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Classification Systems as Boundary Objects in Diverse Information Ecologies

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0. ABSTRACT

The notion of the classification scheme as a transitional element or "boundary object" (Star 1989) offers an alternative approach to the more traditional approach that views classification as an organizational structure imposed upon a body of knowledge to facilitate access within a universal and frequently static framework. Recognition of the underlying relationship between user access and the collective knowledge structures that are the basis for knowledge production points up the dynamic role of classification in supporting coherence and articulation across heterogeneous contexts. To this end, it is argued that the library should be an active participant in the production of knowledge and that this role can be effected by the development of classificatory
structures that can support the needs of a diverse information ecology (Nardi & O'Day, 1996) consisting of a complex web of interacting agents, users and technologies. Within such an information ecology, a classificatory structure cannot follow a one-size-fits-all paradigm, but must evolve in cooperative interaction between librarians and their user groups.

1. INTRODUCTION.

A bibliographic classification system is intended to provide both an overall structure for a document collection and a set of concepts that will guide the information searcher into the nowledge domains encompassed by the collection. Traditionally, classification research has approached
these objectives by developing schemes based on a one-size-fits-all-searchers paradigm:. "We have created a standard system, because, deep down, all users are the same!" Such classificatory tools too often fail to fulfill their function of supporting the searcher's access to and navigation through the domain structure. In most databases, including catalogues on the Web, the searcher may find it difficult to comprehend the organizational structure that has been imposed upon the materials. This is not due simply to the often exotic notations of the scheme or to the surface characteristics of the classificatory data. Rather, the problem is often characterized as a lack of match between the structure imposed upon the retrieval system by the classification scheme and the user's individual knowledge structures and search strategies. Classification research has responded to this problem by collecting the terminology of individual users and compiling the results to generate larger, broader, and potentially more successful sets of access points for users:

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"If we design an end-user thesaurus, that should do the trick." In his recent book on information seeking and subject representation, Hjørland (1997) argues that such endeavors to compile end-user vocabularies are generally conducted without recourse to an underlying theory of knowledge. Because failure of the classificatory structure to support user access is generally interpreted as a mechanical question of matching between different individual knowledge structures -- between those of the searcher, the author, and the indexer (cf, for instance, Ingwersen, 1992) – the underlying relationship between user access and the collective knowledge structures that are the basis for knowledge production has not been widely recognized.

From the perspective of sociology of science, Star (1989) has argued that the Turing test, which is intended to measure the degree to which an expert system is able to perform as a human expert in its interaction with individual users, should be replaced by a "Durkheim test", where the system is evaluated on its ability to support the goals of a specific community of users. Star argues that scientific work is not all of one piece, but is distributed and heterogeneous, with differing viewpoints emerging only to be reconciled within the existing knowledge base. In her view, information systems should not be designed simply to represent consensus but to accommodate the dissent that can be expected to appear among the various communities participating in their use. To this end, she brings forward the concept of boundary objects as a method for resolving problems of heterogeneity in knowledge production and use -- or, in terms of library and information science [LIS], problems of variety among information producers, information mediators and information users.

In this paper, we will investigate how classificatory structures can act as transitional elements, or boundary objects (Star 1989), to support coherence and articulation in the heterogeneous and sometimes distributed contexts where knowledge is produced and mediated. In particular, we will review, within the context of the library, two perspectives, put forward by Hjørland (1997) and by Star (1989), that analyze information systems as dynamic social constructs. We will build an
analogy between a scientific enterprise and the library as an active participant in the general production of knowledge and use this analogy to bring forward a view of modern classification research that engages the library directly in the development of classificatory structures that can accommodate information searching by heterogeneous user groups. Following Nardi & O'Day (1996), we regard the library as a diverse information ecology, comprising a complex web of interacting human agents, users, and technologies. And we will argue that, within such an information ecology, a classificatory structure cannot follow a one-size-fits-all paradigm, but must evolve in cooperative interaction between librarians and their user groups. In this context, we draw on examples of information systems in Danish public libraries: the Book House (Pejtersen, 1980); and Database 2001 (Albrechtsen, 1997).

