technologies.

I share the view expressed by Limberg that the FRN definition constitutes a broad and fruitful conception of information studies. It is, however, one conception out of many, and, as such, it includes something (it includes many things because it is broad) and excludes something else. In my opinion, Limberg, by supporting this definition, is also trying "to create a common theoretical framework for the discipline of information science." This seems therefore to be a misplaced criticism of domain analysis. It should also be emphasized that it is necessary for any discipline to exclude something. The field of information studies suffers greatly from a tendency to accept any paper or thesis as a part of the field as long as it is written in one of our educational programs. Sonnenwald (2016) is a book about theory development in the information sciences. It contains a chapter by Hilary S. Crew entitled "Illuminating daughter-mother narratives in young adult fiction." As written in a book review (Hjørland 2017a) daughter-mother narratives in young-adult fiction cannot be considered a part of information science—no matter how we define our field. Crew's chapter is about literature studies, not about information science. Our field is in a crisis if we accept contributions from any other field as a valid contribution to our field.

If information science is about everything, then we are not experts in anything but amateurs in everything.[43] Therefore, we must have the goal of creating a common theoretical framework for the discipline of information science (or LIS or KO).

5.5 Conclusion

This section examined some[44] of the arguments that have been put forward against the domain-analytic point of view. Most visible have been arguments that may be interpreted as critical of the more historicist, hermeneutic, pragmatic, and critical aspects of domain analysis. There has also been a broader criticism that seems to question the very goal of an identity for LIS/KO. There probably exist other forms of criticism that have not been expressed in the literature. To argue against the silent criticism is difficult because the criticism has not been expressed and therefore cannot be examined. There may be beliefs that more straightforward or easier approaches exist. Many scholars subscribe to alternative views, such as the cognitive view. Such views need to be examined and evaluated, if not, KO cannot progress. We need to examine what Slife and Williams (1995) called "the hidden theoretical assumptions" of the field, and to take theory seriously in KO.

6.0 Further methodological examples and considerations[45]

6.1 Domain-analytic studies made outside KO

Beak et al. (2013) and Smiraglia (2015) have provided valuable studies of domain analysis within knowledge organization. Here it must be stated, however, that domain analysis needs to consider in addition studies made outside information science and KO. It cannot be overemphasized that information science, LIS, and KO are part of the metasciences and need closer cooperation with them–as well as with the specific knowledge domains they investigate.

The degree to which domains study themselves vary. Budtz Pedersen, Stjernfelt and Emmeche (2016, xiii) wrote:

> We are aware that the humanities very rarely make themselves an object of study. In contrast to the social sciences, where there is a longstanding tradition for not only examining the field's own research practices but also for studying research cultures in the natural sciences, there has never been a "humanities studies."[46] The humanities are overdebated, but under-investigated.

The book by Budtz Pedersen, Stjernfelt and Emmeche (2016) can be considered a domain analysis of the humanities, and part of a greater research program "humanomics." The quote above indicates that various disciplines' study of themselves as well as the study of disciplines made by other fields should be considered. Although the focus of KO is the making of classification systems, thesauri, ontologies, and other kinds of knowledge organization systems (KOS), this field should not consider itself too narrowly, and the methodology should not be understood too narrowly, mechanically, or positivistically.

Lee's book (2009) challenges mainstream economics in the twentieth century (the neoclassical paradigm), including the influence of the British *Research Assessment Exercise* and the ranking of journals and departments in economics. It is relevant to information scientists doing bibliometric research and to domain-analysts in KO, whether they use bibliometrics or other methods. The field of economics seems to be a domain that to a large degree has studied itself, and those in KO who want to study this domain should consider such studies.

A third example of a valuable contribution from outside KO is Andersen (2000). He found that social sciences differ with respect to the degree of consensus on what constitutes their core journals. Within the single social sciences, the picture is a pluralistic view rather than a monolithic hierarchy. This finding confirms that different perspectives on a given domain need to be considered, and that journal rankings such as the one made by *Journal Citation Reports*® should not be used uncritically.

6.2 The status of "ordinary people" in domain analysis

One of the issues sometimes raised in domain analysis is the status of "ordinary people" (i.e., people not associated with formal disciplines). Here this problem is illuminated by considering the example of homosexuality in relation to psychiatric diagnoses. According to Drescher (2015), the American Psychiatric Association decided in 1973 to remove homosexuality as a mental disease from the official American diagnostic manual (*Diagnostic and Statistical Manual of Mental Disorders, DSM*). Homosexuality was considered a mental disease in the two first editions (American Psychiatric Association 1952 [*DSM*-I] and 1968 [*DSM*-II]) until the sixth printing of *DSM*-II (in 1974). Here we do not go into detail regarding how homosexuality was considered in later editions, but the overall picture is that homosexuality was depathologized after 1973. Within the discipline of psychiatry (as in other disciplines, e.g., psychology), different theories of homosexuality competed at that time and still compete today. These theories are associated with broader "paradigms"

