Brief Communication: Why a New Universal Classification System is Needed†‡

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Ingetraut Dahlberg started work on thesauri and classification in the early sixties. She developed her concept theory in 1972 together with her work on the establishment of a universal classification system of knowledge fields, the Information Coding Classification, published in 1982. In 1974, she founded the journal *International Classification,* now known as *Knowledge Organization*, and was its editor for twenty-three years. She also founded the German Society for Classification in 1977 and chaired it until 1986. In 1989, the International Society for Knowledge Organization was founded, and she served as its president until 1996. In 1980, she founded the INDEKS Verlag, which was taken over by Ergon Verlag in 1997.

Dahlberg, Ingetraut. 2017. "Why a New Universal Classification System is Needed." *Knowledge Organization* 44(1): 65-71. 27 references.

Abstract: Research history of the last 70 years highlights various systems for contents assessment and retrieval of scientific literature, such as universal classifications, thesauri, ontologies etc., which have followed developments of their own, notwithstanding a general trend towards interoperability, i.e. either to become instruments for cooperation or to widen their scope to encompass neighbouring fields within their framework. In the case of thesauri and ontologies, the endeavour to upgrade them into a universal system was bound to miscarry. This paper purports to indicate ways to gain from past experience and possibly rally material achievements while updating and promoting the ontologically-based faceted Information Coding Classification *as* a progressive universal system fit for meeting whatever requirements in the fields of information and science at large.

Received: 28 November 2016; Accepted: 2 December 2016

Keywords: classification, knowledge, concepts, universal classification, thesauri

† Based on a conference paper presented at a workshop on "Corporate Semantic Web," Dagstuhl, Germany, June 2016.

‡ Herewith I would like to acknowledge gratefully the very good translation of my article into English by Dr. Herbert Eisele, France.

1.0 The crux of our time

Few people realize how they are eventually getting ever more lost in (or tied up with) their narrow concerns and regard the world from their little window. Egocentrism may be normal, yet can the aim of human life be so skimpy vs. personal fulfilment recommended, e.g., by esoterism? Incitements cannot be discarded such as prompted by an article in the German mainstream journal *Die Zeit*, entitled "I and My Syrian Friend," propagating humane feelings even at the risk of being deceived. Also, the question may be raised why a new universal classification system if there is no universal interest therein?

The answer will be provided hereafter by showing that there is indeed a widespread demand for compatibility, interoperability linked with streamlining, cooperation and also wholeness and universality. A recent study (cf. Szostak 2014; Gnoli and Szostak 2015) entitled "Universality is Inescapable" gives a first hint in this direction. It is just a repetition of what happened some sixty years ago as will be explained in the following section. This innovation occurred actually on the initiative of computer engineers who eventually discovered towards the end of last century that their data had a meaning and they got the knowledge of meaning from information specialists, i.e., librarians and documentalists and their classification

systems and thesauri, onto which, however, they imposed their own terminology and called their creation henceforth "ontologies." Thus, many a fresh ontology freak tinkers with his system—perhaps in a sort of self-fulfillment—and enticing colleagues to follow suit, so that in the wake of this fashionable mania, a tremendous tide of thousands of such ontologies has swamped the data world, particularly in the United States, which has brought a need for super-ontologies to harness the flood and get an overview. In addition, it was felt urgent to streamline the phenomenon and in 2006 an "Upper Ontology Summit" was convened for ensuring compatibility and interoperability between the various odds and ends (emphasis added) "to find a way to interrelate ontologies in such a way as to *provide a freely available common ontology* that has sufficient detail to precisely specify meanings of terms and concepts in domain ontologies and which is a compatible subset of all the linked upper ontologies."

To reach this aim would imply the linking of all upper and lower ontologies within a universal ontology, which amounts in fact to producing a universal classification. However, these ambitions have not been obtained thus far, except that there are endeavours to set up an "Open Ontology Repository, OOR" in the United States.

