SOME SCHEMES FOR RESTRUCTURING AND MOBILISING INFORMATION IN DOCUMENTS: A HISTORICAL PERSPECTIVE

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Abstract — Mobilising the information stored in documents to advance learning and social well-being provides information science with a fundamental social objective. It also presents it with a characteristic set of technical and professional problems. Until recently, information storage and retrieval systems, of which the library is one of the oldest and most important examples, have not provided a direct solution to the problem of providing access to needed information. Instead they have attempted to identify and provide physical access to written or printed documents that might contain information that is needed or might be useful. Perhaps creating systems to substitute what documents may be about for what documents contain is a process of realistic simplification in the face of overwhelming technical and "epistemological" problems. But it is speculative approaches to overcoming these problems that are the subject of this paper.

ACCESS TO KNOWLEDGE-CONTEMPORARY SPECULATIONS

It seems clear that to be more effective than they have been in the past in providing access to information recorded in documents, information storage and retrieval systems must go beyond the level of physical and intellectual access to whole documents. There are a number of modern speculative approaches, including those that involve hypertext and hypermedia, that suggest how this might be done (e.g., Council on Library Resources, 1988; Kochen, 1988; Jonassen, 1989; Davenport & Cronin, 1990). All have in common, though expressed in different ways, a recognition of the need to develop systems that will process the "information" that documents contain according to particular needs, so as to create "new" documents actively responsive to those needs. The systems proposed imply an enlarged view of what constitutes a document. They also attempt to deal with the different kinds of document formats entailed in this view -written and printed texts, numerical data, various kinds of images, objects and sound, for example.

Thus, these new kinds of information systems represent a practical response to an increasingly catholic view of what documents, information, and texts are. Their development in the last few years has been paralleled by more theoretical discussions by educators, systems designers, and researchers. The general problem of concern to them has been how to find ways of breaking down barriers to information management and the provision of information services that have arisen from different, but equally limited, conceptions of information, text, and document. These conceptual differences may be considered to have arisen as a result of the emergence, relatively recently, of "separate" modern professions of librarianship, archives administration, records management, and museology. Each of these professions has developed a characteristic form of organisational incorporation based on historically determined commitments to different technologies, media of communication and record, and primary client groups.

Over the past 20 or 30 years, however, there has been a growing awareness that what has been accepted as separating these professions may no longer be relevant and may have become dysfunctional (e.g., Rayward, 1983a, 1985; Buckland, 1991, 1992; Bearman, 1989,

1992; Saracevic, 1992). Such views find a perhaps unexpected echo in the recent re-conceptualisation of his discipline by one of the most distinguished bibliographers and textual critics of his generation. For McKenzie (1986), texts must now be regarded as "open, unstable and indeterminate," The role of bibliography is to record and explain "any structure of meaning which is recordable and discernible" regardless of how the texts are transmitted.

It is possible to place into a fairly long historical perspective some of the emerging approaches to broader information provision than libraries, archives, and museums have typically been organised to supply individually. Such a perspective may help us to clarify possible objectives for, and become more generally aware of the complexity of a modern information "profession." Libraries, archives, and museums, and the various forms of '*documents" that are their stock-in-trade are central to this profession, but it is important that identification of it not be restricted to any one of them. This perspective suggests that society has broad cognitive or epistemological requirements, the importance of which have long been recognised, but which have been extremely difficult to satisfy effectively. Setting aside their commitment to aesthetic values, modern libraries, archives, and museums, from this point of view, are to be seen as inventions, imperfect and evolving, for the institutionalised storage and retrieval of information (cf. Swanson, 1979). They have a long history of adaptation to changing social needs and of increasing technical sophistication. Their adaptability has been prompted in part by attempts by an increasingly professionalised cadre of personnel to overcome the limitations inherent in their current organisational manifestations, and in part by speculation as to what was actually needed for the effective mobilisation of knowledge in society.

ACCESS TO KNOWLEDGE-HISTORICAL SPECULATIONS

This paper presents a brief account of five schemes that represent speculative approaches to solving the problem of restructuring and mobilising the content of documents for use. These schemes cover, albeit unevenly and incompletely, a 300-year period. The discussion of these schemes, given the necessary limits of this paper, presents little by way of historical bac kground.

The Office of Publicke Addresse

Mid-Seventeenth-Century England was a period of great political, religious, and social change. The struggles between King and Parliament led to civil war, the execution of the King, and the Protectorate of Oliver Cromwell. A period of intellectual and religious turmoil, the Puritan revolution that had these momentous political consequences gave rise to widespread debate about education, science, and social reform, which resulted among other things in a massive increase in publication (Webster, 1975, pp. 489-491).

