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Conceptual Navigation in Multimedia Knowledge Spaces

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0. Introduction

The possibilities of the Internet are evolving slowly. Nearly 55 years ago, when Vannevar Bush[1] described his vision of the future he focussed on the idea of hypertext, the possibility of linking any word with any other word. A decade later, Douglas Engelbart outlined a vision of multimedia e-mail which, as he noted in his keynote to the WWW6 Conference (Santa Clara, 1997) has still not been achieved.[2] Pioneers such as Ted Nelson explored aspects of that vision.[3] When the earliest version of the Internet began in a military context (1969) it was largely so that physicists could communicate with each other at a distance in order to share scientific information. This goal also inspired Tim Berners Lee (1989) to make his breakthrough with Hyper Text Markup Language (HTML), which led to the World Wide Web as we know it today.

The past decade has seen a shift in these goals of the Internet. At a superficial level there has been an enormous increase in the range of subjects covered which include government and business information, philosophy, literature, art, news, entertainment and many personal sites. At a more profound level there is an increasing quest to distinguish two levels of communication on the Internet: one for communication between individual human beings in natural language; the other in machine readable form such that

computers can communicate without human intervention. In his keynote at WWW7 (Brisbane, 1998), Tim Berners Lee, outlined this vision in terms of a global reasoning web. He pursued this theme at WWW8 (Toronto, 1999), where he described the need for a semantic web.[4]

Aspects of this vision go back at least three decades when persons were faced with the challenge of dealing with repair manuals for complex technology such as aircraft carriers. These manuals were so copious in printed form that they would sink the aircraft carrier if they were loaded on board. Electronic versions thus became a necessity. Linked with this was a need to print different subsets on demand, without having to rewrite the entire manual each time. This led to Standardized General Markup Language (SGML), which distinguished between the structure of content and the various ways in which it could be presented. SGML thus allowed a distinction between one content and multiple forms of expressing that content. The disadvantage of SGML was that it was so complex that it could only be used readily by highly trained professionals. The advent of HTML, which was a stopgap measure, effectively marked a step backwards because it undermined that distinction.

The past years have, therefore, seen the emergence of a new eXtensible Markup Language (XML). This re-introduces the distinction between a single content, which can be produced in different forms. XML is intended to cover the basic needs of content description. More specialized needs will be covered by subject specific markup languages ranging from Chemical Markup Language (CML), and Mathematical Markup Language (MML) to Wireless Markup Language (WML). From an historical point of view these new markup languages in their attempt to deal with the structure of language are effectively re-inventing the principles of grammar in electronic form.

The vision outlined by Tim Berners Lee goes far beyond this. His goal is to separate rhyme (the subjective expressions of individuals) from reason (the objective statements of individuals). His global reasoning web or semantic web requires that every unit of knowledge will contain summary information describing itself in terms of its logical truth-value, its quality and so on. To achieve this the W3 Consortium is building on earlier attempts to create a Protocol for Internet Content Selection (PICS) and is creating a Resource Description Format (RDF), which will enable all information to have a self-describing component in machine-readable form. From an historical point of view, RDF is re-inventing the principles of dialectic.

Meanwhile, scholars at the University of Southern California have been working on rhetorical structure theory. If this is applied to the world wide web, then we shall soon have in electronic form the entire trivium of grammar (the structure of language), dialectic (the logic of language), and rhetoric (the effects of language).[5] It could be argued that a parallel re-invention of the quadrivium (geometry, arithmetic, astronomy and music) in electronic form is also underway.[6]

At a practical level, a recognition of these trends helps us to understand why there has been an exponential interest in meta-data in the course of the past decade. Content is

information that interests humans. Information about that information is what machines require to "communicate" without humans, which also helps to explain why agents have become central to discussions of the Internet. Much has been made in recent years of a trend for Internet communication via e-mail gradually to exceed communication via voice telephony. This overlooks another, more subtle trend. Once there are in fact two Internets, one which is machine-readable and the other which conveys purely human messages, machine-readable communication using meta-data via agents will compete with human communication.

This paper explores some of the potential implications of these trends. Many persons assume that the web will simply present us, in electronic form, things which have hitherto been available in print. In this view all that is required is to scan in our museums and libraries in order to have everything accessible in the comfort of our homes. We believe that interoperability of content is as important as interoperability of the pipelines and have made this a central goal of a new European Network of Centres of Excellence in Digital Culture.[7]

The consequences of the web are much debated. Some assume that making subsets of these collections available on-line will constitute a new form of advertisement and serve to draw more persons to visit museums and libraries. In this view the Internet is ultimately a new tool for business, tourism and for education. In certain minds, the latter two are merely subsets of the former. Our basic claim is that the Internet will have a far deeper effect: it will lead us to re-define our concepts of learning, knowledge, and of truth itself. And as outlined below, in our view, the situation is also considerably more complex than is often assumed for at least eight reasons.

1. Electronic Equivalents of Footnotes

First, each new medium requires new methods to determine the veracity, reliability and quality of the sources. The advent of print brought an enormous increase in the production of documents and at the same time required the introduction of footnotes and bibliographies in order to establish which documents were reliable. The radical increase of new journals in this century heightened the importance of peer review to discern which articles are truly worthwhile.

The new media are bringing an explosion of a different order. Instead of citing an occasional quote from a Greek or Roman source, a classicist potentially has the entire corpus of ancient texts at their disposal through electronic versions of the *Thesaurus Linguae Graecae* (TLG) and the *Thesaurus Linguae Latinae* (TLL). Instead of citing a sample image of a painting or drawing of an artist, art historians will in the near future have access to images in a range of different resolutions (from vignette or thumb-nail to imagette, full page and high definition to very high definition image)[8]. Through advances in infrared reflectography the same painting will be accessible in a series of say –at least four—layers. A single painting will thus generate twenty images (five resolutions times four layers). In the case of famous paintings such as the *Last Supper* the original will inspire at least four copies. These in turn are likely to inspire further paintings, which are

copies, versions, based on, in the manner of and caricatures of the original. This generates another twenty images. But these images are also likely to undergo at least three restorations and three reconstructions. In which case a single original may well generate 3,600 images (20x20x3x3). In the case of a single reproduction of an original, printing introduced the need for captions. If electronic media potentially introduce 3,600 or more reproductions of a given image then we clearly need new kinds of caption.

All this will require electronic equivalents of footnotes. These will need not only to identify the veracity of a given document but also to establish its distance from an original source, with respect to generations of copies, and at the same time to provide users with conceptual maps for navigating between a given original and its many copies. The new media will thus force us to redefine our criteria for and concepts of truth. To meet these needs the Maastricht Mcluhan Institute (MMI) is working with the European Commission in establishing a new network of centres of excellence, which will have as one of its concerns the establishment of a long term meta-data project.

