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Syntactic and Semantic Interoperability: New Approaches to Knowledge and the Semantic Web

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1. Introduction

At WWW7 (Brisbane, 1997), Tim Berners-Lee outlined his vision of a global reasoning web. At WWW 8 (Toronto, May 1998), he developed this into a vision of a semantic web, where one could search not just for isolated words, but for meaning in the form of logically provable claims. In the past four years this vision has spread with amazing speed. The semantic web has been adopted by the European Commission as one of the important goals of the Sixth Framework Programme. In the United States it has become linked with the Defense Advanced Research Projects Agency (DARPA).

While this quest to achieve a semantic web is new, the quest for meaning in language has a history that is almost as old as language itself. Accordingly this paper opens with a survey of the historical background. The contributions of the Dublin Core are reviewed briefly. To achieve a semantic web requires both syntactic and semantic interoperability. These challenges are outlined. A basic contention of this paper is that semantic interoperability requires much more than a simple agreement concerning the static meaning of a term. Different levels of agreement (local, regional, national and international) are involved and these levels have their own history. Hence, one of the larger challenges is to create new systems of knowledge organization, which identify and connect these different levels.

With respect to meaning or semantics, early twentieth century pioneers such as Wüster were hopeful that it might be sufficient to limit oneself to isolated terms and words without reference to the larger grammatical context: to concept systems rather than to propositional logic. While a fascination with concept systems implicitly dominates many contemporary discussions, this paper suggests why this approach is not sufficient. The final section of this paper explores how an approach using propositional logic could lead to a new approach to universals and particulars. This points to a re-organization of knowledge, and opens the way for a vision of a semantic web with all the historical and cultural richness and complexity of language itself.

2. Historical Background

In the Western tradition, knowledge was subordinate to philosophy, which was concerned with understanding causes, why things happened, with concepts of truth, and hence inevitably with ontology, with questions of absolute being and essence. The Greeks formulated two seemingly opposed ways of arriving at these ultimate questions and answers. On the one hand, Plato began from the standpoint of an abstract world of ideas, a world of universals. On the other hand, Aristotle laid the foundations of another approach, which began from the particulars in order gradually to arrive at universals. Plato's deductive approach seemed opposed to Aristotle's inductive approach.

As Alfred North Whitehead[1] once pointed out, the whole of Western philosophy can be seen as a series of footnotes on Plato and Aristotle. Throughout the centuries there were great debates whether the way to knowledge was top-down (deductive) or bottom-up (inductive). To be sure, there were some who argued that knowledge was merely a rhetorical game (Sophists), some who doubted the criteria for truth (Stoics, Sceptics) and even some who denied the possibility of knowing anything (Nihilists). Nonetheless, the assumption that knowledge was ultimately ontological remained dominant.

As Foss[2] observed, Greek notions of knowledge and truth, because they were linked with final causes, were curiously related to a concept of perfection, which is closed, static and timeless. And as Auerbach[3] claimed, this Greco-Roman approach was fundamentally different than the open, dynamic, temporal dimensions of the Judaeo-Christian tradition.

In the field of language, the Greeks laid the foundations for what became a threefold distinction between structure (grammar), logic (dialectic) and effects of language (rhetoric). This was later codified as the *trivium* and along with the *quadrivium* (arithmetic, geometry, music and astronomy), became known as the seven liberal arts. This framework continued throughout the Renaissance (1400-1600), the Enlightenment, and well into the nineteenth century. Granted that, as Koyré[4] noted, there was a shift from a closed Ptolemaic universe to an open, potentially infinite, Copernican universe, but the idea remained of an underlying cosmological unity, which was ontologically valid. Until the third and fourth decades of the nineteenth century, it still seemed possible to thinkers such as Paley that one could have a *Natural Theology*, whereby the truths of the natural, physical world provided proof of a metaphysical world: science was a way to prove religion.

As early as the 1140s, the Latin West adopted a new approach to other religions. Abbot Suger (St. Denis) was against Islam. But instead of simply fighting the so-called infidels, Suger decided to have the *Koran* translated into Latin. Hereby, understanding of the other, implicitly became a pre-requisite for disagreeing with the other. In the centuries that followed, the Christian West continued to learn about other religions: Hebrew, Chaldaean, Zoroastrian etc. By the nineteenth century, this led to some subtle, but fundamental shifts. For instance, Max Müller's monumental *Sacred Books of the East* definitively challenged the idea that there was necessarily a unique, religious system. By implication, there was no longer a single ontology, which could be linked with a single religion and summoned to explain everything.

Meanwhile, history, which had largely been a field of chronicling lists of major events along a time line, emerged as a discipline unto itself. Ironically as history became a separate field, the idea that every field could have its own history slowly emerged. Thus, the rise of a critical (Niebuhr) and universal (von Ranke) history[5] went hand in hand with a philosophy of history[6] and the rise of disciplines such as the history of art, history of science, history of music, history of architecture, the history of language, etc. Once subjects had a history, they also developed their own cycles, and developments. Organic metaphors[7] of growth and decay gave way to new images of evolution (Comte, Darwin), development, and the idea of progress.

In the case of language, the introduction of history took many forms. At the level of individual words, it led to the field of etymology. In a crude sense, this field had existed since the time of Isidore of Seville[8] (590-636) and had been brought to a certain level through Coles[9] in the seventeenth century and the *Accademia della Crusca* in the eighteenth century. Nonetheless, the nineteenth century contributions of the Brothers Grimm (Germany),[10] Gaudefroy,[11] Larousse (France); Trench[12] and Murray[13] (England) provided a new basis for dictionaries. It is noteworthy, for instance, that The *Oxford English Dictionary* (OED) was initially called *A New English Dictionary based on Historical Principles.*

In the traditional *trivium*, grammar provided the structure of language or its syntax. Dialectics provided the logic underlying that structure. Once words were recognized as having a history, structure and logic were no longer enough. It is no co-incidence, therefore, that the same half century (1850-1900), which introduced etymology as a serious field, also introduced the field of semantics, the so-called science of meaning.[14] According to the *Oxford English Dictionary*, semantics was first defined by Martineau (1887) as: "that branch of philology which deals with the meanings of words, sense development and the like." Bloomfield defined semantics (1895) as "relating to signification or meaning."[15] A first book in English on the subject, translated from the French, was published by Michel Bréal (1900).[16]

The rise of linguistics, introduced a distinction between syntax (i.e. form, structure) and semantics (i.e. meaning). Now a given word could have one or more meanings. Parallel with these developments in philology, was a rise of new cataloguing and classification systems. Here again there was implicitly a distinction between a given field, element or container, its structures (cataloguing rules) and the meaning of the contents within these fields.