such as behaviorism, psychoanalysis, cognitivism, and neuro-biology that more or less prevail in different disciplines and in the broader community at different times (in relation to disciplinary interests and the "Zeitgeist"). What is interesting in the case of homosexuality is that it was political pressure from the homosexual community that influenced the scientific and scholarly psychiatric community. "Ordinary people" in this case consists of people in the homosexual movement and others, and it therefore does not constitute a homogenous group. "Others" may be more or less influenced by different views—some by official psychiatry, some by religious ideologies, some by the homosexual and antipsychiatric movements, etc. For domain analysis, the conclusion is that it is important to consider the relative dominance of different paradigms in different domains at different times, including their relation to the broader society. Whether or not homosexuality should be classified as a mental disorder can be done only by considering the theoretical and political arguments, not by studying the opinion of people in general.[47]

6.3. Epistemological dimensions of bibliometric domain-analysis

Raghavan et al. (2015) contributed to the second thematic issue of the journal *Knowledge Organization* that was devoted to domain analysis[48] (the first appeared in 2003[49]). Their paper is a fine descriptive, bibliometric study of the domain "information retrieval" (IR) as treated in two databases (Institute of Electrical and Electronics Engineers database, IEEE and EBSCO's Library, Information Science & Technology Abstracts, LISTA) during the period 2001-2014. The authors assumed that the IEEE database in particular reflects the computer-science community, whereas LISTA in particular reflects the LIS community. Of course, these kinds of assumptions are legitimate; they appear frequently in almost all research. Here we try to suggest how that study could be followed up by new domain analytic studies. What we try to do here, is to suggest how this study could be followed up by new domain studies, and in particular relate the suggestions to the narrow view on the methodology of domain analysis (see Section 4.6).

First, Raghavan et al. (2015) were interested in the relative differences in contributions to IR from different communities. The hypothesis that IR has largely migrated from information science to computer science has recently been stated (see, for example, Bawden 2015 and Hjørland 2017a). In order to examine this hypothesis bibliometrically, it is necessary to identify the set of information sources associated with each community. Just a few problems are mentioned here:

1. Even at the journal level, the disciplinary link is often unclear. *Journal of the Association for Information Science and Technology* used to be the journal mainly about (library and) information science, but LIS is now a minority field in its own flagship journal (cf., Chua and Yang 2008[50]).
2. Some of the journals that are considered to represent LIS in LISTA in fact belong to other communities (Information Systems, for example, is a third community, and *ACM Transactions* classified as LIS is clearly a journal associated with computer science).
3. The coverage of the different databases needs to be known in much more detail if the hypothesis concerning IR is to be tested.
4. Raghavan et al. (2015) relied on the terms that were assigned to each document (INSPEC Control Terms in the case of IEEE and Subject Terms in the case of LISTA). This, however, makes the investigation dependent on the indexing in the respective databases. Such indexing inserts a level of interpretation between the document and the searcher. It is important separately to study: 1) the development of specialist language in different communities; and, 2) the development of indexing languages and their representation of documents (including the quality of indexing). Studies of language and terminology in domains is one of Hjørland's eleven points, but it is currently poorly represented in domain studies.[51]

These four points are not meant as a criticism of the paper by Raghavan et al. (2015). They have made an important start and identified, for example, that "clearly the Web has been the major influencing factor in determining the direction of research in IR" (598). The purpose of the present article is, however, to outline methodological issues in domain analysis and to consider how such issues may improve our studies. We have not yet considered the epistemological point, which was claimed to be the most important. The choice of journals and conferences and other sources covered is, however, of major importance, and so is the choice of assigned terms, title words, words from abstracts or full text, and the way they are studied. Any deeper level of bibliometrics/domain analysis has to consider such issues.

IR seems today dominated by statistical approaches, and we might ask whether Robertson (2008) is correct in his claim: "statistical approaches won, simply. They were overwhelmingly more successful [than other approaches such as controlled vocabularies, including thesauri]." If the community of KO still believes it has a role to play in relation to IR, how has it responded to this challenge? Has it joined the statistical approaches or has it developed alternative approaches to information retrieval?

What theoretical assumptions are dominant in the LIS and KO communities in relation to information retrieval?

Many publications in the fields of LIS and KO seem not to consider this challenge and instead stick to traditional issues. There may be two views here: 1)that such publications are also important contributions to the future; or, 2)that they are not. Any responsible person should, of course, determine the course of his/her research and teaching, based on an informed consideration of such issues. Therefore, the identification, examination, and evaluation of the basic theoretical assumptions in the fields related to information retrieval are the most important things to do from the perspective of domain analysis. Examples of such approaches were presented in Hjørland (2016b). Other assumptions should also be examined, including the idea that KO should give up its ambition of making controlled vocabularies for full-text retrieval (and major disciplinary databases?) and restrict itself to applications where no other IR technology is effective, such as small- and medium-scale in-house collections or non-text collections (cf., Dextre Clarke 2016, 141).