2. Dynamic Knowledge

Second, there is the question of dynamic knowledge. As McLuhan noted, printed texts constrained us to present knowledge in a linear form. This form was also static. With respect to individuals this led to static lists of their publications, of their paintings, their inventions and so on. Yet, when viewed from the context of the centuries, these lists are dynamic. The manuscripts known to have been written by Leonardo in 1700 were different in number than those known today. The paintings attributed to Rembrandt in 1800 are different than those attributed today. Indeed even at present, different scholars frequently have competing views as to what that number might be. Provided we have a system of electronic footnotes and captions linked with versioning methods, electronic lists will lead to new kinds of dynamic knowledge, whereby we can see how views change over time. This applies not only to lists of titles but also to transcriptions, translations, interpretations, judgements of quality, maps and most of scholarship. In short, the new electronic media will transform the static knowledge of print culture into new forms of dynamic knowledge. To achieve this will require new attention to meta-data far beyond the interim solutions offered by the Dublin Core community.

3. New Relations

Third, there is a question of new relations among elements of knowledge. The advent of print in the West during the fifteenth century brought new efforts towards standardisation of knowledge and at the same time much greater attention to classification of knowledge. The last century has seen many developments in the systematic treatment of classification, with respect to defining specific relations between concepts. Efforts of scholars such as Otlet, LaFontaine[9] led to an extension of Dewey's Decimal Classification (DDC) to a more Universal Decimal Classification (UDC) which reflected more complex relations, which have since been further developed by thinkers such as Perreault (cf. Appendix 1). These efforts have also led to principles for terminology (Wüster[10]) and knowledge organization (e.g. Dahlberg).

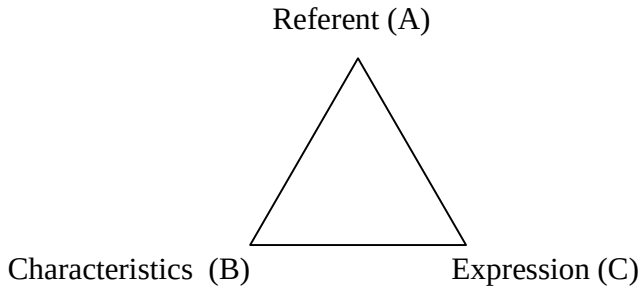

Figure 1. Dahlberg's three components in a concept triangle.

One of Dahlberg's basic ideas, for instance, is that concepts entail three fundamental elements (figure 1): A (Referents); B (Characteristics) and C (Expressions). Changing relations among these three elements determine the kind of definition. These can be ostensive (when C=A), nominal or stipulative (when C=B) or real definitions (when C=B from A).[11] These latter she distinguishes as generic, partitive, opposition and functional according to her four kinds of material/content relationships (se below section 7)

Many discussions of digital libraries are still limited to creating electronic catalogues and at best to scanning in digital versions of full text documents, as if all that was needed was to have on our computer screens what was formerly only accessible in libraries. One way of going considerably beyond this model is to focus on the full potentials of the reference rooms of libraries, which are effectively the search engines of the collective memory of mankind, and use these as the basis for digital or virtual reference rooms. Here the essential idea, which has been discussed elsewhere,[12] is that one can create new links between concepts and classes of concepts in classification systems, the words in dictionaries, the explanations in encyclopaedias, the titles in catalogues and bibliographies and the partial contents in abstracts and reviews in order to create a nexus of new entry points into the full contents stored in our libraries. This approach will greatly expand our potential search strategies.

Dahlberg's distinctions invite us to go much further. In very practical terms we could re-define our definition of the dictionary itself, such that every word has accompanying it, not only a series of etymological (both spatially and temporally) definitions, but also a clear indication of the kind of definition entailed. This could provide us with an important search parameter. Sometimes we might wish to consult real definitions in their four distinctions, in the sense explained above, and at other times we might accept nominal or stipulative definitions.

There are, of course, also quite different kinds of dictionaries. Some, such as the Oxford English Dictionary, are universal in their scope. Others are very much linked to specific professions and crafts: medical dictionaries, engineering dictionaries etc. As Budin has pointed out in his important book on *Knowledge Organisation and Terminology*,[13] there are new challenges of creating links between general knowledge and specialist dictionaries.

With the rise of agent technologies one can readily imagine going considerably further. Fields which have specialist dictionaries typically also have specialist classification systems and/or thesauri. Medicine, for instance, has the Medical Subject Headings (MeSH). It is therefore perfectly possible to take the catalogues of classification systems and thesauri collected by the International Standards Organization and link the terms therein with corresponding entries in specialized dictionaries. By classing the level of these classification systems, thesauri and dictionaries in terms of their generality or degree of specialization one would then have the basis for a whole new approach to reference materials. A search system could then identify the level of the user, (child, student, research physicist etc.) and automatically recommend the classification systems, thesauri, dictionaries, and potentially also the catalogues, bibliographies, abstracts and reviews one would usually consult. Other options would, of course, remain open. There might well be times when a physiologist with an F.R.C.P. wished to compare the approach of a bio-chemist at an equivalent level of expertise. The system would thus provide both standard references and new entry points into other fields of expertise.

Traditionally there has been a chasm between the depth of etymological dictionaries, which focus on the history of terms in one language and the breadth of multilingual dictionaries which provide equivalent terms in two or more languages. This meant that if I wished to study the etymology of a term in multiple languages I needed to consult a new dictionary for each language involved. A person wishing to trace a word through the 6,000 languages of the world would therefore require a very large table. Using agent technologies one can imagine new kinds of virtual dictionaries, which trace when a new term entered into various languages. At a microscopic scale this will transform the field of philology. At a macroscopic scale this will open the way for new kinds of cultural history, which allow one to tackle concretely and substantively the enticing visions of an archaeology of knowledge as described abstractly by Foucault.[14]

To this end one could, for instance, take the terms in earlier classification systems and knowledge structures in the tradition of Raymond Lull and Pierre de la Ramée (Ramus)[15] and study these in terms of the kinds of definitions on which they relied. In the longer term, this can lead to a new history of definitions, which will reflect the ongoing interplay of philosophy, logic and language that so fascinated McLuhan.

Such approaches (see also section 7 below) will mean that digital libraries become much more than on-line versions of the old. They will offer us new insights into the rationale for major collections. They will also demonstrate that the cumulative experience of methods for dealing with enduring knowledge can fruitfully be applied to the rapidly expanding repositories of both enduring and ephemeral knowledge on the Internet.

