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Mankind's Memory Managers: a New Paradigm of Library Science

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Introduction

Library science is in ferment. The problems we encounter are no accident, but rather are the result of rapid development in the world of information. Library science has faced many changes in recent years, and, as a result, it is a discipline in need of revision.

Practically speaking, we can see that conventional library materials have been joined by a great variety of new types of records. Materials such as books and serial publications, and less common ones such as maps, manuscripts, and incunabula, which predominated for centuries, now compete with microforms, sound recordings, videorecordings, CD-ROMs, computer files, Internet sites, and so forth. All these items can be found on the shelves of virtually every library, irrespective of its size. The increased variety of records is the first and the most apparent change since the new technologies of recording became our everyday companion. Because of these new types of records, a library is no longer seen only as an institution where one can get hold of books. This new image causes misunderstandings, not only among users but also among librarians

Librarians previously used a card index to catalog materials. Cards have a compact form (still appreciated by librarians) because of space limitations that required a terseness of expression. When working with computerized bibliographic records such limitations no longer exist. Librarians may be confused by this freedom, as cataloging rules are altered and extended and get more complex year by year. Moreover, it often seems that the authors of the "improvements" to the rules do not know the exact purpose of this exercise and therefore they experiment. When we add to these changes the continuous improvements to computer hardware and software, we should not be surprised that some librarians are apprehensive.

We began by considering the problem of the diversity of materials, continued with the changeability of cataloging rules for controlling those materials, and now get to the root of the matter, namely the theory of the library science and the question of its subject matter and course of study. Examining the professional literature of librarianship makes it clear that the

problem is fundamentally conceptual. Such terminological confusion and vagueness can hardly be found in any other discipline. The need to draw a distinction between logical facts and aims and physical facts and technologies for achieving them on the other hand is more wishful thinking than reality. Some authors prefer to stress technological advances and recount all the available computer services, others fancy the image of the library as an information center, although they cannot tell you in detail what aspects of information they have in mind.[1]

First, we must establish some primary conceptual boundaries and, on that basis, try to illuminate some aspects of the domains of physical and logical. To put the practice of librarianship into the new social context which is introduced by digitization will be an experiment, a working hypothesis.

Analog and Digital Records

Life teaches us that human memory is not very reliable. If we look at history, we see various types of records that help us overcome this obstacle. Human culture preserves itself by means of these records. And it in is this social reality that the practice of librarianship is set. An objectivized memory, or, in other words, various types of records, are the subject of study of that aspect of library science which preserves and transmits materials to users.

Physical Carriers of Records

A book is first of all a physical thing, a bunch of papers bound together and written in ink. It is this physical fact that enables the tired memory to find a temporary domicile. Paper and ink can be replaced with other materials, but we still have to deal with some kind of physical carrier. At another level, a writing system can be looked at as an encoding system. This is the most common but not the only type of human record. Mathematical science often records its findings in a different graphical form (for example, the system of coordinates), the art of music has its own graphical system, as do, naturally, all the visual arts. All these systems are various forms of records. If we look at them from a psychological point of view, we can say that they are methods of noting down the products of the human mind (ranging from meanings to emotions and perceptions).

We have different types of records as well as different types of physical carriers. Therefore, heterogeneousness appears on two levels. The first level is the physical form of recording and the second level is the method of recording. One feature common to all the records exists at the level of methods of recording, and will be the focus of further discussion.

Analog Records

All conventional records, that is, records with no connection to computer technology, have one feature in common. That is a similarity between the form of record and what is written down.

Thus, a painting presents physical reality or other realities by means of spatial elements. The given reality (the recorded data) and the picture (the record) have similar spatial form. The similarity between the record and what is recorded is the most apparent in an area such as painting. If we take our argument even further we could say that the analogy exists within the field of visual perception (meanings conveyed and emotions aroused by a painting are here of secondary concern).