The early pioneers of these cataloguing rules, classification systems and thesauri, were sometimes pragmatic (e.g. Dewey, Cutter), but often continued a quest for an ontological solution (e.g. Otlet, LaFontaine, Ranganathan, Wüster, Diemer, Dahlberg). There was an assumption that if only one made a sufficient effort, one could arrive at the ontological meaning of a term. Authors on semantics (Ogden[17]) and semiotics (e.g. Eco[18]) explored the potentials of conceptual triangles.

From this grew a series of organizations, the Mundaneum, the International Union of Associations (UIA), the International Federation of Documentation (FID) and the International Standards Organization (ISO) with its Technical Committees (TC 37, 46). For a while, it seemed as if the international was the key to the universally valid

Entities	Activities	Dimensions
Subsumptive Relations	Determinative Relations	Ordinal Relations
Type/Kind	Active	Conditional
Whole/Part	Limitative	Comparative
Subject/Property	Destructive	Positional
	Interactive	
	Passive	

Figure 1. Entities, activities and dimensions, which link with Perrault's subsumptive, determinative and ordinal relations.

and ultimately the way to maintain the ontologically true. As the quest for international standards expanded in scope, the quest for a science of meaning became more complex. The German schools of philosophy (e.g. Frege, Husserl, Cassirer, Hönigswald,[19] Carnap and Wittgenstein -- whose ideas further evolved when he went to Britain) and the English schools (Russell, Ogden), pointed to myriad difficulties. Semantics remained a significant topic in philosophy and philosophy of science (e.g. Quine,[20] Putnam[21], Kripke[22]).

The second half of the twentieth century (1950-2000) also brought another series of subtle but fundamental shifts. First, in the 1970s, semantics also emerged as a key discipline in linguistics (Lyons23). This brought new hope in the quest for a science of meaning. Second. in terms of the conceptual triangle, Dahlberg noted that changing relations among its three elements determine the kind of definition. Hence, a definition can be ostensive, nominal or real. This pointed to a need to re-organize our dictionaries in terms of these different levels of definitions – a challenge, which has yet to be met. Third, although the term ontology underwent a certain revival in terms of popularity, its meaning in everyday usage shifted from something absolutely true, to something generally accepted and negotiated. Fourth, it became clear that only specific domains readily lent themselves to such negotiation. For instance, in domains such as physics or Medical Subject Headings (MESH), it was necessary, albeit often difficult, to achieve internationally agreed upon definitions of terms. In other domains, agreement might only be possible at a national, regional or local level. In rare cases even less was feasible.

In the case of syntax, there were many more problems than originally foreseen. While classification systems such as the Dewey Decimal Classification (DDC), Universal Decimal Classification (UDC), Bliss, Riders International and Colon Classification (Ranganathan), claimed to be international and universal in their scope, none of these could claim to be ontologically true.[24] Rather than being based on clear intellectual principles, their categories were largely pragmatic, with a bricolage of different methods. They did not entail a systematic use of relations in the sense later defined by Perrault[25] (figure 1).

By implication, no single system could handle all the world's needs. Even in specific domains such as art history, a specialised classification such as *Iconclass*, which aimed to be universal, had a heavy bias towards Western art, and was more biased towards the Protestant North than the Catholic South. At the national level, Canada, France, Russia and others produced their own attempts at categories, which aimed at universality. At the regional and local levels there were a myriad other alternative versions.

A similar phenomenon emerged in terms of library catalogue rules. When the idea of Machine Readable Cataloging (MARC) became popular, there were soon different approaches in various countries: e.g. the United States (US MARC), differed from Australia (AUS MARC), Britain (UK MARC) and Canada (CAN MARC). Admittedly there are renewed attempts at a Unified MARC (UNIMARC) system, but even so something as seemingly straightforward as the fields of a library catalogue still eludes a single, international, universal, solution. In addition to the many flavours of MARC there were various alternative methods such as *Maschinelles Austausch Format* (*MAB*) and PICA.[26] Not only were there differences in the amount of detail covered by these competing systems, there were frequently different terms for the same category. For instance, the field for *Author* in one system, might be *Name* in a second system and *Creator* in another system. Even without clear criteria to assure the intellectual superiority of any given system, a certain imperialism of classification and catalogue methods and systems continued.

The advent of the Internet, which brought into play millions of new users without any training in cataloguing, indexing and classification, made these problems much more acute. For there were now clearly two distinct languages: the disciplined use by a small elite who had learned the principles of indexing, classing, knowledge organization and knowledge management; then the undisciplined use by a great majority who had no training and less inclination in these domains. There were those with a controlled grammar and those who often had no idea at all of grammar.

3. Dublin Core

The most important response to these new challenges of the Internet was the Dublin Core (Metadata Initiative), which was inspired in part by the vision of Yuri Rubinsky (1994) for a metadata semantics. This set out to identify a minimal set of universally applicable fields on which one could hope to gain international acceptance. These fifteen fields, known as the Dublin Core, went through a phase, which recalled the imperialist intentions of earlier efforts. Initially the Dublin Core was to be used for new web sites. Some assumed that the use of these fields could be extended to major collections in libraries, museums and archives. This is unrealistic given the much richer content description fields of MARC, PICA and other systems. Hence, instead of replacing the more comprehensive systems of memory institutions (libraries, museums and archives), the fifteen fields of Dublin Core served as a new kind of portal, a bridging device to connect otherwise heterogeneous resources.

This has led to a quest to match equivalent fields in different systems, which is alternatively called mapping, bridging, linking, creating crosswalks, walkthroughs or more generally interoperability which is at least a twofold problem:

1) interoperability of the fields or containers: i.e. we must agree that the field *Author* and *Name* are equivalent
2) interoperability of the meaning of the terms in those fields. To take a simple example: Qua containers/elements or fields we must decide that *Subject* and *Topic* are equivalent. Qua meaning of terms in the fields we need to agree that *car* and *automobile* are equivalent.