It is much more important to learn about the (theoretical) development of a domain than to simply map which topics have been most studied. A study of the theoretical development of a domain needs to identify different "paradigms" or major theoretical views, such as those listed above. The first step to clearly identify the paradigms and examine them. The next step is to support information retrieval in order for the important approaches to develop. In a way, the disciplinary affiliation seems to be less important than the theoretical assumptions. It is highly important to uncover and examine theories and assumptions, whether they are implicit or explicit. Bibliometric techniques, such as those used by Raghavan et al. (2015), are important, and should form part of the competencies of information and KO researchers. The point made here is that other kinds of knowledge of the domain examined may improve future studies and, in particular, that domain-knowledge is needed and the domain analyst needs to consider herself part of the effort to develop the domain. More about bibliometrics and the philosophy of science in Hjørland (2016a).

Smiraglia (2015, 97-98) found that domain analysis "helped to enrich the contextual understanding of the functions, activities, shared semantics, and evolving constraints of knowledge-based domains. There has been little applied research, however, reporting the development or evolution of pathfinders or subject gateways, even in the face of expanding digital hegemony over all human activity." Smiraglia also observed (98): "we have studied our own domain in detail, but we have studied few other domains adequately for either knowledge discovery or development of knowledge organization systems."

It is important that KO contribute to other domains. Dubitzky et al. (2013) edited an encyclopedia of systems biology to which many concepts from knowledge organization and related fields have been integrated. It contains, for example, entries on classification, controlled vocabulary, data mining, interdisciplinarity, international classification of diseases, interoperability, ontology, paradigm, and XML. To have knowledge organization and information science integrated in disciplinary encyclopedias should be an important goal, but so far this is done much too seldom.

6.4 Conclusion

This section considered some methodological issues in addition to the model provided by Section 3 and by the discussion of criticism in Section 5.[52] The methodological implications of the arguments are that domain analysis should not just search for a narrow methodology to organize a set of items, but must be based on broader knowledge of the domain under investigation.

7.0 Conclusion

Imagine a librarian answering a question about a given topic, such as birds. Or imagine a specialist in a domain such as the arts, chemistry, or medicine working as a subject specialist in a library. In both cases, two kinds of qualification are needed: 1. subject expertise (e.g., about specific terminology and important theories); and, 2. LIS expertise (e.g., about information retrieval, bibliometrics and knowledge organization). Domain analysis suggests that the specific competencies that information specialists have or should have is information about information infrastructures and information retrieval (and the others of the "eleven plus three" points listed in Section 1).

Domain analysis further suggests that subject qualifications and LIS qualifications are not independent of each other. Just as one cannot study Chinese medicine by studying Chinese and medicine as separate subjects, information science needs to study infrastructures in all the domains that should be served by information professionals. Further, to be considered a research-based field of study, information science and KO must provide explanations of information use as well as criteria of relevance and optimal informational infrastructures. The domain-analytic view finds that criteria of relevance are implicated by the theories in a given domain, and explanations of information behavior relate to the information seekers epistemological beliefs. From the domain-analytic point of view, information specialists should know about, for example, the relevant databases, search strategies, subject terminology, knowledge organizing systems (e.g., the-

sauri), bibliometric methods, and criteria for what counts as valid knowledge (epistemology). Clearly, it is a huge advantage if the information specialist has background knowledge in the domain, but that is not what defines the information professional. Many things related to scholarly communication, genres, and documentation processes, and retrieval processes need to be mastered if someone is to consider himself or herself an information professional—and this always needs to be combined with relevant subject knowledge.