2. CLASSIFICATION SYSTEMS: FROM RATIONALISM AND EMPIRICISM TO SOCIAL CONSTRUCTIVISM.

Hjørland (1997) argues for a more philosophical and sociological orientation for classification research. In his view, the problem of the searcher's uncertainty is a function of

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relative task uncertainty in the user's problem domain. Because information searching takes place within a particular social framework -- for example, an academic discipline – task uncertainty is primarily a function of the relative consensus or dissent within the discipline itself. Classification research has too often neglected such broader social backgrounds that inform information searching and has relied, more or less implicitly, on either a one-size-fits-all paradigm (rationalism) or on the accumulation of data about user behavior (empiricism). While the rationalist approach argues that "We just need to get everyone to understand this", the empiricist counters that "We just need to get more data about users" and proceeds to collect more or less meaningful sets of "facts" on the individual user's relative success measured as the number of "hits" resulting from a series of search queries.

Figure 1 divides the different approaches to classification research and practice into two broad epistemological categories: Rationalism/Empiricism on the one side and Historicism/Social Constructivism on the other. Both rationalism and empiricism are based on assumptions regarding the nature of truth and the objectivity of knowledge. From the empiricist approach, knowledge is reduced to sensory observations or facts. In classification research, empiricism is the prevalent epistemology in bottom-up thesaurus construction based either on user warrant or on terminology warrant, particularly when the process lacks grounding in a theory of knowledge. In contrast, rationalism strives to reduce knowledge to an all-embracing structure of concepts that is intended to be universally comprehensive. It is, for example, the epistemological foundation for Ranganathan's notion of universal facets. Rationalism is also closely related to more sociopolitical actions undertaken by one agency, or from within one disciplinary viewpoint, which are intended to impose one view of knowledge on all research and practice within that domain. In a paper discussing the role of dialogue in the development of classificatory structures, Jacob & Albrechtsen (1997) have shown how the American Psychiatric Association's construction of DSM-IV, the international classification for mental disorders, created a device for marginalizing and eliminating the viewpoints of competing professions such as psychologists.

In contrast, social constructivism, or historicism, views knowledge as an historical, cultural and social product. According to a social constructivist epistemology, then, the concepts in a classification system are dependent upon the knowledge domain for which the scheme has been created, and reflect experience and use within the particular domain. Designers of classification schemes are viewed as active participants in the process of knowledge production. Such involvement on the part of the classificationist is particularly evident in areas of interdisciplinary research which engage participation from many different professions. The HIV/AIDs vocabulary, developed by Huber and Gillaspy (1996), provides an illustrative example of such involvement on the part of the scheme designers. This system, which was not intended as a classification, per se, but as a mediating vocabulary, was developed to support dialogue between the different communities involved with the HIV/AIDs epidemic, including clinical and medical researchers, practitioners of alternative medicine, nutritionists, psychotherapists and other

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professionals, as well as those individuals who are either living with the disorder themselves or caring for someone who has contracted the disease. The HIV/AIDs vocabulary is built on a theory of knowledge generation that explicitly eschews the standard life cycle for knowledge production in medicine -- a knowledge cycle that proceeds in a top-down fashion from theory developed at universities and other research institutions, to applied clinical research, to daily clinical application. Rather, according to the epistemological view driving the HIV/AIDs vocabulary, research in lived experience must necessarily feed into basic clinical research. Accordingly, this scheme was not developed solely as a tool for retrieval of information in the database of the local community, but also as a tool for facilitating communication both within and across diverse interest groups, from the so-called layman to the cloistered scientist. In Star's (1989) terms, the HIV/AIDs scheme serves as a boundary object precisely because it support cooperation and common understandings between the various interest groups touched by this epidemic.

3. CLASSIFICATION AND BOUNDARY OBJECTS.

The notion of "boundary objects" was developed by Star (1989) as a structure for coordinating distributed work, such as may occur with a scientific enterprise that not only involves heterogeneous actors, elements, and goals but may also incorporate different research methods, values and languages. From her field work with scientific communities -- observations ranging from brain science to the development of a zoological museum in California -- Star has found that scientists are able to cooperate without consensus or shared goals. They can work together successfully because they create objects that function in the same way as a blackboard in a distributed artificial intelligence system:

> I call these *boundary objects*, and they are a major method of solving heterogeneous problems. Boundary objects are objects that are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual-site use.
>
> Like a blackboard, a boundary object "sits in the middle" of a group of actors with divergent viewpoints. Crucially, however, there are *different types of boundary objects depending on the characteristics of the heterogeneous information being joined to create them.* (Star, 1989, 46-47. Emphasis in original)

