Kim H. Veltman

Past "Imprecision" for Future Standards:
Computers and New Roads to Knowledge

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1. Introduction

Anyone involved in the day to day work of museums and libraries is constantly faced with a need for standards in terms of hardware and software. If only my machine were completely compatible with my colleague's machine next door. If only they were using the same kind of software. The past two years have seen fundamental steps in the direction of solving these problems. IBM is working together with Siemens. One of the key individuals in the Philips compact disc interactive (CDI) project is now working on the joint IBM - Apple venture. Increasingly there are multi-tasking functions that link various databases. Within a decade, the experts assure us, these problems will have been solved. In a sense these are merely problems of form, yet these have been so pressing that many of us frequently forget that computers are supposed to be helping us with content.

With respect to content, the need for standards has been equally pressing. Names are the most obvious example. When the libraries associated with the University of Toronto went on-line in a system that was not always as happy as its Latin name FELIX suggested, there were over 20 different versions of the name René Descartes. Some listed him under Des Cartes; others under Cartes, others under René, Sieur Descartes and so on. As a result a great deal of energy is now being spent to create authority files such as the Union List of Author Names (ULAN) by the Art History Information Program (AHIP) of the Getty Trust. Gale Publishers have produced a *Dictionary of Artists Names*. Most of us are dreaming of the day when these lists will be truly comprehensive, the assumption being that then we can throw away all those variants. Which brings me to the first reason for the title of this paper.

Computers are like perfect mirrors. They reflect what is given them. If we load them only with a list of standard names then they will give us indexes of standard names and nothing else. Hence a person looking for Jean Pélerin will find this if they type Pélerin but will not find copies of this book listed under Pelerin, Pelegrinus, Gast or Gastius in other libraries. In the past we were forced to choose one spelling of a name or object and that version dominated our lists and catalogues, while "see also" references paid lip service to other versions. The computer is often hailed because it will bring a universal standard to spellings of names and things. The real power of the computer lies in allowing us any number of access points to the same names and objects. Every variant name is the equivalent of a "see also" term in subject catalogues and serves as a new point of access into earlier lists and books. This will prove an immensely important tool in our search strategies as full text indexes become standard practice.

That which applies to artists' and authors' names applies equally to titles of works of art. To search for Leonardo's *Mona Lisa*, the computer needs to be told that she is also called *La Gioconda* as well as variants in other languages. Indeed this applies to all kinds of old lists and inventories in our museums and libraries. We tend to assume that once we have the latest catalogue we can forget about the rest. If we do so we are then left simply with standardized titles that will block our entry to earlier literature. We need to include the historical dimension in our program(me)s: old catalogues and new ones; variant names of persons and objects as well as standard names. Ironically, only by including the imprecisions of past spellings will our present quests for standards create richer search tools in the future.[1] This is transforming the way we approach knowledge and is ultimately redefining our concepts of what is knowledge.

2. Levels of Knowledge

While knowledge is often described as if it were a monolithic, static phenomenon, it is useful to distinguish at least seven levels each of which has its own particular functions (fig. 1).

Level	Type	Function
1	Classification systems	Cubbyholes
2	Dictionaries	Definitions
3	Encyclopaedias	Explanations
4	Bibliographies	Names of Containers (Books)
5	Surveys, Indexes	Partial contents
6	Art, Books, Instruments	Full contents
7	Specialized literature	Analyses

Fig 1. Seven levels of knowledge with their different functions.

The first of these levels entails classification systems, the process whereby we create different branches for the tree of knowledge, general cubbyholes for organizing an otherwise overwhelming amount of material. In the past the theoretical system that was developed began from a practical concern of arranging books in a library, or objects in a museum. Institutions were forced to adopt or develop one system to the exclusion of others. Initially the categories were large ones such as theology, law, medicine, philosophy, mathematics, art and history. These are now the general headings in major systems such as the Library of Congress. Books in a given class were placed in a separate section, later a different room, or even a separate building. The advantage was that a doctor of medicine could go the section or room on medicine and find most of the books in his field. The disadvantage was that a book could only be classed once. If it happened to deal with both science and art, it might end up in science and be ignored by those studying art or conversely. Similarly, in a museum a beautiful stone might end up in a section on geology, jewelry or a more general section on ornament and be ignored by students of other sections. The choice of where books and objects were classed varied with the intelligence, training and experience of the librarian or curator and inevitably involved another example of the imprecisions that are the topic of this paper.

While computers cannot eliminate the difficult and sometimes painful problems of classing objects, they can transform the consequences. In order to locate physically an object or its surrogates in the form of microfilm, video, CD-ROM etc., we need a single classification system that functions as the equivalent of a standard name. But just as the computer permits access to a standard name from any number of variants, it allows access to the terms used in a standard classification system from any number of other classification systems.