2.0 Developments in the course of the last century

Reverting to our own history, I remember my post-war beginnings when we had to set up a documentation pool for scientific periodica, and our efforts were initially viewed with great suspicion by librarians, whereas elsewhere in Germany the trend was to use current UDC, in force since 1895 when two Belgians, Otlet and Lafontaine, adapted and widened the English *Dewey Decimal Classification* (*DDC*) and translated the scheme into French. In the years 1934-1951, a German edition of the UDC was established comprising supposedly one hundred forty thousand classes (www.udcc.org).

Otlet and Lafontaine spared no effort to add to their new system some auxiliary digits, allowing linking of local and temporal data, as well as languages and document types with subject entries for application to the whole scientific world literature. The result can be viewed even today on a fount of cards in an array of cabinets in the dedicated Belgian centre, the so-called Mundaneum (Dahlberg 2014), 24). A German version was strongly supported by the German Standardisation Institute (DIN), which not only edited the German UDC but also supported twelve of twenty-six revisory committees and published a dedicated periodical. Regular German documentation center users soon knew by heart the system's pertinent digits, whereas newcomers to documentation had some difficulties in the beginning. This led to a demand during the annual meeting of the German Society for Documentation (DGD) in 1961 for subject headings instead of the unfamiliar digits. In the event, many documentation centers started to produce their own thesauri so that by 1982 I could publish volume 1 of the *International Classification and Indexing Bibliography* with a systematic listing of the bibliographical data of two thousand two hundred sixty-one thesauri and some classification systems (Dahlberg 1982). However, it soon appeared that a uniform assessment of literature via decimal digits had gotten lost since there were as many thesauri as operators. As early as 1965, the president of the FID Classification Committee convened a meeting in Warsaw to discuss issues of compatibility between the various systems and reach an agreement on cooperation—in vain. In a second attempt, thirty years later, initiated by ISKO equally in Warsaw (Dahlberg 1995), the same issues were even more thoroughly discussed, recommendations were formulated as well as a bibliography comprising five hundred titles (Dahlberg 1995) issued in order to achieve system compatibility and consistency, without finding, however, general agreement of colleagues. Yet, a few participants like Stella Dextre Clarke, who afterwards was substantially involved in ISO Standard 25964 on Interoperability of Thesauri, and Dagobert Soergel who was the main promoter of said recommendations and who ten years later, in 2006, participated in the famous Upper Ontology Summit (UOS 2006) (mentioned above) carried their experience into forthcoming developments.

Instead of becoming compatible, individual thesauri were getting ever more voluminous, because indexing and the growth of new literature required a steady inclusion of new concepts.

Thus, a number of stupendous super-thesauri emerged, comprising sometimes half a universal classification, e.g., AGROVOC with twenty-three thousand concepts in twenty-three languages, an Economic Thesaurus with six thousand descriptors and twenty thousand synonyms to facilitate access, an Ecological Thesaurus of the German Federal Office of Ecology with over thirty thousand concepts in thirty-three sub-sections and a Technical Thesaurus (TEMA) with fifty-three thousand two hundred "concept families" and a total of one hundred sixty-seven thousand five hundred descriptors. That's today's situation—all those thesauri appeared in Germany over the last fifty years. I have actually mentioned only some thesauri, while a great deal of other domains have, of course, produced their own. 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. A convenient overview of those systems affords BARTOC, the Basel located Register of Thesauri, Ontologies and Classifications covering up to now more than one thousand seven hundred systems; it is the creation of Andreas Ledl who not only scanned all systems but also classified them using *DDC*.