Accordingly, Star (1989; Star & Griesemer, 1989) has identified different types of boundary objects in her various case studies, including:

- *repositories* -- databases, libraries, or museums;
- *ideal types or platonic objects* -- diagrams, atlases or abstract concepts such as, for example, the concept of "species" used by both the creators of a zoological museum and other interested parties involved in its construction;
- *coincident boundaries* -- common objects with the same boundaries but having different internal contents, such as maps of a geographical area that cover the same terrain but are outlined according to different knowledge interests such as, for example, the life zones identified by biologists contrasted with the trails and collection sties identified by museum conservationists;

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- *standardized forms* -- forms created as methods of common communication across distributed work groups such as, for example, the forms filled out during field work or the cataloguing formats used for cooperation and networking between libraries which may, or may not, be part of each repository's database.

Unlike the model of the ideal universal computing machine whose goal, as proposed by Turing, is to emulate individual human mental capacities in all domains, boundary objects are advanced as an ecological concept -- that is, a concept that respects local contingencies and the viewpoints of different knowledge interests. In Star and Griesemer's (1989) case study on the formation of Berkeley's Museum of Vertebrate Zoology, a classificatory structure of the species and subspecies of mammals and birds in California constituted an important boundary object. This classificatory structure established a shared conceptual structure and a shared vocabulary that provided for communicative exchanges across the different social and intellectual worlds represented by the scientists and the groups of amateurs who were involved in building the museum's collection.

Although they approach the problem of classificatory structures and knowledge access from two different angles, Star's exposition of the communicative and integrative functions of classificatory structures in the general knowledge production of the sciences is closely related to Hjørland's identification of the epistemological positions adopted in classification research and his argument for following a more pragmatic philosophy of classification (Hjørland, 1997). Star builds on practical and theoretical work in scientific communication and knowledge production, while Hjørland builds on practical and theoretical work in the area of information searching for knowledge production. Nevertheless, both argue that classifications always serve pragmatic purposes, in the same way that science serves human action. According to Hjørland's theory, however, scientific classifications reflect a highly abstract and generalized way of knowledge organization, in contrast to classifications with more local contingencies, such as categorizing fruit and vegetables in a supermarket or the amateur horticulturist's categorization of plants by use or cultural preferences. Such variations in taxonomic structure could be argued to reflect different levels of ambition among the interested parties and thus to function as boundary objects, created and negotiated by different social worlds, with the scientific structure functioning as a more specific taxonomy dictated by the needs of the scientific community itself.

4. THE ROLE OF CLASSIFICATIONS IN DIVERSE INFORMATION ECOLOGIES.

American anthropologists Nardi and O'Day (1996) have introduced the concept of "diverse information ecology" to describe the socio-technical network of heterogeneous materials, people and practices that constitutes a modern library:

> What we learned in the library suggests the possibility of a socio-technical synthesis, an opportunity to design an information ecology that integrates and interconnects clients, human agents and software agents in intelligent ways congenial to extending information access to, potentially, all of humanity...As we design the global information infrastructure, the ultimate goal should be to design an ecology, not to design technology (Nardi & O'Day, 1996, 83).

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Information ecologies are situated and constantly evolving. They cannot be controlled by one single agency, but evolve in a collaborative way in heterogeneous socio-technical networks, striving for coherence and wholeness. The notion of an information ecology also implies a collective
view of information systems as striving to meet heterogeneous community goals rather than the goals of a single agency or individual. In their study of two research libraries in software companies in the United States, Nardi & O'Day (1996) explored how the work practices and expertise of librarians can serve as a model for the design of computerized information services. They found that librarians are exemplary agents who evince particular expertise not only in communicating with users but also in searching for information. These two skills are closely interrelated in that the librarian's search strategy tends to evolve in collaboration with the user's project. Nardi & O'Day propose to extend this working relationship between the librarian and the user to the collaborative design of information ecologies.

