Organization, Management and Engineering of Knowledge: Rivals or Complements?

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Abstract
Knowledge Organization is a discipline that has its origin in the library field and was extended by new documentation and information tasks. Thought it claims to encompass all kinds and aspects of knowledge storage and retrieval it is bound more or less to the idea to express the structure of knowledge which is behind a scientific collection of objects and their descriptions. Its aim is to facilitate the exchange between scientists and their knowledge. Knowledge Management instead deals with the elicitation, processing and diffusion of economically important information. Knowledge gets here the main notion of competitive intelligence for a limited target and community. Knowledge Engineering is the technique of making cognitive units and links machine readable and processable. It achieves its advantage over human interaction and understanding with the growth of the data bases and the speed of numerical based decisions. Though rather surprising information mining might be possible by Knowledge Engineering a qualitative or ethical inference remains nearly unsolved. If one contrasts Knowledge Organization, Knowledge Management and Knowledge Engineering to each other these knowledge disciplines get a clearer shape and their special claims, contributions and limitations have to be taken into account. On the other hand it becomes obvious that facing the typical problems and solutions of all knowledge disciplines will result in better outcome in each. Thus practical solutions will always have to take into account these three aspects of knowledge at least.

Keywords: Knowledge Organization, Knowledge Management, Knowledge Engineering, eScience, Concept Analysis.

20 Años del Capítulo Español de ISKO. Actas del X Congreso ISKO Capítulo Español (Ferrol, 2011)
Universidade da Coruña (España), 2012. ISBN: 978-84-9749-535-6 Pp. 541-551

1. PREFACE

'Knowledge Organization' (483.000 results in Google in June 2011 – alternative denominations not included) is a widely used term in information science and is the key term in the naming of the ISKO society. Often it is confounded with 'Knowledge Management' (21.900.000 results), a term that grew up also rather recently and rapidly, but from another application area. Papers on congresses often seem to mix these two terms as well as the term 'Knowledge Engineering' (1.430.000 results) which is somewhat older and has been confused already with more traditional work within the knowledge task, like 'classification', or 'thesauri'. As 'organization', 'management', and even 'engineering' are rather broad concepts and can be used in everyday language in very different meanings it is not sufficient to explain the linguistic meaning of these before mentioned terms. Instead of this one has to look at the history of these terms and their typical application areas. And even more the concept 'knowledge' is very broad but seems to have a more precise meaning in these special fields which are described by the terms discussed here. Thus we will go back to history, to the typical applications, and try to shape the difference. Nevertheless we must ask for links between them as in eScience and other newer areas knowledge is handled in a more open way than in traditional science.

2. KNOWLEDGE ORGANIZATION

Knowledge Organization is a discipline that has its origin in the library field. Knowledge Organization is a newly created term that was established together with the foundation of the ISKO (International Society of Knowledge Organization) in 1989. Ingetraut Dahlberg (2006) describes it as follows:

> Knowledge Organization is the science of structuring and systematically arranging of knowledge units (concepts) according to their inherent knowledge elements (characteristics) and the application of concepts and classes of concepts ordered by this way for the assignment of the worthwhile contents of referents (objects/ subjects) of all kinds. (translated from German)

More precisely, Dahlberg (1998) defines Knowledge Organization as a subject area encompassing the organizing of:

a) units of knowledge concepts and
b) all types of objects (minerals, plants, animals, documents, pictures, museum objects, etc.), related to particular terms or categories, so as to capture what is known about the world in some orderly form allowing it to be further shared with others.

Knowledge Organization encompasses according to her the following nine sub-areas:

1. the epistemological, mathematical, system-theoretical, cognitive scientific and scientific theoretical premises of order of concepts as well as their historical background,

2. the knowledge of elements and structures of systems of concepts,

3. the methodology of intellectual construction, conservation and revision of this system and computerization; including questions of paradigmatic and syntactic relating of their elements and units as well as keeping the system compatible and evaluating this system,

4. the methodology of intellectual and machine applications of this system via classification and indexing,

5. the knowledge of existing universals and

6. special taxonomies and classification systems including documentation language (thesauri),

7. questions arising from the influential areas linguistics (~ linguistics mathematics) and terminology; including the retrieval problems, especially in online access,