Is this not an undue amount of effort? Why not use only one system? A simple answer is that any system reflects the categories of the culture that produces it and therefore emphasizes some terms while suppressing others with the result that whole topics can quite readily get lost. This sounds so unlikely that a concrete example is useful. In 1974 one of the leading German scholars on the history of mathematics wrote an important article on the German tradition of measuring wine barrels (*Visierkunst*)[2]. The author claimed that interest in this theme had been limited mainly to Germany. When I read the article in 1977, I had just spent six years reading English and other sources in the history of science in the British Library and remembered having encountered the topic. I went to Peddie's subject catalogue and looked under wine barrels, measurement and related headings with no success. Fortunately I had made photocopies of a number of Renaissance texts where I found that they referred to this activity of measuring wine barrels as gauging. I then returned to Peddie's catalogue and behold, under gauging, found a whole series of titles on the subject.

The point of this story is that none of us knows all the words under which to look for things. We rush to the Subject Headings of the Library of Congress but this effectively only gives us a catalogue of standardized contemporary terms. To go back to gauging, in late mediaeval and early Renaissance Europe, wine was one of the most important export items. The barrels were shipped by river and cities along the way depended on import

and export taxes for their economic prosperity. Hence the development of accurate measuring instruments became a fundamental key to the economy of the time. Today the basic factors of the economy are to be found in cars, computers and other electronic devices. If we class the worlds of knowledge simply in terms of today's categories then all the objects and technologies which have become obselete would be forgotten.

The Library of Congress system omits a number of topics that are found in the catalogues at Göttingen and other major European libraries. Similarly, new systems such as the Art and Architectural Thesaurus (AAT), have the advantage that they create clear hierarchies of basic terms, but the disadvantage that they omit many of the (historical) complexities of topics. ICONCLASS is much more sensitive to the historical dimension, but does so from a particular northern viewpoint. A friend in the National Library of Belgium (Brussels), pointed out to me, for instance, that the categories of ICONCLASS worked much better for Protestant Dutch art than Catholic Belgian art. I cite this not to criticize either the AAT or ICONCLASS. They are the best tools that we have. I am noting that they pointers to knowldge which reflect the cultures that produced them. The solution is not in abandoning *a* in order to choose *b* or conversely. The challenge lies is learning to use *a* plus *b* plus *c* plus every other system we can find.

Each classification system is a search engine. It gives us much more than just standard subject headings for a topic. It gives us clusters of terms associated with that problem by a given culture, which provides us a) with other points of entry into a problem and b) with glimpses into the associations of that particular culture. For instance, in the Library of Congress system (mathematical) perspective is clustered with descriptive geometry. Classification systems before 1800 had different clusters. Computers potentially allow us to use every existing classification system, compare which terms they have in common and discover how their different cultures give access to different samples of the corpus of knowledge.

One of the great qualities of reference sections and open stack libraries as particularly found in North America[3] is that a reader can browse and thus find other books on precisely that topic and also books in related topics. This advantage is limited, however, to the library in which one happens to be. A computerized method of accessing not only the books on a given topic but also the clusters surrounding it would a) turn a hitherto random, empirical approach into a clear search strategy and b) would extend this advantage to any number of libraries without requiring that one visit them in person. Indeed a scholar who recalled vaguely a book that he had seen once at the Vatican Library, could call up their classification, move to the topic and browse the books under that topic. Indeed if at least the reference sections of the world's great libraries were entered on video, one could tele-browse.

The levels of knowledge method[4] departs from the concept of different layers of depth, level one being the surface and each successive layer providing greater detail about a subject. Classification systems are seen as a first level of knowledge because they are effectively the containers for containers, beginning with the universal headings such as history, art, and science in the Library of Congress system, followed by the classes

themselves. Dictionaries are seen as a second level because they provide definitions which on the one hand help to limit the potential ambiguities of a term and on the other hand provide another cluster of terms that are related to the word being defined and thus provide another set of search engines into a topic.

In a conventional dictionary these clusters of related terms function either implicitly or explicitly as "see also" markers to other parts of the dictionary which in the case of the Oxford English Dictionary (OED) and other major examples means constantly going from volume to volume trying to find definitions of the family of words related to the one with which we began. Since computers allow automated access to these related terms, the "see also" becomes explicit (through the equivalent of a hyperlink function). In conventional dictionaries use of illustrations and photographs was typically limited to technical and children's versions. In level two of an electronic version, visual and audio material can be used for any kind of dictionary. Polyglot dictionaries pose no problem.

Nor do historical dictionaries. The electronic version of the OED already offers important insights into etymology by citing earlier examples. In future, systematic entry of dictionaries will allow individuals to trace how definitions of a term changed historically. In the past we studied Shakespeare at school by consulting the notes in the edition which our school board or our teacher happened to pick. In future students will be able to consult dictionaries of the period in learning the terms, while more advanced students will find themselves exploring how editions over the centuries have emphasized and de-emphasized aspects of the plot and the text, thus achieving in a more systematic way that which deconstruction has begun to tackle intuitively and anecdotally.