At the heart of much of the intellectual ferment of the time was Samuel Hartlib, known to his contemporaries as "the Agent for the Advancement of Universal Learning" (Webster, 1975, p. 71). John Dury, a clergyman, was a close friend and colleague, most of whose career was devoted to attempting to secure ecclesiastical pacification and reconciliation between the Protestant churches of Europe then caught up in the destructive ebb and flow of the Thirty Years' War. The first approach by Hartlib and his colleagues to what Dury (1642) called the "Reformation in Learning and Religion" (p. 97) was to speculate about how they might attempt to realise the pansophical ideas for educational reform of Comenius, the great Bohemian educator then living in religious exile in Poland. Comenius had been summoned for a brief period to London in 1640 by the enthusiasm and what he took to be the promises of his English disciples (Turnbull, 1920; Young, 1932). His ideas later influenced their conception of the functions of the Office of Publicke Addresse.

The first sustained public account of the Office of Publicke Addresse was given by Dury (1647). He proposed that a special kind of information bureau should be created under the supervision and with the support of the state. Its purpose would be to achieve a "well-ordered Society" by providing information for the "relief of human necessities." Dury suggested the Office would have two parts. One would be called the Addresse of Accommodations and would be concerned with information related to all the matters of

daily living. The second, the Addresse of Communications, would be concerned with information related to intellectual and spiritual matters.

The Office of Addresse for Communications was Dury's chief concern. Its functions were to provide to all those who might benefit from its work "Addresses and informations in matters of religion, of learning, and all ingenuities which are objects of contemplation and delight unto the minds of man for their strangenesse and usefulnesse unto the life of man." Particularly important to Dury was the way in which the Office would "facilitate the means of rectifying mistakes" and reduce disputes about matters of religious opinion and practice. It would do this by developing a body of what he called "Practicall Divinity" (Dury, 1653, p. 186). In his view, the Office of Communications would help to realise the ideas of Francis Bacon for the advancement of learning, on the one hand, and to "perfit Mr. Comenius undertakings" for the reform of education, on the other. The Office's technological function would be to seek out and make available the most useful kinds of inventions.

Dury thought that both the Office of Addresse for Accommodations, like that for Communications, would be directed by a Warden. Under the Warden's supervision, "all manner of registers, inventories, catalogues and lists" would be developed. The content of some of these would be permanent, whereas that of others would change from time to time, according to the kinds of information being recorded. In addition, the Warden of the Office of Addresse of Communications would have as major task setting up and maintaining a widespread communications network, a "correspondency and learned trade," with as wide a range as possible of scholars at home and abroad. An important component of this network or "correspondency" would be "the chief library-keepers of all places" from whom the Warden could learn of the existence of, and obtain, books and manuscripts.

Dury believed that libraries and their keepers should be part of the great movement for reforming and advancing learning that he and the Hartlib circle were promoting. He suggested that the Office of Addresse of Communications should be located at Oxford because of the "great library there." In his *Reformed Librarie Keeper* (Dury, 1650), he spelled out in detail what he thought libraries should be and do. For him the role of the librarian was that of a "factor and trader for helps to learning" whose work required the maintenance of an extensive correspondence, on the one hand, and an extraordinary set of professional, what we might today call "proactive," tasks on the other. The purpose of these activities was to help "reduce" the "whole variety and diversity of matters useful unto this present life, as they come within the sphere of learning" to a convenient form for achieving Puritan social and religious ideals. Clearly these library functions were closely related to those of the Office of Communications.

In an unpublished treatise, Dury (1649?) provided for the Office of Communications an epistemological framework, which set forth the kinds, sources, and interrelatedness of knowledge. His idea was to reduce "all things that can be known or conceived" to a limited number of pre-established categories. Then, whenever and wherever new discoveries were made or special expert knowledge that should be communicated to others was encountered, this new information could be organized under or "brought home to one of these heads." For Dury the office was a kind of institutionalised encyclopedia comprising registers and "books" in which a staff recorded information according to the broad categories of existing classification systems. Dury's great cry from the heart was that if only those concerned with the advancement of learning would "mind the frame and subordination of notions" and would seek "the orderly and usefull concatenation of human notions as they relate to their proper ends," all of "the confusion and superfluity, which we groan under" would be avoided.

William Petty, later surveyor of Ireland and one of the founders of the Royal Society, believed that the Office of Addresse should become a focal point for a broad range of institutions that were needed to realise his group's objectives for educational reform and the development of learning (Petty, 1648). For Petty, like Dury, one of the tasks of the Office would be to allow people "to see what is well and sufficiently done already, exploding whatsoever is nice, contentious, and merely fantastical." To achieve this result he believed that a survey of the current state of knowledge was necessary, and he suggested

how this might be done by a systematic process of indexing, abstracting, and codifying doc-ument content. Incidentally, he clearly recognized the problem of inter-indexer consistency and the need for carefully formulated instructions and tests to ensure consistency and accu-racy in indexing. From indexing and excerpting the existing literature would come a great encyclopedia not dissimilar to Leibniz's and Otlet's. "Out of all of these books one book or great work may be made though consisting of many volumes. The most artificial indi-ces, tables, or other helps for the ready finding, remembering, and-well-understanding all things contained in these books must be contrived and put into practice" (p. 3).