Musical transcription imitates the sequence of a melody in time. The feelings aroused by the music are of no importance for the record. The task of the record is only to make a record of sound. The structure of note transcription is similar to the structure of the tones of the melody in time.

Writing systems are the most widespread form of recording and, following Saussure, we can say that writing tries to copy speech (or, more precisely, the phonetic and phonemic structure of language) into a graphical form. We will not delve into the question of how meanings can be expressed by phonemic structure and what is meant by the notion that we have "only differences in language" (Saussure 1916). It is enough to see the analogy between the structure of a record (writing) and the phonemic structure by which it is written down. As the phonemes of speech are arranged in a linear sequence in time, so to the writing is organized as a string of graphical symbols.

In summary, the basic feature of records with no connection to computer technology emanates from the analogy between the form of the record and the recorded material. Conventional records are therefore analog records. (For the sake of accuracy, we should not forget to mention analog computers although they are very rare today.) So far, libraries have dealt mainly with books, and therefore this type of conceptual unification has not had much meaning (or was of little help). But with the appearance of computers things change dramatically. The appearance of computers presents many problems to be solved, and the development of uniform criteria for controlling heterogeneous analog materials is only one of them.

Digital Records

In the pioneering early days of computing, the first experiments were done on analog computers. These experiments were performed by computers imitating the continuous varying of physical quantities in time. The mathematical record that appropriately describes this physical reality is called a continuous function. Its characteristic is continuity analogs to the characteristics of physical quantities. The transition from continuous functions to discrete (discontinuous) functions marked the birth of digital records. The discrete functions operate with separate units called *intervals* in geometry and *numbers* in algebra. Looking from more

general point of view, records can be seen as one huge arithmetical operation written in numbers. There is no doubt that we have some kind of analogy between the record and the recorded material. Time-space continuity changes are in accordance with the rule of discretion converted into units that are functionally (arithmetically) connected. The terminological distinction between analog and digital (continuous/discrete functions) is commonly used in the natural sciences and we will use it for the purpose of our discussion.

For the sake of simplicity the binary pattern of a digital record consisting of 0's and 1's has prevailed. However, this should not be the reason to confuse binary and digital systems. The binary is clearly the most simplified but not the only form of discreteness. If we compare digital and analog once more, we see that a digital record does not mirror the direct form of the recorded material (its time-space continuity) but disunites the entire phenomenon into a great number of discrete mathematical calculations represented by 0's and 1's. Text becomes a string of signs with assembled computational value where the sequence itself presents some kind of computational value. So now we can understand analog records such as text, pictures, and so forth, as a representation of the recorded material in its given reality, that is, in time-space continuous form. The digital records transform this continuous form into discrete calculus.

As the elements of pictures have a linear arrangement in space and time, so too digital records do not represent only a large number of numerical entities but also put these 0's and 1's in some kind of mutual and functional (numerical) relationship. That this relationship is represented by patterns of 0's and 1's reveals the fact that this kind of record is actually simplified, namely reduced to a digital form. In short, digital records are complex (discrete) arithmetical operations. In a computer memory a full stop has some computational value, the place where it stands (for example, at the end of this and that sentence) has some computational value as well and so has the entire text and its parts (for example the paragraphs). Likewise, the software editor that shows us the text on the screen and the operating system that enables the operation of the editor also have some discrete computational values. Representation of these digital records in a form of analog records that are readable for us (which means that the digitized text appears on the screen as text) is also some mathematical function, or, in other words, a discrete mathematical calculation of graphical representation in one part of a device (for example, on the screen or the printer).

The distinction between "bites and bites about bites" (Negroponte 1996) is not very precise. It is only the surface appearance that is based on the analogy of the distinction between a book and a bibliography. The fact is that we have to deal with more then one level (operating system, user software, text and pictures, HTML tags…) and the levels are not always in a hierarchical order. There is a possibility of connecting anything with everything (to connect any record with every record). Looking from the viewpoint of digitization, the connection can be understood as a functional connection of two calculating values. As long as one calculating value is in charge of the operating system and the other creates the image of a Rembrandt the connection is possible, but it is only after the actual usefulness is considered that connections are really made.