Notes

1. Hjørland and Albrechtsen (1995, 400) wrote: "You may ask: Is domain-analysis really new? Or is it old wine in new bottles? Is the phrase "domain-analysis" new, is it given a new meaning, and what fundamental claims in the theory behind this view are new? We will try to show that many past and contemporary approaches to IS implicitly share many of the basic assumptions in this view, but that an explicit formulation of this view and its theoretical assumptions and consequences has hitherto been absent from the contemporary scene."
2. An anonymous reviewer wrote: "There is too much emphasis on LIS. First, KO is not LIS. It is not officially a part of LIS. Some acknowledge its relationship to LIS, and it often is taught in schools of LIS, but many consider it to be its own domain (especially its founder). Also, an encyclopedia of KO should not have articles about LIS, but rather about KO. And, the author should try to understand that 'library science' was a naïve term from the early 20th century; that that discipline, brought together at Chicago with Carnegie money to use empirical methods for the problems of managing information institutions, merged about 1961 with documentation into what has been known as 'information science' but now is more often called, simply, 'information.' See work by W. Boyd Rayward, and especially the work by Machlup and Mansfield, itself now quite old. This change was made 60 years ago!"
   Answer: Hjørland (2002a and elsewhere) considered domain analysis as part of information science and LIS, and KO as a subfield of information science/LIS. Other prominent researchers consider KO an independent field (Dahlberg 2006, Smiraglia 2015, 1). How can it be decided which claim is correct? In an informal communication dated August 29, 2016, Ingetraut Dahlberg wrote: "With regard to my professional activities which Richard [Smiraglia 2014, 40] called 'indexer', etc., I was trained to become a documentalist, but I developed into an Information scientist and this is what I usually say when people ask me and this you can also find in my description in Wikipedia." This quote by the founder of ISKO documents that KO must be considered part of information science. Although Smiraglia (2015) considers KO an independent science, many of the contributors presented in the same book can best be described with the label "library scientists," or "library and information scientists" (e.g., Jesse Shera, Margaret Egan, Patrick G. Wilson and Elaine Svenonius), which also demonstrates that KO must be considered part of LIS. "Library science" was certainly not a term that was used only in the early 20th century. Saracevic (1992), for example, discussed its relation to information science, naming it both "librarianship" and "library science." He wrote (14): "While information science and librarianship are great allies, to the point that the term 'library and information science' is assumed by many to describe one and the same field, the reality is that differences described are of such qualitative magnitude that they make this assumption not only unwarranted, but also moot."
   Concerning the referee's claim that KO "is not officially a part of LIS," there is no official agency or criterion that has the authority to determine the relation between sciences. People in the field of KO who are concerned with classifying knowledge and disciplines should know that better than anyone else.
   Three other arguments are: 1) the literature of KO (e.g., as published in the journal *Knowledge Organization*) is bibliometrically more closely coupled with information science than with science studies, for example; 2) in developing theory for KO, we need to consider it from the perspectives of the Internet, search engines, and research in information-seeking and retrieval. It seems dangerous to isolate the field from the broader field of information science; and, 3) The institutional frame of KO is overwhelmingly institutions of information science, and it seems dangerous to contribute further to the fragmentation of that field.
   Concerning the complicated relations among fields associated with information science, see Hjørland (2013b), in which it is documented that LIS emerged in 1964 as the integration of information science and library science. As for domain analysis, it serves as a theoretical frame for IS, KO, and LIS and a general outline, like the one in the present article, will be identical in these three contexts (if it makes sense to consider them as different contexts).
   A sad conclusion is that KO and LIS, which deal with organizing knowledge, are themselves ill-defined and disordered.
3. Egan and Shera (1952) were the first people to use the term "social epistemology." It can be argued, however,

that social dimensions of epistemology first became influential in the groundswell of Kuhn (1962). Thus, Egan and Shera (1952) (or Shera's later works) do not have a clearly expressed epistemological position. This is to be found in later works, mainly from outside LIS.

4. The eleven approaches should not necessarily be combined in the same study (as this would probably be awkward), but different studies of the same domain based on these approaches may supplement each other and provide the basis for a deeper understanding of the domain.
5. However, as noted in Hjørland (2017a) in 1975 Saracevic declared "the subject knowledge view" the most fundamental perspective of relevance, but this view was since forgotten or repressed without argument by Saracevic.
6. It is difficult to say what the trends in employment of different kinds of professionals are in research libraries, in public libraries, in university departments for LIS etc. One example is provided by Larsen's study (2009, 17) of the State Library in Aarhus, Denmark, showing decline in the employment of both subject specialists, general librarians, and support personnel but an increase in computer specialists.
7. "Most MEDLINE indexers are either Federal employees or employees of firms that have contracts with NLM [the United States' *National Library of Medicine*] for biomedical indexing. A prospective indexer must have no less than a bachelor's degree in a biomedical science. A reading knowledge of certain modern foreign languages is typically sought. An increasing number of recent recruits hold advanced degrees in biomedical sciences" (https://www.nlm.nih.gov/bsd/indexfaq.html#qualifications).
8. "But nowadays, in the context of a very complex world, upper ontology had to be divided into a lot of practical formal ontologies. Such a project has been carried out in a very competent way by Barry Smith in more than 450 papers, and a lot of collaborative experiments have established not only a set of principles for ontology development but real open ontologies in biological and biomedical domains (genes, proteins, infectious diseases, embryology, anatomical information ...), in geospatial sciences (geographical categories, spatial objects, tools for geographic representation ...) and also in social and cognitive sciences (information artifact, theory of the act, documents, naive physics, cognitive geometry of war, etc.)" (Parrochia and Neuville 2013, xiii). Further: "So, for Barry Smith, an alternative to 'fantology,' might be set out for a better applying of mathematical concepts to the real complexity of the world, at different levels and in different domains: that is what the author tried to do. In more that 450 publications, 15 books and the management of impressive projects, the author has begun to build formal regional ontologies. He has done all that with the help of eminent scientists in several domains like medicine, biology, genetics, geography or ecology, and our intention is not to criticize a so massive work" (Parrochia and Neuville 2013, 49).
9. For a discussion of the education of medical librarians, see Smith (2005).
10. Mai (2010, 629) wrote: "Research on specialized libraries and information services has challenged the assumptions and begun working out frameworks that are domain specific and pluralistic; the work of the British Classification Research Group in the 1960s and 1970s (cf., e.g., Foskett, 1974; Vickery, 1975; Langridge, 1976) and Hjørland et al. recently (cf., e.g., Hjørland and Albrechtsen, 1995; Hjørland, 2002[a]) are good examples of this line of work." To the prehistory of domain analysis may be added Mote (1962) and Shera (1965).
11. The American Psychological Association (APA) carried out a large research project studying scientific communication in psychology for the purpose of optimizing both specific products such as the *Psychological Abstracts*, and its system overall, including the journal program. Among the many publications from this project (the so-called "APA studies") is Garvey and Griffith (1964).
12. By its focus on specific contents, information science may be different from media studies, for example. Depending on the research question raised in the study, a study of Google may be considered part of LIS, or it may be considered part of media studies or other fields. A typical information science question is the comparison of Google's retrieval of medical knowledge with that of other kinds of systems (e.g., Dragusin et al. 2013a and 2013b). A study of Google's importance for printed newspapers (as a competitor for advertisements) is, on the other hand, a media study.
13. Many terms are near-synonyms of "domain." Tennis (2003, 194-195, note 2) provided the following "terms related to a domain": ba, communities of practice, context, cynefin, discipline, discourse community, field, position, situated knowledge, subject matter, and work environment.