The initiators of the Dublin Core use semantics to refer to the definition (or meaning of the elements or fields). They focus on the containers rather than the contents of those fields. In this context, semantic interoperability becomes a question of "Content Description Standard (DC, AACR2, TEI, FGDC)." In the Dublin Core, structure becomes a way of presenting the meanings of fields in human readable or machine-readable form (e.g. RDF, which is seen as "a data model for specifying semantic [in the sense of meanings of fields] schemas"). The Dublin Core approaches this structure or syntax in terms of entity relationships, typically consisting of a noun linked with attributes.

In the Dublin Core one thus begins with semantics and goes on to syntax, both of which emphasize the fields, elements, or containers of cataloguing or classification systems.[27] These are essential first steps. Lacking in the Dublin Core is a model, which takes into account cultural and historical dimensions of meaning of individual words. Hence, it is not designed to deal with either local variations or historical shifts in words. Lacking in the Dublin Core also, as we shall see later (in section 6), is a concept of knowledge, which goes beyond simple entity relationships. Protagonists of this system such as Thomas Baker have rightly pointed out that this results in an electronic equivalent of pidgin English.[28] Traditionally “pidgin” was used only by those at the margins of civilization who had not mastered the niceties of a foreign tongue. Now there is a danger that a marginal solution becomes seen as a core solution. Since the Dublin Core is becoming an important element in the larger Resource Description Framework (RDF) of the W3 Consortium this deserves careful attention.

4. Syntactic Interoperability

In the Dublin Core, syntax is reduced to arrangements of single terms in the form of entity relationships using triples. In this context, syntax is defined as "grammars to convey semantics and structure" (e. g. "XML, which is seen as a markup idiom for structured data on the web).[29] This solution is ideal in the case of obvious truths: e.g. Creator (John Doe) (has an) Address (26 Maple Street, Portand, Oregon). It is not designed to deal with cases where there may be conflicting claims: e.g. the claims of Russia, Germany and Poland about the boundaries of Poland. Nor is it designed to deal with matters of interpretation. The Dublin Core is limited to entity relationships which are subsumptive relationships. It does not always distinguish between type/kind and whole/part.[30] It does not deal with determinative or ordinal relations (figure 1). As we shall see these are limitations of concept systems.

In traditional grammar, syntax is the “arrangement of words (in their appropriate forms) by which their connexion and relation in a sentence are shown” or “the department of grammar which deals with the established usages of grammatical construction and the rules deduced therefrom” (Oxford English Dictionary). Syntax in the traditional sense is about the structure of sentences rather than just isolated terms combined as triples (x is a /has a y). Hence, with syntax in the traditional sense, the challenges of syntactic interoperability become: a) identifying all the elements in various systems; b) establishing rules for structuring these elements; b) mapping, bridging, creating crosswalks between equivalent elements using schemas etc.; c) agreeing on equivalent rules to bridge different cataloguing and registry systems.

These steps to syntactic interoperability are theoretically objective, although there are ultimately subjective dimensions in each cataloguer's interpretation of the rules. A challenge lies in co-ordinating local, regional, national and international levels. One way of doing so is through virtual reference rooms,[31] where resources such as classification systems, thesauri, dictionaries, catalogues and the like can be integrated. Using such centralized reference materials one can arrive at authority files which make possible access to distributed, heterogeneous databases. A 5th framework IST programme, IMASS[32], is exploring this new approach. A full treatment of syntactic interoperability will require more than the structured fields of Dublin Core or Library Catalogue tools and Resource Description Aids such as MARC or PICA. It will require a number of levels of detail including: transfer protocols; resource numbering; rights management; resource finding aids and tools; resource description and full-content description.

4. Semantic Interoperability

Semantics is defined as the meanings of terms and expressions. Hence semantic interoperability is "the ability of information systems to exchange information on the basis of shared, pre-established and negotiated meanings of terms and expressions," and is needed in order to make other types of interoperability work (syntactic, cross-cultural, international etc.)

Semantic interoperability entails a co-ordination of meaning. In the latter 19th century, there emerged a vision that it was possible to determine a single, absolute meaning. This inspired initiatives such as the International Federation for Information and Documentation (FID, 1895ff.) and the ISO Technical Committees (e.g. TC 37, 1936). Implicit in these initiatives was the assumption that problems of semantics could be solved in terms of universals, internationally, in a top down, deductive, way. The Dublin Core continues this tradition.[33] Because Dublin Core has a global agenda it focusses more on the universal meaning of the basic fields or elements (containers) than on the local and regional contents in those fields or elements.

In the sciences, and technology such an approach is often essential. For instance, modern chemistry requires a clear international definition of zinc, hydrogen, and other elements. Thus the meanings of terms and words need to be negotiated with a domain specific semantics at an international level (as in the case of ISO). This is equally true in medicine: We want the same definition of the aorta around the world if doctors in Berlin, Rio, Shanghai, Sydney, and Los Angeles all have to operate on the heart.

Science is concerned with defining formulae in chemistry and laws of physics, which apply globally. Science is concerned with regularities, rules without exceptions, universally the same. If there are national, regional or local variants, the laws are not valid and it is not science in the modern sense. Culture is concerned with exceptions to the rules and thus focusses, by contrast, on national, regional and local variants which are unique. If we use the methods of science in the realm of culture the result is McDonaldization, whereby everything becomes the same. Some persons in the United States may see this as an ideal worth pursuing. In Europe, Asia and the rest of the world it is generally agreed that something else is needed: that cultural diversity is as vital as bio-diversity. Places are interesting in direct proportion to their being different and this difference is one of the keys to tourism, which is also the most important

economic activity of all the G7 countries. Hence, if there were no differences, if everywhere was the same, the world would be a much poorer place economically also.

As long as localities remained isolated, each local village and town ensured that its own customs were saved, and perpetuated. The rise of printing made it possible to share customs over a large area using a common language. Hence printing introduced a new level of nationalism. The rise of radio and television introduced new levels of nationalism. Some assume that a global internet will produce imperialism in a new guise, a new kind of global state. If we aim solely at McDonaldization this could become a reality.

On the other hand, if the Internet is to become global in the sense of reflecting all the cultural diversity of the world and become more than the instrument of a given country, language, or ideology, it must reflect knowledge at all levels: locally, regionally, nationally and internationally. This has already begun to happen almost spontaneously. In 1995, the Internet was more than 95% English. By 2000 it was 50% English and there were 70 other major languages. In August 2001, it receded to 43% English. By 2005 it is due to become 25% English. Meanwhile, knowledge is being entered by individuals, villages, regions, national governments and international organizations. We need better methods to distinguish materials from these different levels.[34]

The Dublin Core has rightly stressed the need to agree internationally on the names of fields and elements when dealing on a global scale. This is an essential first step. A next step lies at the level of the content of those fields. Here we need to know at what level the meanings of a term have been negotiated: i.e. internationally (as in the case of ISO, ICOM, UNESCO etc.); nationally (as in the case of a national standards body); regionally or locally. In addition to formal terminology we need to know whether the meaning of a dictionary is international, national, regional or local.