Therefore, after the primary distinction between the physical carrier and the record was made, the distinction between the digital and the analog records was added (TABLE 1). Let us describe first the physical carrier of the digital records and see what are the advantages of the digital form of recording. In this way, it will be easier to pinpoint the differences between the digital and analog forms and bring out consequences of digitization for library science.

Hold and Transfer Records

In the *McGraw-Hill Encyclopaedia of Science and Technology* we can find the following definition of the digital computer: "Any device for performing mathematical calculations on numbers represented digitally; by extension, any device for manipulating symbols according to a detailed procedure or recipe." (McGraw-Hill, 1987: 256). There follows an explanation of what we in this paper called the physical carrier: "At the lowest level it is a network of wires and mechanical parts whose voltages and positions convey coded information." (McGraw-Hill, 1987: 256). And further it is said: "Numbers are represented within a digital computer by means of circuits that distinguish various discrete electrical signals on wires inside the machine." (McGraw-Hill, 1987: 256). If we simplify it, we can say that the controlled stream of electrons is the physical carrier in the computer that carries (and in this way represents) the digital records, this is, 0's and 1's that are functionally and mutually connected. All other forms of digital records (hard disk, floppy disk, CD-ROMs and so forth), are only additional or derivative forms that would make no sense without a computer, as it would not be possible to convert them into analog forms understandable to humans.

Now the notion of multimedia can be critically examined. At the level of a physical carrier, multimedia means a transfer of records by means of different physical substances (magnetic substance on a hard disk, electronic substances on the operating computer, paper substance on printer). At the level of analog records, multimedia means a combination of many kinds of analog records that function as a whole (for example, sound, picture, and speech in a film). With digital records, the two above-mentioned types of multimedia are complemented by the third type. That is the process of unification in terms of discrete calculating value that allows for interactive and convertible nature of complex records.

The main feature of digital records operating in a computer is their dynamics. These dynamics are twofold: physical and logical As digital records are, in physical sense, a stream of electrons, they are in the same physical sense very flexible. Compared with the printed book a distant transfer means a total inversion. As these facts are common knowledge, let us present them briefly. When a record is available in digital form, access to that record is unlimited--24 hour access from any place on the earth. It is up to a user (and technological possibilities) how to represent the record (screen, paper). Basically, this means that it is enough to have all of Shakespeare's works collected on one operating computer, and all the rest is a question of free reproduction of that digital record. With regard to the digital physical carrier we can conclude with the statement that digitization breaks down the physical barriers of time and space when accessing materials (records). When considering the electronic media such as telephone, TV, radio we can also notice that this barrier is partly

broken down. More about the differences between the above and digital media in the last section of this article.

Dynamic Record Instead of Fixed Record

"Two kinds of logical circuits are used in the design and construction of digital computers: decision elements and memory elements. A typical decision elements provides a binary output as a function of two or more binary inputs. ... A memory element stores a single bit of information and is set to the 1 state or reset 0 state, depending on the signals on its input lines." (McGraw-Hill, 1987: 257). Whether we deal with some kind of logical function of transformation (for example, AND, OR) of one kind of binary signal into some other signals or with binary memorizing of signals the conclusion is the same: digital records are in a logical sense (according to analogy) only discrete computational values. This fact in combination with the physical medium of existence of digital records (in the computer) enables also its extreme dynamic in terms of logic. One computational value is easily converted into some other computational value.

When looking at the conventional (digitized) records the changeability is less apparent. For example, a text editor allows us to make various corrections, combinations, selection and other forms of text editing. (An image editor does likewise). A whole variety of conversions is possible: changing a font, conversion of text into speech and visa versa. Search tools can browse any element or feature of text.