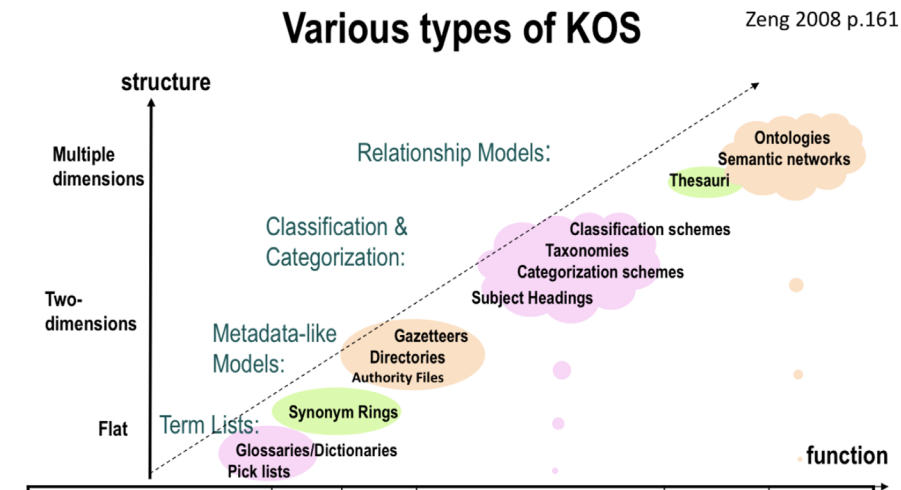
8. the application of content indexing of all types of documents and in all subject areas,

9. the entire periphery of knowledge organization in the workplace, individual centers, societies, countries and in international areas, as well as the question of education, the economy, the user, etc.

Before the founding of ISKO, in library science one was speaking of "classification", which was confounded later with numerical classification, e.g. cluster analysis, and hyphened the systemic approach of (but not only) bibliographic classification systems, such as DDC or UDC (cf. Figure 1). This old fashioned way of indexing together with its confusion with statistical procedures were some of the reasons to look for a new brand name. In even earlier days the name "theory of ordering" (German: Ordnungslehre; see Drietsch 1912, Greiner 1979) has described this kind of classifying and shelfing books with the main goal to be able to find them under conceptual aspects. A task which was already virulent in Ancient times, as in the libraries of Pergamon and Alexandria or even already in the Sumerian culture, while we must assume here that more formal criteria were used to store the clay tablets (Ohly, 2009).

The understanding of classification systems goes back to Aristotle who understood Science and its sub-disciplines as an arbor with branches which grows out of scientific virtues. In the medieval times the tree of wisdom was further developed by Raimundus Lullus as well later by Diderot and others who tried to understand encyclopedic knowledge as only specialized knowledge of more general main scientific chapters (Ohly, 2011).

In the sixties of the last century with the common distribution of computers new possibilities of indexing and retrieval could be developed. The idea was that natural language or - as a derivate - controlled terms with certain combination rules would describe better the concepts behind scientific outcome, like books or articles. Whereas in classification the



Major functions						
eliminating ambiguity	xxx		xxx	xx	xxxx	xx
controlling synonyms		xxxx	xxx	xx	xxxx	xx
establishing relationships: hierarchical			x	xxxx	xxx	xxx
establishing relationships: associative					xxxx	xxxxx
presenting properties						xxxxx

Figure 1. Types of Knowledge Organization Systems. Source: Zeng, 2008

concept level had to be constructed mainly in the indexing procedure now the main concept creation competence was demanded for by the query formulation in the retrieval process. Never the less – arising from both - the processes of bringing concepts of authors, intermediaries (documentalists), and users together is in principle the basic question of Knowledge Organization. This should be achieved by pre-established systematic lists of terms or concepts and rules for their combination as well as guidelines for indexers and users.