At the national level there may be corpora, which are written and not formalized. At the local and regional level there may in addition be oral recorded materials (archived as tapes but not written) or even oral sources (which have not even been systematically archived). Semantic interoperability in this larger sense thus becomes a quest a) to identify these various levels and b) to make make users aware of these alternatives when databases are being searched (figure 2). Such an approach for culture goes beyond the homogenizing methods of science and will ensure the cultural diversity that is needed.

The quest for a single, universally applicable, semantic meaning, entailed an implicit hierarchy, whereby the local is quaint but unacceptable, the regional is a bit more organized, but still unacceptable; the national is one step better and ultimately only the international is fully acceptable. In other words: the international is rhetorically good, the local and regional are less interesting and rhetorically bad.

Such a quest for a single, universally valid, international meaning is thus opposed to national, regional and local particulars, which ultimately entail too many embarrassing details. This is excellent for scientific laws but disastrous for unique objects of culture and art.

1. Containers/	**Fields/Elements**	
	Meanings of Definitions of Fields	
2. Contents	**within the Containers/**	**Fields/Elements**
International	Terminological Meaning	Domain specific semantics where meanings of contents are negotiated worldwide (ISO).
	Dictionary Meaning	Formal Meaning
National	Terminological Meaning	Domain specific semantics where meanings of contents negotiated countrywide (NIST)
	Dictionary Meaning	Formal Meaning
	Corpus	Written not formalized
Regional	Terminological Meaning	Domain specific semantics where meanings of contents negotiated regionally
	Dictionary Meaning	Formal Meaning
	Corpus	Written not formalized
	Oral Recorded	Archived not written
Local	Terminological Meaning	Domain specific semantics where meanings of contents negotiated locally
	Dictionary Meaning	Formal Meaning
	Corpus	Written not formalized
	Oral Recorded	Archived not written
	Oral	Not systematically archived.

Figure 2. Different layers of semantic interoperability.

For this reason we propose an approach, which holds that particulars are every bit as important as the universals and requires only that one distinguish clearly between the two. This approach is an integration of the top down (deductive), Platonic tradition, with the bottom up, (inductive) Aristotelian tradition. In this context, a) the local, regional and national are as important as the international and the global; b) multi-lingualism and multi-culturalism are essential dimensions. A new challenge lies in relating these different levels. Our approach thus offers a method of going beyond the dichotomies between regional (jihad) and global (McWorld) as outlined by Barber. The local, regional and national now play a key role in conjunction with the international and the global.

5. Concept Systems versus Propositional Logic

Traditionally there have been debates as to where meaning lies. In the twentieth century, for instance, some claimed that individual words are enough. This led to the development of concept systems (*Begriffsystem*, e.g. Wüster). Others, claimed that semantics is not just about the meaning of individual terms and words but also about the meaning of statements, or propositional logic (*Aussagesystem*, e.g. Dahlberg). Here again there is a difference in approach between the Dublin Core and some approaches in Europe.

The initiators of the Dublin Core implicitly follow the tradition of concept systems and assume that meaning is limited to individual elements or fields. In this approach, the construction of sentences is reduced to simple entity relationships through triples: i.e. every term becomes the starting point for properties. This has four important consequences: 1) Sentences are reduced to *is a* and *has a* statements. 2) There is no way to distinguish between intransitive verbs or copulas (*is a*) and transitive verbs (*has a*). 3) Sentences are reduced to static statements about what something is and has without consideration of other relations: i.e. other aspects of subsumptive, determinative and ordinal, (cf. figure 1). 4) Sentences state what is assumed to be true but one has no means to make claims about their truth: i.e. they assume ontology without any mechanisms for testing, verifying the claims.

In traditional grammar and propositional logic, one begins with words or terms, which are then structured in sentences to become opinions or claims (cf. Latin *sententia*), which can be checked for their veridical value. At the simplest level[35] a sentence has a subject (noun), a verb and an object: John (noun, subject) mowed (verb) the lawn (noun, object). This can be reduced to the questions Who? did What? At a next level, adjectives, adverbs and subordinate clauses, provide further context about conditions by answering the questions When?, Where?, How? and Why? To develop the above example: "John mowed the lawn in his backyard quickly on Saturday afternoon because his wife told him that unexpected guests were coming for a barbecue that evening."

At a next level, one can report on the form of the statement: e.g. "The curious neighbour said that John mowed the lawn in his backyard quickly on Saturday afternoon because his wife told him that unexpected guests were coming for a barbecue that evening." At a next level one can record the general context of the claim: "In her telephone call to her aunt," or "In her weekly letter to her mother, the curious neighbour…." This approach can make statements assumed to be true, but can also formulate them such that their veracity is opened to question: "The curious neighbour suspected that John had not mowed the lawn because….."

In the traditional *trivium*, this analysis of language in terms of its structure (i.e. using subjects, verbs and objects), is called grammar. In Dahlberg's approach to knowledge organisation, this is called syntax. It is instructive to note the differences between syntax in the Dublin Core and in Dahlberg's sense. In the Dublin Core, syntax is restricted to claims about *is a* and *has a*; about Who is Who? and Who has What? In Dahlberg, syntax covers all six basic questions: Who?, What?, Where?, When?, How?, and Why? The Dublin Core makes statements, which are assumed to be true. It lends itself ideally to databases, with a tacit assumption that they only contain true information. Dahlberg's syntax involves statements which are claims about what happened and as such are open to being verified whether they are true or not. If I doubt what I hear via the neighbour, her mother, or aunt, then I can check whether John mowed the lawn and even ask John about why he did so.

The Dublin Core's syntax is aimed primarily at a minimal number of commonly accepted fields as found in databases. The syntax of traditional grammar, propositional logic and Dahlberg extends to the whole of human language. The Dublin Core focusses on the fields and containers. The syntax of traditional grammar includes containers and content. Both make a contribution and both are potentially

complementary. However, if one assumes that Dublin Core solves all the problems of syntax and semantics, then one has committed oneself to a very limited view of reality. Understanding the consequences of such choices becomes all the more important as the world commits itself to visions of a semantic web.

