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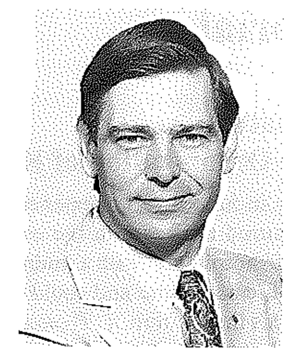

Computers and a New Philosophy of Knowledge

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In the tradition of Marshall McLuhan it is shown how different media, i.e. speech, parchment, manuscript, printed book are determining factors in the limits of knowledge and communication thereof. New possibilities introduced by computers are considered: multilinear access, variants, new distinctions between verbal and visual, scale, integration of geometrical and algebraic methods, emphasis on process, and system. Computers are the first tool with multi-media capabilities, allowing output in the same medium as the input. The philosophical implications of these innovations are explored.
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1. Introduction

Praise of computers is very frequently on technical grounds: the new machine will have more memory, will do more operations, will do everything much faster; or economic grounds: the new machine will be much cheaper, will take up much less space and still be much, much more powerful. Philosophical grounds for computers are hardly ever mentioned. That is one reason for this essay. Another concerns philosophy. Today many persons consider philosophical systems as if they were purely a matter of taste, changing as regularly as the seasons: one is a constructivist one year and a deconstructivist the next. Similarly the approaches to knowledge that they entail are treated as if these, too, were simply questions of fashion, like wearing a new hat or changing the colour of one's clothes. The few individuals who disagree and continue to search for facts, are called old fashioned, outmoded, inductive, or positivist, all of which are new age swear words much more damning than if one were called antidiluvian two generations ago. This essay invites even worse abuse in making a more audacious claim: that there is a relation between one's concepts of knowledge and the methods one uses to organize them. The method is like a container and the container one chooses affects the knowledge one seeks to contain. To this extent Plato's system was not entirely a matter of opinion and knowledge systems are something quite different than the cyclical seasons or the cycles of fashions. As containers change so, too, do their contents and their quantitative horizons: 50,000 was a large number for cuneiform tablets. A million pergament manuscripts at Alexandria set a record in that medium which was never surpassed; c.10-15 million printed books has been the maximum of the greatest libraries in London, Paris, Washington or Rome (unless of course one counts periodicals as do Leningrad and Moscow). The largest data banks, e.g. RLIN, are already larger than the world's biggest library in terms of titles if not yet of contents. One can only know as much as one can handle and what one can handle depends on the means one has of storing it. That is why the shifts from oral culture, where knowledge was memorized; to scribal culture where knowledge was handwritten; to printed culture, where knowledge was organized in books were such momentous events in the history of civilization. And that it is why the shift to computer culture where knowledge is digitalized is much more than a technical or an economic change. It will alter the horizons of what is known so basically that it will transform the very nature of what it means to know. To illustrate this it will be useful to review basic changes during the past 2500 years. We could go back further, but then it is obvious to everyone that the civilization of Greece was a great advance over cave persons. Why Plato could not have our concepts of knowledge is less obvious. So let us begin there.

2. Plato and Mental Knowledge

In Greece the shift from oral to scribal culture had been heralded by the Homeric tradition. By Plato's time scribal methods were winning the day, as is attested by the very existence of a collected works of Plato. Yet Plato is highly complex partly because he remains nostalgic for the old method. In the *Phaedrus*[1] he makes an impassioned plea for the value of memory and issues a stern warning that those who depend on written manuscript learning will find their memories getting out of practice. For him the new container is a threat. To understand why, we need to examine Plato's concept of knowledge.

Plato associates reality with the world of ideas. In the case of a temple he holds that the universal idea of a temple is real and that any physical temple such as the Parthenon is merely an imperfect copy which is less true than the archetypal idea. The world of ideas is described as if it contained visual knowledge, but this is not the case. A picture of a temple is usually of a particular temple. By contrast the word *temple* is universal: it does not per se refer to any one temple. Ergo Plato's concept of knowledge is based on verbal knowledge, not visual knowledge. For Plato rhetoric is more than a clever way of arguing socratically. It defines the limits of his mental concept of knowledge, as becomes evident the moment we consider the problem of communication. Plato may claim that he can visualize the idea of a temple in his head, but any attempt to share this idea visually requires drawing a particular rather than a universal building. Even if universal ideas could be mentally pictured they cannot be physically drawn. No objective model is therefore possible. Even a standard of comparison cannot be established. Examples such as the Parthenon may offer a good example of a temple, but because it is particular, it is not universal and therefore detailed knowledge of the Parthenon, or any other actual temple, falls outside of the scope of Platonic knowledge. Since there is no visual standard, neither concrete examples nor drawings count, and Plato is forced to fall back on verbal formulation. Discussion with others in universal terms can at best bring a verbal consensus. Dialogue is not just the form of Platonic knowledge. In a sense it is also the content. That is why Plato debates a great deal about knowledge but never argues for an encyclopaedia of knowledge.

The consequences of Plato's approach are not superficial. First, since reality is assumed to be in the world of ideas, all that occurs in the physical world is outside the scope of both reality and knowledge. All human effort in making new temples is not significant. There is no need to record variations between temples in Greece, Sicily, Italy and Turkey. None of this is knowledge and Baedeker does not need to be written, let alone read. Second, since the reality of the world of ideas is held as eternally true, the idea of a temple must remain static. Changes in the building of temples, developments in building practices are of no serious interest. A history of temples is not necessary, because it has nothing to do with real knowledge. (Inevitably modern individuals who defend Plato's point are usually those without a sense of history).