Now what happened to the proposal to establish a "Universal Source Thesaurus"? Soergel had pinpointed in his famous 1974 book "the unhealthy situation of the existence of too many special thesauri" and proposed a solution in form of a "Universal Source Thesaurus," to assist anybody and any documentation center in formulating special content assessment of documents. This idea may have inspired Gernot Wersig for his exposé at the 1975 3rd FID/CR Conference in Bombay, presenting a format for comparison and correlation of different thesauri and other ordering systems and which years later led to an aborted proposition for the creation of a "macro- thesaurus" for all federal ministries. A series of meetings in Prague, Paris, Bielefeld and Columbus, Ohio in the eighties and a number of articles in various specialized periodicals also took up these issues to be solved in an "integrated thesaurus" especially for social sciences, but apparently no sponsor was found. UNESCO equally took up the issue in 1980 by inviting a project proposal on "Guidelines for the Establishment of Compatibility of Information Languages in the Social Sciences," which was based on an outline for a social science "Compatibility Matrix;" however, despite being quoted as an example in some national articles, it never materialized.

Instead of closer cooperation among centers having common interests, there appeared, as already mentioned, a number of super-thesauri, e.g., the UNESCO Thesaurus comprising now seven thousand entries, the U.S. TEST for technology and the U.S. Unified Medical Language System, and under the auspices of the British Standardisation Institute, the ROOT Thesaurus, covering quite a number of domains.

3.0 Data-processing avenues: cross concordances

Computer technology opened up new avenues for comparability of terminologies and thesauri, leading to the creation of terminology networks with reference literature. The biggest so-called "mapping effort" of Germany was the 2004-7 KoMoHe Projekt at the GESIS Centre for Social Sciences, Bonn (KoMoHe=Kompetenzzentrum, Modellbildung, Heterogenitätsbehandlung, URL: http://www.gesis.org/forschung/drittmittelprojekte/archiv/komohe/), which includes a concordance of twenty-five thesauri and terminologies (between one and seventeen thousand terms) of eleven knowledge fields in three languages (German, English, Russian) depicting over five hundred thirteen thousand relations in sixty-four "crosswalks" (cf., Mayr 2008).

This induced, finally, librarians keen on unifying (streamlining) indexing to produce concordance schemes for universal classifications used in Germany. They started comparing *DDC* with the subject heading system of the German National library. A 2010 workshop in Cologne discussed the results, where Soergel's exposé caught much attention. A next step in this direction was meant to be a tentative concordance between *DDC*, RVK (Regensburger Verbundklassifikation) and the Basis-Klassifikation (BK). A project, financed by the German Research Agency under the chairmanship of R. Diederichs, devising electronic devices for concordance work, was going to pave the way. However, in contrast to thesauri descriptors of library classification systems, one has to deal with pre-combined concepts which can hardly compare. *DDC* has thirty-eight thousand classes, RVK, relying on the U.S. Library of Congress configuration, has eight hundred fifty thousand. Why?

The classifications were based on book-themes corresponding to the principle of "literary warrant," which means that only themes could be retained which occur in literature. The result has been a steadily growing book-title system liable to distend the pre-combined thematical concept classification. A concordance between such different systems as *DDC*, RVK and BK would break up their concept combinations into their ingredients, which would entail a sizable reduction of concepts; hence, one could ask whether it would not be simpler to fit the parts into a new universal classification system obtaining thereby an all-round concordance?

4.0 The discovery of S. R. Ranganathan

The Indian mathematician S. R. Ranganathan was only thirty-one years old when he was put in charge of the direction of Madras University library. He went to England to inform himself of local librarianship and during a tour of London, his eyes fell on a toy-shop window displaying a sort of mechanical construction set like Märklin or Meccano. This gave him the idea of creating a classification system consisting of elements liable to combine as need be, for instance to identify book-themes via the combination of their intrinsic features. This led to the creation of an analytical-synthetic classification as it already had been outlined by Otlet and Lafontaine for the UDC on a small scale; it was also introduced into *DDC* but not before their eighteenth edition (they are currently in their twenty-third edition).

Already in 1933, Ranganathan put this into practice in his Colon Classification; he ordered by a formula of his own categorially sorted and column-wise printed concepts

under twenty-one disciplines, which permitted both to seize a book-theme for classification and show it printed separately column-wise in the classification system. He called his formula PMEST: Personality, Matter, Energy, Space and Time. These five elements (in India the number five corresponds to our holy number seven) equate to a sentence consisting of subject, its attributes, predicate (verb) and punctual concepts of time and space. This sequence is preset, both for the print in the book edition and for the classification of assessable themes and recognizable by the colon preceding "energy," i.e. respective predicate with its circumstances.