Internet developers preach a goal of potentially linking anything with anything else on the web, which recalls the enthusiasm of pioneers in early concordances, who believed that a simple listing of all words would answer all the needs of scholarship. A challenge lies in co-ordinating the discipline and experience of indexers in order to distinguish between quantitative occurences and quality links. Using the emerging dynamic

knowledge listed above, we need new ways of visualizing the history of knowledge as a growing network of relations between and among concepts. Such a history would trace a progression from the use of isolated words through lists, controlled lists, trees and hierarchies to dynamic relations whereby we can see how terms and their contexts change spatially and temporally.

An integral aspect of this history centres on the insight that information entails terms in isolation, whereas knowledge arises through establishing links between concepts[16], claims and theories. One of the great insights of the late Eugen Wüster was that all terms require definitions. Needed therefore is a history of definitions whereby changing relations of concepts are made visible.

4. Cultural and Historical Dimensions of Knowledge

Sometimes a same term means very different things in different languages. For instance the phrase "*Alles wissen*" means "to know everything" in German and "to delete everything" in Dutch. It is a well known phenomenon that different languages have terms and concepts not found in other languages. Some of these differences are nearly obvious. The Inuit have a hundred terms for snow whereas many languages in more temperate climates do not have such a variety. There are also more subtle differences. In the United States there is a Knowledge Management Consortium International (KMCI)[17]. In the Netherlands, the English term 'knowledge management" is translated as "*kennismanagement,*"[18] which reflects practical experience and everyday knowledge and is quite different from the scope of KMCI. In the Netherlands, a more theoretical "*management van het weten"* or"*wetensmanagement"* does not exist.[19] While the Dutch "*kennismanagement,*" has a rough German equivalent in "*Wissensmanagement*," the latter has more theoretical connotations. Dahlberg in Germany has also founded the International Society of Knowledge Organisation (ISKO), which includes theoretical foundations and not just management.

English structures of knowledge are often pragmatic borrowing such theory as they have from strict logical premises. German knowledge structures are often ontological (cf. Diemer, Dahlberg[20]) as are those of Americans, although less based on careful theory. Austrian knowledge organisation frequently assumes the possibility of an evolutionary dimension (cf. Budin)[21], which is very foreign, say, to a Dutch mind. French knowledge structures, whether they follow Descartes or the post-structur(e)-alists, are different again. A simple positivistic approach would assume that one of these many alternatives has to be "right" and that the others are somehow wrong. Needed, however, is a more subtle methodology whereby we can accept these differences and recognize therein some of the subtle cues that help us to distinguish the Austrians from the Germans and the French from the English, not merely by superficial accents, but rather by different approaches to life.

These different cultural approaches are reflected in the use of images as much as in the use of language. Some cultures express their narratives in verbal stories, others in pictorial cycles. This use can also change. The Netherlands and parts of Germany and

England produced many images and then rejected this tradition during the iconoclastic tendencies of Calvinism (*Bildersturm*, *Beeldenstorm*). A truly comprehensive cultural history would help suggest to us how a given culture at a given time might have expressed a story differently.

This applies to all cultures. In Europe there is a tendency to associate culture with the fine arts, particularly painting and sculpture based on literary motifs from the Bible and the classics (Ovid, Virgil etc). In India, Malaysia and throughout much of Southeast Asia, by contrast, there is an equal reliance on sacred texts such as the *Mahabharata* and the *Ramayana*, but the stories therein are often the basis of dance, theatre, and other performance based expressions such as puppet shows. A European, on not finding paintings to the same degree as in Western museums might be tempted to see this as proof of these countries having less culture, when in fact they merely have different expressions.

5. Levels of Abstraction

Fourth, a new integration of levels of abstraction is needed. Contemporary thinkers such as Barber[22] have noted what they see as a tension between an increasing local approach with regionalism/ separatism and an ever greater globalism (Jihad vs. McWorld), as if the former were an embarrassing fossil from an earlier age. In fact the often tedious details of the local are the substance on which the statistics of the global level rely. McLuhan's characterisation of a global village in which the two tendencies co-exist is therefore closer to reality in representing both as naturally co-existing phenomena. A new challenge thus looms of creating new links between concrete materials at the local level and various levels of abstraction as we move from local through regional and national to global levels.

6. Multi and Inter-Disciplinarity

One of the great challenges has always been how one can study a sufficient range of subjects in order to achieve a synthesis between seemingly disparate topics. Aristotle did so by attempting to understand all that was known at the time. Thomas Aquinas chose to make a summary of what was known in his day. Leonardo used the approach of a universal man but in fact focussed on a relatively small number of topics. Since the Renaissance there has been an increasing trend towards specialisation.

There have also been interesting shifts in emphasis. For instance, in the past decades there has been a shift away from library science towards information studies. In the process many of the earlier insights in classification and indexing theory have been neglected or forgotten. Needed here is an integration of etymological awareness into our systems. According to the Oxford English Dictionary, for instance the term "index" entered the language in 1578 (Lyte), "classification" in 1804 (Abernethy), linguistics in 1837 (Whewell), while terms such as "cladistics", "information science" and even "artificial intelligence" do not occur in the 1971 edition.[23] Such etymological awareness is strikingly absent, for instance, in George Miller's WordNet (Princeton),[24] which is also

the basis of the ontological thesaurus at the University of Southern California and of a new Euro-WordNet. [25]

The rise of artificial intelligence, which as cynics have noted was often mainly the former,[26] frequently overlooked that the questions in which they were interested had been treated for centuries by discerning philosophers, grammarians, philologists, linguists and others. In the past decades there have been deliberate attempts to correct this through attention to a wider range of interests. For instance, the rise of cognitive science in the latter 1950's saw an attempt to combine the insights of artificial intelligence, computer science, computational and theoretical linguistics, computational neuroscience, philosophy and psychology.[27] Even so cognitive scientists are frequently unaware of the work of systems theorists,[28] classification experts and indexers. Indeed most computer specialists are very much surprised to learn that there are at least 5,000 classification systems and over 1,500 thesauri in the world.[29] And at the same time many classifiers and indexers remain unaware of the contributions of fields such as cladistics.[30]

Traditional library classification systems class topics in terms of disciplines. "See also" references give some indication of occurences in related fields. Needed, however, is a revision of these classification systems such that at least one version thereof explores the content behind the titles relating to any field and then correlates this with other fields which deal with the same topic. This would provide us with a map of inter-disciplinary connections, which uses content as a point of departure in pointing to emerging links between disciplines. The grouping of fields that led to the rise of cognitive science may well be intuitively correct, defensible and laudable. Yet one of the great challenges lies in finding connections which are not obvious as would be provided by the above mentioned map.

7. Man and/or versus Machine

Earlier we noted the emergence of two internets[31]: one for human communication, the other machine readable for inter-computer "communication."[32] Here there is a great need for more interaction between the Internet community and the terminology community. These developments could have important implications on some long-standing debates in the library world. At the same time, the Internet community can benefit greatly from the long accumulated experience from disciplines, which derive from the ancient trivium.