The Office of Addresse of Communications, whose purposes were essentially schol-arly, was to have as a practical counterpart an Office of Addresse of Accommodations, Dury had little to say about this. Hartlib, however, explained in some detail how he thought that the Office of Accommodations would function (Hartlib, 1648). What was needed, he says, is "a place of common resort appointed like unto an exchange where they [people] should receive information of all that they desire to know . . ." The Office's standing or permanent registers would contain, among other things, "a catalogue of all catalogues of books." This would allow an enquirer to find at once anything written on the subject of his or her enquiry. There would be a standing register to provide geographic information on all the localities in the country and another to provide a directory of officials through-out the kingdom. Other standing registers would record other categories of relatively per-manent information. Through its standing or permanent registers, the Office would make available, in effect, the kinds of information now found in a range of yearbooks and direc-tories (including Who's Whos) that are the staple of ready reference sections of every mod-ern public library. The Office of Accommodation's Changeable or Occasional Registers, on the other hand, would provide information on "matters of daily occurrence." These were active files that needed regular, perhaps daily, updating. Here would be had biographical information about important persons and families, information about shipping movements and what we would call courier services, notification of interest rates for money available for loan, and currency exchange rates. There would be information about matters such as employment, tourism, real estate, importation details of foreign commodities, information about locally produced commodities, including transportation and marketing data, and so on. What was to be advertised through the Office was specified in great detail: real estate for sale or rent, commodities of various kinds for sale or wanted, and employment sought or available. All of the information was to be collected, entered, discharged, and the ser-vice as a whole managed by a staff under the supervision of a Warden.

Effectively, what Hartlib was describing was an agency that combined the functions of a citizen's advice bureau or neighbourhood information centre, a labour exchange or employment bureau, a tourist information office, and classified advertising of the kind found in newspapers and certain specialised periodicals (advertising the sale of antiques, rare books and manuscripts, art, hobbies, etc.). Given the importance of the work of the Office, Hartlib thought that "there should be one in every place of resort" and further, that the offices should be networked "by the correspondency of one office to another in every principal city." It is clear that Hartlib was much influenced in his conception of the Office of Accommodations by what he had learned of Théophraste Renaudot's extraordinarily innovative Bureau d'Adresse recently active in Paris. Hartlib sent a number of enquiries about the Bureau with English visitors who were visiting Paris at the time (Solomon, 1972; Gilles de la Tourette, 1884).

The Office of Addresse in its two sections was taken very seriously by its proponents, and speculations about what it should do and for whom, how it should be financed and what its employees should be paid, who should run it, what its legal and constitutional foundations should be (an Act of Parliament was even drafted to set it up and to give Hart-lib and others responsibility for it) continued until the Restoration. With the return to Eng-land of Charles II and much of the old order he represented, that exciting interregnum period of speculation about social reform and new approaches to education, learning, and the mobilisation of knowledge came to an end. The one great practical consequence of these (and related) developments in the period of revolution and commonwealth was the found-ing of the Royal Society in 1660.

Leibniz

Leibniz was born in 1646, two years before the signing of the treaties that brought the Thirty Years' War to an end. It was the year in which Hartlib and his circle had begun to discuss the need for a new kind of information agency that would promote the advancement of learning and contribute to the improvement of social welfare in the English Commonwealth. Like his English colleagues, Leibniz was profoundly influenced by the writings of Comenius about the teaching of languages, the relation of language to concepts and things, and the need for an encyclopedic apprehension of reality by means of which disputes could be resolved and collaborative learning encouraged.

Very early in his career Leibniz became involved in the work of church reunification. Dury had believed that, to be successful, such work required the preparation of a body of "Practical1 Divinity" that would reveal common bases in belief and practice that could serve as the foundation for the reconciliation of the Protestant churches. Similarly, Leibniz (1679) believed that, by means of a new approach to logic and a special kind of universal language, he could make "incontestable" demonstrations, "as certain as anything that can be proved by arithmetical calculation" (p. 261) of the truth about key theological subjects that divided the Catholic and the Protestant churches. Here is a continuing thread of speculation that runs from the earliest to the last of Leibniz's writing. It involves the creation of a new form of encyclopedia. "If this encyclopedia were made in the way I wish," he said (Leibniz, 1680), "it could furnish the means of always finding the consequences of fundamental truths or of given facts through a manner of calculation as exact and as simple as that of Arithmetic and Algebra" (p. 40). But for the encyclopedia to work by demonstration and deduction in the way Leibniz envisioned, it had to be based on what he called a universal characteristic or language directly expressive of the basic elements of human thought. As a youth, this idea had come as a revolution to him (Leibniz, 1677): "there must be invented . . . a kind of alphabet of human thoughts, and through the connections of its letters and the analysis of words that can be composed out of them, everything else can be discovered and judged" (pp. 19-20). To create the alphabet "it was necessary to analyse all concepts and reduce them to simple elements by means of definitions" and this, suggests Courturat (1961), "comes back to making an inventory of human knowledge" and this implies the encyclopedia (p. 79).