6. Information and Communication Technologies (ICT) and the Semantic Web

The quest to deal with knowledge electronically goes back more than half a century. One of the great pioneers in this domain was Claude E. Shannon (1916-2001) who worked at Bell Labs (now Lucent) and was later professor at MIT (Cambridge, Mass.). One of Shannon's[36] fundamental goals was to separate "the technical problem of delivering a message from understanding what a message means:"[37] to separate form from content. To this end he introduced the idea of **bi**nary uni**ts** or bits. By using bits, one could communicate words without worrying about their meanings.

In the second half of the twentieth century, the founders of computer science pursued Shannon's approach and redefined the terms, syntax and semantics. Computer syntax deals with format, i.e. the spelling of language components and the rules controlling how components are combined.[38] Computer semantics deals with the "meaning" of an instruction.[39] In a slightly different formulation, syntax "specifies the domain of all legal programs" and semantics "specifies the behavior of all legal programs."[40] In this approach, computer syntax is the computer language or code (which can be in a human readable form such as C++ or LISP or in machine-readable form as simple bits) and computer semantics relates to the actions, which the code sets in motion. This formulation reduced "meaning" to action.

As Grant Fjermedal, has noted in *The Tomorrow Makers* (1986) ,[41] one faction of the Artificial Intelligence (AI) community articulated a more radical goal: to create autonomous decision robots,[42] which could ultimately replace human beings in all decision making because:

> The necessary turnover in personnel you get in human-based systems, because of their very short lifetimes, seems to throw instability into the system. And the general diversity of human stock we have, in terms of different languages, cultures and interest is not something that can be smoothed out very quickly.[43]

Fjermedal notes that this has frightening implications for culture:

> The computer has thus begun to be an instrument for the destruction of history….For when society legitimates only those 'data' that are 'in one format' and that 'can easily be told to the machine' then history, memory itself, is annihilated….And the curious paradox is that the immortality of knowledge means the death of culture.[44]

This quest on behalf of some aspects of the military and of NASA, to create not just machine-readable code, but systems which can replace humans altogether,[45] helps to explain a growing commitment to a) natural language; b) so-called common sense worlds which were described by Jerry Hobbs and Robert Moore (1986);[46] c) the rise of artificial intelligence projects such as Doug Lenat's CYC (as in en-cyc-clopedia-);[47] Rodney Brook's Cog;[48] Generic Artificial Consciousness (GAC) and Common

Sense;[49] d) projects such as Word Net which assume that present usage alone can reveal meaning and e) the Defense Advanced Research Projects Agency's (DARPA) role in Knowledge Query Markup Language (KQML), Knowledge Interchange Format (KIF), DARPA Agent Modeling Language (DAML) and in the quest for a semantic web. Theoretically the concern is with syntax and semantics. In practice, if the underlying aim is to create robotic decision-making devices, there is no longer a need for the cultural and historical dimensions of human knowledge.

In the 1990s, companies such as Autodesk introduced a new vision into the world of Computer Aided Design (CAD) through the idea of Industry Foundation Classes (IFC). Instead of trying to draw each individual element independently the new quest was to develop architectural elements such as doors and windows, which are "intelligent": i.e. they "know" their inherent characteristics and adjust these to meet individual needs. Hence, the door for a skyscraper "knows" that it has to be more sturdy than for a one-storey cottage.

Inherent in this approach is an assumption that if one could only capture the generic, universal characteristics of a door, then one no longer needs to send all the details. One can be more efficient by sending the generic parameters of a door and then add individual characteristics as an extra. While very tempting, this approach overlooks one of the fundamental problems with all technological solutions, which aim at generic algorithms to capture universal characteristics of objects in order to do away with the bothersome details of particulars. Industry Foundation Classes may capture the basic characteristics of doors, but they can never show us the uniqueness of doors such those at Saint Zeno (Verona), St Michael (Hildesheim) or the Baptistery (Florence). Pure technologists see such examples as exceptions to the rule, which do not quite fit their mold. Meanwhile, historians of architecture and art insist that precisely because they are exceptional, these examples are more worthy of detailed study than the predictable archetypes.

In light of our earlier discussion, it is easy to see that the universal claims of the technologists and the particular claims of historians of art and architecture, are the old debates of Plato's deductive and Aristotle's inductive approach in a new guise. With the new media, a new synthesis is possible. In some cases, generic models may seem enough. But if one makes available the exceptions of particular examples also, then they can provide a stimulus for new creativity. The complementary role of Platonic universals and Aristotelian particulars thus becomes the basis for a new synthesis of art and science.

Grammar	Structure, Syntax[50]	Extensible Markup Language[51]	XML
Dialectic	Logic, Semantics	Resource Description Framework	RDF
Rhetoric	Effects, Style, Pragmatics[52]	Extensible Style Language	XSL
Geometry	Continuous Quantity	Mathematical Markup Language	MML
Arithmetic	Discrete Quantity	Mathematical Markup Language	MML
Astronomy	Applied Continuous Quantity	Astronomical Markup Language	AML
Music	Applied Discrete Quantity	Standardized Music Description Language	SMDL

Figure 3. The seven liberal arts (*trivium*, *quadrivium*) and their modern equivalents in electronic form.

In the past five years, Tim Berners Lee has articulated the vision of a semantic web, whereby one can separate rhyme from reason: i.e. the subjective dimensions of art and poetry from the objective dimensions of logic, which is one definition of science. At one level, this is a direct continuation of the vision, which inspired Shannon and grew out of the subject-object distinction that Cassirer[53] traced back to the Renaissance. In some senses it also goes back to the Greek debates about universals and particulars.

In terms of the *trivium*, Tim Berners Lee's emphasis on the logic of language reflects the concerns of dialectic in Antiquity. In the vision of Tim Berners Lee,[54] there is a great emphasis on distinguishing the basic structure of content from the various forms in which it is expressed. In the *trivium*, this is the distinction between grammar (the structure of language) and rhetoric (the effects of language). There is corresponding attention to the *quadrivium.* Optimists will note that the makers of the World Wide Web (W3) Consortium are addressing all the questions of the ancient *trivium* and *quadrivium* such that all the potentials of the traditional seven liberal arts are becoming available in electronic form (figure 3). At the same time there is a danger in being too easily satisfied. The *trivium* and *quadrivium* have grown out of oral, manuscript and print culture. As McLuhan[55] showed, print culture imposed a static, linear form on all codified knowledge.