Traditionally, when a brief definition proved insufficient, we consulted an encyclopaedia which gave a more detailed explanation of a term. In our scheme this becomes level three of knowledge. It includes both universal encyclopaedias such as the Encycopaedia Britannica, historical encyclopaedias such as Zedler's Universal Lexikon and specialized subject encyclopaedias such as Thieme-Becker's Künstler Lexikon. These standard reference works also contain other variant names which in turn provide additional search engines into the corpus of historical literature.

This corpus of literature is highly complex and hence is dealt with in four further levels, i.e. levels four to seven of the system. Level four deals with titles of books and articles and is thus the equivalent of traditional bibliographies, the difference being a) that it integrates earlier bibliographies such that one can trace the growth of a field or discipline, thus doing for earlier centuries what the Humanities and other Citation Indexes are doing for the present, and b) that it has additional points of entry in terms of names (editors, illustrators, publishers, sellers, as well as authors) systematic key words (which are linked with the terms in classifications), country, language and alphabetical lists based on standard and full titles.

Level five gives access to partial contents of books, paintings, instruments and other objects of knowledge. In the case of books, for instance, this entails tables of contents, indexes and general surveys. Level six gives access to full contents of these objects, e.g.

facsimiles of the books. Level seven provides analyses of these objects. Traditionally this was the domain of specialized scholarly literature but the process remained largely unsystematic and haphazard. It is useful to distinguish between different kinds of analyses, notably scales-contexts, universals-particulars, practice-theory, development, verbal interpretation, visual reconstruction, and levels of discourse, each of which need some explanation.

3. Scales and Contexts

Scale basically gives us the size of the original and sizes of copies, which can also be expressed in proportions. Hence if an image of the *Mona Lisa* is six inches on my screen, there would be a note that this is 30% of the original. If we look at an object in its original size its scale is 1:1 which can fruitfully be seen as a kind of mid-point on a spectrum between microscopic and telescopic scale. In microscopic scale the image is larger than the original: e.g. 2:1, 10:1, 1000:1, 1,000,000:1 which we would use when we wish to focus specifically on the *Mona Lisa* or some other object of study.

By contrast, in telescopic scale the image is smaller than the original: e.g. 1:2, 1:10, 1: 1000, 1:1,000,000. As we move along this part of the spectrum we increasingly see the context of the object that we are studying. For instance scales from 1:10 to 1:50 will show us the room in which *Mona Lisa* hangs. A scale of 1:100 will reveal her position within the Louvre as a whole; 1:1000 will show us where the Louvre is in Paris and subsequent scales will show us where Paris is in France, where France is in Europe until we arrive at 1:1,000,000 which shows us where Europe is in the world. Increasing scale is thus a key to context. Conversely decreasing scale is a search strategem, because every choice delimits more clearly the scope of potential topics, taking us literally from the world of knowledge to a specific object of study. Hence scale is about the question where? as much as it is about how much? In contemporary terms systematic co-ordination of scale is a particular domain of Geographical Information Systems (GIS), which are tending to become Visual Information Systems (VIS).

Scale is much more basic than it at first appears. In terms of everyday knowledge it underlies many of our comparisons: x has a bigger car, a larger house etc. It is instructive how often these comparisons are made on the basis of things that cannot be readily tested, like the big fish that got away. Once we are able to measure accurately an object it becomes part of scientific, scholarly knowledge, which explains why quantification is frequently treated as nearly synonymous with science.

In an extended sense, questions of concrete and abstract are also a problem of scale. A cube of pyrite is a concrete physical object. All attempts to record this object in terms of a physical model, a photograph, a painting, a diagram, a geometrical figure or an algebraic formula can be seen as points on a spectrum from concreteness to abstraction. Some would have us believe that the domain of scholarship should be limited to expanding our abstraction and look at the historian's task as one of translating earlier concrete statements into their contemporary abstract equivalents. In history of science this takes the form of reducing verbal descriptions to algebraic formulae.

Underlying this activity is the assumption that knowledge and truth are essentially non-visual. To defend this position the experiences of scientists in the 1920's dealing with quantum physics particularly those at Göttingen are often cited while Hilbert's work on *Geometry and the Imagination*[5] at that same institution is frequently not cited. More recently there has been a serious movement to challenge the basic assumption that progress is merely abstraction. Mandelbrot's *Fractal Geometry of Nature*[6] has argued persuasively that visual information is essential for understanding more complex phenomena in nature. Indeed at the level of high science there is now an emerging field of visualisation that uses visual modelling as an essential dimension of knowledge. These developments do not deny the value of abstract equations. Rather they are leading us to see that knowledge lies in establishing a spectrum between concrete and abstract instead of being limited to some point on that spectrum[7].