    To Tennis' list may be added: academic tradition, conceptualization, (a) literature, (sub)culture, hobby, (a) science, sect, specialty, subject area, topic, and trade. These and many more terms (such as theory and paradigm) may be examined with respect to their varying implications for the study of domains.
14. According to Arango and Prieto-Díaz (1991, 12), in the context of software reuse, the expression "domain analysis" was introduced by Neighbors (1981[sic]). Neighbors (1980, 1) wrote, "The concept of domain

analysis is introduced to describe the activity of identifying the objects and operations of a class of similar systems in a particular problem domain. A domain analysis is represented by a domain-specific language, a pretty-printer, source-to-source transformations, and software components."

15. Prieto-Díaz wrote (1990, 50): "Library Science—Another application of domain analysis occurs in Library Science when deriving specialized classification schemes [Vickery1960]. Specialized faceted classification schemes are derived through a manual process that consists of grouping related terms from a sample of selected titles, defining facet names from such groups, ordering the terms in each facet, and specifying rules for synthesizing compounded classes. The resulting classification scheme becomes a conceptual model for the domain of the collection. Grouping of terms from titles is equivalent to finding objects and operations in an application domain. The naming of facets and defining classification rules is equivalent to deriving a domain model or creating a domain language."
16. The methodology of facet analysis was discussed by Hjørland (2013a), who characterized it a "logical approach."
17. Is there a contradiction in this quote? Is it possible both to consider a domain "open" and, on the other hand, demand that it must be "more concrete" and "operationalized?" Of these two demands, the quality of openness should be considered the most important.
18. Khalidi (2013, ix) also uses the term "domains" in relation to classification. "This picture of the world, which is the one conveyed to us by modern science, suggests realms of existence arranged in levels, from smallest to largest. But these are not self-contained, compartmentalized levels like the floors in an apartment building, since there are intricate relations and interactions between the levels, or domains, as I shall call them later in this book. Additionally, the domains are not discretely arranged in a hierarchy. Much of the universe is a jumble of domains, some coexisting at the same spatiotemporal scale and within the same regions of space-time and others overlapping partially, or, to use a term that I have used elsewhere, 'crosscutting' each other. Modern science has evolved an array of disciplines, subdisciplines, and interdisciplinary research programs to study this complex multiplicity, each with its toolkit of categories, generalizations, and methods. This book is about the assortment of categories that scientists have devised to study the multifaceted nature of reality, and specifically which of these categories are valid or, to use the philosophical jargon, correspond to 'natural kinds.'"
19. Nascimento and Marteleto (2008) relates Hjørland's concept "domain" to Bourdieu's concept "field."
20. The concept "epistemic community" has been discussed in relation to domain analysis by Guimarães et al. (2015), Mustafa El Hadi (2015), as well as in Martínez-Ávila et al. (2017). The last publication understood epistemic communities as networks of knowledge-based experts that hold in common a set of principled and causal beliefs, have shared notions of validity, exchange knowledge, and shape, demarcate, and articulate the identities of present and future knowledge producers.
21. Keilty and Smiraglia (2016) is a study of male homosexual communication on an Internet contact site, which provides an argument for considering this a domain. It is clearly an example of a domain that is an alternative to an academic discipline.
22. Andersen (2000, 689) provided an interesting domain analysis of Danish social science. He wrote: "Nevertheless, on the whole these results show that although a set of common journals can function as a medium of communication, thus making visible the reputation of research results and researchers, this function is weak, at least in the Danish social sciences."
    In general, it can be said that if a domain has no, or extremely little, consensus concerning the most important information sources, it is impossible to provide efficient library and information services for that domain.
23. An anonymous reviewer wrote: "Ørom's study in 2004 was interesting, but it also was published prior to the decade and a half of progress in domain analysis in KO. An encyclopedia article in 2017 should not be dependent on it, but rather should show how domain analysis for KO has evolved over time." Answer: Hjørland (2017b, 114) concluded: "the study of classification involves the study of theories in different domains and the ontological claims of those theories. The justification of a good classification in this perspective is to make a justification of the theoretical premises on which it is based." In spite of the many studies mentioned by the reviewer, there have still been very few such studies, and therefore Ørom (2003) is still considered a model of domain analysis.
24. In an email dated June 19, 2016 Hanne Albrechtsen wrote (abbreviated and translated): "11 approaches in my opinion opened the door for methods that do not match the critical-hermeneutical approach which you and I recommended in the article from 1995, but include Smiraglia's and Lykke's quantitatively oriented approaches, which may be said to consider domains in a traditional sense. In my opinion a paper is not domain-analytic just because it contains the term 'domain' in the title." In a 2015 article, Albrechtsen wrote