The approaches of the Dublin Core, the Defense Advanced Research Program's Agent Markup Language (DAML), topic maps,[56] and many aspects of the Resource Description Framework (RDF) are ironically still in terms of the static modalities of print culture. They are codifying in electronic form the methods of an earlier technology rather than bringing into focus the emerging potentials of a new technology.

The multi-medial and multi-modal world of ICT potentially opens up new horizons in terms of dynamic knowledge. Instead of static lists in printed books, we can now have dynamic lists, which show how they evolve over time. Instead of static definitions of words and concepts as in printed dictionaries, the Wordnet project or even the Cyc project, we need dynamic definitions, which change culturally and historically.[57] Instead of static maps of printed atlases, we could have a new dynamic, cartography, which shows how boundaries change over time and even how they change depending on one's political and cultural views: Poland's maps of their boundaries do not always correspond to Germany's maps of Poland's boundaries, or Russia's maps of Poland's boundaries.

Truth is about sources and about the contexts of sources. Making digital versions of analogue objects opens many possibilities. It also opens many dangers if we are not very careful in developing methods, which take us back to the originals; unless we have methods, which allow us to reconstruct the originals with all possible fidelity. As Mitchell[58] has noted, in an electronic world, editing is all too easy, and yet paradoxically our methods for documenting editing are still surprisingly primitive by comparison. We really need at least three levels: 1) databases of our digital copies; 2) databases which record the parameters under which we copied and 3) databases which make explicit the methods used in making those copies. Too often we assume that the future of digital culture is only about scanning in our analogue past. It is equally about developing new methodologies in order to ensure that we know how what we are seeing relates to the originals. None of our present databases are equipped to deal with

these complexities. Most of our teachers are not even aware of the potentials and yet we want to have students prepared for tomorrow's complex, emerging possibilities. Too many are focussed on developing new tools while unaware that the underlying methods need to be completely re-considered, re-defined.

Fortunately, a new vision of an e-Europe[59] foresees the development of a European Research Area (ERA), with a broadband network of centres of excellence linking researchers. Such centres are obviously essential in fields such as high-energy physics, aerospace, automobiles, biotechnology and nano-technology. To achieve an e-Europe in a deeper sense, an e-knowledge society, we need such centres for e-meta-data, e-epistemology, e-knowledge (cf. the German: *e-Erkenntnis*) and e-culture. New centres such as the International Institute of Infonomics (IIoI)[60] and Maastricht McLuhan Institute (MMI) are already exploring these issues under headings such as e-basics and e-content. They need to be linked in a broadband, European network of centres of excellence to ensure that Europe's multi-lingual, multi-cultural richness is maintained and further developed. Our vision of a future, which integrates global standards with local and regional diversity (rather than opposing them as in Barber[61]), is a key to cultural diversity, which is as vital as bio-diversity.

The quest for a semantic web is a noble quest. We must be careful, however, in defining semantics. Tim Berners Lee has rightly noted that it is easier to record the reason (logic, science) than the rhyme (art, poetry). It would be a great mistake however, if the World Wide Web focussed only on the objective and attempted to exclude the subjective. The new horizons of ICT are neither limited to Platonic universals or Aristotelian particulars. They offer a new synthesis for both. They offer an integration of multiple viewpoints, of bringing to light the value of the local, regional, national and the international. As such they offer us not just a digital version of old knowledge, but rather possibilities for new approaches to knowledge at a series of different levels.

A half-century ago, the pioneers of ICT, often simplified processes in order to arrive at practical solutions more quickly. This was entirely reasonable. Since then the potential speed and capacity of the technology has expanded incredibly. We must be very careful to not let ourselves be limited by technical constraints of yesteryear as we try to develop our visions of tomorrow. Ted Nelson has pointed out that technologists sometimes present their political decisions, e.g. portals, or even their lack of vision, as somehow being defined by the constraints of technology.

The semantic web can become many things. Semantics in the computer science sense equates meaning with instructions (i.e. code which initiates operations), and thus reduces meaning to action(s). This may suffice for military operations but is too limiting with respect to culture. There is very little action in the Reading Room of the British Library or the Vatican and yet there is much meaning there. The early makers of the network often became so concerned about their pipelines and containers that they often forgot about the contents. They focussed on an information highway rather than on knowledge or wisdom, without a vision of where to go, where to stay, or why. If we follow the new possibilities of syntactic and semantic interoperability outlined in this paper, there is a richer future ahead, as semantically rich as human language and experience, as potentially infinite as the near boundless dimensions of our imagination, our hopes, and aspirations. This is the semantic web which we need.[62]

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Notes

[1] Alfred North Whitehead, *Adventures of ideas*, New York: The Macmillan Company, 1933.

[2] Martin Foss, *The Idea of Perfection in the Western World*, Lincoln: University of Nebraska Press, 1946 (Bison Book).

[3] Erich Auerbach, *Mimesis, The Representation of reality in Western Literature*, Translated from the German by Willard R. Trask, Princeton: Princeton University Press, 1953. Original published Berne: A. Francke Ltd, 1942-1945.

[4] Alexandre Koyre, *From the Closed World to the Infinite Universe*, New York: Harper and Row, 1958.

[5] *Theories of History*, ed. Patrick Gardiner, New York: Free Press, 1959*; The Varieties of History from Voltaire to the Present*, ed. Fritz Stern, Cleveland: World Publishing Company, 1956. George Grant, *Time as History*, Toronto: Canadian Broadcasting Company, 1969 (The Massey Lectures).

[6] Georg Wilhelm Friedrich Hegel, *The Philosophy of History*, New York: Dover, 1956. Based on lectures in Berlin 1831-1832. ,

[7] Alexander Demandt, *Metaphern für Geschichte. Sprachbilder und Gleichnisse im historisch-politischen Denken*, Munich: Verlag C.H. Beck, 1978.

[8] Isidore, of Seville, Saint, *Etymologiarum sive originum, libri 20;* recognovit brevique adnotatione critica instruxit W.M. Lindsay, Oxonii: E Typographeo Clarendoniano, [c1911].

[9] Elisha Coles, *An English dictionary; explaining the difficult terms that are used in divinity, husbandry, physik, philosophy, law, navigation mathematics, and other arts and sciences; containing many thousands of hard words (and proper names of places) more than are in any other English dictionary or expositor; together with the etymological derivation of them from their proper fountains, whether Hebrew, Greek, Latin, French, or any other language*, London: Parker, 1692.