Third, the idea of a temple concerns a temple on its own, independent of any context. Whether a temple was built on a hill or in a valley, whether it dominates its setting or is dominated by the surrounding environment, whether it be large or small, are again questions outside the scope of Platonic knowledge. Geography, environment, and ecology are like history in Plato's system: there are no ideas for these dimensions which would complicate the static perfection of a pure idea. Hence Plato may claim knowledge about the eternal idea of a temple, but even if he had lived to see it, he would have had no way of explaining how temples led to churches, or how Santa Sophia could start as a church, become a mosque and then a museum. Indeed Plato's static concept of temples means that there can be no dynamic knowledge of their function and hence no understanding of their changing social and cultural significance. (Alas, those who plead for social context in our day are often still using Plato's assumptions).

This relates to a fourth problem that takes us beyond temples to the persons who build them. If universals be reality then there is no room for individuals. Persons are of interest to the extent that they reflect universal qualities in the form of abstract ideals: beauty, the good etc. These characteristics are static. Either one is beautiful or one is not. Personal growth, development, change, transformation, history, geography are unimportant. In this context individuality is not worth noting, uniqueness is a hindrance. Hence everyman may get a mention but never plays a significant role on the Platonic stage. The scene is set for godlike abstractions, not human beings. The world of ideas leaves no room for a world of humans with faults and failings, worries, hopes and dreams. As a result, while Plato may theoretically promise everything in universals, both his macrocosm and microcosm are devoid of individual practice and experience. There is a deductive structure where abstract concepts of law, politics, language and love are the big topics, capable of being verbally argued but not visually seen, incapable of being tested let alone recorded or shared. As a result, any socalled discussion of truth boils down to a set of questions which increasingly confine the scope of the answers until a socratically planned conclusion is inevitable. Hence Plato introduces a funnel-like linearity into knowledge, a linearity that is also a straight-jacket. While Plato is brilliant, and inspiring in his search for truth, his container for knowledge is more about talking than worth talking about. There is of course a school which insists that Plato was deeply involved in mystery cults, that he deliberately veiled his writing to prevent it being misused by the uninitiated. This is fully possible, but if he had secret knowledge, it will remain a secret forever. It does not change or increase the success of his text in communicating his intent.

3. Aristotle and Parchment Knowledge

Being Plato's student, Aristotle inherits his teacher's framework, and one can trace the consequences especially in theoretical works such as the *Metaphysics* or the *Prior* and *Posterior Analytics.* Yet there is a difference. Whereas Plato emphasizes mental knowledge and the wane of memory, Aristotle has no such qualms. He accepts writing as a fait accompli, and the new container affects the contents of his knowledge. Plato wrote isolated dialogues. Aristotle's works follow a larger plan. When he deals with a problem in the *Physics,* he reminds us that he has dealt with other aspects in his work on the *Senses* or in the *Metaphysics.* Because there is a system in which facts are written down, there is room in Aristotle's container for more than universal generalizations. Individual plants, rocks and other objects that his student, Alexander the Great, brings back from India can be included. Temporal and spatial variants are noteworthy, as exemplars of or seeming exceptions to the grand theory, rather than for their own sake. This appears to open the way to encyclopaedic knowledge. It makes possible the library at Alexandria and the parchments of Pergamon, but they burn down and the possibility of a new order of knowledge fades. Aristotle does not replace Plato. Both approaches continue together. And as long as the container remains even partly mental there is inevitably conflation between container and contents, and the temptation to remain self-contented is usually too great. For minds less ample than Aristotle the container is more seductive than the contents. Saving the appearances remains more important than studying what lies beneath them. Parchment knowledge opens another course, for since the container is initially blank, a distinction between container and contents is implicit. But in this case, the leap from implicit to explicit takes longer than one might have expected. There is an intermission of 1500 years.

4. Aquinas and Scribal Knowledge

Some basic changes occur during this intermission. The Judaeo-Christian tradition with its concept of creation out of nothing introduces a new approach to reality. The physical world created by God is no longer an imperfect copy of a world of ideas. It is real. So, too, are man, woman and person-made objects. Given creatural realism, as Auerbach calls it, the abstract idea of a temple no longer constitutes an essential aspect of knowledge. Universal characteristics of a temple become secondary. Of primary importance is knowledge of a particular temple and its individual characteristics. The Athenian Parthenon is no longer an imperfect copy: it is a real example worthy of study. This applies equally to other temples. Variations in size and shape of a temple are no longer embarrassing departures from the ideal. They are worthy of study in their own right. Since particular examples are more important than a universal exemplar, the concept of a temple cannot remain static. Temples change with time. A history of temples thus becomes possible and necessary. Moreover each particular temple involves a specific location, setting and context. Whether a temple is on a hill or in a valley is now a dimension of knowledge. Creatural realism implies that things change temporally and spatially and thus requires both a history and a geography of temples. With Marco Polo a new body of travel literature emerges which serves as repository for this deeper interest in spatial-temporal variants. However it is some time before library systems adapt themselves to store these new facts in ways that offer good access. Much progress is not possible until the advent of printing again rearranges the shelves and even then only a linear order is possible.

The implications of scribal knowledge for persons are no less dramatic. Since God created man and woman in His own image and likeness, an opposition between ideal and material disappears. Body and soul are now wholly related. Since man and woman have been created out of nothing, a static norm is untenable. Since persons have sinned from the outset, the pretence of godlike perfection is more than hybris: it is a patent fiction. Change, growth, development are realities. An open, dynamic approach to knowledge of things and especially of persons is required. There are also subtle changes in the container. First, since the created world is real, the mental world of ideas cannot really be the container. Hence while the mediaeval period witnesses ongoing contentions about Plato vs. Aristotle, not least in the form of a protracted debate about universals and particulars, Plato inevitably loses and so, too, does mental knowledge. Paper knowledge now dominates and, instead of writing on scrolls, bound manuscripts become the norm. These can be shelved more systematically in terms of size and even arranged alphabetically. The whole process of what we now call data entry has changed also. Texts are still written by individuals. But the corpus of knowledge is seen as the domain of scribes working in scriptoria. Knowledge is teamwork and a cumulative process.