Leibniz was a librarian, and he was an imaginative and resourceful one. He saw his brief as extending to information broadly conceived. As well as attempting to develop the collections and bibliographic apparatus of the library of his employer, Duke Johann Friedrich of Hanover, he suggested that a special information bureau be set up, rather like Renaudot's Bureau D'Adresse in Paris, to alert people to the existence of goods and services for sale or rent, of educational opportunities, and of things to see and do throughout the state. He also suggested that the Ducal archives be reorganised and developed in such a way that they could readily provide useful information (Aiton, 1985, pp. 85-86).

As a librarian, Leibniz was much concerned with organising, simplifying, and codifying existing knowledge as represented in books. He was disturbed by the confusion and difficulties presented by "that horrible mass of books that keeps on growing . . ." (Leibniz, 1680). He wondered if this situation might eventually become so appalling that the time might arise when it would be "as disgraceful to be an author as it was formally honourable." However, he saw no end "to books continuing to increase in number." He concluded that a pricely patron should step in to underwrite the development of a system in which "the quintessence of the best books [would be] be extracted and joined to the best observations not yet written of the most expert in each profession, in order to build systems of solid knowledge for promoting man's happiness. Based on experiments and demonstrations and adapted for use by repertories such a work would be a most durable and great monument to his [the Prince's] glory . . ." (p. 29-30).

The problem of how the contents of books were to be made to flow into and be processed by this great intellectual engine, this new kind of encyclopedia, considerably exercised his imagination. His first scheme dates from 1668. It involved the creation of a journal that would review the most important works appearing at the half-yearly book fairs in Frankfurt and Leipzig. The *Nucleus Librarius Semestralis,* as the Journal was to be called,

would comprise an inventory of notable books selected for their importance. They would be reviewed briefly and objectively in not more than a page, which would present each book's "nucleus," its various divisions, and any noteworthy features (Schulte-Albert, 1972, p. 36).

But Leibniz's thinking soon took him beyond a simple book-reviewing journal (of 300–400 pages each half year, let it be said!). If all the summaries were combined, "a *historia literaria* in chronological order as well as a perfect index of subject matters and notable facts" could be produced. "Thus one will have a type of inventory of human knowledge deposited in books as it has been desired long ago by Francis Bacon, the Chancellor of England" (Leibniz, quoted in Schulte-Albert, 1972, p. 38). But more could be added to the journal to increase its usefulness. It might include, for example, information about new inventions and ". . . advice, ideas from new points of view, [and] items which are dispersed over different locations of the earth, which are nowhere else combined into one work and which nowhere else come to the attention of all" (Schulte-Albert, 1972, p. 40).

In a later memoir, Leibniz develops his ideas of the encyclopedic function of *Semestria Literaria* further. The journal should include an index or systematic catalogue of the contents of all that was published. In addition to published documents, unpublished material would be included, such as "old works in manuscripts and buried in libraries and archives or more recent but unknown or misunderstood works. . . ." If this scheme were followed, the upshot would be that "in a few years almost all the best books in the world will be analysed; also through the descriptions of faculties, arts and professions, in a sense the total experience of mankind wili be recorded on paper; and finally the subject matters will be brought together and the true foundation laid for the main structure: *Encyclopaediae Perfectae,* on which one should secretly work in the meantime." In this work, knowledge will be "resolved," that is, broken up into separate, constituent elements or parts, and arranged in an orderly way (Schulte-Albert, 1972, p. 44-45).

Leibniz realised that the task of creating the Encyclopedia as he conceived the idea lay well beyond the scope of any individual. It needed groups of scholars organised formally into learned societies and academies for the purpose. The desirability of such societies and academies to oversee and encourage the development of science and learning in general, and to create and manage the Encyclopedia was another of those matters that exercised him throughout his life. The responsibilities of bodies of this kind for the encyclopedia variously took three related forms that constituted a kind of circle: the collection and epitomising or abstracting of received or public knowledge; the analysis and recording of unpublished knowledge that lay within the traditional, empirical expertise of the trades and professions; and finally, the reduction of all of this knowledge by means of a process of definition to primitive concepts or ideas. These could then be expressed by the universal characteristic and manipulated by the logical calculus to provide demonstrable truths.