(559): "Yet the proposition at this point is: We did not do domain analysis. While the projects were domain-specific: software development for diverse work domains ranging from libraries to the space industry and medical informatics and robotics, we also developed knowledge organization systems (KOSs) for specific domains like software. Still, it needs to be highlighted that the development of knowledge organization systems for specific domains is not, in and of itself, a domain analysis."

25. The intellectual foundations of the CWA framework were further developed by Vicente (1999), and a recent text on that subject is Naikar (2013). Raya Fidel, the former Head of the Center for Human-Information Interaction, the Information School, University of Washington, and co-director Jens-Erik Mai also used CWA as theoretical framework (cf. Fidel 2012).
26. The term "film classification" is normally understood the classification of films for different age groups. Perhaps "film genre" is among the better alternative terms for classifying films in libraries, archives, and databases/filmographies.
27. Mark Pejtersen also developed "the Book House" database for fiction retrieval, based on a large-scale research program. See further in Eriksson (2010) (summarized in English in Hjørland 2013c).
28. According to Google Scholar on February 19, 2017, this article (Tennis 2003) has been cited eighty-five times. It is thus rather influential, and is Tennis' most cited paper.
29. Guimarães et al. (2015) consider "that axis one, the extension of the domain, can be characterized as the analysis of the researchers that contribute to the development of the domain 'knowledge organization,' by means of citations and co-citations; while axis two, specialization and depth, can be used to identify, by citation and co-citation analysis, the domain of the researchers that constitute the scientific community in order to characterize the core of researchers that the community recognizes as fundamental, or more impactful, in knowledge organization and its main areas of research. We aim to build a co-citation network to analyse the degrees of the density and centrality of the researchers in the network."
30. Tennis' two dimensions are understood by Smiraglia (2015, 4) as "extension and intension. The terms mean breadth and depth, respectively."
31. Tennis wrote (2012, 10; emphasis original): "If we pick a constrained domain, like Shakerism, we can see perhaps what the definitions, scope and reach, and purpose might be of one of its domain analyses.
    Definition of Shakerism: The church is official called United Society of Believers in Christ's Second Appearing. It is a religious movement founded by the Wardleys of England, by recognizing Ann Lee as the second coming of Christ in 1747. From that time 'til 1990s with the publication of Stephen Stein's *The Shaker Experience in America* (Yale University Press) in 1992.
    Scope and Reach: For the purposes of this domain analysis I will use Stein's 1992 work and sources cited in that work. These comprise some 300 resources, both primary and secondary resources. *Extension*: All concepts I can identify in these texts, and their relationships. Exclusion: I am not considering anything after 1992 and not considering other sources for this domain analysis. *Name*: Shakerism according to Stein. *Focus and Specialization*: Specifically looking at theological and architectural terms, not focused on the music or art.
    Purpose: The purpose of this domain analysis is descriptive. I hope it will serve as a starting point to create an ontology of early American theological terminology in relation to the built environment, but that is not the primary concern. The primary concern is to take stock of Stein's perspective of Shakerism given the constraints above.
    It is perhaps by following these outlines that we can see more clearly the core, the scope the reach, and the purpose of a domain analysis, form one perspective and at one particular point in time."
32. A mapping of a domain may take as its point of departure the literature of and on that domain, or it may use other information sources (e.g., people). Nevertheless, the problem of selecting the sources is the same, and in all cases needs justification.
33. For example, according to Wallerstein et al. (1996), the existing disciplines of the social sciences appeared between 1850 and 1914, when the structure received formal recognition in universities. The five main locales for social science activity during the nineteenth century were Great Britain, France, the Germanies, Italy, and the United States.
34. "The truth is always in the minority; and the minority is always stronger than the majority, because the minority is ordinarily composed of those who do actually have an opinion, whereas the strength of the majority is illusory, composed of the crowd which has no opinion—and which therefore the next minute (when it becomes apparent that the minority was the stronger) embraces the opinion of the minority, which now becomes the majority, that is, the opinion becomes rubbish by statistics and the whole crowd on its side, while truth is again in a new minority. As far as truth is concerned, the same thing happens to this awkward monster, the majority, the public etc. as we say hap-

pens to the person traveling for his health: he always arrives one station too late" (Kierkegaard [1850] 2015, 120-1). To Kierkegaard's quotation should be added, however, that even if the truth is always in a minority, that does mean that is in any minority view, whatsoever.