3. KNOWLEDGE MANAGEMENT

If we are going back to Dahlberg's definition we are finding more areas than only this consideration of functional indexing systems. Dahlberg mentions applications and the periphery of Knowledge Organization. And already the founders of classification systems, like Dewey or Otlet (Rayward, 2010) were not only thinking of a classification system as a simplified and standardized instrument to express and communicate scientific concepts. They also were interested in the collecting, storage and dissemination – if not even synthesizing - of all knowledge (or information) necessary for the advancement of human mankind. This goes far beyond the question of shelfing and distributing books. With such a focus on usability are going hand in hand questions like: What kind of knowledge is worth being collected? Where do we get it from? How can it be transferred to the people concerned? These were the problems per se of managers who were in need of information to stir their company by developing qualitative products, exploiting the human capital of their workers, placing their products on the market, and convincing the consumers. Whereas in earlier

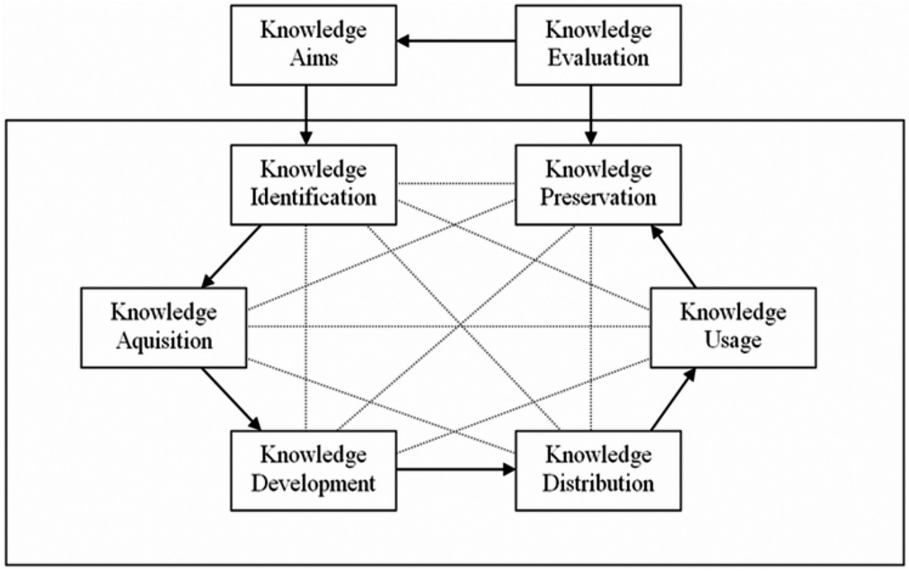


Figure 2. Elements and Processes of Knowledge Management.
Source: Probst; Raub; Romhardt, 1999

days one was speaking of Management Information Systems (easy access for managers to their enterprise data) or Warehouses (systems where every important outcome or method of an enterprise is protocolled and assimilated with similar data or text documents) to concentrate and distribute all know how of enterprises, now the newer aspect of Knowledge Management comes into the main focus. Who has important knowledge, how can it be codified, and to whom should it be delivered? (cf. Figure 2) Nonaka (after Capurro 2004) hyphened the tacit knowledge, which is not already expressed and codified but is finally as (or even more) important as the open standard knowledge. Ensuring the deposit of all critical knowledge and the proliferation to those who are dependent from it should be the aim of Knowledge Management. Especially the sector of business is addressed as here exclusive knowledge is needed to be competitive with the other players on the market and to make most profit of the private knowledge – the specialized knowledge of the members of the concerned enterprise. Gottwald (2008) sees this as a paradoxon, as the individual value of members in an enterprise is their exclusive know how and it would be devaluated with the opening of this specialized knowledge to others. This holds even more for consortiums and networks where on the one hand all parties can make more profit by exchange of common knowledge but an individual member institution might lose the profit of its investments in future research if the findings are exploited by free riding partners. If we transfer this idea to the standard information and documentation situation, we have to ask what "information" is. According to Wersig (1973) information, as interpreted data, has the potential to reduce uncertainty of the informed person. If a fact is already known, there is no information advantage. Only the individual exclusive knowledge – compared with the open general knowledge – will have an information value for the user if he is acting in an uncertain decision situation. In so far Knowledge Management addresses the balance between communicating common knowledge and making profit out of exclusive knowledge

(see: Kuhlen 1995). This can be compared with the dynamics of a free exchange market in contrast to a protected market of goods. Both have advantages and disadvantages. The exchange market will work only if an equivalent good can be obtained by exchange and the protected market will have advantages only if the exchange with externals will lead to exploitation. In so far Knowledge Management is always a question of motivation, slide regulations, and profit for each involved partner.