In retrospect all this is obvious and can be summarized in one sentence: there was a change in the meaning of content and the shape of the container. It is important however, to remember that it took 1500 years to get from the works of Aristotle to the *Summa* of Aquinas. And even Aquinas was not fully aware of all that was entailed in redefining content and altering the shape of the container. Aquinas saw himself as recovering Aristotle and hoped that it was only a matter of ironing out a few discrepancies between the ancient master of those that know, other Ancients and the Christian faith. His hope was shared by a series of remarkable individuals in the period 1200 to 1500: Roger Bacon, Albertus Magnus, and Ficino in philosophy; Dante and Petrarch in literature, Raphael in painting. It was not until the early 16th century which brought Leonardo on the one hand; Luther and the reformation on the other, that hopes of a grand synthesis waned. Or, more precisely, they took on a new form.

5. Leonardo and Visual Knowledge

A created object is something individual and a commitment to know individuals leads in unexpected directions. Mental picturing will not do, because it is, as we have shown, ultimately solipsistic, telling us about the picturer rather than the pictured. Nor can verbal images suffice, because they describe universals, a class of all churches rather than the particular church around the corner. Individuals involve a new kind of knowledge and require a new kind of study. Hence the socalled revival of art at the time of Giotto is quite distinct from a simple rebirth of ancient methods. Rather than seeking to link a universal concept in the mind to a picture, the challenge is increasingly to establish a one to one correspondencece between an individual object and the canvas. This new quest leads via Brunelleschi, Alberti, Piero della Francesca and Leonardo da Vinci to the development of perspective. A correct perspective drawing of a regularly shaped object requires coordination of a ground plan and elevation and thus introduces a systematic approach to representation. In the case of irregularly shaped organic objects perspective requires coordination of four to six viewpoints. Nor is it simply a question of representing the surface of objects. There is now a challenge of recording various layers. In the case of a hand there are layers of skin, tissue, nerves and bones. Knowledge of a hand thus requires four views times the number of levels, i.e. 40 drawings in Leonardo's case. And since he is also concerned with temporal changes, that is, tracing differences between the hands of a child, boy, full grown man, and an old man, this series of 40 needs to be repeated four times. A hand thus requires 160 drawings. Leonardo's visual knowledge of a hand is very different from Plato's mental knowledge of a hand in the world of ideas. Plato's hand can only be discussed. Any attempt to record it visually is inevitably as a poor copy of the original. Indeed there is no way of communicating the original. In Leonardo's method the extent to which a reproduction is accurate can be measured. Hence there is a means of testing how successful was the attempt. Knowledge is also no longer static. One can make four drawings to gain some knowledge of a hand. One can make 160 to gain a detailed knowledge. But one can also go further. If one has a microscope and is able to distinguish 100 layers, then one could make 1600 drawings. Leonardo does not do this. The printing techniques of his time are not even able to deal with his programme of 160 drawings for a hand.

Perspective also brings with it a use of instruments for recording objects as drawings and reproducing these. Instruments establish geometry as a means of recording and demonstrating relations between objects. Because these geometrical relations are visual they can also be measured in terms of arithmetical numbers. Hence the ancient opposition between geometry (continuous line) and arithmetic (discrete number) is gradually replaced by an approach where both can be integrated, where numerical values are catalogued as geometrical coordinates in Descartes' analytical geometry. These results can be recorded algebraically so, paradoxically, these advances in visualization are simultaneously advances towards abstraction

This visual method creates a new kind of knowledge very different from either Plato's abstract ideas or Aristotle's concrete definitions of essence. Where Aristotle pursued closed notions of quiddity Leonardo embarks on an open search for function in terms of relations. His notebooks are records of experiments and at the same time experiments in finding a container that will do justice to his new approach. The problem is a profound one. Plato's knowledge boils down to a verbal argument which requires that one establish a line of thought and once established this can be recorded in linear fashion in a written text. Aristotle's quest for substance is equally amenable to this linear textual approach. Visual knowledge in terms of relations and layers is different. In the case of a hand one can start at the surface and work down to the bones. But at other times one may prefer to start at the bones and work up to the surface, or try other combinations. Unfortunately a text is a container that limits one to a chosen linear sequence. Leonardo recognizes the problem. His interim solution is to keep his anatomical drawings unbound. But this introduces other limitations because as the pile grows there are increasing problems of finding the loose sheets one wants. Printing has the same limitations as writing in this respect. Indeed it has taken nearly five hundred years until computers provided a new container with a solution to the problems introduced by Leonardo's visual knowledge. RAM (Random access memory) is much more than an acronym: it implies a new approach to the philosophy of knowledge.