But how to code or represent knowledge in some effective symbolic way? How to create effective inferential procedures that could be used both to verify and amplify what was known and to derive from this what was not yet known, what Leibniz (1951) called his Method of Certitude and Art of Discovery? These were the problems of the "universal characteristic" and the logical calculus, and they proved to be intractable. In the final analysis, the ideal of the encyclopedia was forever elusive, the logic or art of discovery necessary for it remained incomplete, and the problem of the universal characteristic and the alphabet of thought was insoluble. Yet, in the remarkable range of Leibniz's ideas and the proposals he put forward for realising them in practice, is much that is surprisingly contemporary: the need to manage information to assist scientific and technical development, the importance of special procedures to improve the effectiveness of access to recorded knowledge, and the need to capture and integrate with recorded knowledge expertise nor recorded formally in documents. The inferential procedures and knowledge domains that so fascinated him are the stuff of modern artificial intelligence and expert systems.

Otlet

Very early in his career Paul Otlet became critically aware of the problem of duplication and lack of systematic cumulation that characterized the ever increasing literature

of the social sciences. For Otlet, like Leibniz, a key question, formulated in his first paper on bibliography (1893), was: How best is order to be introduced into this proliferating disorderly mass in such a way that progress in the world of learning can continue efficiently and effectively?

Otlet's ideas about bibliography and the organisation and dissemination of knowledge were formulated and tested against a background provided by a series of experimental services provided by the International Institute of Bibliography. This was set up by Otlet and his colleagues in Brussels in 1895. First was the creation of what might be described as a vast, cooperatively elaborated database. Initially this was bibliographical, the Universal Bibliographic Repertory. It grew to nearly 16,000,000 by the early 1930s. Very quickly it was given a full-text and "image" or iconographic dimension in the form of a parallel Universal Iconographic Repertory and by the creation of a prototype of a new kind of "encyclopedia," an Encyclopedic Repertory of Dossiers (or files) in which substantive information and illustrative materials were placed. An international library was also set up as a cooperative venture involving a large number of learned and professional associations then located in Brussels. The ordering of the library and of the various databases and the provision of subject access to their contents were handled by what was, in effect, a highly sophisticated software package, the Universal Decimal Classification (UDC). The first edition of UDC in its complete new form, as developed from Melvil Dewey's Decimal Classification by Otlet and his colleagues, was issued in the period 1904-1907 in a volume over 2,000 pages in length. It was the first of what are now called faceted classifications, and a complex apparatus for number compounding for subject specification was devised for it.

The UDC had a place in Otlet's thinking similar to that of the Universal Characteristic and the Calculus of Reason in Leibniz's. Even unmodified as it first came to hand, Melvil Dewey's Decimal Classification suggested to Otlet that the classification numbers displayed "the links, the genealogy even, of ideas and objects." Indeed, the Classification constituted "a complex system for representing science." As Otlet and his colleagues worked to develop the Classification's synthetic features, the linguistic potential of the classification struck them more forcibly. "As a bibliographical notation, it must become a veritable pasigraphy able to interpret by numerals, grouped into factors having separate and permanent meaning, all the nuances of ideologico-bibliographic analysis" (La Fontaine & Otlet, 1895). The use of the word "pasigraphy" is of great interest, because it denoted a universal writing system in which the symbols, like Leibniz's "universal characteristic," bore a direct relationship to the things symbolised.

The existence of this expressive function of the UDC, together with a rather simplistic, mechanistic view of knowledge, led Otlet (1918) to formulate what he called the "Monographic Principle" (p. 149). According to this principle, separate items of information were to be recorded separately, or "analytically." Among the implications of the application of this principle were continuous intercalation of entries for the various databases that he and his colleagues attempted to set up, and international cooperation in creating such entries. The use of the minute subject divisions of the UDC helped to define and relate subject headings where entries, either for bibliographic references or for actual textual or image information, would be placed. Moreover, the indexing of materials to be included in the bibliographic database, on the one hand, or the "partitioning" of documents to be included in the encyclopedic repertories according to the "monographic principle," on the other, could be at any level of specificity: the whole document, chapters, sections, and so on, down to "facts," which the indexing procedure would "detach" from the text of a document. The subsequent manipulation of cards and sheets, their organisation and re-organisation, led Otlet to envisage the reconstitution of knowledge contained in documents in a flexible encyclopedic way-what he called "codification."

Otlet's ideas for these matters provided him with the basis for conceptualising a new field of study and research. As early as 1903 he began to call this "Documentation" (Otlet, 1903). Documentation involved not only written and graphic records, but objects as well, because they had a "documentary" value. He envisaged revolutionary information services that he called "offices of documentation." These would draw as needed on text, image, or object as sources of information. Linked together by common methods, shared tasks, and

formal agreements, the office of documentation would transform libraries into stations in an information network reaching around the world. Their essential business, closely coordinated with that of archives and museums, would be deriving information from the immense variety of printed and other sources that were available.