[10] Jakob Grimm, Wilhelm Grimm, *Deutsches Wörterbuch*; Fortgesetzt und bearbeitet von Moriz Heyne, Rudolf Hildebrand, Karl Weigand ... [et al.], Leipzig: S. Hirzel, 1854-1960. 16 v. in 32.

[11] Frédéric Godefroy, *Dictionnnaire de l'ancienne langue française: et de tous ses dialectes du IXe au XVe siècle, composé d'après le dépouillement de tous les plus importants documents, manuscrits ou imprimés, qui se trouvent dans les grands*

bibliothèques de la France et de l'Europe, et dans les principales archives départementales, municipales, hospitalières ou privées, Paris: F. Vieweg, 1881-1902.

[12] Richard Chenevix Trench, *A select glossary of English words used formerly in senses different from their present*, London: Macmillan, 1865. 3rd ed. rev. & improved.

[13] Sir James Augustus Henry Murray, *A new English dictionary on historical principles : founded mainly on the materials collected by the Philological Society; with the assistance of many scholars and men of science.* Oxford: At the Clarendon Press, 1888-1933.

[14] In some senses, of course, the roots of meaning go back to the origins of language. Certainly, in the Jewish tradition an integral part of the Talmud was that there were words, which constantly had to be interpreted anew by Rabbinic scholars. In the Christian tradition, the notion of exegesis, of writing commentaries and glossa, was also an integral dimension. There were static words, which were dynamically interpreted. In both the Jewish and Christian traditions a given word could be interpreted to mean a, than b, and c and subsequently a again. The tradition of interpretation allowed many meanings but it did not pretend that the meanings could be fixed rules and by knowledge of historical developments.

[15] Bloomfield, *American Journal of Philology*, 1895 as cited in the Oxford English Dictionary.

[16] Michel Jules Alfred Bréal, *Semantics; studies in the science of meaning*, translated by Mrs Henry Cust from the French*: Essai de sémantique*, London, W. Heinemann, 1900. Reprint: Michel Bréal, *Semantics: studies in the science of meaning*, Translated by Mrs. Henry Cust. With a new introd. by Joshua Whatmough, New York: Dover Publications [1964]. Michel Bréal, *Essai de sémantique: science des significations*. Genève: Slatkine Reprints, 1976.

[17] Charles Kay Ogden, *The meaning of meaning; a study of the influence of language upon thought and of the science of symbolism*, London: K. Paul, Trench, Trubner, 1923.

[18] Umberto Eco, *La struttura assente*, Milano: Bompiani, 1968. German: *Einführug in die Semiotik*, München: 1972); Ibid., *Il segno*, 1973 Milano: Isedi. German: *Zeichen. Einführung in einen Begriff und seine Geschichte*. Frankfurt a.M.: 1977; Ibid., *A Theory of Semiotics*, Bloomington: Indiana U.P., and London: Macmillan, 1977.

[19] Christian Bermes, *Philosophie der Bedeutung: Bedeutung als Bestimmung und Bestimmbarkeit: eine Studie zu Frege, Husserl, Cassirer und Hönigswald*, Würzburg: Königshausen & Neumann, 1997.

[20] Willard V. Quine, *Word and Object*, Cambridge Mass: MIT Press, 1964.

[21] Hilary Putnam, *Philosophy of Logic*, London: Allen and Unwin, 1972; Ibid., *Mind, Language, and Reality*, Cambridge: Cambridge University Press, 1975..

[22] Saul A. Kripke, *Naming and Necessity*, Cambridge, Mass. : Harvard University Press, 1980.

[23] John Lyons, *Semantics One*, Cambridge: Cambridge University Press, 1977; Ibid., *Linguistic Semantics: An Introduction*, Cambridge: Cambridge University Press, 1996.

[24] The standard history of this field remains: E. I. Samurin, *Geschichte der bibliotekarisch=bibliographischen Klassifikation*, Munich: Verlag Dokumnetation, 1977, 2 vols. Original Russian: *Ocerki po istorii bibliotecno-bibliografceskoj klassificacii*, 1955-1959.

[25] J. Perrault, "Categories and Relators", *International Classification*, Frankfurt, vol. 21, no. 4, 1994, pp. 189-198, especially p. 195.

[26] Cf. Bernhard Eversberg, *Was sind und was sollen Bibliothekarische Datenformate*, Braunschweig: Universitätsbibliothek, 1994.

[27] In the Dublin Core, there is also a tendency to speak of any classification, catalogue system or method of structuring as an ontology. By contrast, as we have noted, in the European tradition, an ontology was something with claims to truth. The systems as they now exist do not have a legitimate claim to truth as such. For this reason we prefer to speak of methods of syntactic and semantic interoperability, rather than ontologies.

[28] Thomas Baker, "A Grammar of Dublin Core", Preprint for D-Lib Magazine, October 2000.

See: http://www.gmd.de/People/Thomas.Baker/DC-Grammar.html

[29] Stuart Weibel, *ALCTS Metadata Program, The Metadata Landscape: Conventions for Semantics, Syntax and Structure in the Internet Commons*, 5 May 1998.

See: http://sylvia.harvard.edu/~robin/weibel/sld006.htm. In the Dublin Core, there is also a tendency to speak of any classification, catalogue system or method of structuring as an ontology. By contrast, as we have noted, in the European tradition, an ontology was something with claims to truth. The systems as they now exist do not have a legitimate claim to truth as such. For this reason we prefer to speak of methods of syntactic and semantic interoperability, rather than ontologies.

[30] Here the important work of Traugott Koch, Phil Cross and Dan Brisckley with respect to an RDF Thesaurus and RDF Classification Specification are making an important contribution.

See http://ilrt.org/discovery/2001/01/rdf-thes/.

Cf. http://www.ilrt.bris.ac.uk/discovery/2001/04/rdf-class/classification-rdf.html.

[31] For an introduction see the author's: "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, 22 pp. (CD-ROM and Internet).

[32] IMASS (Information Management and interoperability of content for distributed Systems of high volume data repositories through multi agent Systems).
See: http://dbs.cordis.lu/fep-cgi/srchidadb?ACTION=D&SESSION=169972001-3-3&DOC=4&TBL=EN_PROJ&RCN=EP_RCN_A:53600&CALLER=PROJ_IST

[33] It is true that the Dublin Core allows for regional or domain specific elements/ Qualifiers, but these regional variants are seen more as exceptions than as a central part of the system.