However, this dynamic can be seen very clearly in terms of logic if we look at some very recent forms of records. Digital records make possible the recording of "things" that were previously not possible by analog forms. Here, of course, we do not speak of audio and video records which existed before the appearance of digital records. An example would be something such as a computer simulation. Here we can see all the key features of this dynamic: in one complex record different kinds of analog records are mutually connected (as analog they appear only to us), namely, sound, moving pictures, and text, all this is provided simultaneously and in mutual connection. All the given elements are not fixed, as there is an interactive relation between elements and users, "players", as well as between single elements. The activity "on the other side" is the result of a computer simulation or the response of additional "co-players", users.

The most dynamic conventional forms of records, music and film, are also dynamic by themselves. A computer simulation, however, is a record of an interactive scenario, which is a feature of the everyday experiences or everyday practices of humans. When using simulation all the elements (records) appear in some time frame and have a mutual connection which is real. The notion of reality refers to frame of time and to the "lawful" mutual connections (for example, connection of 3D space, the plane in that space and orders given by the "player") while particular tactile and gravitational experiences and so forth are missing. Although a simulation displays a reduced record of everyday practice it still includes the basic information on a symbolic level together with the interactive connection of information in the time frame. All the activities and cognitive processes that you need to

perform in everyday life can be simulated in that record, for example shopping, sailing, taking an exam, making bank payments, and so forth.

Previously we found out that the dynamics of records on the physical level have a great influence on the accessibility of material. What advantages do the dynamics of records have for library science on the logical level? We can see that analog forms that are already digitized open new possibilities for searching and ordering materials. New digital forms which simulate social practices bring new ways of performing those practices. Library science is also part of social practices and therefore subject to the transition to simulative and automatic forms. Practices that are of symbolic nature (for example payment of money) can be completely digitized and carried out simulatively.

The transition to digital forms is gradual and in follows the development of technology. A suitable digital substitute for the book has not yet been found, and therefore a digital library science cannot predominate. However, there are more and more documents that can be exist in digital form and more and more users who find going to the library more time consuming than searching the Internet.

There are many unresolved matters in the domain of digital records, particularly problems of a practical nature, ranging from the question of adequate interface for the transfer of data to users to the possibility of records on different servers using a unified software (and interface). Unfortunately, librarians do not have much influence on the problems mentioned above and their only choice is to get used to rapid advances in technology from the commercial sector. However, this issue is beyond the scope of our discussion.

Dynamic Culture as One Complex Computational Value

If librarians hold and transfer the objectified memory of mankind, we have to add here that at the end of the second millennium this memory has gained its unitary digital (primary) form, and library science its unitary subject of study. For the first time in the history we are faced with a unitary form of record that is suitable to all forms of human expression. Questions arise such as when and how the user will get access to the records, how the records will be searched, what and how much will be “borrowed”. The answers to these questions are left more and more to the individual user. The task of librarians is only to get rid of time-space limitations when transferring material by means of digitization and to index the material in such a way to enable users to find what they search for regardless of the criteria used. Literally this means that one of the primary tasks of librarians in the next century is to digitize all existing analog records (first of all books).

The fact that not only the recorded forms of symbolic character (texts, pictures) that have been known until now but also the simulation of social practices (designing and planning, traffic routing, financial transactions) are being transferred to digital form forces us to draw conclusions that are beyond the field of library science. Digitization of human culture opens new possibilities of dynamic connections of everything with everything (on the symbolic level) as culture as a whole becomes one complex (discrete) calculation (according

to its means of functioning; the content of records is an entirely different question). The role that librarians will play in this new dynamic culture is not yet clear. Once we transfer commercial materials in digital form and by means of telepayment and in more or less automated form (computer simulation) then the question of free or non-free access is only one of the additional features of a record.