In the information science world, for example, indexers (e.g. Fugmann[33]) warn that natural language is not sufficient and that only careful human study can extract from complex texts the concepts and their terms that are relevant for indexes. On the other hand, those in the computer community, especially pioneers of neural networks (e.g. Chanovski[34]), would have us believe that fuzzy techniques are so effective that we shall soon be able to forget the tedious problems of creating indexes, classifications and thesauri manually. All this they claim can be automated. Such debates frequently descend into pseudo-moral debates with simple oppositions: human classification is good; machine classification is bad. Or: human classification is possible; machine classification is inaccurate, does not really work well and is thus effectively impossible.

Original Categories	Form Categories
1. Entities	1a Principles
	1b Immaterial objects
	1c Material objects
2. Properties	2a Quantities
	2b Qualities
	2c Relations
3. Activities	3a Operations (active)
	3b Processes (passive)
	3c States (zero activity)
4.Dimensions	4a Space
	4b Time
	4c Position in dimension (Lage)

Figure 2. A development of Aristotle's form categories by Dahlberg. Aristotle distinguishes between substance (entities) and accidents (properties, activities and dimensions, 2a-4c). The numbers have been added by the author.

At the outset it is useful to note that both methods have their intrinsic value. Often I am looking for a specific name, term or data in which case I need all the precision offered by the best of indexing. If I am trying to determine the amount I owe the bank or ask a person how many children they have, I expect a very precise answer. On the other hand if I am beginning a search of a new field then some of the associations provided by fuzzy searches may prove very useful in suggesting some less obvious places to look.[35]

Rather than thinking of these as two opposed methods it is more interesting to explore how they can be combined in complementary ways. At the simplest level users would have a choice between direct and fuzzy searches. One could also imagine a more subtle combination. One uses a fuzzy search to suggest a number of terms and then check these through alternative classification systems to filter out those which are pertinent from those which lead away from the topic at hand.

This is an area in which a great deal more can be achieved if there is more co-operation between the pioneers concerned with creating two complementary Internets (both through the WWW and the Internet Society), and those in the traditional disciplines of philosophy, language and more recently terminology.

In the interests of clarity it is useful to recall some basic distinctions introduced by Aristotle and developed by Dahlberg,[36] who distinguishes between categories of being, of form and of matter (content) -- as combinations of being and form. She identifies nine areas of general objects relating to categories of being and matter[37] and twelve form categories.

With respect to the form categories (figure 2), automation in the sense of machine-machine communication of the second Internet, has enormous potentials for entities (1) provided, as outlined earlier, that we create careful links between terms and their

	Philosophy	Logic	Computer Science	Example
1	Abstraction[38]	divisio[39]	Type-Instantiation	Type-Kind
2	Partitive	partitio	Aggregation	Whole–Part
3	Opposition	oppositio	----------	Dark-Bright
4	Function	Syntaxis	Syntax	Subject-Predicate

Figure 3. Four basic kinds of material relations according to Wüster and Dahlberg with corresponding names in different disciplines.

definitions; properties (2) and dimensions (4) --cf. the rapidly converging fields of Geographical Information Systems (GIS) and Global Positioning Systems (GPS). The objections of Fugmann apply primarily to activities (3) and more specifically to processes (3c). To meet the valid portion of these worries,[40] some steps can be taken. One could make the presence of an index (and its level) part of future meta-data in electronic book catalogues. The indexed terms of books with serious indexes could then become a further form of partial contents intermediary between a table of contents and abstracts of a book. As such, this could become another useful dimension of search strategies for books.[41]

Even if one does not accept automatic classification, one can use automated methods to collate retrospectively the results of human methods of indexing. Library catalogues and book catalogues are also indexed under key words. With the use of agents it is possible to collate the connections which have been made so far between a given title and a number of terms. Viewed chronologically these can provide us with maps of how a given title has been classed differently over the centuries. In short we can use automation in giving us a better overview of past human indexing without accepting that automation can replace human indexing.

In addition to form categories there are material (content) categories/relations. Dahlberg, following Wüster in part, distinguishes between four kinds of material relations. This list becomes the more interesting when one compares the corresponding names in the disciplines of philosophy, logic, and computer science (figure 3).[42]

While the details of Dahlberg's approach go far beyond the limits of this article,[43] there are at least three reasons why these distinctions are of fundamental concern for our topic. First, it will be noted that there are four material relations, the last of which Dahlberg divides into four levels: subject -predicate; 2) purpose, conditions, place, time; 3) form of statement; and 4) global context. This goes far beyond the typical entity-relationship models with which some computer scientists still believe they can define problems.[44]

Second, as Dahlberg notes, with the help of the form categorial (figure 2) and the material (content) concept relations, as combinations of form and being categories, one can create concept systems. Form categorial concept systems lead to facetted classifications and material concept systems lead to abstraction, partitive, opposition and functional systems and combinations thereof. Facetted classifications,[45] in the tradition of Aristotle's basic distinctions, since the Dorking Conference (1957), have been seen as the "most helpful form of classification scheme for information retrieval."[46] Library

classification systems such as the Dewey Decimal System (DDC) typically deal only with the first two material relations, namely, abstraction and partitive. The limitations thereof inspired Otlet and Lafontaine to develop the Universal Decimal Classification (UDC). Perreault demonstrated how the UDC could be adapted to include a much larger range of relations (see Appendix 1) in using the UDC notations to form classificatory statements (classates).

It is striking, however, that a comprehensive list of all the kinds of form characteristics, form concepts and relation concepts has yet to be made. Here is an area where those in the terminology, library and knowledge organisation communities should work together with the Internet community in order that the Resource Description Format becomes as comprehensive as it should.

Third, on looking more closely at the material relations, Dahlberg notes that these concept systems are in fact definition systems, i.e. one can distinguish between abstraction definitions; partitive definitions; opposition definitions and functional definitions. This takes us back to the need for new kinds of dictionaries as discussed earlier. The history of knowledge thus becomes an evolution from indiscriminate attempts at definition to systematic uses of kinds of definition on which the principles of modern terminology are based.

From all this emerges a vision whereby those in more traditional fields such as philosophy, logic, library science, knowledge organisation and terminology have specialised knowledge of great potential use to those now concerned with organising the World Wide Web. On the other hand, this challenge of organisation is not limited to new materials on the Internet. The advent of data, and information in electronic form, challenges us to re-organize all our knowledge in new ways.