The Office of Documentation was an organisational and technical response to what Otlet identified as an important emerging information function, "consultation.," a kind of heightened ready-reference enquiry capability. He believed that information should be supplied quickly, efficiently, and ready for use. Time-consuming study of a few texts was being displaced by rapid, purposeful perusal of many disparate documents to extract the information needed. Documents had to be processed in such a way that those wanting information from them were released from the tyranny of sequence and structure imposed by the authorial act of creation. For him, Offices of Documentation were a new form of encyclopedia in which the movement from bibliography to document to re-structured, recodified knowledge would be mediated by a series of reconceptualised "professional" activities and organisations (Otlet, 19 19).

What Otlet had discovered in 1895 was a new kind of bibliographic technology. Based on the standard card and loose-leaf or sheet, it permitted mass storage of information. It also involved a procedure for sorting and retrieving all that was stored, basic functions of computer processing. But how to gain access to the elements released by the monographic principle from their containing documents, how to retrieve and copy them, and how to store the copy locally for personal use? Anticipating Vannevar Bush's "Memex" machine, Otlet believed that these problems of communication and storage could be solved by the new technology of microfilm. Otlet and his engineering colleague Robert Goldschmidt conducted a number of experiments as early as 1906 in the bibliographic applications of microfilm (Otlet & Goldschmidt, 1906).

Otlet's discussions of the Monographic Principle, dismembered documents, the UDC, and the universal network of documentation are interesting as anticipations of many of the aspects of hypertext and hypermedia systems. The various bibliographic, iconographic, and "fulltext" databases assembled in the International Office of Bibliography in Brussels constituted a kind of rudimentary hypertext system covering the universe of knowledge. The UDC provided the links between the various "nodes" that were implicit in the application of "monographic principle." It also controlled "navigation" in and between the enormous range of files that eventually were produced (Rayward, 1976, ch. VI, VII).

In the last part of the *Traité de Documentation,* Otlet (1989) speculated about technological inventions that he foresaw being made in the realm of the book. The new systems for restructuring information and providing new modes of access to it that he envisioned would constitute a kind of "exodermic appendage" to the brain, "a substratum of memory, an external mechanism and instrument of the mind" (Rayward, 1990, p. 1). Extrapolating from the most recently introduced technology of his own day, Otlet believed that eventually radio, television, x-rays, cinema, and microscopic photography would all be brought together in a single workstation-like machine, a kind of "a mechanical, collective brain." When this happened, a person in an armchair would be able to experience, on an individual screen, any aspect of the world as a form of what we might call virtual reality — "all the things of the universe and all those of man . . . the moving image of the world-its memory, its true duplicate. " He commented in a kind of aside in the *Traité de Documentation* that "a Wells would love" these ideas (p. 428), little realising that a few years later Wells would in fact be describing remarkably similar phenomena as constituting a World Brain.

It is sometimes forgotten how extraordinarily imaginative and forward-looking Otlet's thinking about access to information was. He clearly anticipated modern approaches to hypertext and hypermedia systems. He had an inkling that something like the modern computer workstation was needed to help scholars deal with the ever increasing mas of information and its variety of formats. His notion of "consulting" rather than reading is relevant to the way in which we continue to attempt to get a grip on this problem by means of electronic systems, most notably in recent times by hypertext systems.

William   Learned

In 1924 William Learned published ***The American Public Library and the Diffusion*** of ***Knowledge*** (Learned, 1924). This work extrapolates from contemporary developments in public librarianship in the United States a set of functions and activities that present an ideal of information and library service that we have yet to achieve. Though to some extent echoed in the Neighborhood Information Centers project (e.g., Childers, 1976), the tasks and functions of the Community Intelligence Service proposed by Learned, like the schemes of Hartlib, Leibniz, and Otlet, present a challenge to current library expertise, technological capability, and professional aspiration.

Learned suggests that a range of social pressures had been building up that now required "some rational and economical organisation for distributing knowledge." One of these pressures "appears in the rapid accumulation of vast masses of information which makes imperative some means of selection, digest or abridgment whereby anyone who needs them may gain possession of essential facts without delay and without discouraging or prohibitive effort" (p. 8). Other pressures, in Learned's view, arose from the need to obtain appropriate information for self-education, a concern of both Leibniz (1667), who uses the term "auto-didact" (p. 87), and of Otlet. Learned believed that a new kind of organisation had become necessary "to make knowledge wieldy and appropriable for general use."