The oldest records (writing, sketches, pictures) are noted down using some special (graphical) patterns and the same technique is used even when some time frame is noted down (speech, music). The primary physical carrier of speech, the sound, needs to be restored by us while reading. Newly developed analog forms on film tapes or music records are able to preserve the primary picture-sound substance and reproduce it through a frame of time. However, this repetition of time dynamics is fixed and defined in advance.

Digitization can do more. Digital records can capture the interactive time connection between elements of a particular record. So, traditional analog forms where a particular symbolic communication is going on in some time continuum are being transformed into complex symbolic forms that combine text, sound, and picture interactively. These complex symbolic forms respect time-space limits by their nature in such a way that they simulate some time (and space) that is presented as an analogical form for the purpose of use. (Here time can be also accelerated or extended).

With regard to physical carriers of digital records we have already shown that whether it is lunchtime or bedtime, whether we are in the Antarctic or in Europe, makes little difference when the access to records is unlimited. While teletransfer is already a feature of some types of analog media, it is only with the appearance of digital records that all the possibilities offered by electronic media are used, since digital records as calculating values enable interactive and complex connection of elements of symbolic communication. We are faced with a kind of segmentation and rearrangement of time and space on both levels: on the physical (holding and transferring of records) and on the symbolic level as far as the form of record is concerned.

The ideology of digital culture is rough and sharp. The content of digital records generally comply only to a certain extent with traditional narration and its flow of action. The time and place of narration is falling apart. This is the feature that is already mirrored by modern analog forms. Consider the film *Pulp Fiction* where the flow of action is upside down. Other typical examples are TV-advertisements. The images alternate in quick sequences, now and then some slogans appear, events are linked by sound and sometimes vigorous background speech. The viewer has to connect the elements of the record into a meaningful whole. Our exploration of dissociation of records in terms of the content is done by using terminology which stresses the decay of time-space continual form. As the analysis of Ivan Kosovel shows the processes of the postmodern era can be explained only when we approach the problem from the standpoint of a subject: “In order to make the analysis of a context that results from the contemporary conditions possible we will have to part from the discussion of object and pass to the discussion of subject or, in other words, to the individual as a centre and medium of this never ending process of translation. The subject of the post-modernity lives in the world that is not constituted from one piece anymore and it is not

centred around two Cartesian coordinates. Furthermore, the subject himself is not centred anymore, or at least, not in terms of classical Descartian meaning of the word … First of all, we have to pay attention to the fact that the movement of the subject of post-modernity or let us call him 'alternative' subject, a subject in constant alternation, actually always happens within these entirely different 'worlds' of his own" (Kosovel 1994: 56-57). The question is not what is the primary source of these processes (form or content of records). The examples serve only as an illustration of some kind of resemblance.

It is only at the level of content that the issues concerning the so called "information age" are clearly established. Even when we try to define the term information[2] we are in trouble. We can ask ourselves a question: is fear in children's eyes information? The answer to that and similar questions would be less difficult if librarians distinguished between symbolic forms of information and all other (informal) forms of information or between recorded and unrecorded information. In making this distinction, our field of activity would become a social practice that deals less and less with books alone and displays a kind of managing of mankind's memory which is recorded in many different forms. Lately it has found some universal (mathematical) form as we have tried to show in this article.

Digital forms of mathematization have caused social relations, or the symbolic part of social relations, to become mathematically directly expressible. The new dynamic functioning of culture brings changes which are not confined to the field of library science.

1.You will probably agree that taking every piece of information into account is not what we have in mind here. I hope you share my opinion that it would be wrong to consider a news report on CNN to be library information. But you might not agree!

2. A proper definition of the term *information* would require more space and time then available here. Therefore, we will only briefly consider some aspects of the above term.

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TABLE 1

CONVENTIONAL AND MODERN RECORD	Analog record	Digital record
1st level: physical carrier	Fixed (paper, magnetic…)	Primary dynamic (controlled stream of electrons) + Secondary fixed (magnetic, optical…)
2nd level: form of record	Analog form (time space continuity form)	Dynamic discrete computational value + Simulated analog form of representation