8. Visualisation

Mediaeval manuscripts were very frequently illustrated/illuminated. One of the unexpected consequences of printing was to reduce emphasis on the visual aspects of communication largely because it was technologically difficult and economically costly. The rise of computers is changing this. As was noted earlier, images are becoming ever more central to computers. Parallel with this is a trend to use a) visual symbols as a means of communication and b) visual display methods to convey patterns in ideas. Instead of simply displaying classification systems as lists there is a quest to present them also in tree forms. Graphs and charts are now typically a part of even basic programs (cf. Microsoft Excel). There is a trend towards knowledge representation, scientific visualisation and, more recently, information visualisation.[47]

At present such charts and visualisations typically require separate software. In future it is likely that the integration of such features will become ever easier such that one can go from a list of statistics to various charts and visualisations seamlessly. Underlying these trends is a more general quest: how I can see not only the information itself but also the underlying relations, structures, patterns associated with that information? This is a

further challenge for meta-data as we learn to separate two kinds of internets: one for human-human communication, the other for machine-machine communication.

9. Dangers

While these developments offer enormous possibilities of potentially utopian proportions, it is important to recognize that they also entail considerable, potential dangers.

Virtual vs. Concrete

There are, for instance, paradoxical developments in the Internet. On the one hand the Internet is becoming increasingly abstract and virtual. There are now virtual museums, virtual malls, virtual chambers of commerce, virtual universities to the extent that it seems we are creating a copy of the physical world in the virtual world of computers. On the other hand, what was once educational theory is increasingly becoming learning practice. Education, which derived from the Latin term "to lead out of (*educere*), and was linked with the ideal of learning for the sake of learning, is now ever more in the hands of –isms and theories: connectionism, constructivism[48] (and learning environments, i.e. the technology of constructivism), post-modernism, semiotics, activity theory, socio cultural theories, cybernetics, systems theory, and semiotics.[49] These bring an ever greater emphasis on problem based learning and, more recently, project based and even product based learning. Hence as the Internet becomes more virtual the goals of learning are ever more concrete, with a teleological emphasis that resembles training.

The move towards project and product-based learning has been inspired by the automobile and aircraft industries where large teams linked in a collaborative process are necessary for the design of complex machines. A serious question poses itself, however, whether the needs of these very specialized branches of industry should serve as a model for the whole of learning. If, for instance, students are trained strictly along these lines, they will learn to work towards someone else's goal. But will they learn to develop critical skills? There may be a rhetoric that they are engaged in active learning, but are they not passively responding to someone else's agenda?

In the past there was an active and a contemplative life. Those who chose the active life went into business and politics. Those who wished a contemplative life chose the worlds of scholarship and religion. The trend towards project and product-based learning can be seen as an attempt to bring the goals of the active life into the realm of the contemplative. The idea of art for art's sake, of scholarship as an end in itself seems doomed to extinction. Yet if everyone is doing in this sense, who is there to be a conscience and think about the bigger picture? For this reason a small group has begun thinking about a need to re-introduce a new version of a mediaeval notion, in the form of electronic monasteries.

There is further reason for such musings. In 1995 a group of experts chaired by Gorbatchov, contemplated developments in the next generation. Within twenty years, they predicted, twenty percent of the population would be employed, while eighty-

percent remained unemployed. What to do with this eighty percent of unemployed? Their answer was "tittytainment": in short a combination of the Roman tradition of bread and circuses combined with Hollywood.[50] In our view there are more constructive alternatives. The enormous numbers of relations needed for deeper insight require an enormous amount of patient drudgery which, appropriately enough is called the work of monks (*Monnikenwerk*) in Dutch. Hence, perhaps we need a revival of the mediaeval monasteries in order to put to better use the otherwise unemployed of a post–industrial society in order to achieve something for the common good. In any case we need new contexts where we have time to reflect and not simply react to a barrage of demands via telephones, e-mails, faxes, which all expect an instant response.

Non-Monetary Sides of Value

Underlying the above trends, whereby the active life is encroaching ever more on the contemplative life, is a conviction that short-term business is the only model for human action. Economics is no longer just a consideration. It is assumed to be the only justification. Accordingly pupils and students are being introduced to the ways of business at ever younger ages through learning partnerships, which are more concerned with conditioning youth for the rules of the office and the marketplace than expanding their minds to new intellectual horizons. Successful scholars are now supposed to be fund-raisers and then managers of the funds that have been raised. But they can readily be so active in these tasks that there is no time to reflect upon the nature of scholarship. Even those in large research institutes are judged in terms of the number of spinoff companies they produce, only to find themselves so busy therewith that they have little time left to "produce" ideas worthy of being spun off. Basic and fundamental research are being replaced increasingly by applied research: Where is the product? Show me the money are the cries of the new executives as if economics were simply about money.

Using such simplistic criteria none of the great artists or architects could ever have finished their work. Leonardo's *Mona Lisa* would have been considered an excessive amount of time spent on such a small canvas. Michelangelo's projects for the Sistine Chapel and later Saint Peter's Basilica would have been dismissed as completely uneconomical. And yet it is precisely such works, which are now the fundamental reasons why tourists flock to the Louvre and the Vatican, and why tourism has become one of the main sources of financial income for Paris and Rome. In other words some of the most uninteresting investments from a short-term perspective are precisely the most precious when seen in light of achievements in the course of the ages.

Ultimately the deeper value of a Leonardo or a Michelangelo is not to be measured in terms of their box office returns. Far more precious than their contributions to statistics concerning this year's tourist tickets, is the ability of such remarkable figures to inspire in us a vision that goes beyond the drudgery of everyday life, to remind us of what some would call the sublime or the transcendent. Genius may contribute to economics but ultimately it reminds us that there are realities which money cannot buy.

Those who speak of a new knowledge economy are right to point to its potentials. But it may well be that the potentials lie elsewhere than expected. Traditionally (from the Latin verb *trado*, *tradere*, to carry), there were scribes who carried out the rather mindless work of copying things from one medium to another: parchment to manuscript, or translating from one language to another: from Greek to Latin, from Latin to Italian. They were paid very little, but they saved Western civilisation and helped to prepare the way for the modern world. Today those who make CD-ROMS are effectively nothing more than scribes. They are simply copying things from one medium to another: from print to electronic form and from one container to another, from a hard disk to a CD-ROM. Yet these persons frequently assume that their work is worth at least $200/hour. At this price we cannot even hope to translate new knowledge into the new media, let alone to translate retrospectively the thousands of years of accumulated knowledge in our libraries, archives and museums.

Unless we find a more reasonable price for dealing with our past we shall find the past unaffordable, in which case we shall lose more than we think we have gained. In short, economic values may be a useful aspect of our equations and yet if we reduce everything to profit schemes we shall have a society where money is the only standard of value. Those who reduce everything to e-business and e-culture might say that we have already arrived at that point. But these overlook the inestimable worth of human qualities associated with culture and civilization, which no amount of money can buy. We may need new meta-data to include economic values, but then we need equally to include values relating to quality of human expression, of human interaction, of human ideals.