What is wanted, he suggested, is the creation in most neighbourhoods of a Community Intelligence Service. Perhaps the most important task facing this new agency was, in Learned's   view, "the reorganisation of important knowledge." This would involve "sifting and condensing" and "recasting ideas to suit a special age, attitude or point of view." He made the important point that the problems that arise when people try to acquire information are not necessarily the result of their personal limitations, so much as they are a consequence of the way in which information itself is presented. To be effectively assimilated and used, the same information had to be reformatted to suit the cognitive needs, social characteristics, and personal needs of individuals. "There are wide fields," Learned suggested, "that must be reworked repeatedly for different types of mentality and experience" (Learned, 1924, p. 19). As for lists of books, as commonly conceived by librarians, quite simply, "they are of no use."

This new kind of information agency would require an especially expert professional characterised by "personal tact, quick intellectual sympathies and appreciation, a thorough knowledge of a certain field of material, precision and discrimination of thought and the power promptly to organise results" (p. 13). What is no longer needed, says Learned, are "mere grubbers in books according to professional tradition or a prevalent conception of a public librarian" (p. 17). Learned is quite clear that the new community intelligence service he is envisioning will emerge from the public library.

> Progressive librarians everywhere realise that provision must be made for digesting and reducing to useable form the great masses of important information now accumulating with unexampled rapidity, and that means must be found whereby trustworthy knowledge of wider range than here to for may be made available, especially for adult minds, with relative promptness and good judgment if our actual resources are to prove effective (Learned, 1924, p. 26).

That the public library is the agency that would best be able to meet these objectives had become clear to Learned when he surveyed recent developments and experiments in public libraries around the nation. The new service he proposed would take what was most successful from these developments, and would concentrate and consolidate them. If the community intelligence agency were set up, "instead of the library becoming a place of storage for certain traditional bodies of knowledge contained in books merely for their own sake, it becomes the warehouse and market exchange for all permanently important or temporarily useful information, in whatever form, that a given community may find to its advantage" (Learned, 1924, p. 53).

The Community Intelligence Service proposed by Learned and the Office of Publicke

Addresse proposed by Hartlib, Dury, and others are very similar. Their strong function; similarities are perhaps a little obscured by differences of language and a philosophical orientation that for the one is derived from the American Progressivist Movement of the early decades of the 20th century, and for the other from a movement of religious and social toleration of the mid-17th century. The two are, however, animated by a very similar sense of social purpose and need. Both are concerned with broad areas of information provision,' Each foresees the need to devise processes for extracting, restructuring, and re-working information so that it can be mobilised for the use of individuals and groups. Both are also concerned with similar issues of institutionalisation, so that the new services will have stability, permanence, and official status.

H. G. Wells

Finally is the scheme for a World Brain of H.G. Wells. Wells had begun to speculate about the need for a new kind of encyclopedia in his "encyclopedic" survey, *The* Work, *Wealth and Happiness of Mankind* (Wells, 1934). Here he envisaged the creation of something more substantial and more permanent than he could provide in this work itself. Harking back to Comenius and the great encyclopedists, Wells suggested that a new kind of encyclopedia, a World Encyclopedia, was necessary to help produce a "systematic ordering" of knowledge.

Wells developed these ideas in a number of papers that he collected and published in 1938 as *World Brain* (Wells, 1938). Like Otlet, Wells had become passionately aware of the failure of the League of Nations to promote international peace and to provide a secure foundation for a new world polity. He dismisses the League Committee on International Intellectual Cooperation, the forerunner of UNESCO, with both exasperation and contempt. And yet, also like Otlet, he is convinced that "the time is ripe for a very extensive revision and modernisation of the intellectual organisation of the world" (p. 26). "Our World Knowledge Apparatus is not up to our necessities," he declared. "We are neither collecting, arranging nor digesting what knowledge we have at all adequately . . ." (p. 42). But he believed that "modern facilities of transport, radio, photographic reproduction and so forth are rendering practicable a much more fully succinct and accessible assembly of fact and ideas than was ever possible before."

The encyclopedia he outlines would "consist of selections, extracts, quotations, very carefully assembled with the approval of outstanding authorities in each subject, carefully collated and edited and critically presented" (pp. 13-14). But more! The encyclopedia "might act not merely as an assembly of fact and statement, but as an organ of adjustment and adjudication, a clearing house of misunderstandings; it would be a synthesis, and act as a flux and filter for a very great quantity of human misapprehension. It would *compel* men to come to terms with one another" (Wells's emphasis, pp. 15-16). This ability to demonstrate truth in such a way as not only to dispel error but to resolve disputes is reminiscent of the hopes that Dury and Leibniz had in the 17th century for a new "machinery" of knowledge. Wells concluded that his "world brain" would be a new "world organ for the collection, indexing, summarising and release of knowledge" (p. 59). At the core of the World Encyclopedia "would be a synthesis of bibliography and documentation with the indexed archives of the world."