What museums and galleries have been doing is collect evidence along the whole spectrum from concrete to abstract. As long as we were convinced that relevant knowledge was limited to abstract equations, it was easy to dismiss museums as tombs of dead knowledge. If the new trends are not just a passing fashion, then the recent boom in new museums is no co-incidence and museums will become ever more relevant to knowledge. Far from being dead tombs, museums are living homes of "missing" or rather forgotten links on the spectrum of concrete-abtract. This implies however that the mandate of museums cannot be limited to displaying a few choice samples, or even to recording electronically everything they have. A new mandate looms which challenges them to make visible the links that have been hiding in their basements. Only then can the scope and value of museums be appreciated.

4. Universals and Particulars

In mathematical terms objects are either identical i.e. equal (=) or they are not. Much of what we term knowledge lies in defining the gray areas where there is doubt about the equation because some factors are (or at least seem to be) the same, whereas others seem not to be the same, which takes us into the why of classification. When is the next bird just another well recognized member of a species, or the first of a new species?

In ancient Greece, Plato developed the theory that we have an a priori universal idea in our minds of every object we encounter in the physical world, i.e. when we see a chair we recognize it as a chair because we have a built-in idea of what a chair looks like. Hence knowledge is deductive. This is a very seductive explanation. If it were true then we would have an innate dictionary of ideas at birth. If so then the Greeks and non-literate cultures should have had images of computers, jet engines, space ships and other advanced technologies. Yet the only evidence of such ideas is found in highly literate countries. Are we then to assume that the meaning of innate varies geographically and temporally?

Plato's best student, Aristotle, intuitively saw the flaws in this approach and made a first attempt at formulating a method that proceeded inductively, by gathering examples of

particular cases and even asked his best student, Alexander the Great to collect these for him as he went about conquering the known world. Yet as Plato's student, Aristotle ultimately saw these examples as stepping stones for conclusions about universals. Christian theology established a new dignity for the individual through the concept of creatural realism with the result that the middle ages saw an ongoing debate concerning the role of universals and particulars. The Renaissance brought a new emphasis on particulars. This led to increasing collections of individual examples and went hand in hand with pattern books that attempted to codify universals. Printing was essential for these developments but it also defined the potential limits thereof. The printing of images was costly. Until the nineteenth century even simple colour printing was impossible. Books were limited in size. As a result a corpus of particulars and universals was gradually produced but in so fragmented a form that systematic access to these materials has inevitably remained very difficult at best and frequently impossible.

Electronic media offer a first opportunity of gathering all known particular examples and all corresponding universals that have been proposed. This corpus will inevitably be housed in a central repository just as we now house our major collections of books in national and regional libraries. In the past those outside the centres typically requested books from these centres through inter-library loan. In the future we are told that this will occur using fiber optic modems. In the shorter term if the topic to be studied is small, e.g. Roman amphitheatres, the information could easily be downloaded to personal computers. Larger fragments could be pressed onto personal CDs. A next scale of study might require going to one's local library which would have a dedicated fibre optic connection with the central libraries and have terminals capable of dealing with larger amounts of information. Major research projects might still require going to centres equipped with very large machines, multiple terminals and multi-tasking facilities.

Once this technological framework is in place it will become clear that many scholarly activities which seemed quite different and even independent in the past were actually subsets of the universals-particulars problem, notably the study of copies, versions, variants, comparisons (other than those of scale), contrasts, relations and parallels, for all of these involve situations where identity is not complete.

Taken together it can be seen that this set of problems has dominated the world of scholarship for at least the past five hundred years and yet, because the publication of results was always in terms of fragmentary, isolated cases, the larger patterns in this corpus have remained invisible. Once the corpus exists electronically the nature of scholarly activity will change considerably. Discoveries of new copies, variants, versions etc. will become cumulative and will immediately become accessible to all.

Again there will be a temptation to define knowledge simply in terms of the connections we know now, pretending that this (cognitive) map of hyperlinks is all that matters. The greater challenge is to find new ways of visualizing earlier types of connections produced by print and manuscript culture in order that we can begin to understand larger patterns in the growth of systematic knowledge.

5. Practice and Theory

Problems concerning practice and theory can be seen as another dimension of the universal-particular nexus. For instance, books on perspective contain a wealth of examples of basic forms that were, in the early period, based on forms that had been mastered in practice. Once electronically accessible these forms offer the equivalent of a ready made grammar of forms, visual shape library, alphabet of visual forms or a comprehensive symbology library as it is variously termed in the jargon of computer literature. Often these examples in the texts are effectively abstractions from concrete practice. Hence practice-theory offers one set of entries into the abstract-concrete problem which also belongs to the nexus of universal particular. Perspective books are, of course just an example. They are a subset of how to do it books which will need to be treated accordingly.