Public-Private

In the European tradition there has been a clear distinction between the public and private. In the United States this distinction is far less clear. Not surprisingly therefore, American software producers are developing new technologies which ignore this distinction.[51] They assume that the sites, which a person visits, reflect the person's interests and they therefore propose to record all such searches. Let us assume that a single person is at work and spends eight hours a day studying African economics because that is their job. In the evenings, after work, (and before going home where they do not yet have Internet access), they go searching for blonde women for an additional two hours. American software of the sort described would thus include blonde women as part of the profile of the person. Because it is statistically based the software would assume that two tenth's (i.e. 20%) of the young executive's interests are focussed on blonde women. The programme would therefore begin providing a twenty percent ratio of blonde women as part of the daily diet. This might, indeed, be very attractive to the young man but considerably less so to his superior.

What we clearly need therefore is a more subtle approach to profiles, which keep separate our various goals. That which interests me as a business person is invariably different than what concerns me as a scholar or as a lay person in my leisure time. Even in my activities as a scholar there will be a variety of different profiles. My activities at the beginning of research into a field will be very different from the phase when I have

identified a key set of texts which concern me and very different again from a final phase when I am checking bibliographical references and adding final footnotes. We thus need multiple profiles some of which can be more generally accessible whereas others need special protection in terms of privacy, just as in the physical world, my boss may have every right to read my business correspondence but no right to read my personal mail.

Popular and the Enduring

Marshall McLuhan's scholarly studies arose out of a doctoral dissertation at Cambridge, which traced the history of the trivium in an attempt to understand the background of the seventeenth century author Thomas Nashe. This led him to the insight that some media and therefore some cultures pay more attention to one aspect of the trivium than another. He noted for example that during the Renaissance the advent of print led to a favouring of dialectic (the logic of language) over other elements. In later studies he noted, for instance, that the advent of television brought a greater emphasis on rhetoric (the effects of language, and images).[52]

This interest in effects led many to judge the world in terms of ratings. Those which are highly rated are successful. Those which are less highly rated are deemed to be unsuccessful. One of the unnerving trends of the past years has been that this model from the world of television has begun to affect every dimension of our daily lives. Public broadcasting, education, everything we do is threatened with becoming a popularity contest. As politicians know only too well popularity has to do with what one seems to be which is always easier than the difficulties of truly being. The Internet has focussed new attention on the value of having access to the latest information, the value in knowing of stock trends three seconds faster than a competitor. This information, the value of which lies strictly in competitive advantage, will soon be uninteresting. Yet the same Internet is making us more aware than ever of the enduring knowledge that will continue to be valuable over the centuries. Conceptual navigation in multimedia spaces requires also a need to distinguish between these differing dimensions: the concerns of the moment and those of eternity.

10. Conclusions

Nearly 55 years ago there emerged a vision whereby human knowledge could be hyper-linked at will. In the past generations this has led to the Internet. In the past years a vision of two Internets has evolved: one for communication among humans in terms of natural language, another for machine-machine communication using a machine-readable language. This second Internet accounts for many of the developments in meta-data and agents and has inspired great interest in the structure of language (grammar), the logic of language (dialectic) and the effects of language (rhetoric). These fields, which have been linked since Late Antiquity through the trivium, are the sources of more recent fields such as philology, linguistics, indexing, classification, knowledge organisation and terminology.

While some would have us believe that the main purpose of these advances is electronic commerce, we have suggested that the implications of the Internet are much more profound. They are changing our approaches to learning, knowledge and the concept to truth itself. Eight aspects of this deeper vision were outlined: 1) electronic equivalents of footnotes; 2) dynamic knowledge; 3) new relations; 4) cultural dimensions of knowledge; 5) levels of abstraction; 6) multi and inter-disciplinarity 7) man and/or versus machine and 8) visualisation. A number of dangers were also mentioned: the problems of virtual vs. concrete; the non-monetary aspects of value; the need to keep separate public and private; and to distinguish between the popular and the enduring. These problems may seem somewhat removed from the conventional problems facing terminology and yet they have profound relevance for conceptual navigation. We need to navigate not only through quantities of bits and bytes, but also through various dimensions of their quality. Precisely where quality lies is less obvious than many of us assume. Hence before we re-organise the whole of knowledge it will be useful, nay very necessary, to reflect upon such questions. This aspect of electronic monasteries may prove to be even more vital than their potential role in helping to translate existing knowledge from printed into digital form.

If these dangers are to be overcome and the true potentials of the Internet uncovered, then there is a great need that the traditional fields, especially those of philosophy, logic, language and terminology, work closely with more recent fields such as knowledge organisation and the pioneers of the new Internets. Else there is a danger not only that the wheel is re-invented, but also that the new wheels lacking in historical and cultural dimensions, will drive us to seeming solutions (in hardware and software) which exclude the subtleties to which we are accustomed. All this might be enough for machine-machine communication, but we must remember that such “advances” only truly help us if they ultimately improve communication among humans. If machines are extensions of man, of man’s needs, they must help and not hinder us, in our quest for wider, deeper horizons. Many persons think computers are merely translating our printed knowledge into a form that can be seen on monitors and screens. As we have shown, the process is much more profound. It is changing the very way we define all our relations: with each other, with machines and with everything that we associate with truth.

Appendix 1. Perreault's list of relations

Relation in general[53]	Alternation		
	Conjunction		
	Reciprocal		
	Converse		
	Negative		
Logical relation	Subsumptive	Type/Kind	Principle/Manifestation
			Genus/Species
			Species/Individuum
		Whole/Part	Organism/Organ
			Composite/ Constituent
			Matrix/Particles
		Subject/Property	Substance/Accident
			Possessor/Possession
			Accompanance
	Determinative	Active	Productive
			Causing
			Originating, Source
			Influencing, Environment
		Limitative	Restrictive
			Orienting, Establishing
			Frame of Reference,P.ofView
		Destructive	Injuring
			Suppressing, Eliminating
			Curing
		Interactive	Concordant
			Differing
			Contrary
		Passive	Produced
			Limited
			Destroyed
	Ordinal	Conditional	State
			Attitude
			Energy
		Comparative	Degree
			Size

	Duration
	Identical
	Similar, Analogous
	Dissimilar
Positional	Figurative
	Spatial
	Temporal
	Toward
	At
	Away

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Notes

[1] See Vannevar Bush, "As we may think," Atlantic Monthly, July 1945.
Cf. http://www.theatlantic.com/unbound/flashbks/computer/bushf.htm.

[2] Cf. http://kk.ucsb.edu/culler/engelbart.html.

[3] Cf. http://www.sfc.keio.ac.jp/~ted/.

[4] See: http://www.w3.org/Talks/1999/05/www8-tbl/slide1-0.html.