In an information ecology, a classification system would function as a boundary object, supporting coherence and a common identity across the different actors involved. In its role as boundary object, a classification should be weakly structured in common use, while remaining open to adaptation in individual communities. Across diverse information ecologies, classification schemes would function as discursive arenas or public domains for communication and production of knowledge by all communities involved. This also implies that the task of constructing a classification scheme would no longer be invisible work. Such a view of classification systems is in line with the concept of "coordination mechanisms" in distributed collaborative work, as put forward by Schmidt & Simone (1996). The development of classification schemes as boundary objects and discursive arenas, in cooperation with heterogeneous user groups and technology, engages the library as a facilitator of connections and ensures its continuing participation as an active contributor in the general process of knowledge production.

In the following we will illustrate how the role of classification systems is changing within the information system that is the library, shifting from reliance on a single, standardized or mainstream view of order, where classification is the invisible precursor to the organization of a collection, towards the creation of more diverse information ecologies, where classification takes place within an arena of discourse to create a shared order across heterogeneous social worlds.

5. SOMETHING OLD, SOMETHING NEW, SOMETHING UNIVERSAL, SOMETHING LOCAL.

As indicated in Figure 2, classification systems have served different pragmatic purposes in the history of libraries and information retrieval systems. In a recent European study of public libraries in the information society (Thorhauge et al., 1997), it was demonstrated that public libraries have progressed through three distinct stages, evolving from manual, paper-based services, via the automated library, to the current phenomenon of the electronic, multimedia library. This progression should not be understood to imply that the current status of libraries has been driven entirely by technology. Rather, the electronic, multimedia library must be understood from a more integrated socio-technical point of view, where the various actors,

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including librarians, computer suppliers, and researchers in computing and information science, constitute a heterogeneous network of agencies that bring certain technologies to the foreground while marginalizing others. In the recent development and use of communication technology, for example, there is a convergence of hitherto separate, even disparate, media and activities. This is apparent in the development and application of Web technology, which integrates text-based materials, graphic illustrations and audio materials with interactive features such as online conferences and e-mail. It is characteristic of this development that the technology is not only plastic and customizable to almost any context of use, rather like a boundary object, but is constantly re-negotiated and re-developed through such use.

In the recent past, manual, paper-based libraries focused on collection building. Intermediaries, or librarians, served both as collection builders and as agents controlling and interpreting the order of the libraries. Classification systems were frequently standardized in order to support interlibrary cooperation with the result that classification research was itself dominated by the development of universal schemes which could be adopted by central agencies to control the organization of knowledge across libraries. As a result of such standardization, classification became invisible work performed without regard to the needs of the local community of users. And, because maintenance and development of these classification schemes was often based on literary warrant, reflecting only those subjects represented in large, national collections, they can be interpreted as imposing an implicitly empiricist view of knowledge. There was, then, at this stage in the library evolution, a mix of rationalist and empiricist epistemologies underlying classification research and development.

The role of librarians as intermediaries was challenged during the 1980s by the development of online retrieval systems, and, in particular, by the introduction of online public access catalogues [OPACs] for end-user searching. During this decade, classification research was dominated by
work on thesauri and indexing systems. There were numerous experiments with automated indexing, including the application of text analysis techniques developed in computational linguistics. OPAC development was often based on studying users, sometimes in naturalistic settings, but generally without prior analysis of their different social worlds or the functional role of libraries in knowledge production and mediation. Research in information retrieval systems was very much oriented by a mechanistic conception of human competence in information searching, indexing and classification, thereby neglecting the variety and heterogeneity with which human agents (both librarians and users), information sources and technology interact in different settings. Furthermore, as technological fixes were thrust to the foreground, displacing the search competence of the librarians, the librarian's role as intermediary was gradually becoming marginalized as invisible work -- work that occurred without contact with or recognition by the users.

During the 1990s, the library has increasingly switched its service emphasis from building and guarding the collection or offering users access through the local OPAC to providing local access to global information resources available on the World Wide Web. This represents a shift from a
closed to an open system. In some European public libraries, for example, traditionally introverted and bureaucratic organizations have migrated toward a project-oriented culture,

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where librarians and users cooperate on the development of new services, using the interactive affordances of Web
technology and the Internet. In general, such projects have not involved the library schools in Europe, the traditional research communities in the library and information sciences. Close cooperation between libraries and the community of LIS researchers in Europe has yet to be manifested (Albrechtsen & Kajberg, 1997). In the United States, communities of LIS researchers have come together in workshops and research projects related to the social informatics of what are called "digital libraries", but could equally well be termed "electronic libraries" (Bishop & Star, 1996). In this research area, major topics include how knowledge is structured in digital libraries, including cataloguing and classification, and how digital libraries are used -- how knowledge is produced, communicated, applied and recycled in distributed social worlds. Research methods comprise ethnographic studies of communication and knowledge production in [digital] libraries as well as comprehensive sociological studies of professional classification schemes in medicine (Bowker & Star, 1994) and nursing (Bowker, 1996). Thus it seems apparent that classification research is gradually evincing a more sociological, historical orientation.