6. Diderot and Printed Knowledge.

Changing containers of knowledge is a much slower process than is generally recognized. In the case of printing for example it appears that the basic technology had been developed in Korea by the twelfth century. It took until the 1450's before Gutenberg attached his name to the techniques and set Europe on its unique course. Even so it took nearly eighty years before scientific texts began to be printed at all systematically. It took one hundred and fifty years before real equivalents to medieaval encyclopaedias appeared in printed form and over three hundred years before Diderot and D'Alembert created their famous encycopaedia, and this was more a record of the latest techniques than a genuine attempt to deal fully with the history of each subject. Nineteenth century visionaries such as Müller, Fox and Montelius saw the necessity of including historical dimensions and laid the foundations for such an approach. There were even rare cases such as the *Real-Lexikon für Altertumswissenschaft* which sought to collect all written knowledge in a particular field. But aside from elementary line drawings this great project made no attempt to catalogue the enormous visual material concerning Antiquity. Hence the advent of printing may have seemed a container to replace all others. Its impact was enormous as witnessed simply by the existence of more than 70,000 libraries with over 2.3 billion books in Europe alone. It introduced a cumulative dimension to knowledge. Yet five hundred years of experience have brought to light five fundamental limitations in the method. One is the problem of natural limits to the amount of books that can conveniently be stored even in great institutions such as the British Library and Bibliothèque Nationale, new buildings and visions of a TGB (très grande bibliothèque) notwithstanding. A second is that precisely in these great collections books get worn out by use faster than they can be restored; a third concerns the consequences of linear presentation broached earlier. Fourth there is the inability of printing to deal effectively with visual material. Indeed 500 years of printing have produced fewer results in this domain than thirty years of microfiche. Fifth, while isolated editions and occasional series have had many cumulative dimensions, the inability of the publishing trade to initiate large scale systematic projects has led to an ever more fragmented view. The encyclopaedia, which once set out to catalogue man's knowledge of the universe, has dwindled in scope where even in its macropedic form, it serves merely as an introductory map to the vast territories of things known. We have come to a stage where there are so many specialized bibliographies that even Besterman's bibliography of bibliographies is only a rough guide in a terrain that requires years of training. Gutenberg's vision that books would simply replace manuscripts has been less true than many imagine. Even today a great number of manuscripts have never been published in printed form. Indeed in many collections, even seminal ones such as Madrid, a number of manuscripts still await to be catalogued. Most major collections of books have either never been completely catalogued or are in desparate need of being catalogued anew.

7. Idealized Creatural Realism

Physical containers impose certain limitations on knowledge. In addition there are psychological and political containers that impose subtle, often unconscious limitations on knowledge. One is idealized creatural realism. In the case of temples, for instance, the reality of individual temples is tacitly accepted. One concentrates, however on outstanding ones, treating these as corporeal manifestations of the ideal. Hence an example such as the Parthenon becomes an epitome of a temple, often to the exclusion of all others. Temples at Selinunte, Miletus, Ephesus or Aegina are ignored. The history of temples is overlooked. Moreover it is the structure of the Parthenon that is emphasized. That it is situated on a hill, its precise place on the Acropolis, its context is also downplayed. The fact that it lost many of its marbles, not just so-to-speak, is also overlooked, or the facts about each of these is recorded in isolated terms such that only a fragmentary sense of the whole remains. Knowledge becomes impressive facts, bookish, dry and ultimately devoid of the sensuous reality of that which once was there. Or, if this be attempted, it is through a highly idealized model in the form of an artist's reconstruction.

The implications of this approach for the way one treats persons are even less desireable. Idealized persons ef exceptional beauty, intelligence, physical strength etc. are made the focus of attention. The average person is given minimal attention or overlooked altogether. Qualities and talents of these idealized persons set them apart from their fellow men. Extraordinary talents are often seen as a means of gaining supremacy over ordinary talents. Supremacy assures financial and other means to do as one pleases, concentrating on one's own advantage. A metaphorical ladder of success seen in Darwinian terms of survival of the fittest emerges.

In modern society the constant emphasis on idealized persons in advertisements in the mass media, make the average man, everyman, feel hopelessly inadequate. By way of defence an inverted superiority complex emerges. This appears to confirm the vertical image of class perception. Human qualities that all individuals share are thus obscured, as are unique aspects of each individual. Personal differences are translated into impersonal conflicts unwittingly dedicated to destroying talents which are the heritage of humanity as a whole. In self-defence the talented retreat, which appears simply as an admission of their guilt. The few thus become scapegoats for all that is bad. A rhetoric of the bad few and the good many leads the average man to strive for abolition of all that is extra-ordinary in his fellow-men. Elitism now appears as a root of all evil. In this context, intelligence is wasted and knowledge is often forgotten.

8. Materialist Creatural Realism

Materialist creatural realism is a more complex variant. History and geography are interpreted causally. History becomes a story of progress towards intellectual concepts such as freedom, liberty, equality. etc. Concrete objects are subordinated to these abstract concepts. For instance, if a fortress such as the Bastille becomes a symbol for the history of liberty, the date when it was stormed becomes crucial, but other facts, when it was built, its early history, its context, are forgotten. A conceptual teleology subordinates and limits history and geography to key ideas, ideologizes everything, and screens out most knowledge. Thus knowledge of other fortresses is irrelevant. A complete history of temples is unnecessary. Examples are not studied for their own sake. Only those which illustrate the ideology are valid. Knowledge cannot be cumulative in its fullest sense.

This can lead to an even more sinister form of elitism: extraordinary talents are encouraged, fostered, rewarded privately but are not publicized, except occasionally abroad for political reasons. Officially attention is focussed on the average man, everyman. Universal equality is rhetorically asserted. The average man is encouraged to be self-satisfied about his mediocrity. The value of any independent effort is denied as are all spiritual dimensions. Attention is focussed on historical necessity. Although supposedly deterministic the goal needs to be worked for collectively. The promise of an abstract paradise now seems to have its material equivalent on earth. Particularly attractive is the important role given to everyman in achieving this goal, and the promise that everyman will benefit from the results. To lend credibility to these hopes, knowledge, especially in the form of news, is filtered to show constant progress, with a rhetoric that earthly paradise is just around the corner and would be here already were not others preventing this. With both a goal in sight and an enemy defined the ideals blind everyman from examining the situation more closely.