[5] A full history of this subject would reveal a surprising continuity underlying the many claims to revolutionary innovation. For instance the Greeks and Romans (c. 600 BC-320 AD) introduced the idea of ontological structure (philosophy), structure in language (grammar), logic in language (dialectic) and effects of language (rhetoric). During the Middle Ages and throughout the Renaissance and much of the Enlightenment (301 – 1799) these remained as philosophy and the trivium (grammar, dialectic and rhetoric). The past two centuries have seen quibbles as to whether philosophy can be reduced to logic and thus serve as an ontological standard for everything or whether one needs to distinguish between mathematical logic, verbal logic and perhaps description logics. There have been attempts to banish grammar and re-invent its principles using names such as linguistics and structuralism. Similarly rhetoric may now appear under new names such as rhetorical structure theory or reception theory, but is still concerned with the effects of language. Sadly many linguists remain unaware of landmark books such as Karl Bühler's, *Sprachtheorie. Die Darstellungsfunktion der Sprache* (1934).
cf. http://www.kowi.uni-essen.de/koloss/themen/buehler/010010001001.htm) or, the work of his student, Montague of Montague Grammar fame. See, for instance, the *Handbook of Logic and Language*, 1996.
See: http://www.elesevier.nl/homepage/sac/hll/contch1.htm).

[6] See, for instance, the Global Info project of the Deutsche Forschungs Gemeinschaft (DFG).

[7] Cf the website of the Maastricht McLuhan Institute.
See: http://www.mmi.unimaas.nl under Research and External.

[8] These are the levels introduced by the Joint Picture Expert Group (JPEG).

[9] For a useful introduction to this theme see E. R. Sukiasyan, "Classification Systems in Their Historical Development: Problems of Typology and Terminology," *Structures and Relations in Knowledge Organization, Proceedings of the Fifth International ISKO Conference 25-29 August 1998*, Würzburg: Ergon Verlag, 1998, pp. 72-79.

[10] Eugen Wüster, *Einführung in die Allgemeine Terminologielehre und Terminologische Lexikographie*, Wien, New York: Springer, 1979.

[11] See, for instance, Ingetraut Dahlberg, "A referent oriented, analytical concept theory for Interconcept," *International Classification*, vol. 5, 1978, no. 3, pp. 142-151. See also ibid., Conceptual definitions for Interconcept," *International Classification*, vol. 8, 1981, no. 1, pp. 16-22.

[12] See "Towards a Global Vision of Meta-data: A Digital Reference Room,"*Proceedings of the 2nd International Conference. Cultural Heritage Networks Hypermedia*, Milan: Politecnico di Milano, 1999, pp. 199-209; "Digital Reference Rooms: Access to Historical and Cultural Dimensions of Knowledge,"*INET '99 Conference, San Jose*, 1999, (in press).

[13] See Gerhard Budin, *Wissensorganisation und Terminologie*, Tübingen: Gunter Narr Verlag, 1996. (*Forum für Sprachforschung*, Bd. 28).

[14] Michel Foucault, *The Archaeology of Knowledge and The Discourse on Language*. New York, Harper & Row 1972.

[15] Cf. Walter J. Ong, *Ramus, Method and the Decay of Dialogue*. Cambridge, Mass.: Harvard University Press, 1958.

[16] See Ingetraut Dahlberg, "Die gegenstandsbezogene, analytische Begriffstheorie und ihre Definitionen," *Beiträge zur Begriffsanalyse*, Hrsg. B. Ganter, R. Wille, K. E. Wolff, Mannheim: B-I Wissenschaftsverlag, 1986, pp. 9-22, particularly, p. 10 (translation by author):

> A concept is a knowledge unit which arises when significant and verifiable claims are made about a referent and for the purpose of communication these are summarized in a short and meaningful way in the form of a term (a name or a code).

[17] See: http://www.km.org/

[18] See: http://kmn.cibit.nl/nl/km.html

[19] Similarly, Dutch science education tends to emphasize practical experiments, whereas Belgian science education is more theoretical, as is also the case with French and German science.

[20] Cf. Ingetraut Dahlberg, *Ontical Structures and Universal Classification*, Bangalore: S. Ranganathan Endowment for Library Science, 1978, pp. X, 1-64. Ingetraut Dahlberg *Grundlagen universaler Wissensordnung*, Pullach bei München: Verlag Dokumentation, 1974, p. 104.

[21] Gerhard Budin, *Wissensorganisation und Terminologie*, as in note 11 above.

[22] Benjamin R. Barber, *Jihad vs. McWorld*, New York: Random House, 1995.

[23] *The Compact Edition of the Oxford English Dictionary. Complete Text Reproduced Micrographically*, Oxford: Oxford University Press, 1981.

[24] See: http://mu.www.media.mit.edu/wordnet.html. Cf. the rise of numerous corpora. See: http://www.psyc.memphis.edu/POL/POL.htm#files.

[25] See: http://www.let.uva.nl/~ewn/

[26] This has led pioneers such as Fred Brooks (University of North Carolina, Chapel Hill) to emphasize the need for Intelligence Augmentation, IA rather than AI.
[27] See: http://plato.stanford.edu/entries/cognitive-science/#His
[28] Cf. L. Bertalanffy, *General Systems Theory: Foundations, Development, Applications*, New York: Braziller, 1969. Some of the leading universities in this field include Berkeley, Groningen, Harvard, MIT, Padua, Paris, and Stanford.
[29] See, for instance, *Classification Systems and Thesauri*, 1950-1982, Frankfurt: Indeks Verlag, 1982, *International Classification and Indexing Bibliography* (ICIB 1).
[30] See: http://www.williams.edu/library/ejournals/descriptions/clad.html
[31] This is quite distinct, of course, from the debates about Internet II, a new high speed version of the Internet being introduced in select universities throughout the United States. That second Internet raises some important questions about universal accessibility which are important and yet less fundamental than those which concern us here.
[32] Lurking here is an interesting philosophical question: can machines communicate? Or to put it differently, can communication be reduced to a set of logical principles? It is true that logical principles provide us with clues concerning each other's intentions, and yet is not communication ultimately something that transcends these rules when we feel that the other person understands what we intend rather than grasps what we say?
[33] Robert Fugmann, *Subject Analysis and Indexing. Theroetical Foundation and Practical Advice*, Frankfurt: Indeks Verlag, 1993. (Textbooks for Knowledge Organization, vol. 1).
[34] Thijs Chanovski at the Dutch Media Lab (Schellinghout), who was one of the pioneers of the CD ROM, for instance, has recently developed the Aqua Browser, which uses fuzzy logic as a means of determining associations among words.
[35] It is important to recognize that both sides have flaws in their arguments. Those on the side of fuzzy logic criticize the rigour of classifications and indexes on the grounds that these require a great amount of prior knowledge. This may be true, but their corollary claim that fuzzy results require no prior knowledge is misleading. A fuzzy search will produce many words, which may appear related but are not strictly connected with the topic at hand. Unless I have some prior knowledge of the field every suggested term will be equally attractive and I will find myself going down a set of blind alleys.