These regulations as well as lots of ideas concerning the ordering of concepts by classes and rules for implementing classification were recapped by Ranganathan in his 1963 "Prolegomena to Library Classification." The Colon Classification went through six editions within the forty years up to the author's death in 1972. Its fundamental innovation was the introduction of facets, that is, in terms of classification, the categorical aspect of a particular concept pertaining to a subject field.

The Englishman Douglas Foskett, who was taken to India during World War II, made acquaintances with Ranganathan and his innovative classification and imported it to England, where it was hailed and immediately adopted for special classification systems and later-on even for thesauri. Since 1970, it has been used for the revision of the Bliss Classification, although with a particular serial format ("citation order") of its thirteen facets. Martin Scheele was the first scientist in Germany to set up his biology classification following those rules.

5.0 The delicate issue of contents assessment of documents

A book index is made, for instance, by parsing each page for significant words and adding synonyms in case of need to facilitate access. To assess, e.g., the contents of an article in a technical periodical via descriptors of a thesaurus, only some salient features will be highlighted without thus enabling the user to get a complete picture of what the topic is about.

In contrast, contents assessment via a faceted classification system attempts to seize a document's theme by calling on a combination of class concepts; therefore, it seems to be a great advantage if a theme is already scheduled in the system via a pre-combination of thematical features as done in many old universal classification systems. However, in most instances such is not the case. In the case of a faceted classification like Colon or Bliss, a concept sequence needs to be given via a corresponding syntax formula. In all other prior systems (classification or thesauri), such syntactic aids, whereby the order of concepts and thus the ins and outs of a theme, clearly was missing. This was the fundamental innovation of the Colon Classification whose application requires, however, some reflection as well as the necessary knowledge.

Unfortunately, the Colon Classification is totally outdated and the Bliss Classification is not yet finalized and uses only capitals of the Latin alphabet, whereby it is unfit for many languages.

6.0 A completely innovative universal classification system: the *Information Coding Classification* (*ICC*)

ICC has existed for forty years now and is cited in many a publication, first in Dahlberg 1982 and finally in Dahlberg 2014, but, apart from a few occasional interests, nobody has hitherto taken the trouble of seriously looking into it. Finally, the ontologists of Darmstadt transferred it to Wikipedia (https://de.wikipedia.org/wiki/Information_Coding_Classification) along with its author.

It actually is the beginning of a modern universal system, first because it covers only knowledge areas and their fields, which delivers it so far as an upper ontology. Its knowledge areas were structured by a combination of the concepts of ontical level objects and categorical concepts and its subdivisions into knowledge fields use the categories, thus, forming facets (these still need to be added). So far, all of the approximately six thousand five hundred knowledge fields have been defined up to their different digit levels, and more than half of them included in an Excel format, with English equivalents. Since *ICC* encodes concepts via decimal numbers, which configure under their first digits in a 9x9 matrix (cf., the respective Wikipedia entry), the latter permits an intelligible overview of the system for the subdivisions under their nine integrative "levels of being" and via the nine categorical concepts on the zero-level to form not less than eighty-one knowledge areas. Given that these in turn comprise nine subdivisions, the third hierarchical level allows for seven hundred twenty-nine knowledge fields. A fourth level would permit additional knowledge fields. Now, if this applied to all third level fields, it would mean that on the fourth level almost six thousand six hundred knowledge fields or their subdivisions could be covered (*nota bene*: the comprehensive mathematical classification of the U.S. Mathematical Society covers over five thousand concepts which could be easily accommodated under such four levels). This tends to show how efficiently *ICC* may be articulated on the sole level of knowledge areas even before the many objects with their attributes and their activities with their subdivisions and their idiosyncracies and other relations of their fields show up in the system. In Dahlberg (2014) *ICC* has been presented,

explained and described up to the third level via its theories in twelve pertinent principles.