4. KNOWLEDGE ENGINEERING

Knowledge Engineering has its roots in the attempt to expand the facilities of computers. In the beginning computers were mainly used for calculation, then with larger computers the possibilities grew considerably to store, manage and retrieve data and text documents as extended brain for archivists and librarians. With new non procedural programming techniques and additional storage and computing devices one tried to extend or copy the human brain, as it is expressed by terms like "artificial intelligence" or "expert systems". Some of the new features to become more understandable even to laymen are: logical deduction, language processing, semantic understanding, dimensional reduction and graphical representation (cf. Figure 3). In data, text and information mining we could speak of "finding a needle in a haystack". E.g. Knowledge discovery in databases is defined as the

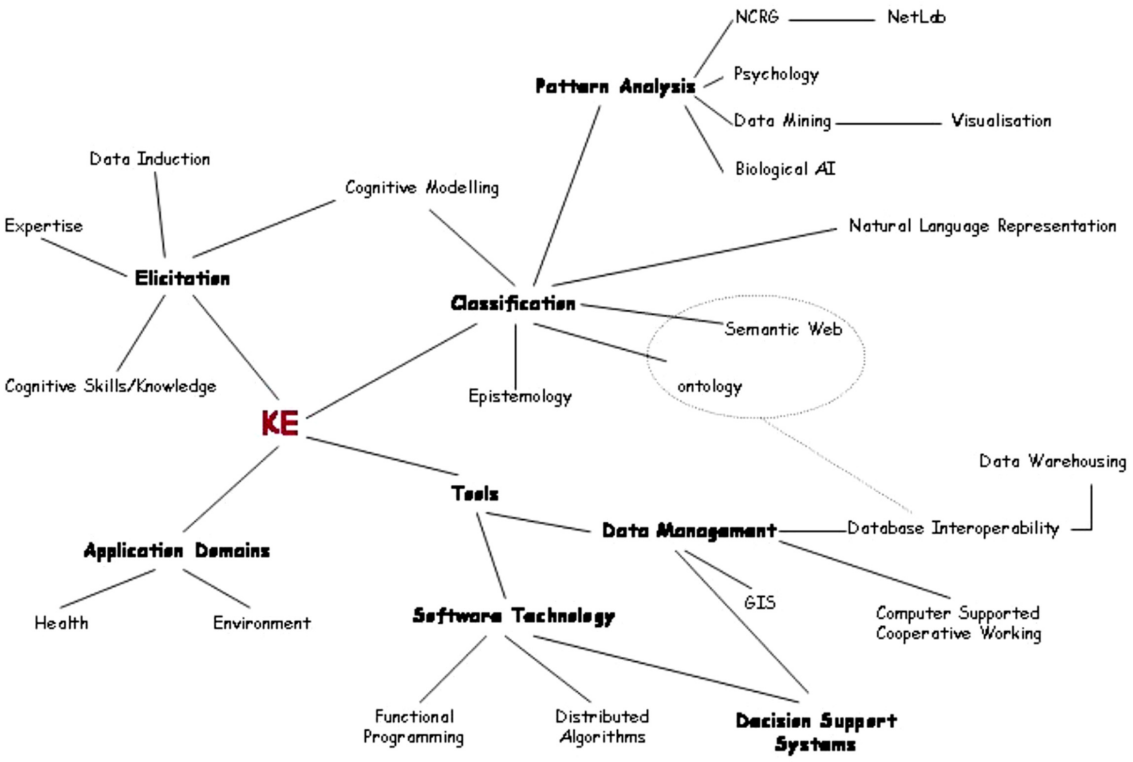


Figure 3. Areas of Knowledge Engineering (Mind Map of the Knowledge Engineering Group of Aston University; Source: http://pkab.wordpress.com/2008/10/21/peta-pikiran-sistem-berbasis-pengetahuan).

"non-trivial extraction of implicit, previously unknown, and potentially useful information from data" (Frawley et al., 1992). As far as conceptual information is managed by machines or even semantic understanding can be processed to replace human understanding then we can speak of Knowledge Engineering what goes far beyond Data Base Management. Newer the less more "simple" - though demanding - questions are amelioration of performance, user interfaces, common platforms and different layers of computation tasks (e.g. middleware) to get quicker and more integrated results with no restrictions where the data come from and who should be informed. Especially with the Internet and computer grids the extended integration mechanisms, real time processing, interaction, and big mass storage and computing capacities become important.