Similarly there are problems on the indexing side. When pressed, theorists of indexing such as Fugmann, inevitably make a basic distinction between simple names (persons/subjects) and processes, noting that human indexing is required for the latter. This overlooks the enormity that could be achieved through a systematic access to names of persons and subjects through the use of authority lists.
[36] Ingetraut Dahlberg, *Grundlagen universaler Wissensordnung*, Pullach bei München: Verlag Dokumentation, 1974, p. 104.
[37] Dahlberg, *Grundlagen*, as in note 36 above, p. 262.
[38] Alternatively this is called generic.
[39] In the library world the less technical term for this relation is Broader-Narrower.
[40] Some of these views are based on the limitations of technology a generation ago when storage space, speed and also the potentials of neural networks imposed very different constraints than today. Here it is vital to look ahead to what will be possible a generation from now.
[41] In future, the combinations of terms in classification systems, thesauri and dictionaries will offer possibilities, which were impossible even a generation ago. Instead of simply

attempting to collate every use of a term in the manner of the first electronic concordances, an agent could check the use of a term against definitions in dictionaries of a corresponding level of specialisation and with the aid of neural networks check this against the context of the term as used in the book in order to suggest –and one day— provide an appropriate term for the index.

[42] In library science the first two of these distinctions are typically called hierarchy, although at least one American scholar terms them as Typonomy and Hieronomy respectively.

[43] For instance, in *Grundlagen universaler Wissensordnung* (as in note 36, pp. 103-104) Dahlberg distinguishes between:

1) Relations among subject concepts
Form characteristic: to be an object

Type	Kind (German: Gattung-Art).
Whole	Part
Object	Make Up, Components (German: Gegenstand-Austattung)

2) Relations among form concepts
Form characteristic: to be a process

Action	Result
Cause	Effect
Process	Characteristics of Process, Process Moments

3) Relations between form and subject concepts

To be dealt with	Someone who deals with
Action	Means of Action
Action	Use of Action

4) Relations between subject and form concepts

Carrier	Characteristic
Object	Function
Object	Position in Dimension (Lage)

Further relations through common possession of characteristics in relation

Identity	identical characteristics
Equivalence	equivalent " "
Analogy	similar " "
Negation	opposite " " etc.

She also notes how combinations of being characteristics and form characteristics generate three kinds of concepts: subject, form and relation concepts:

Being Characteristic	Form Characteristic
Being Concept	Form Concept
Subject Concept	

Form Characteristic Form Characteristic
Form Concept Form Concept
Form Concept

Form Characteristic Form Characteristic
Form Concept Form Concept
Relation Concept.

Dahlberg also notes how combinations of being characteristics and form characteristics generate three kinds of concepts: subject, form and relation concepts. She distinguishes between:

a) subject categories which contain subject concepts
b) form categories which contain subjects concepts
c) form categories which contain form concepts.

[44] Cf. Peter P.S. Chen, "The Entity-Relationship Model: Towards a Unified View of Data," *ACM Transactions on Database Systems*, 1 (1), 1976, pp. 9-37. According to F. Miksa (personal communication), this system was further developed while Chen was a professor of computer science at Louisiana State University in 1980.

[45] "As facets those characteristics are taken up which belong to a given field of knowledge which can be seen as specific for the conceptual ordering. All other classification systems set out from subject categories, i.e. from subjects, which name disciplines. They develop their mostly mono-hierarchical concept orderings such that the lower order concepts are not expressively derived from form categories and yet… are less flexibly constituted for combinations of concept combinations." (*Grundlagen*, as in note 36, pp. 106-107, translation by author).

[46] Dahlberg, *Grundlagen*, as in note 36, p. 107.

[47] For an introduction to this theme see "Frontiers in Conceptual Navigation," *Herausforderungen an die Wissensorganisation: Visualisierung, multimediale Dokumente, Internetstrukturen, 5. Tagung der Deutschen Sektion der Internationalen Gesellschaft für Wissensoganisation*, Berlin, October 1997, Hrsg. H. Czap, H. P. Ohly, S. Pribbenow, Würzburg: Ergon Verlag, 1998, pp. 129-139. The proceedings contain an abstract which appears in its full form in *Knowledge Organization*, vol. 24, no. 4, 1997, pp. 225-245. These themes are further explored in *Frontiers in Conceptual Navigation for Cultural Heritage*, Toronto: Ontario Library Association, 1999 (in press).

[48] On further consequences of constructivism see: David H. Jonassen, Rose M. Marra, "Concept Mapping and Other Formalisms as Mindtools for Representing Knowledge":
See: http://www.icbl.hw.ac.uk/~granum/class/altdocs/dav_alt.htm

[49] Cf, for instance a site at the University of Denver.
See: http://www.cudenver.edu/~mryder/itc_data/theory.html;
cf. another site at the University of Calgary:
See: http://www.acs.ucalgary.ca/~kmchitre/index.htm;
cf also learning theories on the Web at Augustana College:
See: http://inst.augie.edu/~hanavan/media/theories.htm.

[50] Ths topic has become a cause célèbre in Germany and Austraia thanks to a book: Hans Peter Martin, Harald Schumann, *Die Globalisierungsfalle. Der Angriff auf Demokratie und Wohlstand*. Reinbek bei Hamburg: Rowohlt, 1996. Cf. Horst Afheldt, *Wohlstand Für niemand? Die Marktwirtschaft entlässt ihre Kinder*, Munich: Kunstmann, 1994.

[51] See for instance the work of Professor Kristian Hammond at Northwestern University's Info Lab: http://cs-www.uchicago.edu/~kris/index.html. Cf. his "Redeeming Big Brother in the Information Age," *IUI 99, 1999 International Conference on Intelligent User Interfaces*, Redondo Beach, Los Angeles (New York published): ACM, 1999, pp. 181-182.

[52] In this context Australia has introduced a series of nine principles which have had an international influence on the world of advertising:

1.Isolate basic human needs
2. Preach to the converted.
3. Keep it simple.
4. Impact with a big idea.
5. Appeal to the heart not the head.
6. Give the ad a local tone of voice.
7. Make message sympathetic to the medium.
8. Create a powerful slogan.
9. Use elements that will bear endless repetition.

The Science Museum in Sydney has some fascinating illustrations of these principles.

[53] J. M. Perreault, "Categories and Relators", *Review of International Documentation*, vol. 32, 1964, no.4, pp.136-144. Reprint with amendments in *Knowledge Organisation*, vol. 21, 1994, no. 4, pp.189-198.