ICC's ontological basis relies in its main structure on said nine "levels of being" referring to integratively interlinked objects, since each level preconditions the following according to this schedule:

1. Form and structure;
2. Energy and matter;
3. Universe and Earth;
4. Biological life sciences;
5. Human beings and life;
6. Social beings and life;
7. Material products—economy and technology;
8. Intellectual products—knowledge and information; and,
9. Spiritual products—culture and humanities;

The first subdivision by knowledge areas follows as mentioned by nine categories on the matrix's zero-level (except for a few object linked cases). Knowledge areas and their knowledge fields are subdivided under a digital localizator (called systematifier) which takes also into account the epistemological dictum by which each knowledge area and its fields is characterized by its own object and activity division, which in turn comprises the syntax for its thematical articulation as follows:

1. Generalities, theories, principles (axiomatic and structure relations);
2. Object area: objects, types, parts, properties (object related);
3. Activity area: methods, processes, activities (activity related);
4.–6. Characteristic knowledge fields of a knowledge area;
7. Influences on a knowledge area or its fields from outside (instrumental relations);
8. Application of methods on another area or field (resource relations); and,
9. Information about an area and synthetical social tasks (updating relations).

Since objects are always dealt with on the second digit level, the whole system offers on this level the possibility of adding or integrating taxonomies of other operators, e.g. in botany its respective nomenclature of plants, same for zoology, pedology with respective soil types, for sea vessels all ship types, for info-sciences all document types etc. *ICC* functions in this respect (and possibly also in other respects) as accommodator for classification systems and taxonomies of other operators.

A third particularity is the possibility of interlinking all concepts, if required for a theme or a proposition. The knowledge area level offers to this effect three positions, viz. 1, 8 and 9 which afford to clearly show and define how the heavily inter-and transdisciplinary knowledge areas are reticulated. A paper at the Copenhagen ISKO Conference (cf., Dahlberg 1994a) on domain interaction explains these relationships and how they are handled by the *ICC*. Also, in 1994 a research study presented at a meeting on ecology noted that such relationships can be duly depicted for all knowledge areas (Dahlberg 1994b) which means that this applies also to many other knowledge areas like standardisation 18, economy 71, technology 73. Regarding history 69, there is an exception, since this refers on level 6 only to social history; for Earth history cf. paleontology 338, archeology 969, science history, 816 and churches and their history 996. These, like the first two, should have proper designations, since they don't refer to social developments; cf., under principle 7 in (Dahlberg 2014, 103-4); this combination range has been shown there in detail.

7.0 Now why a new universal classification?

Problems and needs have already been dealt with *in extensor* (Dahlberg 1974, 28, 274 and 278-82). Considering that neither the envisaged universal ontology of 2006 nor the proposed universal-source-thesaurus by Soergel 1974, nor the Dahlberg compatibility matrix of 1995, nor the impressive cross-concordance project KoMoHe of 2008 have been effective, except for invaluable data collections, and on top, that the universal classifications *DDC* and UDC are totally outdated particularly by structure or unusable because of their preset combinations as other library classification systems mentioned above, we really cannot decently pass them on to our children; therefore, it would be most appropriate to recognize the chance to have a closer look at extant innovative *ICC* and upgrade it to cater for present challenges including also the subdivisions of the general categories as its general concepts (in general language) for additional use with pertinent scientific concepts (cf., chapter 5 of Dahlberg 2014; Dahlberg 2011).

ICC's theoretical basis relies on principles; its easy handling permits a just as easy structuring, systematisation and application. Class access would naturally be feasible via the alphabetical index, which should adopt a thesaurus format comprising also equivalent concept designations and other required references. *ICC* hence offers anybody a new platform including the semantic web, permitting an easy overview of our scientific human knowledge, as well as insights into that knowledge's interrelations, which is necessary to understand what it is all about.