6. CLASSIFICATIONS AS BOUNDARY OBJECTS IN LIBRARIES: LIBRARIANS AND USERS IN MUTUAL DESIGN ACTIVITY.

Ballerup, a Danish public library, is a medium-sized library on the outskirts of Copenhagen. There is, in this library, a tradition of direct collaboration between the librarians and their users. Until recently, a majority of the librarians regarded themselves as cultural workers – as intermediaries between collection and user, very much in line with the traditional perspective described above for libraries in the manual stage. In 1995, the library started a new project called Database 2001. This project, which was evaluated by Albrechtsen (1997), involved the development of an enriched multimedia catalogue on the Web. In addition to the evaluation researcher, the project group for Database 2001 included six librarians with different areas of expertise: several in the group were experienced intermediaries and online searchers, while others were specialists in catalogue design and in management of the library's technological resources. However, none of the librarians had experience with Web design or Internet browsing.

During the development of Database 2001, the project group collaborated with user groups and colleagues in the library to identify different kinds of materials, including books, musical recordings on CD, CD-ROMs, and audiotapes of books. Text, pictures and sound were selected as
enrichment for the database, the idea being to emulate a kind of virtual library on the Web. The menus were designed as graphical layers of icons representing both user groups and the kinds of materials available. The subject icons in Database 2001, which represent the subject content of materials in the database, went through several iterations. In addition, the interface designed for browsing the menus was customized for both children and adults. The librarians arranged evaluation session with users who represented different user communities and their evaluations were very positive: users with different interests were able to use the icon-based interface for

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browsing in the database even though they had very different interests and different goals for searching.

In the database, documents were indexed using standard call numbers from the Danish variant of the Dewey Decimal Classification [DDC]. Even though indexing by class number would take advantage of the hierarchical structure of DDC, and hence be potentially useful for browsing by users, the librarians knew from their practice as intermediaries that users found it very difficult to understand the standard classification. They experimented with a more pragmatic and much more weakly structured classification which could reflect the kinds of questions actually posed to library staff by the different user groups. For instance, for the children, they worked with the seven categories listed below and designed for each of these categories an icon for subject browsing on a Web page:

1. Computers
2. Astronomy, nature, animals, environment
3. First love, star signs, being young today
4. Horses
5. Excitement, humor
6. Fantasy, science fiction
7. Books that are easy to read

From a semantic or disciplinary point of view, the separation of subjects like animals and horses would appear to be "incorrect" or "illogical". For the children, however, this classification worked very well. Category 2 [Astronomy, nature, animals, environment] was intended for a broad group of interests, including fact literature, whereas Category 4 [Horses] was intended, in particular, for girls interested in novels about horses. There is, in Denmark, a special research tradition within children's librarianship, based on Wanting's research on how children ask questions in libraries (Wanting, 1984), that advocates mediating literature according to the different user interests of children. Pejtersen (1994) has also studied children's use of libraries in Denmark and their communication with librarians. In her development of the Book House system in the 1980s, Pejtersen used a collaborative prototyping approach, engaging librarians, information scientists, and users in Danish public and school libraries, and subsequently designed a special interface of subject icons for browsing of the Book House system by children. Database 2001 took advantage of both of these research approaches to children's information searching.

The Book House (Pejtersen, 1994) is a retrieval system for fiction and is based on a general conceptual model that seeks to surround users with an adequate resource space within which to situate their own search spaces. The design involves multidimensional representations of different
kinds of user needs, search strategies and literary paradigms as well as authorial intentions. This multidimensional structure for subject access is intended to match the different levels of user interest. The system interface is constructed around the metaphor of a "house of books", guiding the users through the rooms of a library where they can browse the collection. Users can also switch between different search strategies, including analytical search in the multidimensional database structure, visualized as icons for each dimension, and browsing of subjects, visualized

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as icons in a picture gallery. The design of these icons involved classification experiments, using both word association experiments and evaluations of suggested icons in Danish public libraries.