All of these developments are of the greatest importance for the world of museums. As long as a rhetoric of universals continued to dominate the world of learning it was easy to limit exhibits to isolated examples that served as the equivalent of a visualization of these universal concepts. That only 3% to 10 % of major collections could usually be shown was therefore accepted as one of those realities about which one had to do something someday. If knowing all the particulars is recognized as basic to the advancement of knowledge, then it becomes a fundamental mandate of the great collections to find ways of making their hitherto hidden treasures visible, at least electronically if not on permanent exhibition. At the moment it is as if much of the world's knowledge had been imprisoned in the forms of basements, storage rooms and warehouses. As scholars such as Kubler[8] have pointed out, material culture is an essential dimension to our cultural heritage, because if we are to show that knowledge is not just abstract theories and claims we have to make it come alive with all the evidence of practice and everyday life. We have to illustrate the verbal learning that we relegated to libraries with the visual learning that we confined to museums and galleries and link this anew with the experience of everyday life.

6. Verbal Interpretation

Many persons would still pretend that verbal interpretation is the only legitimate kind of analysis. It is important to recognize that this is partly a reflection of technology. Until very recently verbal knowledge was the only kind that could be recorded and reproduced with some precision and hence it became linked and indeed for most persons was considered synonymous with scholarship. It is also important to recognize that different media affect the role of verbal interpretation. Ironically, one of the ways in which the advent of printing made verbal description much more powerful was by using visual exemplars as their models thereby creating systematic methods of describing.[9] The advent of multi-media (fig. 2) will transform anew the role of verbal interpretation, by introducing a series of new methods for recording and exposition.

7. Visual Reconstruction

A good number of descriptions in the form of verbal interpretations are implicitly visual reconstructions. The archaeologist who summarizes his research concerning the Parthenon will frequently describe what he thinks the building looked like in its original version. A good deal of scholarly debate could be removed if all such verbal claims could be translated into visual claims and one had access to photographs of the original concrete evidence of the sites and objects they contain.

Systematic comparison of such visual reconstructions would reveal the extent to which these are influenced by ideological, philosophical and cultural traditions. The Roman forum is not a static object. It both erodes with time and becomes more or less buried. More importantly conceptions of what it looked like in the days of its glory are partly a function of solid archaeological evidence and largely a function of different schools which reflect different ideals and assumptions. Hence a nineteenth century French interpretation of the Roman forum differs strongly from a German one at the time of Bismarck or an Italian one at the time of Mussolini. Sometimes, nay often, these visions were produced by persons who had never been to the spot. Occasionally as in the case of Arthur Waley, famous scholars prided themselves that they had not been to the places that they studied! Systematic access to these alternative visions will help us to understand at a new level the interplay between the actual works of art and architecture; their representations and external factors such as politics, technology and science.

There will inevitably be "purists" who claim that we should focus on a standard interpretation (i.e. their standard) and ignore the rest, which seem to them as irrelevant as the imprecisions of variant names, unnecessary distractions from their rhetorical conception of truth and what is "relevant". If museums and galleries succumb to this position they will become reduced to being banners for the ideology of the day and foresake what is potentially their greatest strength. For if they continue their task of making ever more visible the ways in which culture and ideology both shapes and mis-shapes knowledge, this can become our most powerful tool in educating persons to view critically and with a certain amount of irony all interpretation. Exhibiting past imprecisions and even past errors is our greatest hope of real progress. The alternative is becoming a place where nothing is so old as the new. Too many persons assume that museums are storehouses for out of date things: they are actually treasure houses to remind us that there are different ways of doing things, many of them far more beautiful than the ways we do them today.

Visual reconstruction also has dynamic dimensions including film, video and animation. The advent of multi-media techniques will integrate these into museum exhibitions and make them powerful tools for exporting the museums' treasures beyond their walls. These dynamic methods, because they include time, illustrate in new ways how type questions. At present, the historical instructions, to the extent that they have been recorded, exist in how to do it books which are stored in libraries. The instruments for and products of those instructions are often in museums. A spinning wheel standing in the corner of a local museum is usually of little interest mostly because it is accompanied by signs of do not touch and hence there is no way of interacting or relating to what we see. If one could watch a video with a personalized audio headset showing spinning wheels in action, or

actually see models in action, the purpose of that seemingly dead object would become much clearer. Within a generation it is entirely thinkable that the spinning wheel and indeed most objects in museums could be accompanied by head-mounted displays permitting a person to re-live the experience of spinning, welding, diving, etc. Children could learn about these experiences in school and then come to museums to see the real thing.

8. Development and Time

One of the more subtle consequences of book technology has been the limitations it has imposed on large numbers of visual evidence. This meant that Leonardo was unable to publish his visual work. In the case of Alexander von Humboldt limited publication was only possible by using his inherited wealth to subsidize the project. In the case of the history of technology in our century (e.g Thorndike, Singer) it has been customary to limit historical treatments to (what are assumed to be) first cases and last cases. In so doing, the continuity of inventions such as the lifejacket is often forgotten. An example is found in Leonardo and it is assumed to be the first. Earlier Assyrian examples cited by Montelius (1900,1925) are forgotten as are lifejackets of Taccola and Francesco di Giorgio Martini.