Extraordinary talent forms a criterion for this type of elitism, but the talent is used to prevent everyman from uncovering the fundamental lie upon which the system is based, namely that the few who are rhetorically helping everyman change his pitiable state are precisely those exploiting him and determined to keep him there. Indeed the elite has what the have-nots are lacking but hides the fact by taking five basic steps. First the blame is laid elsewhere. Second, there is an effort to prevent everyman from thinking critically: i.e. from developing a creative scepticism which doubts, considers alternatives and asks penetrating questions. Third, everyman's access to knowledge is severely restricted such that even if doubts arose there would be no means of checking the information personally to arrive at an independent point of view. Fourth, all evidence of spiritual dimensions is downplayed. Religion is suppressed. Culture is supported only insomuch as it can be reduced to technical mastery: ballet and circuses fare equally in this framework. However, poetry, painting, and literature tend to be attacked. Precisely because all spiritual dimensions are dismissed as escapist, there is a tendency to seek escapism in alternative forms such as alcohol, tobacco or hallucinogenic drugs. In severe contexts these forms be they vodka, drugs such as crack and heroin or some combination are actually supported by the political system indirectly while rhetorical campaigns are officially launched against them. Fifth, military power is used to remove any ambiguities. In this context knowledge may advance dramatically in isolated departments, but the system prevents its free development.

9. Computers and New Knowledge.

Computers are new containers offering remarkable new advantages and possibilities which will be considered presently. There are however genuine dangers involved in using computers and we shall consider these first.

9.1 Dangers

Directors of political systems who misuse knowledge in the ways discussed above will try to employ computers for these purposes. This is a serious danger precisely because computer knowledge is inherently different from mental, parchment, scribal or printed knowledge. Mental knowledge of Plato's type may rhetorically claim universality, but since each individual has its own version of what constitutes this universality, there are inevitably many contentions about, yet ultimately no criterion for, a single, standard version, notwithstanding Popperian convictions that the roots to totalitarianism lie therein. With parchment knowledge, it may be very difficult to make copies, but the need for them is built into the system. If Athens is to be the centre of an empire it must influence the provinces. For this to happen Ephesus, Miletus and other cities must have copies of documents. With scribal culture, where knowledge is dispersed in various monasteries, this process of decentralization is institutionalized. Printed knowledge takes this process further. The success of a publication is defined by the number of copies sold. Unless copies are dispersed the whole process of printing makes no sense. Hence mental, parchment, scribal and printed knowledge have all had a decentralizing effect.

At one level computer knowledge continues this process. The very concept of a personal computer implies a tendency where every individual will eventually have its own machine. But this is deceptive. Having a computer may be within the reach of everyman. Having a computer large enough to deal with vast bodies of knowledge will almost certainly never be. Nor would it make much sense. In a library of manuscripts or printed books, a document can only be read by a person who has travelled to the document and consults it in the library and therefore it can only be studied by one person at a time. A complex manuscript may well be monopolized for weeks at a time. In a computerized data bank an electronic version of the document can more easily be downloaded to a person's home than to a machine on the premises. That is why the spread of computers and the spread of modems are so integrally connected. Computers imply networks. This introduces three fundamental advantages. First, it saves the cost of large new reading rooms. Second, the person no longer has to travel to the document (unless they are doing specialized work involving binding and other techniques). Third, because it can now be downloaded within seconds, the document will no longer be monopolized for days or weeks on end. These advantages tend to obscure a basic implication. While computers lead to decentralizion with respect to terminals they lead to centralization in terms of the knowledge on which the terminals rely. This makes computer knowledge fundamentally different than all earlier types, and will appeal to those wishing to instate big brother models.

There is yet another problem. As more knowledge becomes available on computers there will be a temptation to rely entirely on computers for knowledge; to assume that all that can be known lies on the flickering screen. There is an analogy here with the book. A person can read about ecstasy and pain, joy and suffering, love, death and other profound experiences and learn much. But no amount of reading can replace the actual experience. So, too, with computers. The screen can show individuals in very different situations but can never substitute human interactions; it can show experience but cannot give it. The screen can show works of art and list the techniques of art, show examples of creativity but cannot give it. Becoming a writer, an artist, a creative individual, an inventor, a profound human being, is always something far beyond a screen.

9.2 Safeguards

Steps can be taken to safeguard against these dangers. At the outset it must be made clear that computers are an introduction to life not a substitute for it. The programmes they contain should point beyond the computer into the world of experience; should stimulate persons to independent, inventive and creative action.

With respect to political dangers, there should be competition in systems just as there is competition in telephone and television companies. In the United States RLIN, OCLC and commercial firms should become compatible but keep competing. In Europe there is a tradition of more than one national library in a country. Italy for example has national libraries in each major region: Naples, Rome, Florence, Milan and Venice. This should be continued for three reasons. First, because they continue to collect books, each centre will have material to develop their own standards for retrieval. Second, this will in turn ensure resistance against the imposition of standards from an outside centre. Third, each of these centres can nonetheless serve as a backup for an implicit master copy. Discrepancies between local standards and this outside version can thus be studied.

The recent upsurge of nationalism and regionalism may seem a nuisance but actually provides another safeguard. It ensures that local languages and dialects are kept alive. It is relatively easy to manipulate one international language such as English, Russian or Chinese, and big brother systems will seek to employ these. But as long as each region insists on access in its own language, any outside system will need to be translated into all these languages. At the world level, even considering only well established languages, this complicates the problem of manipulation several hundredfold, and if regional dialects be included, several thousandfold. If a would be big brother ignores these variations he will not communicate. If he learns all the variants he cannot remain in his original narrow framework. Even so as an outsider he will always find himself being caught out. No one person can master all languages and variants.