35. This is opposed to the philosophies of rationalism and empiricism. I therefore disagree with Mai's (2008, 18) statement: "Each of these approaches [empiricist, rationalist, historicist and pragmatic] could lead to different classifications of the domain. It would be difficult to argue that any of these approaches is more correct or better that the others—they are just different, based on different assumptions, leading to different classifications." Epistemological positions are not simply something free to choose, however. To argue for a critical-hermeneutical view, for example, is to argue against opposite views.
36. "Hjørland and Szostak have disagreed on multiple occasions regarding the possibility of a comprehensive phenomenon-based classification (Hjørland 2008, 2009; Szostak 2008, 2011, 2013; Fox 2012)" (Szostak et al. 2016, 189).
37. Mills (2004, 548) wrote: "Remember that all special classifications need to draw on a more general one, often extensively." This claim is not justified, however, and the opposite is true: Any general classification needs to draw extensively on special classifications in all areas of knowledge.

    Dahlberg (2017, 66-67) seems to share Mills' view: "It is quite obvious that the emergence and upgrading of thesauri is occurring, whereby it is clear that an assessment of all concepts would reveal that a lot of them duplicate in the various systems, whereas a universal knowledge ordering system reserves for each concept its proper and unique place, so that users can tailor the system to their needs." Dahlberg writes further (70): "The endeavours outlined towards a uniform, yet universal, ordered representation of human knowledge match the work of standardisation centers whose concerns are vital for our economy; just as vital would be the virtual, proposed innovative yet improvable ICC [Information Coding Classification] based on knowledge areas, whose operation would certainly entail considerable economies when it is estimated that the elaboration of a single ontology page for a manual of chemistry costs 10,000€. To improve ICC would require an academy or a 'Leibniz-Institut' for knowledge organization staffed by experts in classification, thesaurus construction, terminology, ontologies and ad hoc disciplines."
38. Different cultures tend to classify living organisms differently. This is studied by the field known as ethnobiology (see, e.g., Berlin 1992). Normally, biological taxonomy rather than ethnobiology is used in bibliographical classification systems. Even if a classification is designed to be adjusted to a specific culture, however, domain-specific (ethnobiological) knowledge is needed.
39. Domain-specific classification cannot be deduced from a set of *a priori* principles. It is the other way around; classification research needs to be "naturalistic," to be based on the study of classification in different domains.
40. Fulani (2000, 151) discussed epistemology from the perspective of being black: "As an African-American child growing up in Chester, Pennsylvania, I (not surprisingly) never heard the word epistemology, rarely heard the word identity, and frequently heard the word race. My race faced mistreatment, poverty and poor education, and I decided that I was going to become a psychologist so that I could help people, and so that together we could change the world. As an undergraduate I was immediately disappointed by what psychology had to offer and disturbed (outraged, really) by the official assessment of the African-American community as a tangle of pathology. I soon became a militant Black Nationalist and immersed myself in Black psychology. I still never heard anyone speak about epistemology, although just about everyone was talking about race, and we nationalists spoke about identity all the time. I rapidly developed one. It was becoming a political activist, a Marxist, a social therapist and a builder of a multi-racial development community that taught me about epistemology and its links to race and identity." Although the quote continues "Having learned what it [epistemology] is, I strongly urge that we get rid of it!"

    It can be claimed, however, that Fulani's position is an epistemological position derived from his experiences as a black person (see Bakhurst 1993, on Marxist epistemology).
41. Consider, for example, the classification of mental diseases (Hjørland 2016c). It is not possible to even imagine a classification that is not connected with an epistemological point of view (atheoretical classification is a paradox). Any ontology reveals the epistemology of its author. To claim that classifications can or should be made without considering epistemology is naïve. Therefore, the defenders of "ontological" or atheoretical classification should suggest a classification of, for example, mental diseases. Hjørland's view is supported by Wesolek (2012), who provides Wittgensteinian support for domain analysis.
42. One distinction is between universal or general classifications on the one hand, and special classifications

on the other. Another distinction is between standardized classifications and non-standardized classifications. Universal systems need some degree of standardization, and are therefore less qualified to fulfill the requirements of a specific domain. The subdiscipline social psychology, has to be classed in a universal system either under psychology (which renders sociologists badly served) or under sociology (which makes psychologists unhappy). In special classifications (as in the thesauri of PsycINFO and Sociological Abstracts), however, both disciplines may have social psychology and be well served. To standardize in order to improve interoperability is to say X should always be classed under Y, which may be unacceptable to those preferring to have X classified under Z. Standardization therefore requires negotiation of different interests—and, again, domain knowledge.