Computers introduce the possibility, for the first time, of including all the examples and thus reconstructing, to the extent that surviving objects and documents allow, a new sense of both continuity and development over time. Again, this process will require new attention to and systematic study of the full contents of museums, their basements as well as what they display in their prime galleries.

9. Levels of "Discourse"

It is as misleading as it is tempting to refer to past versions as imprecise and pretend that our modern version is precise. In practice, every time we refer to the name of some person we are giving an approximation, which changes with context. The man who was once the Chief Scout in certain circles, was called Lord Rowallan in his formal capacity a Knight of the Thistle and Billy by his friends. This applies equally when we name some thing. If we have a collection of scientific instruments, we may refer to a given piece as a universal measuring instrument to a visitor, refer to the same instrument as a sector to an historian of science and refer to it as version *c* of a Galileian military compass to an expert in the field. Similarly, a curator at an art gallery will describe the same painting very differently when consulting privately with an expert colleague, when giving a scholarly lecture or when giving a public talk to local friends of the museum. We change our descriptions with our audience.

In the past what was recorded in our museum, gallery and library catalogues was what aimed to be a single level of "scholarly" discourse. As the twentieth century began producing large quantities of photographs, film, audio tapes, television and more recently videos, the traditional notion of written and printed documents as the only legitimate

sources for study was transformed. Oral history, and visual or pictorial history became realities.

Warren Robinett, one of the inventors of virtual reality, has outlined a scenario where a person could go through life carrying on their heads a camera or cameras which make the equivalent of a home movie of every minute of that person's life. If this sounds absurdly futuristic it is sobering to recall that most banks, (high level) factories, offices and increasingly even public spaces such as subway stations are constantly monitored by video cameras not to mention the satellite images that photograph us non-stop from space. This is of course being done in the interests of or at least under the rhetoric of security. What it means, however, is that the materials for a future (visual) history of bank *a*, factory *b* or subway station *c* are being gathered already.

It is frequently assumed that the significance of electronic technology lies in giving us new access to the sources of knowledge. In fact, in recording knowledge and information from every level of discourse, electronic devices are making us aware of how narrow has been the bandwidth of earlier recording mechanisms. These again are problems to which Foucault, Derrida and their deconstructionist offspring have drawn attention anecdotally, intuitively and usually superficially because, ironically, they have tried to encompass these new levels of discourse using the straightjacketing limitations of a single level of discourse by trying to write all this in traditional scholarly style. Ultimately our new electronic knowledge access tool will need a moveable levels of discourse bar to complement the levels of knowledge bar.

One of the striking features of the above list is that it brings into focus a fundamental difference between earlier advances in communication and the so called electronic revolution which is presently taking place. In a tribal culture, authority was based in the chief's oral words. The scope of his knowledge was limited to his tribe. Knowledge about outside tribes was frequently seen as a threat. When the Greeks moved from oral to written culture, the new medium claimed to replace the earlier one in terms of validity. Of course, conversation was still possible, but it no longer had the authority of the written word. An unexpected consequence was that written knowledge from other states now theoretically had to be taken into account. The shift from oral to written to systematic manuscript and later printed knowledge entailed an increasing universalization in the scope of knowledge. For the past two millenia it seemed that each innovation meant abandoning one medium and replacing it with another.

UNIMEDIA		
Unrecorded Verbal		
Aural	Speech	(Public)
	Conversation	(Private)
Recorded Visual	Letter	(Private, Public)
	Manuscript	(Private, Public)

	Painting etc.	(Private, Public)	
	Book	(Public)	*
	Periodical	(Public)	*
	Newspaper	(Public)	
	Silent Film	(Public)	
	Newsletter	(Public, Private)	
	Photography	(Public, Private)	
BIMEDIA			
Recorded Verbal			
Audio	Radio	(Public)	
	Tape Recorder	(Private)	
Recorded Verbal-Visual			
Audio-Visual	Film	(Public)	
	Television	(Public)	
	Video	(Public,Private)	
MULTIMEDIA			
Omni Visual-Verbal	Computers	(Public,Private)	

Fig. 2. Examples of types of communication as indicators of levels of discourse. Asterisks indicate levels particularly associated with scholarship from the Renaisaance until the mid-twentieth century.

The extraordinary innovation of multi-media is that it embraces rather than replaces earlier methods by integrating them into a single coherent system and at the same time potentially provides tools where one means of commmunication can be translated into another. Hence we can listen to a speech as if it were being given "live" by Thucydides in ancient Greece, we can consult a manuscript record of the speech in the manner of a mediaeval monk, consult the latest critical edition in book form in the way we would consult a modern library, or we can study the recorded evidence with the aid of hyper-text and hyper-picture functions linking words with dictionaries, maps, architecture, sculpture and art.