5. THE USER

In former days users were those who applied the technical facilities. They were the principals or - in case of more diverse groups - target of feasibility studies, represented in user advisory committees and allowed to choose between different offers or to give feedback. More sophisticated information systems apply user modeling to adapt automatically to predefined user groups. Already hypertext systems provided a linkage of different information chunks in order to offer to the user a free choice of access into the world of networked information such that he can find his appropriate depth of information needed. With the development of "social software" this networking principle was expanded to incorporate the user into the semantic understanding of the system. In so far the user is always an author and an indexer at the same time (Ohly, 2007). By linking the identification of users with certain information objects (as known in Bibliometrics) the semantic space can be extended to object relations depending on user characteristics - and vice versa. If the user is allowed to give own index assignments (or evaluations etc.) to the objects the system becomes three-dimensional and allows not even semantic clustering but also object and subject similarities via this "democratic" indexing - and again vice versa. One may argue that this indexing has not the same quality like those of experts and that without authority lists and application rules and it becomes quickly redundant and chaotic. Nevertheless the before mentioned application and user orientation, like intended by Otlet or Dahlberg for Knowledge Organization, becomes revived and a new technical quality.

6. KNOWLEDGE ORGANIZATION SYSTEMS

Under the heading of Knowledge Organization Systems (Zeng, 2008) nowadays the intention is meant to make library indexing systems more logical formalized and hence deductive by machines. Implicit and in so far partly the motivation to establish these systems is the possibility to combine different indexing systems if there exist shared common semantics (e.g. via cross-concordances). How far different indexing principles, different application areas and dynamic development of structures can be managed all together must still be

proved. Efforts like these demonstrate none the less that with new programming techniques and incorporating goal oriented expert knowledge the new generation of Knowledge Organization Systems can be much more powerful and user oriented than ever before.

7. FINAL REMARKS

In comparison with Knowledge Management and Knowledge Engineering it becomes clear that Knowledge Organization is more oriented toward the structuring of semantics for library contents with the aim to facilitate the common access to codified knowledge (cf. Umstätter, 2001; see Table 1). Knowledge Management on the other hand is more interested in exclusively usage and exploitation of information which is important for the market success of an enterprise. And Knowledge Engineering has the main focus on effectively storing, computation, and retrieving of data with a meaningful reference to its application. But Knowledge Organization needs to clarify its focus and values (see: Knowledge Management) and has to apply sophisticated techniques (see: Knowledge Engineering) in order to cope with the different information sources, user groups, and systems for Knowledge Organization. In the same way Knowledge Management needs technical support (see: Knowledge Engineering) as well as semantically stable features (see: Knowledge Organization). And Knowledge Engineering cannot process data without meaning and has to consider the semantics and structure – in most general form as ontologies - of its data (see: Knowledge Organization) as well has to apply mechanisms to reassure and update its data bases and give application oriented answers (see: Knowledge Management). Especially with the growth of different data sources and the need to be usable for multiple purposes at least these three knowledge disciplines have overlapping areas that will be solved more fruit-full if there is an understanding and cooperation between these. A postmodern society is influenced by information techniques but also - as reference frame for the information systems - causes new integrated thinking and information processes (Ohly, 2001, 2008). International and interdisciplinary endeavors like Semantic Web, Enhanced Science, or Electronic Government (which comprise all multiple data qualities, enhanced decision support, and big mass of data) will only be successful if all concerned knowledge disciplines are engaged and are meaningfully connected. Yet in the notion of ‘wisdom’ none of the discussed techniques will be able to substitute qualitative, ethic decisions of mankind. Thus they all must be scrutinized for their normative prejudices (van der Waldt, 2008).

Table 1. Characteristics of knowledge disciplines

Discipline	Area	Methods	Applications
Knowledge Organization (KO)	Library and Information	Metadata	Knowledge Organization Systems
Knowledge Management (KM)	Enterprise	Profit	Business Intelligence
Knowledge Engeneering (KE)	Computing	Machine Logic	Artificial Intelligence

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