The icons for browsing subjects in the Book House and in Database 2001 serve similar functions: to provide the users with an overview of the subjects included in the databases. The Book House system builds on the central design metaphor of rooms in a library which provides a single, uniform interface. Database 2001, in contrast, is realized as a mixture of interfaces which include the Web layer of icons, designed by the librarians; a more or less standard search client offering conventional text-based searching; and a database structured according to a standard cataloguing format that uses traditional call numbers to represent the subject content of the documents. Database 2001 is a localized experiment with system design and classification drawing upon a range of technologies that reflect the heterogeneity of tools used in today's libraries, from conventional customizable applications such as the closed systems of the database and the search client, to the open systems supported by interactive Web technologies. The Book House is a general system for fiction retrieval, which, in its present form, cannot be customized by individual libraries to support the idiosyncratic needs of specific user communities.

7. COLLABORATIVE DEVELOPMENT AND THE AGENCY OF LIBRARIES.

Both the Database 2001 project and the Book House system were realized using a collaborative approach between librarians, users, researchers, and technicians. In this way, users were involved in
negotiating classificatory structures and the design of subject icons in the interfaces of the two systems. Because the Book House was a new approach for interface and database design in the 1980s, it had to be developed technically from scratch. Database 2001, on the other hand, was able to take advantage both of the design ideas generated during development of the Book House system and of the possibilities for integrating modern Web capabilities within existing technology. The process of designing an interface adapted for local needs quite naturally involved local experiments with classification. Thus, in Database 2001, the graphic Web layer and its icons were intended to represent both the users' needs and the existing technology. Decisions regarding the subject icons, as well as those pertaining to the search client and the database, were determined as much by the users as by the demands of the Web technology itself. Thus, the icons employed in the graphic interface constitute an integrated system of boundary objects that mediate between the library, the users, and the technology. In this way, Database 2001 exists as an open system in that it makes the library available not only to local users but to other users as well through the medium of the technology. Without the interface of icons, however, the system would have been technically open, but conceptually closed.

Design of the Book House and Database 2001 involved heterogeneous human actors, elements and goals, which are also found in Star's description of a scientific enterprise. Star (1989) draws upon the example of a scientific enterprise to put forward a more collective concept of design than the psychological approach generally employed for the design of AI systems. Traditionally, design of library systems is based on a consensus model, or a one-size-fits-all approach. Multidimensional

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classifications providing different views of concepts in IR systems are still the exception (Albrechtsen & Hjørland, 1994; Jacob, 1994). But in the Book House system and in Database 2001, classificatory structures can perform as boundary objects by accommodating both the heterogeneous information needs and the various search strategies of different user interests as well as different knowledge communities.

Figure 3 juxtaposes some important boundary objects developed in the Book House and Database 2001 with Star's typology in order to illustrate the analogy between boundary objects in a scientific enterprise and the creation of a library system. Obviously, this analogy between the library and a scientific enterprise, even when supported by parallel structures, does not establish that what goes on in a library is isomorphic to what goes on in a scientific enterprise. As mentioned earlier, Hjørland (1997) has forwarded a theory of classification at multiple levels, from
specific classifications developed in accordance with local contingencies, to those general classifications developed by the so-called "hard" sciences, such as biology and medicine. However, earlier analysis of the role of dialogue in the creation of classificatory structures found that
traditional classification schemes frequently function as control structures that forestall an interpretive approach to scheme design through the imposition of controlled vocabulary that limits the impact of dissonant view points (Jacob & Albrechtsen, 1997). In this manner, developers of
classification systems may function as epistemic engineers, seeking to control the flow of knowledge production within a given domain by systematically legitimizing a single, universal classificatory scheme and thereby disenfranchising those researchers and practitioners who do not participate in the resulting structure.

In general, however, the library and its organizational structures must be viewed as important actors in the general process of knowledge production because their primary goal is to mediate between knowledge producers and users. This role is effected by providing information services to users and producers who are very often members of the same knowledge communities. Although the scenario sketched here is traditionally understood as a closed world, where librarians mediate
between documents and users, it could equally well be described as an information ecology -- as a practice that builds environments by bringing together heterogeneous materials and actors.