In fact, this concerns not only text assessment, but leads also to configuring general and particular knowledge articulation, as for an encyclopedia (e.g., *Britannica*), following

the way men of science have proceeded through centuries. But now it has become possible to deepen that knowledge thanks to scientific concepts of specialists through the ordering channels of *ICC* and the resource fount of accumulated digitized data, streamlined by knowledgeable people following given rules. This would equally allow advanced educational credentials for scientists of special or multiple disciplines.

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* 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 that could use, for instance, the results of the aforementioned GESIS project or, of course, other available lists of concepts, however, not leave classification work to the computer, but call on people's intellect and adequate knowledge to fashion generally acceptable proper concept definitions as required. Such an academy would also be the right place for specific research and much needed teaching. We should keep in mind the motto Soergel advanced in his first 1969 book, namely that the systematization of knowledge is as important as any other scientific research.

Moreover, it is essential that an appropriate science policy ensures the prerequisites for such an institution, its activities and achievements, which would be of great advantage not only to Germany but certainly to the scientific community at large. Unfortunately, there seems to be little concern on the political level—where the urgent need is disregarded if not discarded. However, there is always hope for a change!

References

British Standards Institution. 1985. *BSI Root Thesaurus,* 2nd ed. Milton Keynes: British Standards Institution.

Dahlberg, Ingetraut. 1974. "Grundlagen universaler Wissensordnung. In *Probleme und Möglichkeiten eines universalen Klassifikationssystems des Wissens*, hrsg. Deutsche Gesellschaft für Dokumentation e.V. Pullach bei München: Verlag Dokumentation.

Dahlberg, Ingetraut. 1978. *Ontical Structures and Universal Classification*. Bangalore: Sarada Ranganathan Endowment for Library Science.

Dahlberg, Ingetraut, ed. 1982. *International Classification and Indexing Bibliography (ICIB 1): Classification Systems and Thesauri 1950-1982*. Frankfurt: INDEKS Verlag.

Dahlberg, Ingetraut. 1994a. "Domain Interaction. Theory and Practice." In *Knowledge Organization and Quality Management: Proceedings of the Third International ISKO Conference, June 20-24, 1994 Copenhagen, Denmark,* ed. H. Albrechtsen and Susanne Oernager. Advances in knowledge organizationv4. Frankfurt/Main: Indeks, 60-71.

Dahlberg, Ingetraut. 1994b. "Environment-Related Conceptual Systematisation." In *Environmental Knowledge Organization and Information Management: Proceedings of 1st European ISKO Conference, Sept.14-16, 1994, Bratislava,* ed. P. Stancikova and Ingetraut Dahlberg. Knowledge organization in subject areas, no. 1. Frankfurt: Indeks, 84-9.

Dahlberg, Ingetraut. 1995a. *Compatibility and Integration of Order Systems: Research Seminar Proceedings of the TIP/ISKO Meeting, Warsaw 13-15 September 1995*. Warszawa: Wydaw.

Dahlberg, Ingetraut. 1995b. "The Compatibility Guidelines–a Re-Evaluation." In *Compatibility and Integration of Order Systems: Research Seminar Proceedings of the TIP/ISKO Meeting, Warsaw 13-15 September 1995*. Warszawa: Wydaw, 32-45.

Dahlberg, Ingetraut. 2010. "Information Coding Classification: Geschichtliches, Prinzipien, Inhaltliches." *Information Wissenschaft und Praxis* 8: 449-54.

Dahlberg, Ingetraut. 2011. "A Faceted Classification of General Concepts." In *Classification and Ontology: Proceeding of International UDC Seminar, 19-20 Sept. 2011, The Hague*, ed. Aïda Slavic and Edgardo Civaliero. Würzburg: Ergon Verlag, 177-91.

Dahlberg, Ingetraut. 2014. *Wissensorganisation. Entwicklung, Aufgabe, Anwendung, Zukunft*. Würzburg: Ergon Verlag.

Diederichs, R. 2015. DFG Projektantrag im Bereich Wissenschaftliche Literaturversorgung und Informationssysteme (LIS). Förderprogramm Werkzeuge und Verfahren des wissenschaftlichen Informationsmanagement. Gekürzte Fassung. 18 August 2015.