The most effective safeguard lies in education. Each advance in medium, from verbal to manuscript, manuscript to printed book, increases the danger of the information or knowledge being accepted uncritically as true. In that sense Plato was right. In book culture we have all met naïve persons who insist that any published fact must be true: it says so here in black and white. When one encounters university students who still believe this, one can have them compare an American and English definition of the same term; examine how different encyclopaedias treat a same individual or event in fundamentally different ways; show how even important reference works such as the *Dictionary of Scientific Biography* range from entries which are exemplary in their scholarship to others which are wanting, emphasizing certain historical figures, while omitting others. Or one can demonstrate how adherence to a political party or philosophical school has dramatically affected treatment of events, biography, and even the choice of topics, the problem of containers mentioned earlier.

In the case of computers the danger of an uncritical attitude with respect to contents is more acute because there is a temptation to enter claims without sources. Users must learn to insist on a source for any claim made. Their high school education can introduce them to comparing knowledge in published books with that in databases and claims in one database with that of another. This is why access to different systems which provide different standards for comparison is so important. And given such precautions the legitimate fears and warnings by scholars of the generation who lived through the political horrors of the 1930's and 1940's will largely be allayed. If the dangers are truly so great why, one might ask should one even bother taking the risk? The answer lies in the extraordinary new possibilities introduced by computers. To these we now turn.

9.3 Advantages

One fundamental advantage of computers lies in a multi-linear approach: i.e. a possibility of multiple access or polyvalent ordering. We have noted that Plato's mental knowledge communicated itself in a line of argument and that subsequent methods, parchment, manuscript and print increased emphasis on a linear development. Ideas were arranged in a given order and thereby limited to that sequence. For Plato to change the order meant changing the argument. For scribes changing the order required rewriting the manuscript. In the case of printed books, tables of contents and indexes marked efforts in the direction of polyvalent access, but it remained the case that any change in order meant publishing a new edition of a book. Computers cannot change the nature of text. But if facts are arranged into fields these can be presented in a number of ways: alphabetically, chronologically, geographically, etc. To understand this principle more fully it is necessary to examine its consequences for different categories of knowledge.

Knowledge as Plato, the scribes and publishers knew it was predominantly limited to verbal knowledge in the form of words. Six basic types of verbal knowledge emerged: classifications, definitions, explanations, bibliography, contents and texts. Linearity imposed restraints on each of these, mainly in the form of exclusion. For instance, a library which arranged its books according to the Dewey Decimal system, was unable to use the Library of Congress system of classification. With a computer the books can remain on the shelves in the order prescribed by Dewey and at the same time be accessible using different classification systems, each of which is effectively an alternative means of cubbyholing concepts of knowledge. Hence it becomes possible to examine the extent to which the systems of Bliss, Göttingen or Ranganathan use the same concept and to what extent they use quite different concepts and cubbyholes in classing a given work.

In terms of names the consequences of computers are equally profound. Written and printed catalogues require choosing one name to the exclusion of others. In the case of Leonardo da Vinci for instance this means deciding whether it will be listed under Da Vinci, Leonardo; Vinci, Leonardo da; or Leonardo da Vinci. A written catalogue can provide see also references but frequently does not. Hence if I am in the British Library where the catalogue of names is over 500 volumes this means potentially needing to walk to three different places before locating the list that I want. In the case of Arabic names, where transcriptions are multiple, and there are often western versions it may take ten minutes to learn whether a book by Ibn al Haitham is under Ibn, Al, Haitham or Alhazen as he was termed in the west. Computers remove this bother by listing all variants in such a way that they automatically lead back to a recognized standard. This holds equally for place names which vary in different languages (Liège, Lüttich and Luik are the same place) and at different times in history (Constantinople is Istanbul; Petropolitanus or St. Petersburg is Leningrad. Middle Europe and the Balkans are full of such polyvalent places). Computers will serve as a super gazzetteer both in giving access to a recognized standard and listing variants.

Definitions have traditionally posed similar problems. They were collected together in dictionaries according to a given system. To choose Oxford meant looking specifically at that system. To check another definition meant consulting a different book often on another floor. Computers permit us to compare these different definitions without leaving the terminal. The same holds for alternative explanations which have traditionally been listed in different encyclopaedias, alternative bibliographical conventions and ultimately books, where the problem is more dramatic. In theory, classification systems are designed to assure that books on a specific subject are classed together. In practice many topics are borderline: perspective, for instance is regularly classed under art, architecture, mathematics and technology. In a library of several million books these classes will be hundreds of feet apart. In older libraries where large classes such as art or mathematics are often housed in separate buildings, the distances are often greater. There is a further problem. No library, not even those in London, Paris or Rome, has all the books and manuscripts on a subject. Hence anyone with a desire for comprehensive knowledge finds themselves spending long months battling with inter-library loan in search of rare editions. Computers offer a new solution. The latest technology permits one to store 340,000 pages of text on a single optical disc. Hence all existing verbal knowledge on perspective can be collected on one disc. Instead of having to search for books in different parts of a library, loan books from a series of scattered libraries, and acquire microfilms in the case of fragile books and manuscripts, one can have a knowledge package of everything in a given field at the press of a button, on a single screen without travel. Moreover an adaptation of the jukebox concept familiar from restaurants and bars of the last generation, gives one access to a whole series of such discs as if they were 45 rpm records. Hence this principle can be applied to any field and integrated to create a new kind of compact library.