43. It is, however, easy to understand how this situation (that literature and other disciplines are confused with information science) has arisen; the mediation of fiction is an important part of the function of public libraries, and LIS is supposed to educate students for this task; therefore, fiction becomes part of the curriculum. (Around the year 1990, the Royal School of LIS in Copenhagen had separate departments for, among others, fiction, humanities, social sciences, science and technology; all these fields were part of the curriculum). The domain-analytic point is, however, that fiction (or humanities, science …) as a part of information science has a different perspective as compared to how these subjects are researched and taught in their respective departments at the university. This special focus is defined by the eleven approaches listed at the beginning of this article. These eleven approaches cannot be explored in depth with adequate subject knowledge—ideally information studies should be combined with subject studies, and information specialists should have double qualifications. This is probably the only way LIS can be broad enough and still keep the claim of being a field of its own. I have never seen a proposal by Limberg on how to solve this problem. In relation to Limberg's own domain (school librarianship) and research, Hjørland (1998a) asked about the competencies of school librarians if information-science knowledge does not exist in pure, content-independent form. We may have developed too little concrete knowledge to assist information specialists with their specific tasks (an exception to this rule is probably the medical domain, where relevant domain-specific research is done in relation to medical information retrieval).
44. Holmberg (2013) is a critical analysis of domain analysis from the perspective of Bruno Latour's philosophy. Holmberg found that domain analysis bears resemblance to the "modernist settlement" where the knowledge of a few experts is considered sufficient for the study of a domain. This is, according to Holmberg, problematic.
45. One of the anonymous referees asked for a section on the methodology of domain analysis. This was done to some extent in Section 3, but Section 6 attempts to illuminate this issue further.
46. There are of course many introductory courses in the humanities (see, for example, Pittsburgh University offers a bachelor degree on Humanities (http://www.cgs.pitt.edu/academics/majors/humanities-ba) and Oxford University offers a graduate course on Humanities (https://www.ox.ac.uk/admissions/graduate/courses/humanities?wssl=1). Such courses are, however, not typically based on empirical, historical, philosophical, or scientometric studies of the humanities; in our terminology, they are not domain-analytic. In the single humanities disciplines, there are of course often studies of their history and philosophy. The claim made by Budtz Pedersen, Stjernfelt and Emmeche (2016) is that their research program "humanomics" pioneered such a study. Whether or not this is true is not addressed here. The claim here is just that these kinds of studies are relevant for domain analysis.
47. Influence also goes the other direction, of course—from academic disciplines to the broader public. In the 1920s, behaviorism was a strong force in American psychology. It strongly influenced how parents treated their children. Watson's book, (1928) *The Psychological Care of the Infant and Child,* was a bestseller, and probably everyone in America has been affected, or knows someone who has been affected, by Watson's behaviorist theory, according to which the child's wishes, needs, and feelings were treated as if they did not exist.
48. The second issue of *Knowledge Organization* devoted to domain analysis appeared in 2015 (vol. 42, no. 8) and contained papers including Albrechtsen (2015) about the misuse of the term "domain analysis," Guimarães and Tognoli (2015) about the principle of provenance as a domain-analytic approach in archival knowledge organization; Marteleto and dos Santos Carvalho (2015) about health as a knowledge domain and as a social field in the theory of Pierre Bourdieu, and Raghavan et al. (2015) about visualization of information retrieval as a domain.
49. The first thematic issue of *Knowledge Organization* about domain analysis appeared in 2003 (vol. 30, no. 3-4) and contained papers such as Ørom (2003) on the domain of art studies; Abrahamsen (2003) on musical genres; Tennis (2003) on two axes of domains; Albrechtsen and Pejtersen (2003) on cognitive work analysis (CWA); and

Hjørland and Hartel (2003) on ontological, epistemological, and sociological dimensions of domains.

50. "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, businesss, and the humanities" (Chua and Yang 2008, 2156).
51. The very term "information retrieval" may need theoretical justification. Other terms such as "document retrieval" or "literature searching" might be preferred; the last mentioned term is often used in the medical domain and seems to be more appropriate. A domain analysis of IR should therefore include a conceptual analysis of IR and other terms.
52. Many other domain-analytic studies might be considered. For example, Talja and Maula (2003) identified and defined factors that account for disciplinary differences in e-journal use in the fields of nursing science, literature/cultural studies, history, and ecological environmental science. Their findings suggest that e-journals and databases are likely to be used most heavily in fields in which directed searching is the dominant search method, and topical relevance the primary relevance type; they are used less in fields in which browsing and chaining are the dominant search methods, and paradigmatic relevance the primary relevance type.

    There are also many studies of specific domains, including but not limited to:

    – Art history: Dam Christensen (2014);
    – Earth systems science: Weber et al. (2012);
    – Fiction: Beghtol (1995);
    – Health and medicine: Marteleto and dos Santos Carvalho (2015), and Roos and Hedlund (2016);
    – Music: Abrahamsen (2003), Pietras and Robinson (2012), and van Venrooij and Schmutz (2015);
    – Philippine history: Luyt (2015);
    – Picture collections: Kjellman (2006).

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