Greeks	Renaissance
Substance	Function
What	How
.....	
Why	Where
	When

Fig 3. Types of questions in different cultures.

10. Types of Questions

In school we were taught that everything could be reduced to a few simple questions: what, where, when, how, and why? Cultural historians such as Cassirer have pointed out that the kinds of questions asked have changed with time, that the Greeks who emphasized substance asked questions of what (quiddity) and why, whereas Renaissance thinkers turned to problems of function through questions of how (fig.3).

In light of our earlier comments about multimedia being embracing rather than replacing, it follows these new technologies should lead to a new attention to the whole spectrum of questions: what, where when, how, why and lead us to recognize that all of these are effectively different strategies to knowledge and understanding.

If we reflect for a moment, then we can see that there is a basic distinction to be made between questions which impose quantitative limits on our search (what, where, when); questions that can sometimes lead to quantifiable limits (how), and those where the questions remain qualitative (why). In other words even if we continue to ask all the questions certain questions "logically" precede others.

It follows that we could begin almost any search by returning to the simple questions "what?", which could take us into one of the seven levels of knowledge (fig. 1); "where?", which would show us a map and allow us to enter via a continent and then focus successively on a country, city, building and even an object (such as a painting or piece of sculpture) or "when?" which would lead us to focus in on an era, a decade, a year or even some specific day as the starting point for a search. Having chosen a such a date (or set of dates), the person would be prompted whether they wish to study an object or problem in terms of its contemporary examples (horizontal history, synchronically) or how it relates to earlier and later examples (vertical history, diachronically). Using such a step by step method and providing the user with help bars to remind them of their orientation in terms of what, where, when; in terms of level of knowledge, and level of discourse, the user would discover that entries into knowledge need not be overwhelming.

In the past, beginning any such strategy meant going to a particular building (e.g. library or museum), which usually eliminated alternative strategies for the rest of the morning or even the whole day. If these strategies are carried out at a terminal one can choose a path, change one's mind and choose another set of entries within seconds or minutes, depending on the complexity of the problem.

As the methods of systematic search strategies evolve, these need to be incorporated into our educational system. In the past school taught us to read books so that we could use libraries and museums in order to discover what existed. It taught us to read maps so that we could determine where we were and find the locations of places about which we read. School also taught history so that we could learn when things occured. In some cases it taught us how things worked and theoretically it challenged us to reflect on why questions. In the past this knowledge seemed static. Once one had learned the boundaries

of countries, they were expected to stay that way for one's lifetime. This is no longer true. Everything is changing: both the maps of physical countries and the cognitive maps of every field. Once upon a time we learned only content. Now we need to learn strategies to content. Nor is this limited to schoolchildren. That is why continuing education is looming as much more serious than a simple pasttime.

We are faced with a new problem that is already being described as information overload. The task of recording 9,000,000 titles of a British Library catalogue on CD-ROM may be difficult. The challenge of collecting 30,000,000 titles of books on the network of the Research Libraries Network (RLIN) may be considerable. But in a sense this is the beginning not the end of the process because no individual, not even a modern day Aristotle is prepared or even equipped to read through 30,000,000 titles even if they were given a scholarship at birth to do nothing else.

Here we have come to one of the paradoxes of the so called information age. We have a technological infra- and super-structure that drives us to collecting all our knowledge electronically. Initially it seemed as if this was merely a question of translating existing analogue knowledge into a digital form. As this paper has tried to make clear, the story is not that simple. Some persons may still believe that the explosions in structuralism, constructionism, de- and re-constructionism are merely this season's fads in the fashion show of -isms. But the reality is that even our best examples of traditional structures are no longer functioning. When the British Library first opened it was hailed internationally as an excellent model which was instantly imitated with the result that every country wanted a national library. The new British Library will in some senses be obselete even before it is built and the countroversies that surround its French counterpart confirm that these problems are not limited to English eccentricity. It is easier to use examples from the realm of libraries. In so doing we can pretend to consider the problem objectively before realizing that it is affecting our own institutions equally.

11. Conclusions

The new technologies are transforming both the categories for and contents of knowledge. They are making us aware that collection and conservation of as much as possible, coupled with exhibition of a few choice items is not enough. We need databanks not just for collections management but also to justify the expenditures which will seem immense and disproportionate until we make visible what we actually have. For the past months I have made a habit of asking my fellow Torontonians about the Royal Ontario Museum (ROM). Practically no-one has any clue about the 96 % of the collection that is not on display. Through CHIN, Canadians are very fortunate to have one of the best nationalised databanks of its collections, but as good Canadians they are as unaware of this as are Torontonians about the riches in their museums. These problems are worldwide. We need front ends to museums, which link with the front ends in libraries to create an open system and integrated system in terms of knowledge and not just in the computer jargon sense of hardware and software.