Wells believed that the documentation movement could contribute substantially to the development of his scheme for a permanent world encyclopedia. He observed (1938, p. 58) that "few people as yet, outside the world of expert librarians and museum curators and so forth, know how manageable well ordered facts can be made, however multitudinous+ and how swiftly and completely even the rarest visions and the most recondite matters can be recalled, once they have been put in place in a well-ordered scheme of reference and reproduction. " In a memorandum for the publishers Doubleday and Duran (Wells, 1937), he suggested how a start might be made to compile the basic bibliography and index. But beyond these practical details was the need to take advantage, by means of a "more comprehensive organisation of documentation, bibliography, microfilm records and so on," of the "sort of organic encyclopedism" that was emerging in the modern world. He could be Otlet writing in the *Traité de Documentation.* If the encyclopedia could be successfully

associated "with the growing documentation and record movement," he believed that it "would become a permanent liaison organisation between the universities and research institutions of the world and the general intelligence. It would be the concrete beginnings of an actual world mind. "

In 1937 a World Congress of Universal Documentation was held at Paris under the sponsorship of the League of Nations' International Institute for Intellectual Cooperation (Rayward, 1983b). At this Congress, Wells (1938) suggested that the "work of documentation and bibliography is in fact nothing less than the beginning of a world brain, a common world brain." He believed that from this beginning would come the new encyclopedia he sought. Later he commented approvingly on the commitment of documentalists to indexing the world's literature, on the indexing methods they had so effectively devised, and on the prospect now opening up of printing and keeping current bibliographies on any and all subjects (p. 129).

But it is clearly the interest of the "Documentalists" in microfilm that captured his imagination most. Microfilm for Wells "foreshadows a real intellectual unification of our race" because of the way the multiplication of copies could protect "this new all-human cerebrum" from destruction, as well as making it generally available anywhere in the world (pp. 58-61). Microfilm combined the virtues of compactness of storage, copiability, and portability. At the 1937 Paris conference, Wells shared a platform with documentalist Watson Davis and presumably with Otlet. Davis was the Director of Science Service in Washington, and in 1937 founded the American Documentation Institute, which was to become the American Society for Information Science (Farkas-Conn, 1990). Wells cannot have been unaware at least of the outlines of the "Bibliofilm" service Davis had created as part of Science Service in Washington to distribute literature on demand in microform. One must also assume that he knew something of the schemes of Paul Otlet. Those schemes were as grandiose as his own, were also presented using the imagery of the brain, and also drew on microfilm. After all, in the late 1920s Otlet had begun to publish what he called an *Encyclopedia Microphotica Mundaneurn* (Rayward, 1976, pp. 297, 347).*

Wells was intensely serious about the new encyclopedia he envisaged. Smith (1986) discusses his attempts to gain wide publicity, interest publishers, and get financial support from a range of corporations and foundations in the United States. Yet, in the final analysis, the World Brain did not involve a real program of organisation, nor did Wells have any clear idea about the analytical and other techniques that would be needed for information extraction, relation, and synthesis (presumably the documentalists would deal with them). Nor did he have any developed sense of the international communication systems that would be required for the elaboration and use of the new encyclopedia. The World Brain was a metaphor through which Wells was able to dramatise what he saw as a grave international problem and to present a series of speculations and aspirations about its solution-an intellectual tool that would "hold men's minds together in something like a common interpretation of reality."

CONCLUSION

Certain themes recur in each of the schemes outlined above. These themes may help provide a framework for further analysis. All of the proposals constituted a response to revolutionary social change that suggested to those with an eye to see that there was an urgent need within society for immediately useful information. Each proposal contained an expression of what was advanced as a new set of information functions involving the collection, analysis, and restructuring of information already available in some other but undigested, uncoordinated form. Implicit in each was the need for a cadre of specialist, professional information personnel to carry out this work, though, save for Learned (and Dury to a limited extent), little is said of them. Recognised in the schemes is the need for a network or communications system of scholars and others directly sharing information

*There is correspondence in the Wells papers at the University of Illinois library between Wells and the documentalists Bradford and Pollard, but none between him and Otlet or Davis.

both locally and internationally. In all of the schemes is a role for libraries and librarians who are seen as related to, even essential to, but different from what is being proposed again with the exception of Learned and perhaps Wells, whose imagination had been captured by the "documentalists" and their work. Each reveals a critical awareness that some kind of organisational and governance structure was needed to give these new social "functions" permanent institutional expression and support. Implicit in all of them are goals and objectives for mobilising information that we still struggle to crystallise conceptually and to embody in effective organisational arrangements and systems. How apt to all of these schemes are the future possibilities and current realities of computer-based systems!   .

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