Gnoli, Claudio and Rick Szostak. 2015. "Universality is Inescapable." *Paper presented at the 25th ASIST SIG/CR Research Workshop. Advances in Classification Research Online.* doi: http://dx.doi.org/10.7152/acro.v25i1.14906

International Organization for Standardization (ISO). 2013. *ISO 25964:2013: Information and Documentation: Thesauri and Interoperability with Other Vocabularies*. Geneva: ISO.

Gödert, Winfried, Felix Boteram and Jessica Hubrich. 2011. *Concepts in Context: Proceedings of the Cologne Conference on Interoperability and Semantics in Knowledge Organization, July 19th-20th, 2010*. Würzburg: Ergon.

Ledl, Andreas. 2015. "BARTOC: The BAsel Register of Thesauri, Ontologies and Classifications." In *Classification & Authority Control: Expanding Resource Discovery: Proceedings of the International UDC Seminar 2015, 29-30 October 2015, Lisbon, Portugal*, ed. Aida Slavic and Maria Inês Cordeiro. Würzburg: Ergon Verlag, 221-6.

Mayr, Philipp and Vivien Petras. 2008. "Building a Terminology Network for Search: The KoMoHe Project." In *Metadata for Semantic and Social Applications: Proceedings of the 8th International Conference On Dublin Core and Metadata Applications,* ed. Jane Greenberg and Klas Wolfgang. Singapore: Dublin Core Metadata Initiative, 177-82.

Mayr, Philipp and A. K. Walter. 2008. "Mapping Knowledge Organization Systems." In *Fortschritte der Wissensorganisation, Bd.10: Kompatibilität, Medien und Ethik in der Wissensorganisatio*n, ed. H. Peter Ohly, Sebastian Netscher and Konstantin Mitgutsch. Würzburg: Ergon-Verlag, 80-95.

Ranganathan, S. R. 1933. *Colon Classification.* Madras: The Madras Library Association; London: Goldston.

Ranganathan, S. R. and M. A. Gopinath. 1967. *Prolegomena to Library Classification,* 3rd ed. Bombay: Asia Publ. House.

Scheele, Martin. 1967. *Wissenschaftliche Dokumentation. Grundzüge, Probleme, Notwendigkeiten. Dargestellt an eigenen Arbeiten und Beispielen.* Schlitz//Hessen: Verlag Dr. M. Scheele.

Soergel, Dagboert. 1969. *Klassifikationssysteme und Thesauri. Eine Anleitung zur Herstellung von Klassifikationssystemen und Thesauri im Bereich der Dokumentation.* Frankfurt/M: Deutsche Gesellschaft für Dokumentation.

Soergel, Dagobert. 1974. *Indexing Languages and Thesauri: Construction and Maintenance.* Los Angeles, CA: Melville Publ. Co.

Soergel, Dagobert. 2011. "Conceptual Foundations for Semantic Mapping and Semantic Search." In *Concepts in Context: Proceedings of the Cologne Conference on Interoperability and Semantics in Knowledge Organization, July 19th-20th, 2010,* ed. Winfried Gödert, Felix Boteram and Jessica Hubrich. Würzburg: Ergon-Verlag, 13-35.

Szostak, Rick. 2014. "How Universal is Universality? Letter to the Editor." *Knowledge Organization* 41: 468-70.

Obrst, Leo, Patrick Cassidy, Steve Ray, Barry Smith, Dagobert Soergel, Matthew West and Peter Yim. 2006. "The 2006 Upper Ontology Summit Joint Communiqué." *Applied Ontology* 1: 203-11.

Wersig, G. 1979. "Experiences in Compatibility Research in Documentary Languages." In *Ordering Systems for Global Information Networks: Proceeding 3rd International Study Conference on Classification Research, Bombay 1975,* ed. A. Neelameghan. Bangalore: FID/CR and Sarada Ranganathan Endowment for Library Science, 425-30.