All of you came to hear this keynote address at a world conference or are taking the trouble to read it are aware that these are international problems. One of the purposes of this paper was to emphasize how dramatic are the consequences of the electronic revolution that is changing our basic assumptions about knowledge and the institutions that arise from these assumptions. Another concern was to give you a new sense of purpose about the importance of your task. You and the librarians are the guardians of the combined memory of human culture.

The problem with these meetings is that we spend a few days or in this case a week of euphoric insight and then we are plunged back into the battles with in and out files on our desk as phones ring and faxes whine. What is needed is an international institute that will create prototypes for these new strategies to knowledge, prototypes which would set international standards. Many projects are already underway. What is required is the goodwill of the major players to provide copies of their materials such that they can be integrated into a more comprehensive system.

Sceptics will say that such visions are utopian and ignore the harsh economic realities of our times. Similar sceptics are still reminding us that Gutenberg, who began the printing trade in Europe, went bankrupt but then quietly forget to tell us about the thousands of jobs that printing created in the next generation once appropriate economies of scale had been achieved. Nor do they mention the tremendous rise in cultural networks that resulted. It is very much a question of viewpoint. Of course the situation can be seen as a terrible nuisance of translating all our knowledge to new media: it can also be seen as an incredible source for new jobs, in creating the technology that will make this possible, in entering the material and in making it available. The situation can be seen as a wonderful new challenge in making publicly available knowledge that has been collected and maintained with taxpayers' money.

At the Perspective Unit of the McLuhan Program some seed monies from BSO and CHIN have allowed us to begin a prototype. To succeed in our goals we need the cooperation of museums and galleries who can provide us with copies of their databases. These could then be used in creating new standardized methods which can then be adapted to local museums with their variants, versions and even imprecisions, in such a way that there is a cumulative dimension which leads both to future standards and new roads to knowledge.
Toronto September 1992.

Notes

[1] On this topic two examples from experience come to mind. For the past sixteen years I have been working on a standard bibliography on perspective. In 1979 I visited a series of major libraries in the United States. When I arrived at Yale I discovered that there was an old and a new card catalogue. In the old catalogue there were a few titles that were ambiguous and seemed to contradict evidence in the new catalogue. There were three possibilities: 1) the titles had been catalogued differently; 2) they had been mistakenly entered in the old and had been corrected in the new or 3) these were titles from the old catalogue which somehow had not been entered into the new catalogue. I asked a

librarian about their cataloguing rules. They sent me to other persons. Thirty minutes later I was speaking with the head librarian who unabashedly explained to me that since they were now using the new system they had thrown out the old cataloguing rules, hence there was no way of determining which of the three possibilities was true. This problem is not limited to the United States. At the Bayerische Staats-Bibliothek in Munich a young librarian once tried to tell me that the card catalogue which began in this century was their only catalogue. A second person insisted that their original catalogue had been made in the late nineteenth century. Since I knew to the contrary, I persisted and was taken to a room not open to the public with their old catalogue in several hundred volumes. In Munich the younger librarians had forgotten that they had a past. Fortunately they had not thrown away the records. Searching through those old lists I was able to verify some references and discovered a number of new titles using old subject catalogues.

[2] Menso Folkerts, "Die Entwickelung und Bedeutung der Visierkunst als Beispiel der praktischen Mathematik der frühen Neuzeit", *Humanismus und Technik*, Berlin, Bd. 18, Heft 1, 31 Mai 1974, pp. 1-41. This remains a superb article, notwithstanding the comments above.

[3] The European solution to this strategy is to provide special card catalogues which duplicate the physical organization of the shelves such that one can browse titles without disturbing the order of the actual books. In a sense this is closer to my concept of tele-browsing than the North American solution. It would simply be a question of scanning in these specialized subject catalogues in order to make this a reality.

[4] A prototype for this method using the term perspective by way of illustration is being developed at the Perspective Unit in the McLuhan Centre at the University of Toronto thanks to funds from the BSO corporation (Utrecht) and CHIN (Ottawa) and software including the following: Autodesk, CAT Benelux, Superbase, Image Access.

[5] D. Hilbert and S. Cohn-Vossen, *Anschauliche Geometrie*, Berlin, 1932), translated as: *Geometry and the Imagination*, New York: Chelsea, 1952.

[6] Benoit B. Mandelbrot, *The Fractal Geometry of Nature*, New York: W. H. Freeman and Co., (1977), 1983, p. 21.

[7] For a discussion of historical dimensions to this problem see the author's "Visualisation and Perspective" in: *Leonardo e l'età della ragione*, Milan: Scientia, 1982, pp. 185-210.

[8] George Kubler, *The Shape of Time. Remarks on the History of Things*, New Haven: Yale University Press, 1962.

[9] See Michael Giesecke, *Der Buchdruck in der frühen Neuzeit. Eine historische Fallstudie über die Durchsetzung neuer Informations- und Kommunikationstechnologien*, Frankfurt am Main: Suhrkamp, 1991.