8. CONCLUSION.

Classification systems have been constructed as organizational tools in order to provide structure to a body of knowledge, but they frequently have the effect of limiting or re-structuring individual conceptual structures during a process of information searching. Established approaches to classification research and development appear to suffer from a fear of touching the real thing --
the social worlds constituting an information system and the collective conditions for knowledge production. However, in LIS and the sociology of science, new approaches to classification research are emerging, approaches that build on the idea of information systems as open and

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collaborative systems. A similar trend toward development of open systems has been identified in the public libraries in Europe which are evolving from manual, paper-based services to the electronic multimedia library. In the modern electronic library, classification is similarly transformed from a tool for establishment of order and control over the collection to a boundary object functioning to create cohesion across diverse information ecologies. The modern information ecology is a socio-technical network comprised of heterogeneous materials, people and practices. Within this emerging network, the classification scheme constitutes a discursive arena facilitated by the library and functioning as a boundary object for the various interests that exist among users and librarians. Such an information ecology is at the same time a situated network and an open system wherein the classification scheme supports coherence and articulation across the domains encompassed by the network, both locally and globally.

The practice of classification is changing from invisible work carried out in centralized agencies to articulation work emerging within socio-technical networks. As the role of the library evolves from collection guardian to facilitator of connections, the role of classification is similarly transformed from control of collections to facilitation of communication, maintenance of coherence, and establishment of a shared conceptual context. From this perspective, then, the intelligent intermediaries of today are the human agents in diverse information ecologies who facilitate the process of knowledge production by collaborating with communities of users in the creation and use of boundary objects such as classification schemes.

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	Rationalism/empiricism	Historicism/ Social Constructivism
Basic view on knowledge in information systems	**Knowledge is infallible and objective**	**Knowledge is historically, culturally and socially determined**
View of concepts in information systems	**Objectively given as modules of knowledge** **Example: universal facets**	**Culturally determined** **Domain-dependent, dependent on experience and use**
View of language and dialogue	**Dialogue is secondary to objective knowledge and should be controlled through standard classifications (episteme)** **Example:** **DSM-IV**	**Dialogue is the key factor in knowledge production and mediation** **Dialogue should be facilitated not controlled in IS** **Example:** **HIV/AIDs community IS**
View of information systems and their designers	**IS are value-free, just gateways to knowledge** **The designers are engineers, and their primary value is control and performance**	**IS are full of meaning** **IS are historical products, social and cultural constructs** **The designers are epistemic engineers and catalysts** **Their primary value is facilitation**
View of tools, such as classification systems	**What is a classification?**	**When is a classification?**

Figure 1. Epistemologies for development of classification systems

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	Manual paper-based services	The automated library	The electronic library The digital multimedia library
Primary means of access to knowledge	Collection building	Circulation, acquisition, stock control etc.	Local access to global information Networking
Technology	Cards, phone, fax	IT for housekeeping functions OPACs	Internet Multimedia Web catalogues
Organizational culture	Introvert and bureaucratic	Some change in attitude towards users	Project oriented culture
Role of classification systems	Order and control of collections Invisible work	Order and control Subject access via OPACs Some experiments with thesauri	Support of dialogue in information services Integration and infrastructure in diverse information ecologies
Examples from Denmark	DDC is adapted and maintained in Denmark by central agency	Verbal indexing in Danish national catalogue	Local experiments with classification and indexing in Danish public libraries
Dominating classification research approach	Development of standard, universal classifications	Indexing, thesauri OPAC R&D Automated indexing	Communication studies Domain analysis and science studies Social construction of classificatory structures

Figure 2: Classification research and use in different stages of public library development

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Star's types	Book House	Database 2001
Repositories	Database with many dimensions	Enriched database Many kinds of materials
Ideal type	Icons for subjects and dimensions	Icons for subjects Enrichments
Coincident boundaries	Design metaphor Rooms in library	Web pages Interactive features (e-mail etc.)
Standardized forms	Database structure	Database structure

Figure 3: Boundary objects in the Book House and Database 2001 viewed in relation to Star's typology of boundary objects

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