The implications of computers for visual knowledge are equally striking. We have noted that Plato's oral expression translates visual experience into words, resulting in verbal-visual images which belong to verbal knowledge and thus preclude an independent branch of visual knowledge. Expression on parchment or manuscript permits some visual images: a rough sketch is easy; complex diagrams pose problems. Expression in print transforms the range of possibilities. Mechanical drawing devices such as pantographs, camera obscuras and cameras provide images with a quantitative dimension that permits establishing a scale between original object and record. The one to universal correspondence between an object and a word, is replaced by a one to one correspondence between a particular object and a particular picture. Hence the mechanical processes of image reproduction which introduce the factor of scale, establish the independence of visual knowledge from verbal knowledge. But while establishing the independence of visual knowledge, printing remains problematic: coloured illustrations are not introduced until the 18th century; coloured photographs only become practical after 1950; even in 1990 printing large numbers of illustrations involves prohibitive costs and images remain fixed to one linear sequence.

Computers offer no automatic solution to these problems. Analogue methods were originally of lesser quality than printed photographs. While digital methods are potentially of superior quality, they require enormous amounts of storage: up to 75 megabytes for one slide. Even so computers introduce two new factors of fundamental importance. First, images can be multiply indexed, accessed at random and quantitatively studied. A single image can be used for a book, an article, a lecture and a television programme. Hence the linear limitations of parchment, manuscript and printed media are transcended. A whole range of new questions is thereby opened. One can study quantitatively trends and patterns in image making: for instance how artists in one period emphasized sacred architecture, while those in another focussed on secular architecture. More specifically one can examine the popularity of key monuments such as the temple of Solomon, St. Peters, the Pantheon or the Parthenon and trace how this changes over time.

The second consequence of computers is that different scales of these images can be systematically correlated. Hence maps in different scales can be related to topographical views and aerial and regular photographs. This opens a whole range of further questions: the history of different scales in maps and parameters of accuracy. A history of scale in drawings is also possible: for instance, how artists in one period draw the Parthenon at a distance, while those in another period focus on details, while at another time there are efforts to relate drawings in different scales. Shifts from depiction of literary descriptions of buildings to drawings *in situ*; or to what extent to which buildings of the period encroach upon religious and literary paintings of the later middle ages.

An application of pattern recognition techniques to basic motifs in paintings will permit an automatic exploration of methods introduced by the Warburg school in the early decades of the 20th century, with the profound addition of a quantitative dimension. In the case of individuals, the changing emphasis on classical and/or biblical figures can be traced; whether the Old or the New Testament was favoured; which scenes in the life of Christ are emphasized; whether early Christian or mediaeval saints are featured; how the number of themes from their lives changes; or what parallels there are between developments in painting, sculpture, theatre and literature. In the case of architectural forms the complex interplay between mediaeval and classical exemplars can be studied; how a given motif spreads throughout a region and a period; how some motifs become standardized and perfected in this process; how these motifs in painting practice are recorded and formalized in perspective treatises and architectural literature; how printing changes this interplay between practice and theory, such that theoretical works gradually become models for practice. All these and more are questions which cannot be tackled without the use of computers. With visual knowledge, as in the case of verbal knowledge, computers give access to new amounts of material systematically and from multiple viewpoints. Besides introducing new levels of speed, this changes the nature of the questions that can be asked. Hence computers transform art history, literary history, and our whole awareness of how history affects culture.

Computers also transform mathematical knowledge. In oral culture mathematical knowledge is limited to arithmetic (numbers) and geometry (figures) both of which remain closely connected with verbal knowledge.There are serious claims linking the rise of mathematics with the emergence of literacy. In some semitic languages letters of the alphabet also function as numbers. With oral knowledge it is impossible to impose a widely accepted corpus of mathematical symbols that will remain fixed. This requires codification (the term is significant) in parchment or manuscript. Even then the development of systematic tables is slow. After the advent of printing these become standardized and a coherent set of symbols evolves. Oral knowledge establishes a distinction between continuous quantity (geometrical figures) and discrete quantity (arithmetical numbers), which printed knowledge erodes by making evident that quantitative measurement of continuous quantityis most effectively achieved by discrete quantity. In linking a given geometrical shape with a particular numerical quantity, mathematical knowledge emerges as independent of verbal knowledge (where a given word is linked with a universal rather than a particular) and becomes linked with visual knowledge where a given figure can be linked to a particular object. This discovery brings the rise of practical geometry and applied mathematics, i.e. the use of quantitative methods with respect to the natural world which we now associate with science. Indeed most scientific knowledge in the early modern period turns on this discovery that visual knowledge and mathematical knowledge are fundamentally distinct from verbal knowledge[2].

In the 16th century the computation of the Rudolphine tables took Valentine Otto most of his life. In the 17th century trigonometric tables took Napier, Briggs and Vlacq years of work. Large computers can perform these tasks in minutes: hence their association with number crunching. This element of speed is very important: tackling a complex calculation is no longer something for which one needs to risk literally spending a lifetime. Yet these computational dimensions of speed and quantity are again but two aspects of the computer's significance. Mathematicians such as Mandelbrot, working on fractals have become aware that very large numerical calculations are practically impossible to interpret unless they are visualized and there is now a conscious move to bring back into focus connections between visual and mathematical knowledge. Only something visible can be measured. Only something measurable can be dealt with mathematically. Only something that can be treated mathematically comes into the domain of science in its narrow sense. A scientific formula is actually an abstraction of what has been seen and measured by a camera or other optical device.

Abstraction is the concept of scale in another guise. And just as computers allow the systematic ordering of different scales of drawings, they permit systematic correlation of different levels of abstraction. Microscopic and macroscopic information can now be ordered in terms of scale ranging from photographs in electron microscopes, to regular photographs, to measurements and formulae. In print media all this knowledge may exist but each scale is usually assigned a separate place: electron microscope photographs are in one laboratory or room of a library, regular photographs in another, drawings, sketches, diagrams elsewhere and mathematical formulae somewhere else again. By integrating these various levels of abstraction computers bring into focus the interconnectedness of different levels and kinds of knowledge. In a sense all this depends on its properties of speed and quantity, but the result is a qualitative contribution: in fact it changes our sense of what knowledge in the larger sense is all about.