[34] To be sure there is the .int domain name for the international level and the .name domain name is being introduced for individuals.

[35] Cf. for instance, Ingetraut Dahlberg, *Grundlagen universaler Wissensordnung*, Pullach bei München: Verlag Dokumentation, 1974, p. 104.

[36] Claude Elwood Shannon, *The mathematical theory of communication*, Urbana: University of Illinois Press, 1949.

[37] James Evans, "Founder of digital communications dies**,"** *IDG News Service\Boston Bureau*,
February 28, 2001, 14:42. See*:* http://209.185.240.250/cgi-bin/linkrd?_lang=EN&lah=af7258df4830d61f30696ff2ff699d54&lat=984226865&hm___action=http%3a%2f%2fwww%2etechinformer%2ecom%2fgo%2ecgi%3fid%3d428218.

[38] From internet.com's webopedia.
Cf:
http://www.pcwebopedia.com/Programming/Programming_Languages/syntax.html
[39] See: http://webopedia.internet.com/TERM/s/semantics.html
[40] This definition is from the Free Online Defintion of Computing (FOLDOC) from Imperial College, London.
See: http://foldoc.doc.ic.ac.uk/foldoc/foldoc.cgi?semantics. For a more detailed discussion, cf. Ulf Schönemann's Home Page of Programming Language Design.
See: http://www.cs.mun.ca/~ulf/pld/write.html#Syntax
[41] Grant Fjermedal, *The Tomorrow Makers, A Brave New World of Living Brain Machines*, Redmond: Tempus Books, 1986, p. 188.
[42] Ibid., p. 121
[43] Ibid., p. 143.
[44] Ibid., p. 138.
[45] Ibid., p. 139. For the views of Ray Kurzweil
See: http://www.kurzweilai.net/meme/frame.html?main=/articles/art0134.html.
The physicist, Stephen Hawking's position is that humans need implants if they are to keep up. See: "Smart machines a peril, physicist warns humans," Deseretnews.com, Sunday 2 September, 2001.
See: http://deseretnews.com/dn/view/0,1249,300006902,00.html).
One cannot but wonder whether there are connections between this post-human scenario and a) the rumored Blue Beam project.
See: http://members.aol.com/phmikas/infos/blue_.htm
and b) NASA's recent attempts to create an interplanetary Internet.
[46] Jerry R. Hobbs, Robert C. Moore, *Formal Theories of the Commonsense World*, Norwood, NJ: Ablex Publishers, 1985 (Ablex Series in Artificial Intelligence, Vol 1).
[47] See: http://www.cyc.com/auschron1.html
[48] See: http://businessweek.com/1997/25/b353210.htm
[49] "Battle of the Brains", *Wired*, November 2001, p.
[50] A slightly different arrangement is given by Rohit Khare, "XML. The Least you need to Know."
See: http://www.cs.caltech.edu/~adam/papers/xml/tutorial:

Syntax	SGML
Style	CSS/XSL
Structure	HTML
Semantics	XML

[51] This is a subset of Standard Generalized Markup Language (SGML).
[52] Cf. John Sowa, "Ontology, Metadata, and Semiotics," International Conference on Conceptual Structures, ICCS'2000, 14-18 August 2000, Darmstadt, Germany.
See: http://www.bestweb.net/~sowa/peirce/ontometa.htm. The distinction between syntax, semantics and pragmatics comes from Peirce who saw these as the three branches of semiotics.
Charles Sanders Peirce, "On the algebra of logic," *American Journal of Mathematics*, vol. 7, 1885, pp. 180-202; *Collected Papers of C. S. Peirce*, ed. by C. Hartshorne, P. Weiss, & A. Burks, 8 vols., Cambridge, Mass.: Harvard University Press, 1931-1958. Particularly vol. 2, p. 229.
[53] Ernst Cassirer, *Substanzbegriff und Funktionsbegriff, Untersuchungen über den Grundfragen der Erkenntniskritik*, Berlin: Bruno Cassirer, 1910. English translation: *Substance and Function*, Chicago: Open court, 1923. These ideas were developed in

his *Philsophie der symbolischen Formen, Bd. 3: Phenomenologie der Erkenntnis*, Berlin, B. Cassirer, 1923-29. English Translation: *Philosophy of Symbolic Forms, Volume 3: Phenomenology of Knowledge*, New Haven: Yale University Press, 1957. These ideas were further popularized in Cassirer's, *The individual and the cosmos in Renaissance philosophy*, New York: Barnes and Noble, [1963].

[54] Cf. the World Wide Web Consortium's section on the semantic web.
See: http://www.w3.org/2001/sw/.

[55] Marshall McLuhan, *The Gutenberg Galaxy: The making of typographic man*, Toronto: University Press, 1962.

[56] On topic maps cf. TopicMaps.org.
See: http://www.topicmaps.org/
On a comparison between topic maps and RDF cf. Simon Pepper (Ontopia), "Topic maps and RDF: A first cut."
See: http://www.ontopia.net/topicmaps/materials/rdf.html

[57] This limitation of not taking into account local, regional national and international variants which change over time is also apparent in the work of a) Carl Lagoze and the Cornell Digital Library Group.
See: http://www.cs.cornell.edu/lagoze/lagoze.html
b) Michael Buckland: Preprint of paper published as "Vocabulary as a Central Concept in Library and Information Science" in: *Digital Libraries: Interdisciplinary Concepts, Challenges, and Opportunities. Proceedings of the Third International Conference on Conceptions of Library and Information Science (CoLIS3, Dubrovnik, Croatia, 23-26 May 1999*. Ed. by T. Arpanac et al. Zagreb: Lokve, pp 3-12. ISBN 953-6003-37-6.
See: http://www.sims.berkeley.edu/~buckland/colisvoc.htm;
See: http://metadata.sims.berkeley.edu/.

[58] William J. Mitchell, *The Reconfigured Eye. Visual Truth in the Post-Photographic Age*, Cambridge Mass: MIT Press, 1992.

[59] Cf. the author's: "Towards a European Vision," *IIoI News*, Maastricht, March, 2001, (in press).

[60] See the websites of the International Institute of Infonomics (www.infonomics.nl) and the Maastricht McLuhan Institute (www.mmi.unimaas.nl).

[61] Benjamin R. Barber, *Jihad vs. McWorld*, New York: Times Books, 1995.

[62] These themes are being further developed in the author's new book: *Understanding New Media: Augmented Knowledge and Culture*.