When Cassirer set out to identify the distinguishing characteristics of ancient as opposed to modern science, he did so in terms of substance and function, noting that whereas Aristotle set out on a quest for quiddity aimed at finding the essential contents of a given substance, modern science has focussed on exploring how objects function, how they relate to one another under different conditions. Yet, given the nature of printed knowledge, even in Cassirer's time any new functions and relations were soon cubbyholed into separate classes which obscured their existence as if they had never been discovered. Computers allow these relations to be reorganized systematically. But, as we have noted, they are multilinear and thus not limited to any particular set of relations. Conflicting models can be used to arrange the same facts in different ways and compare them.

At present scientific knowledge is fragmented into narrow fields. A new coordination of knowledge will show many new connections between individual branches of science, showing for instance that mineralogy, botany and biology are all interdependent in a larger ecological context. Computers will help remind us that knowledge is as much synthesis as analysis and will thus allow a big picture in a new sense, one which is open to showing more inter-relationships from different viewpoints; where multiple viewpoints are a basic feature of its structure. By contrast, in all earlier systems changing the viewpoint meant restructuring the argument of an oral expression, rewriting a manuscript or making a new edition of a book.

Computers are more than a faster tool. They are transforming the very nature of what it means to know. This is partly because the term 'computer' refers to more than a machine on a desk. It is a collective term for a series of instruments ranging from compact discs, videos and televisions to international networks; a metaphor for devices covering the whole spectrum of recording and reproduction methods including oral, (written), printed, analogue and digital. This distinguishes computers from earlier recording processes and is of the greatest philosophical consequence. Transfer from an oral to a written record fixed the words in a new way. Transfer from manuscripts to printed records introduced further alterations, even if early printed books deliberately imitated the handwritten format. Transfer from a verbal description of the Parthenon to a drawing or photograph involved a greater translation. Hence, with all previous recording devices, the process of translation into a new medium transformed the nature of the record.

Computers with their analogue and digital methods are fundamentally different because they permit one to record an oral medium and reproduce it orally; record a text and reproduce it as text; record a picture and reproduce it as a picture. Computers thus introduce the possibility of reproducing documents in the same medium that they are recorded. This has profound implications for the notion of objectivity. In the past, the introduction of a new medium has always undermined consciousness concerning and even the existence of the medium that it was replacing. In this sense they all had a built-in anti-historical factor. By contrast, computers, which permit different media be they oral, printed or drawn to be reproduced as they were originally expressed, increase enormously the gamut of historical consciousness, throwing new light on complexities of space and time.

10. Conclusions

Computers are new containers. Thanks to the microchip revolution they have a greater capacity than previous containers. Where 50,000 cuneiform tablets or 1,000,000 papyri were once the limits of a medium, computers with 40,000,000 records already exist and there is every reason to believe that systems of 400,000,000 or 4,000,000,000 will work just as efficiently. However, the enormous numbers of documents which computers can store and the incredible speed with which these can be retrieved represent only two aspects of their profound significance. Their multi-linear nature permits new multivalent access; multi-scale correlation of verbal, visual and quantitative knowledge; multi-medial recording and reproduction of a whole spectrum of different types of knowledge. Computers are much more than a new tool. In transforming the boundaries of what knowledge can be contained and handled systematically, computers are transforming the scope of knowing and changing what knowing means.

The medium, said Marshall McLuhan, is the message. His medium is our container, and if he were writing today he would probably agree that the container is more than a message: it defines the horizons of what can be known. These horizons change but they are not merely a question of fashion or inclination. Each medium has its own limits to truth. In oral culture these limits are described by verbal laws of logic; parchment and scribal and printed culture gradually introduce visual and numerical laws; computers bring into focus the interconnectedness among different laws, show function, relation and scale, enabling us to see that the many details are not just random. They belong to bigger pictures and making bigger pictures is a basic act of knowing, because patterns and systems thus produced reveal important dimensions of structure, order and even meaning.

Those who have a linear definition of truth will find the multilinear dimensions of computers either a threat to their own line of thought or a confirmation that all lines are relative, that truth is merely relative, a matter of fashion, or outmoded altogether. Truth is not out of fashion, because truth is not a fashion. Those with a multilinear understanding of truth will understand that containers and contents may change, but the quest for understanding laws governing such changes is something more profound. These individuals will welcome computers as a tool rather than a threat, recognizing containers for what they are and keeping their eyes fixed on a truth higher than today's box, a spirit beyond the letter of today's law.

Notes

1. Plato, *Phaedrus*, 275A-275B, trans. R. Hackforth, in: *The Collected Dialogues of Plato*, ed. Edith Hamilton and Huntington Cairns, Princeton: Princeton University Press, 1961 (Bollingen Series LXXI):

What you have invented is a recipe not for memory but for reminder. And it is no true wisdom that you offer your disciples, but only its semblance, for by telling them of many things without teaching them you will make them seem to know much , while for the most part they know nothing, and as men filled, not with wisdom, but with the conceit of wisdom, they will be a burden to their fellows.

For another discussion see: Frances A. Yates, *The Art of Memory*, Harmondsworth: Penguin, 1966, p.52.

2. This new integration of arithmetic and geometry also leads via Descartes to analytic geometry and the rise of modern algebra. Hence these new links between visual and geometrical knowledge go hand in hand with a movement towards increasing abstraction. This has convinced some scholars that the emergence of mathematical knowledge requires a separation from visual knowledge. Other thinkers overlook that geometry, in addition to its logical axioms, also has figures; claim that visual expression is not an independent branch of knowledge; that words and numbers are subject to one set of logical laws, and thus conclude that language and mathematics entail the same kind of knowledge.

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